Proceedings of the Seminar on Advances in Fishery Post-Harvest Technology in Southeast Asia

Singapore, 6 - 11 May, 1991

PROCEEDINGS OF THE SEMINAR ON ADVANCES IN FISHERY POST-HARVEST TECHNOLOGY IN SOUTHEAST ASIA

Singapore, 6 – 11 May, 1991

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Organised by
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Southeast Asian Fisheries Development Center
in collaboration with
The Government of Japan

SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER

The Southeast Asian Fisheries Development Center is a technical organisation devoted to the accelerated development of fisheries in the region. The member countries of SEAFDEC are Japan, Malaysia, Philippines, Singapore and Thailand. SEAFDEC has three Departments, namely, the Aquaculture Department in the Philippines; the Training Department in Thailand and the Marine Fisheries Research Department in Singapore.

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FOREWORD

The Southeast Asian Fisheries Development Center (SEAFDEC) came into being as a regional technical body in 1967 and has become a prominent feature of the fisheries scene in this region.

SEAFDEC's stated function at that time was to assist in the accelerated development of fisheries in Southeast Asia at a time when the fisheries resources of the continental shelf had not been fully exploited. Since then there have been profound changes in the fisheries of the region, reflecting, among other things, changes in the Law of the Sea, the application of new harvesting and processing technology and accelerated intra-regional and international trade. In this setting, fisheries production has more than doubled in the region. These developments have been reflected in changes in the scope and structure of the Center. At its inception, SEAFDEC had just two operational departments: the Marine Fisheries Research Department (MFRD) in Singapore and the Training Department in Thailand; and these organisations were supported by a Secretariat in Thailand. Since 1973, it has operated a third department, the Aquaculture Department in the Philippines.

The accomplishments of SEAFDEC during this period have demonstrated the ability of the Center's member countries, Japan, Malaysia, the Philippines, Singapore and Thailand, to work together effectively. SEAFDEC's three departments now cover virtually the whole range of fisheries activities from production to processing, packaging and distribution.

The Center has not only advanced fisheries science, but has also provided direct and tangible benefits to the industry – fishermen, fish farmers and fish processors – of the region. As at 1991, SEAFDEC's three Departments had trained over 5,000 persons from the public and private sectors of the region as well as some from other parts of the world. Some graduates of these courses now play important and influential roles in fisheries development in their own countries and in the region.

Rapid growth has brought new challenges. As fisheries production has increased in the region, so has the need to improve methods in post-harvest handling, preservation, processing, packaging, transportation and marketing of fish.

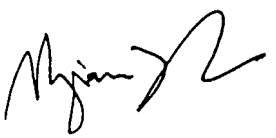
In 1975, recognising the specific needs for improvement in post-harvest technology, and in response to a specific request by Singapore, the Japanese Government dispatched a team of experts to SEAFDEC member countries. The mission of this group was to evaluate the status of post-harvest technology in the region and to make recommendations for action. The team was led by Dr Keishi Amano, an expert in fisheries post-harvest technology and formerly President of the Tokyo University of Fisheries. Out of its mission came the decision to establish a post-harvest technology programme which now exists in MFRD. Dr Amano went on not only to launch the programme but to play a decisive personal role in its implementation over the years.

The Japanese Government has also provided the necessary experts and support to expand MFRD's activities and to gradually establish post-harvest technology as its primary focus.

In a relatively short time, SEAFDEC/MFRD has achieved significant breakthroughs. Particularly important progress has been made in the development of ways to use trawler by-catches for human consumption. MFRD has also made significant progress in the improvement of methods for the preservation of quality in fish and fish products. The Singapore Government being fully committed to this programme, has given continuous support through its Primary Production Department. A recent, major contribution has been the construction of a new product development and packaging laboratory for MFRD.

As part of its 20th Anniversary commemoration in 1987, MFRD organised a Seminar on the Development of Fish Products in Southeast Asia attended by representatives of all member countries, and of several other nations within and beyond the region. The usefulness of this event in facilitating cooperative study of common problems led to this second seminar, in May 1991.

This seminar has generated a wealth of expert scientific and technical information focused specifically on the practical day-to-day challenges facing fishermen and processors in Southeast Asia. As such it is a valuable record of our progress towards a more efficient use of the vast fish resources of this region.



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INTRODUCTION

The Seminar on Advances in Fishery Post-Harvest Technology in Southeast Asia was convened by the Marine Fisheries Research Department in Singapore from 6 to 11 May, 1991. A workshop on Compilation of Fish Products in Southeast Asia was also held in conjunction with the Seminar. The meeting was attended by participants from SEAFDEC Member Countries: Japan, Malaysia, the Philippines, Singapore, and Thailand; by participants from non-member countries Australia, Canada, Indonesia, and Norway; and by members of SEAFDEC Secretariat and the Marine Fisheries Research Department (MFRD).

The Seminar was a sequel to the 20th SEAFDEC Anniversary Seminar on the Development of Fish Products in Southeast Asia conducted in Singapore in 1987.

Following a key-note lecture by Dr K Amano, former President of the Japanese Society of Food Science and Technology, eight Special Papers were presented by invited specialists in fishery post-harvest technology. Each member country then presented a Country Paper on the status and problems of the fish processing industry in their respective countries. This was followed by the presentation of 14 Research Papers covering applied or pure research work in fishery post-harvest technology. A discussion followed the delivery of each paper.

In the Seminar, the 1991 Amano Award was awarded to the Research Paper on Technology for Fish Cracker (*keropok*) Production by Dr Yu Swee Yean from Malaysia and the 1991 MFRD Award to the Country Paper of Thailand by Miss Sirilak Suwanrangsi.

ACKNOWLEDGEMENT

SEAFDEC gratefully acknowledges the invaluable assistance of the following representatives who served as chairmen for the proceedings :-

Dr K Amano, Mr K Inoue, Dr K Miwa, Mr K K Hooi, Mr A Bremner, Dr P Saisithi, Dr Y Shimizu, Dr H Watanabe, Ms E Soetopo, Mr H Madakia and Dr T J Strøm.

SEAFDEC also gratefully acknowledges the excellent work of the co-ordinator of the Seminar, Mr Tan Sen Min, the rapporteurs for the meeting, Ms V T Sulit and Dr Ng Cher Siang, the technical editor, Mr Ron Baynes and also the co-operation and dedicated effort of the Secretariat staff, headed by Mr Mohamed Bin Salim and the contribution of the government of Japan and the Canadian International Development Agency (CIDA) which provided resource persons.

KEY–NOTE LECTURE

The Work Of Post-Harvest Technologists In Our Region

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The major foodstuffs used by humans–cereals, root crops, milk, meat and fish–have been systematically raised, reared and harvested for thousands of years. For all of this time, the primary post-harvest issue was the short "shelf life" of these foods, in particular of milk, meat and fish. One of the most basic responses to this challenge was the preservation of milk or meat in the form of live, walking food on the hoof–a concept which survives in the use of the term "livestock."

Capture fisheries began in the closest and most accessible areas, in rivers, lakes and near-shore coastal areas and the catches were consumed by the catchers, viz, by the fishermen and their families. The market for the surplus, if any, was defined by the keeping characteristics of the fish. In other words it was available only to those neighbours who were close enough to receive the fish before they spoiled.

Although today the system may strike us as being primitive, the important point is that it worked, as proved by the fact that it is still in operation in small-scale fisheries throughout the world.

Fish resources are most abundant close to shore, probably because the natural foods on which fish depend are more densely concentrated in coastal waters. The concentrations of anchoveta that appear regularly off the west coast of South America, and the migration of sardine schools along the shores of Japan illustrate this relationship.

In assessing the efficiency of industrial-scale, distant-water fisheries we need to consider not only the quite remarkable volume of their catch but also at their overhead. In particular we should look at the cost of fuel and other inputs such as fish-detection and on-board equipment. And, as we evaluate the efficiency of the world fishing industry, we should also apply the measuring sticks of energy conservation and production sustainability to them.

For the post-harvest specialist, a basic challenge is preservation of the quality of fish from the point at which it is unloaded to the point of consumption. Although costly and sophisticated systems for achieving these ends may be economically practical in some areas, they are not the answer for our region, at our time.

The usefulness of perishable forms such as fresh fish and shellfish is limited to points at which iced storage is available. Other forms can be utilized in a wider radius after processing by traditional methods such as sun-drying, salting, combination of salting and drying, or smoking and fermentation. This is still the major reason why these long established forms continue to play a primary role in meeting the basic nutritional needs of people all over the world.

To go back to prehistoric roots: foods originally must have been consumed by the people who produced them. As social organization progressed, exceptions to this rule developed as people in the community shouldered roles other than of producers of fish for food. In other words the relationship between producer and consumer evolved as a sort of cooperative partnership.

Still later there emerged a consumer of a different kind, whose only role in this partnership was to sit and eat, and whose requirements were not confined to foods which were essential either for survival or for good health.

This life-style we now equate, erroneously in my opinion, with a high standard of living. In any case it has played its part in the development of industrialized mechanisms which have shaped patterns of world food distribution ever since.

You may have noticed, in your own community, farmers who are not allowed to raise food crops for local consumption but must engage in large-scale cultivation of crops such as banana or sugar-cane for this other class of consumer.

Similarly, exploitation of the resource in the high seas fisheries now proceeds on a highly-industrialized scale with the use of sophisticated on-board processing techniques. This mode of fishing is associated, invariably, with overfishing, depletion of the stocks and destruction of the natural environment. This trend will not reverse itself until its implications for the future are recognized.

It is often said that the role of the fisheries is to supply the animal protein which we are told is indispensable to good nutrition. It is noted, moreover, that we will require an additional 19 million tonnes of catch by the year 2000, at which time we will have a world population of 6.1 billion.

Certainly, it is theoretically possible to arrive at this figure by a simple multiplication of the number of people by an average per capita intake of 12 kg of fish per year. But, in practice, all this is subject to the limitations of nature.

We must turn our attention to the vast amount of waste in the present world catch–for example the "trash fish" from the shrimp fisheries, and the large quantities of fish which are not directed to human consumption.

In responding to this challenge, the agenda for the post-harvest specialist of every country in the region is clearly defined. The primary points of focus must be the improvement of the keeping quality of fresh fish and the improvement of each country's existing fish products.

The decision about which challenge to tackle first will vary by country, and within countries by regions. For technologists in one area for instance the item at the top of the agenda might be freshwater fish; for others, the problem of the shrimp by-catch.

Within these general areas how should the fish technologist choose a problem on which to focus?

The answer, as I see it is simple: go to the fishing industry and, on the basis of careful observation, decide which problem most urgently requires attention. In other words, do not attempt to make this kind of decision from the vantage point of a laboratory bench.

Careful study, conducted on the front line, can reveal problems or ramifications of problems that might otherwise go unnoticed. For example, a recent report on international fisheries research by the World Bank tells us that a shortage of funds and institutional limitations is presently an important barrier to technological improvement. A visit to the industry may uncover such obstacles, but may also reveal that in some important areas, the amount of funding needed is smaller than might have been assumed.

In any case it is healthy for government-reared scientists or technologists, who too often are confined to literature-oriented research, to immerse themselves at regular intervals in the existing problems of the industry. Fish technologists in particular should be realistic about the limitations of their knowledge and experience, and be ready to learn from industry. Technologists should also be prepared to learn from the experience of the food industries of developed countries.

In setting priorities for research we should never ignore the existence in our region (and in many other parts of the world) of many important traditional fish products. We must look objectively at ways to keep these useful products alive in a flood of output from a super-modernized food industry. This means giving these traditional products a priority place in research, and to do so, where necessary, in preference to some modern products.

In doing so, we should bear in mind that the modernized industries which turn out these products are quite likely to be less appropriate candidates for assistance than the traditional producers. In many cases, canned, frozen or fabricated fish products are turned out for foreign markets rather than for domestic use. Another consideration is that international traders set standards for quality control with which producers must, in any case, comply. In short, they may not need research help.

The final choice of the research target may safely be left to technologists. My message is simply this: in making this choice, they should not forget the needs of various small-scale industries in our region who want to improve their fish products.

Post-harvest technologists in this region should also focus on the issue of acquisition and dissemination of information needed to carry out their assignments. In principle, this kind of work should be left to the government of each nation. However, my personal hope is that the Marine Fisheries Research Department of SEAFDEC will play a part in providing this service.

Finally, as a more immediate hope, let me say that I trust this seminar on fishery post-harvest technology will turn out to be a fruitful event. Or, more correctly, a "fishful" event.

SPECIAL PAPERS

Eight special papers were presented by invited specialists. The text of these papers are reproduced, each followed by a summary of the discussion which took place.

Technical Problems In Surimi And Fish Jelly Products

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Introduction

Fish jelly products are traditional foods of Japan and China. However, its production has increased dramatically in Japan, in spite of the diversification of eating habits after World War II. This development is believed to be primarily due to its inherent consumer appeal and to advances in scientific research and technology related to this food.

In this paper, I will review scientific and technical achievements in this field over the past 40 years and look briefly at some technical problems that remain.

Progress In Fundamental Research

In Japan, scientific research in fish jelly products began half a century ago with the work of Wataru Simidu (1935) and Hiroshi Hirano (1939). However, significant advances were achieved by the generation of young scientists who joined in these studies after World War II. The main areas of advance were as follows:

The Mechanism Of Gel-Formation of Fish Meat

Considered to be an issue that was directly linked to the scientific principle of this food, this topic received attention from the very beginning of the studies. Researchers investigated physico-chemical changes of muscle proteins that occur at each stage of processing, for instance, leaching, salt-grinding or heating. These studies were made in order to construct a theoretical explanation for the changes and to establish criteria for each production process.

Mechanisms of the setting phenomenon of fish meat sol, so-called *suwari*, and the thermal degradation phenomenon of raw gel, so-called *modori*, have also been essentially clarified.

The Mechanism Of The Putrefaction Of Fish Jelly, And Means Of Preventing It

In these studies, researchers have clarified the relationship between composition of meat sol and the spoiling phase, between packaging and heating conditions and the spoiling phase, and between heating temperature and the survival of microflora.

The researchers have also clarified changes in the redox potential of meat sol during heating, and have identified various putrefying bacteria. Fundamental research on putrefaction of this food seems to be almost completed.

Gel-Forming Property Of Fish Meat

Research on this subject lags far behind the other two. Variations in the potential gel-forming ability, the setting property and the *modori*-causing property among and within species were subjects of scientific and industrial interest. However, little information has been obtained about them so far, and only about a limited number of species.

New Technology Development

A variety of devices and new techniques have been introduced to the fish jelly industry of Japan over the past 40 years. Listed below are five considered to be particularly important in terms of originality and usefulness.

Fish Sausage

Fish sausage was introduced as a new type of *kamaboko*, which looks like a sausage and can be kept at room temperature. The prototype was made by Seinan-Kaihatsu Company in 1950 by stuffing horse mackerel meat sol with pork fat and spices into a casing of hydrochloride gum. Aided by the timely invention of nitrofuran, and polyvinylidene chloride casings, this new product developed conspicuously in the 1960s. Peak production was reached in 1972 at 180,491 mt, which was equivalent to 20% of the total annual production of fish jelly products.

The extraordinary shelf life of this product stemmed from two main factors. One was the prevention of secondary bacterial contamination by hermetically sealing with a gas barrier casing. The other was the action of the nitrofuran in eliminating those bacterial spores that survived in the heating process. These factors made it possible to keep fish sausage at room temperature, in spite of being heated under normal pressure. However, in 1974, the use of nitrofuran was prohibited by law, because of its cancer-causing action. Thereafter fish sausage became a retort food.

Double Step Heating

This technique is based on the gel-strength enhancing effect of the setting treatment to meat sol, discovered by W. Simidu in 1944. Before World War II, it was taboo to set the meat sol before the heating process, because the products treated this way were very springy but inferior in mouth-feeling. However, on the recommendation of M. Okada in 1959, the technique was immediately adopted throughout the country.

Frozen Surimi

A technique was discovered which made it possible to endow freeze-stability to washed fish mince or fish meat sol by mixing with sugars. Frozen surimi made of washed mince, so-called *muen surimi*, was developed by K. Nishiya *et al* in 1960. Frozen surimi made from meat sol, so-called *kaen surimi*, was developed by T. Ikeuchi and W. Simidu in 1963. Perfection of this technique has contributed significantly not only to the fish jelly sector, but to the fishing industry as a whole by making it possible to utilize Alaska pollack, a hitherto unexploited North Pacific species, as the raw material for fish jelly products. Truly, frozen surimi qualifies as a "once in a hundred years" technique in the history of fish food technology.

Alkaline Saline Leaching

Alkaline saline leaching, first devised by Y. Shimizu in 1963, is a technique in which low gel-forming capability of dark-fleshed fish meat is improved. The effectiveness of this leaching technique is due to the neutralization of muscle pH and the promotion of solubility of sarcoplasmic proteins by the soaking of fish mince in dilute alkaline saline solution (0.25% NaCl + 0.2% $NaHCO_3$).

Crab Leg Analogue

The history of crab leg analogue development began in 1975 when the Sugiyo Company introduced a new type of *kamaboko*, similar in appearance and flavour to crab leg. The first crab analogue was produced by the "cutting" method. In this procedure, cut fibers of *kamaboko* were mixed with a small quantity of fish meat sol and the mixture was tied up into a crab-leg-shaped rod. In 1985 the "continuous folding" method was devised by Osaki Suisan Company, and it replaced the "cutting" method. The introduction of crab leg analogue marked the start of a new era in the history of *kamaboko* by winning, for the first time, acceptance for the product among western consumers.

Progress Of Manufacturing Machines

Over the past 40 years, there have also been remarkable developments in the technology side and specifically in the capabilities of fish jelly manufacturing equipment. Various large, automatic and high-speed machines have been

combined into a continuous manufacturing system. Compared with grinding systems of 30 years ago, today's high speed vacuum cutters are ten times as efficient in terms of treatment volume, and four times as efficient in terms of speed.

Technical Problems Requiring Immediate Attention

Before World War II, the effectiveness of technical control of production depended on the personal skill and experience of the workers engaged in the operation. However, because of technological advances over the past 40 years, control is now much more of a textbook operation and is achieved through the use of automatic machines. Today, if frozen surimi is given, anyone can make products anywhere in Japan. However, the market place is also flooded with springy but unpalatable and generally inferior products.

Southeast Asian countries must not become another Japan. In this sense, I would like to recommend three areas for specific attention in this region.

A Second Look At Traditional Processes

Traditional foods are always the product of the climatic conditions of the regions in which they are developed. Not surprisingly then, the making process of a traditional food is seen at its best in its native setting. This is demonstrated by the example of Japanese *kamaboko* and Chinese fish balls.

The common secret of fish processing is how to remove, eliminate or mask the smell of fish. Leaching process in case of Japanese *kamaboko* is done for the purpose, while in case of Chinese fish balls "soaking" process is carried out in place of leaching. Which is better? Of course, "soaking" process is. In the climate of Southeast Asia, it will never be possible to make high quality products by the Japanese process. This is because during the leaching process the gel-forming capability of myofibrillar proteins is reduced, and so is its tastiness. By contrast, the "soaking' treatment in the making of Chinese fish balls has important advantages. Specifically it allows the washing out of the fish smell without sacrificing either the gel-forming characteristics or the taste of fish meat. The "traditional" process merits more careful evaluation.

Development Of New Local Products

The chief advantage of fish jelly products over other fish products is flexibility in terms of seasoning, shaping the product form, and combining the products with other materials. We should make use of this advantage to develop distinctive new products matched to the eating habits and tastes of different populations. These could include spices, vegetables, cereals, fruits, dairy products, meat products and various aquatic products other than fish.

Use Of Under-Utilized Fish

In various parts of Southeast Asia, large amounts of freshly landed fish go to waste because there is no present market for them. However, I think it is entirely possible that they could be processed into fish jelly products. Such a development would contribute greatly not only to the fish jelly sector but also to the fishing industry as a whole. A good model for this kind of development is *jako-tempura*, a fried *kamaboko* made of miscellaneous small fish in the island of Shikoku, Japan.

Predictable Technical Developments

There are three technical problems currently in focus, and some for which we can expect solutions in the near future.

Standardization Of Methods For Evaluating The Physical Property Of Fish Gel

Since frozen surimi achieved the status of an international product, pressure has grown for the establishment of standands to certify its quality, and FAO has begun preliminary work in this direction.

Along the way it will be necessary to standardize the method of measuring gel-strength – this must be done in order to estimate the gel-forming capability of raw meat or frozen surimi. Various methods have been used for the measurement of gel-strength. They include tensile, puncture, torsion and teeth-cutting tests. Each of these method has its advantages and its drawbacks. We will need to standardize measuring conditions for each test, not only for the evaluation of the surimi quality but in order to conduct scientific research on fish gel.

Establishment Of *Modori*-Preventing Technique

Gel degradation phenomenon occurring during the heating process, so-called *modori* is the most serious obstacle to the use of fish meat for fish jelly products. Recently, our group at Kyoto University has found four types of *modori*-inducing proteinases (MIP), revealed their enzymatic properties, and investigated their distribution among fish species. Since inhibitors which are effective against one type of MIP has also been found in spinach and red pepper, it is reasonable to expect the development of a *modori*-preventing technique in the near future.

Establishment Of The Technique Of Recovering Proteins From Waste Water Produced In The Leaching Process

A lot of water soluble muscle proteins are washed out during the leaching process. Recovering the proteins from the washings is very important in terms of efficient utilization of food resources and prevention of water pollution. Though these proteins have been collected by the use of chemical coagulants such as polyacrylate, the protein recoverd by such a coagulant is of no use either as food or feed.

However, there is a unique method, called the "pH shifting" method, which was devised by Nishioka and Shimizu (1983) eight years ago. In this method, washings are only acidified by HCl or alkalified by NaOH beyond the critical pH zone between 5 and 11 respectively, and then neutralized. By this 95% of proteins are made to precipitate from the washings of Pacific mackerel. E. Okazaki of the Central Fisheries Research Institute, Japan, is now investigating the conditions to put this method to practical use. In the near future we can expect to recover the waste proteins in an edible state.

In conclusion, I hope that fish jelly making technique will promote better utilization of low market value fish in the countries of Southeast Asia, and it will also contribute towards improving the diet of each country in her own way.

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Discussion

In the discussion, Dr Shimizu informed the meeting that in the recovery of proteins at various pH-shifting conditions, monitoring had been conducted using the Kjeldahl method.

World Marketing Trends In Surimi And Surimi-Based Products

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The supply system for surimi in Japan is now changing, to reflect alterations in the international market for this product. Demand for surimi has been on the increase; not only in Japan but also in the USA, Europe, South Korea, Taiwan, Southeast Asia and the USSR. The demand has been mainly for imitation crab stick (ICS) and for products such as fish ball and fried or steamed fish cake. In short, surimi has become an "international commodity".

In 1988, consumption of surimi in Japan was half a million mt but has been decreasing year by year since then, because of a shortfall of supply in Japan, presently estimated at around 350,000 mt. This has been caused by (a) a decrease in the number of large-scale trawlers in Japan, and (b) increased demand for fish fillet products in the USA, and for imitation crab sticks in South Korea and in Europe.

In 1990 Japanese trawlers produced a total of 54,000 mt surimi in the open ocean in Bering Sea and off New Zealand, as shown in Table 1. The question of how many Japanese trawlers will be permitted to operate in 1991, will be settled by nation-to-nation negotiations.

In 1990, Japanese shore plants produced surimi, not only from Alaska pollack (86%) but also from Atka mackerel, scad, salmon, sardine and others (14%). In 1991, the proportion from Alaska pollock will level off while that from other species will increase (Table 2).

Table 1. Estimated demand for surimi in Japan, 1991.

Unit : mt

Produce from	'91 Estimate Quantity	'90 Actual Quantity	91/90 (%)	Projected Future Trend
Japan:				
on board	25,000	54,000	46	A big decrease
on shore	200,000	185,000	108	A slight increase
*JV USSR-JAP	10,000	6,500	154	Big increase
USA(**pw)	10,000	13,500	74	Depends on fillet market
IMPORT FROM:				
USA	80,000 (60,000-100,000)	125,500	64	Depends on fillet market
Thailand	20,000	20,000	100	Level off or a little decrease
Argentina	6,000	6,000	100	Level off or slight increase
Total	351,000	410,500	85	

* JV = Joint venture, ** pw = Pacific whiting

Table 2. Main fish species for surimi production.

Species	Fishing Ground	Use & Trait	Market Rank
Alaska pollack	Bering Sea, Sea of Japan, Okhotsk	Commonly used for all surimi based products	*A
Pacific whiting (hake)	Off USA west coast	Started to produce in '89; surimi has good gel strength	B-
Polar cod	Off south of NZ and off Argentina	Best whiteness, can get high quality surimi-based product	A
NZ hoki	NZ and south of Australia	Good whiteness and gel strength	*B
Threadfin bream	South China Sea and Indian Sea	No black membrane and tissue	*C
Chilean mackerel (scad)	Off-shore Chile	Good taste, white-grey meat colour	C
Yellow croaker	East & South China Sea	Best gel-strength	A
White croaker	East China Sea	Better gel-strength and whiteness	B
Merluccius spp.	Atlantic ocean off NZ	Good whiteness, quality similar to hoki and pollack	B

* A = Best *B = Better *C = Good

As for Japan - USSR joint ventures, the number of Soviet surimi factory ships stands at four, an increase of 3 over 1990 (Table 5). As a result, an increase in exports of USSR surimi may be expected. The exact total depends on developments in the Soviet domestic market.

In 1990, Japan-USA-Canada joint ventures produced 13,500 mt surimi, mainly from Pacific whiting. This year, American fishing boats will operate independently; Japan has ceased joint ventures with the USA but will continue joint ventures with Canada.

In Thailand, prospects for the use of threadfin bream in surimi production have not changed for the better and, as a result, Thai surimi plants are operating at 60% capacity. More recently, these plants have been using their own surimi to make imitation crab stick; there are now four plants in Thailand doing this.

In Argentina, there will be one more joint-venture factory ship, making surimi from Polar cod and scad.

Surimi Market In Japan And In The World

The United States exerts a strong influence on the world surimi market. The U.S. fish fillet market has now become more stable and South Korean and European imitation crab stick plants are offering good price for USA surimi. As a result, total imports of USA surimi into Japan will be reduced in 1991 compared with last year.

Supply and demand for surimi are now so tight that, since the end of last year, a buyer's market has become a seller's market. U.S. sellers are offering Alaska pollack surimi at ¥360/kg for SA grade, ¥330/kg for FA grade and ¥300/kg for A

Table 3. Surimi-based product plants in Japan.

No. of Worker	*Kamaboko* Plant	Fish Sausage Plant
Total	**2,525**	**57**
1	97	1
2	454	4
3	343	1
4	244	3
5 - 9	628	8
10 - 29	471	5
30 - 49	134	6
50 - 99	89	9
100 -299	52	14
300 up	13	6

grade. These prices are too high for most Japanese buyers, and only South Korean buyers and US domestic users are accepting the surimi.

In the USA, there are 24 surimi processing ships and eight shore plants with a total maximum production capability of 170,000 - 200,000 mt. This year an estimated 40,000 mt of product will go to the USA domestic market, leaving 80,000 mt for export to Japan, 25,000 mt for South Korea, 7,500 mt for Europe and 2,500 mt for Taiwan.

The outlook for the surimi market this year is for continued steady market prices supported by strong world demand for surimi especially for use by the imitation crab stick industry. In Japan itself, however, the local demand is still strong for *kamaboko*, which engages tens of thousands of workers, and for fish sausage (Table 3).

Imitation Crab Sticks

As mentioned earlier, surimi has now become an international commodity used primarily for the manufacture of products such as immitation crab sticks, lobster, scallop, clam, shrimp, and now smoked salmon, other seafoods, Frankfurt sausage and others. These are surimi-based products and surimi has come to be known as the hot dog of the seafood business. As a result, demand for surimi as a raw material has increased in the USA and Europe.

The first Japanese-French joint-venture factory for processing of ICS in France started in February of 1991 and to this date there are 3 plants in operation. In France the consumption of ICS in 1990 was 8,000 mt compared with only 1,000 mt five years ago. Total consumption of ICS in Europe including Italy, Spain and England was about 30,000 mt last year.

ICS was first introduced to the U.S.A. about 10 years ago and at that time the consumption was only 3,000 mt. In 1990 surimi-based products consumption will exceed 70,000 mt but the export of ICS from Japan to the U.S.A. has been sharply decreasing year by year (Table 4).

Recently, more than 90% of surimi consumed in the U.S.A. was produced within the USA (Table 5). Demand for surimi in Japan is now around 400,000 mt per year, but the quantity available is now decreasing. However, the consumption in other countries is increasing and is estimated to be about 100,000 mt per year. The Soviet Union plans to build surimi plants in the near future and to export surimi and surimi-based products to Europe.

Table 4. Production & consumption of surimi-based products in U.S.A. (mt).

Year	Production	Import from Japan	Consumption
1985	9,000	32,100	41,300
1986	17,900	26,200	44,000
1987	29,000	18,800	51,000
1988	47,700	8,700	61,100
1989	64,000	5,000	68,400

Table 5. Surimi plants (on board & shore) and its output in the world for 1986 - 1991.

No. plants – ship/shore
Output – mt x 1,000

Country	JAPAN		USA		KOREA		THAILAND		USSR		JOINT VENTURE
Year	Ship/ Output	Shore/ Output	Ship/ Output	Shore/ Output	Ship/ Output	Shore/ Output	Ship/ Output	Shore/ Output	Ship/ Output	Shore/ Output	Output
1986	22/101	39/248	-	-	6/9	-	-	3/15	-	-	127
1987	21/64	38/220	3/5	3/7	8/13	-	-	5/20	-	-	143
1988	41/85	37/202	8/25	4/27	9/14	-	-	8/25	-	-	114
1989	39/96	37/201	16/45	5/35	10/9	-	-	11/25	1/9	-	57
1990	31/54	37/185	24/95	7/65	11/6	-	-	12/25	1/6	-	20
1991	28/25	37/200	24/100	8/80	8/5	-	-	15/30	4/20	-	15

Frozen surimi was first developed in Japan in 1959, and a rapid modernization and rationalization of the production systems in the fish-paste products industry in Japan have since been strongly promoted.

Discussion

Asked why there was decreasing data reported concerning on-board surimi plants in Japan, Mr Sakiura said he believed that limitations imposed by 200-mile economic zones have caused Japanese trawlers to give up operations. Implementation of the 200-mile zone policy by the USA had resulted in the phasing-out of Japan's fishery operations in the Bering Sea area.

Mr Sakiura also reported that from 1986 to 1988, Japan had engaged in a joint venture with the USA for the production of surimi, and from 1989 to 1991 had been conducting a similar operation with the USSR.

Asked about one worker surimi-based businesses, Mr Sakiura explained that these are single proprietorship ventures which concentrate on the production of fried fish cake sold at outlets near the operator's home.

Development Of An Underutilized Fish Species – Male Capelin (*Mallotus villosus*)

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Introduction

Capelin, (*Mallotus villosus*) are found in abundance off the coast of Newfoundland and Labrador. During June and July each year several stocks migrate inshore to spawn. About one month prior to spawning, external sexual characteristics develop on the male. These changes are in the form of spawning ridges along the lateral line and enlarged fins, giving the male a robust appearance while the female retains its delicate silvery form. During this time, the males and the females are easily distinguishable and can be mechanically or manually separated. During the rest of the year, the sexes are almost indistinguishable.

Historically, capelin have been consumed locally in Newfoundland and Labrador in fresh or corned and dried form. Relatively large quantities have been used as fertilizer and as bait for other fisheries, zoofood and fishmeal. Most of the male capelin have been dumped.

In the latter part of the 1970's, an inshore capelin fishery began in Newfoundland, to supply mature roe-bearing female capelin to the Japanese market. The production of frozen roe-bearing female capelin has risen dramatically, from 369 mt valued at less than one million dollars Canadian in 1977, to 35,310 mt valued at 52 million dollars Canadian in 1990. Fig. 1 illustrates the increase in landings of Newfoundland capelin.

In recent years, Newfoundland processors have collectively exported annually an average of 35,000 mt of frozen roe-bearing female capelin. To arrive at this quantity of female capelin, at least an equal volume (ie. 35,000 mt) of male capelin must be harvested, and, indeed, much higher male-to-female ratios have been used. In 1987, it was estimated that the catch production ratio was 2.5:1 (ie. 2.5 mt of mixed capelin were needed to produce one mt of female capelin). The capelin quota has conventionally been fixed on market demand for females. No adequate market for this surplus male capelin has been established and a very large percentage is discarded. This is a huge, potentially available, underutilized fish species.

During 1989 and 1990, the Canada/Newfoundland Inshore Fisheries Development Agreement (NIFDA) Discards Program provided funding for several projects dealing with the utilization of discarded male capelin. These projects are summarized below.

Protein Supplement Project (Triposha)

Objective

The project was designed to examine the possibility of producing an economical supplement fish protein isolate from male capelin.

Purpose And Rationale

Traditional food materials of poor nutritional quality can be improved through the use of supplemental protein products. Fish has long been identified as a source of high-quality protein. Consequently the aim was to develop a dry soluble shelf stable powder derived principally from male capelin. This fish powder could be marketed alone as a source of high quality protein or combined into a composite product to improve the nutritional quality of traditional foods.

In early 1989, NIFDA in response to a project proposal by FADA (Fish Aid Development As-

sociation) provided funding for the Marine Institute to research and develop such a product.

A similar product is currently in use in Southeast Asia to provide supplemental nutrition to pregnant and nursing mothers and young children.

Results

The successful development of a low-cost protein supplement depends on the utilization of a practical method of (a) reducing the lipid (fat) content of the raw material; this concurrently reduces the disagreeable fishy odour (present in the lipid fraction) and (b) the utilization of a non-destructive means of drying.

Conclusion

A high-quality, functional supplemental fish protein isolate can be produced economically using traditional food processing equipment, given a cheap source of starting material. Male capelin may be classified as such a cheap starting material. While the finished product may be produced economically, it remains to be seen whether reasonable markets for such a product exist.

Pickled Capelin, Desalted And Dried

Objective

This project was designed to determine the possibility of producing dried male capelin with low salt content as a source of human food for the Central African market or as a high priced pet food for the Scandinavian market.

Purpose And Rationale

Traditional dried male capelin have long been produced from corned capelin during the "capelin

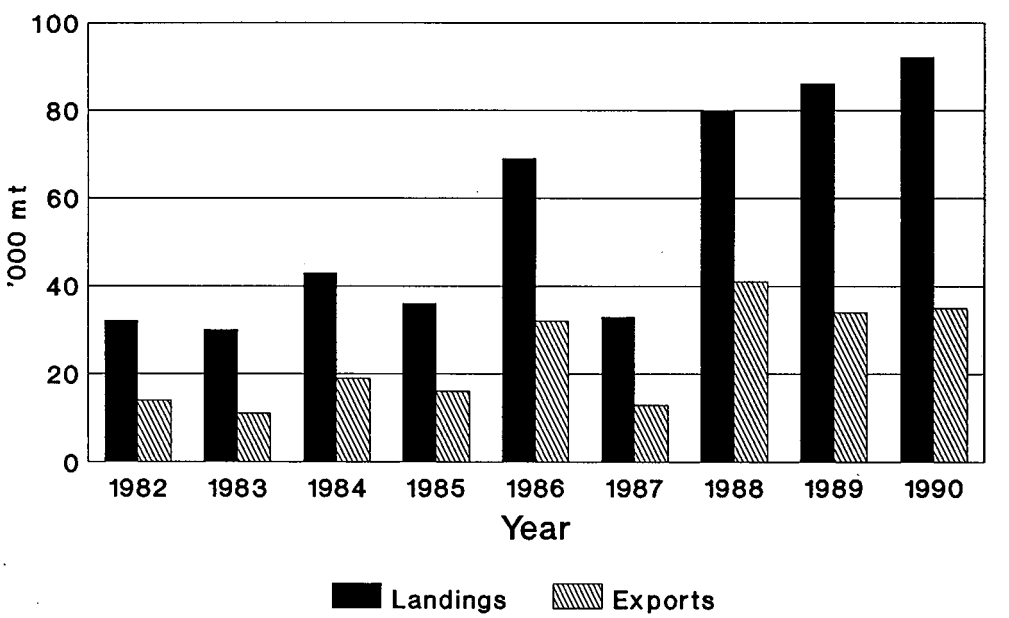

Fig. 1. Capelin landings and exports of Newfoundland and Labrador.

scull" in June and July. The resulting product, when dried to a moisture content of 20% or less, often had a salt content of 12-16%. Attempts to dry capelin without salt during this time of the year resulted in the products being infested with flies and maggots.

Results

The method developed enables male capelin to be salted in reusable 100kg barrels using a 'hard cure'. The barrels can then be held under proper chill conditions, with the liquid level kept properly topped up, for several months.

During September, October and November, these barrelled capelin can be desalted to about 1% salt level, wet weight. The desalted capelin can then be dried, either by sun-drying or mechanical dryer.

The resulting product would satisfy specifications for low-salt dried capelin, with a salt content less than 5%. Phase one of NIFDA's involvement in the product was to provide financial assistance to companies for the production of pilot quantities of this product for market analysis.

The production of pilot quantities identified a problem. The spreading of the desalted capelin on the racks for drying proved to be a very labour-intensive phase and one which threatened to endanger the profitability of the whole process. Without mechanical aid, it required one person-hour to position two flakes, spread 72 lb of capelin, and place the flakes into position for drying.

Consequently, NIFDA responded to a proposal from FADA to provide financial assistance to develop a 'capelin spreading device' to make the process more economically viable. The automatic spreading machine reduced the time necessary to spread the capelin. Final tests indicated that in one person-hour, use of the spreader resulted in 12 flakes, with approximately 430 lb of capelin spread and readied for drying.

Conclusion

It was proven that good quality low-salt, dried capelin could be produced using this method. Furthermore, the labour-cost savings realized by using the automatic spreader during the latter part of the project proved that the process was economically viable. A further test involving 100,000 lb of 'hard cure' capelin, utilizing the automatic spreader, will take place within the next couple of months.

Capelin Pub Snack

Objective

To produce an acceptable smoked pub snack product from male capelin; one that is safe, desirable, of consistent quality and capable of being kept without refrigeration.

Purpose And Rationale

A pub snack product has been produced previously in Newfoundland in an effort to utilize male capelin and to cater to a local taste preference for capelin. Production was sporadic and product consistency with regard to smoke, moisture and salt content were difficult to maintain. Although the product was popular it had limited shelf life unless frozen.

Results

A range of smoked pub snacks was produced from frozen and pickled male capelin. These were produced from round capelin, knobbed capelin, and tail-off butterfly fillets. The aim was to select the most desirable product for subsequent market survey. It was obvious that the butterfly fillet was the most attractive and that it was superior to the round or knobbed capelin. It was also easier to smoke the butterfly fillet and to reduce its high moisture content. The Baader 561 machine was used for knobbing, while the Baader 134 machine was used for filleting the male capelin.

Hot and cold smoked products were also produced. In cold smoking, the temperature does not exceed 30°C and the product is not cooked. In hot smoking, a temperature of 70°C or higher is attained and the product is cooked. The hot

smoked product was drier, took on a smoke flavour and a better colour, had a better overall appearance, and required a much shorter time to smoke (hot smoking of butterfly fillets took two hours compared to 5 hours for the cold smoking process).

Different concentrations of brine, sugar, dye and varied smoking times were used to produce a range of products. Sugar and salt are commonly used to prevent or limit the growth of microorganisms and were selected as optional preservatives. Different concentrations of brine (30°-70° brine), sugar (0%-20%), annatto dye (0-6 mls of dye/4.5 l of water), dipping times (15-60 seconds) and hot smoking times ($\frac{1}{2}$ - $3\frac{1}{2}$ hours) were used to produce a wide range of smoked (butterfly fillet) products.

A taste panel found that the most preferred smoked capelin pub snack had the following specifications:

Type	: Butterfly fillet
Dye (annatto)	: Nil
Sugar concentration	: Nil
Brine concentration	: 30° brine
Brining or dip time	: 45 seconds
Smoke time	: 30°C ($\frac{1}{2}$ hour) -
	50°C ($\frac{1}{2}$ hour) -
	70° ($\frac{1}{2}$ hour) -
	90° ($\frac{1}{2}$ hour)
	Break ($\frac{1}{4}$ hour)
Salt (water phase)	: >9%
Moisture content	: 48% - 52%
Water activity (Aw)	: <0.93

Notes:

1. 30° brine is produced by adding 3.91 kg of fine salt (NaCl) to 45.5 kg of water.
2. An allowance of 15 min is given to clear the smoke at the end of the smoke time.

Three types of packaging used were:

- vacuum pack,
- shrink pack, and
- modified atmosphere pack (M.A.P.)

The vacuum pack gave the best results as the product kept well without refrigeration for more than four months at room temperature. The product must exceed 9% salt in the water phase to prevent growth of *Clostridium botulinum*. Results were quite promising in the modified atmosphere pack, where the composition of gases were in the following proportion: (1) 75% nitrogen and 25% carbon dioxide, (2) 30% nitrogen, 10% oxygen and 60% carbon dioxide. As this was a more expensive packaged product, only limited studies were conducted.

Samples of the selected pub snack produced on a pilot scale were used to conduct the market study. Samples were distributed to pubs and convenience stores in St. John's. Out of a total of 367 surveyed, 90% liked the product and were interested in buying it.

Conclusion

The vacuum packed, butterfly fillet, hot smoked product kept well without refrigeration. This product passed the test of consumer acceptability which was ascertained through a market survey carried at pubs and convenience stores in St. John's. The objective set out in this project was achieved.

Process Summary

The following is a brief description of the processing of smoked capelin pub snack (also see Fig. 2).

1. Butterfly fillets were produced using previously frozen (thawed overnight) male capelin using the Baader 134.
2. The fillets were washed automatically during the filleting process.

3. The fillets were sorted to weed out the defective fillets (4% defective fillet level was acceptable).
4. Approximately 6.7 kg of fillets in a perforated pan were dipped and agitated manually in a 30° brine for 45 sec. The salt content of the fillet was approximately 2.0% at the stage before smoking.
5. The fillets were racked and smoked for a total of two hours at temperatures increasing at half hour intervals (30°C, 50°C, 70°C, and 90°C, respectively). The humidity in the smoker must be regulated to produce a desirable smoked product.
6. The product was taken out of the smoker and cooled to room temperature for 15 minutes. (This prevents condensation of the moisture in the vacuum pack.)
7. The product was packed with three fillets in each package.
8. Each package was checked for proper vacuum sealing. (The badly sealed package will develop moulds within a couple of weeks, when stored at room temperature. This may be used as a practical additional check against poor sealing).

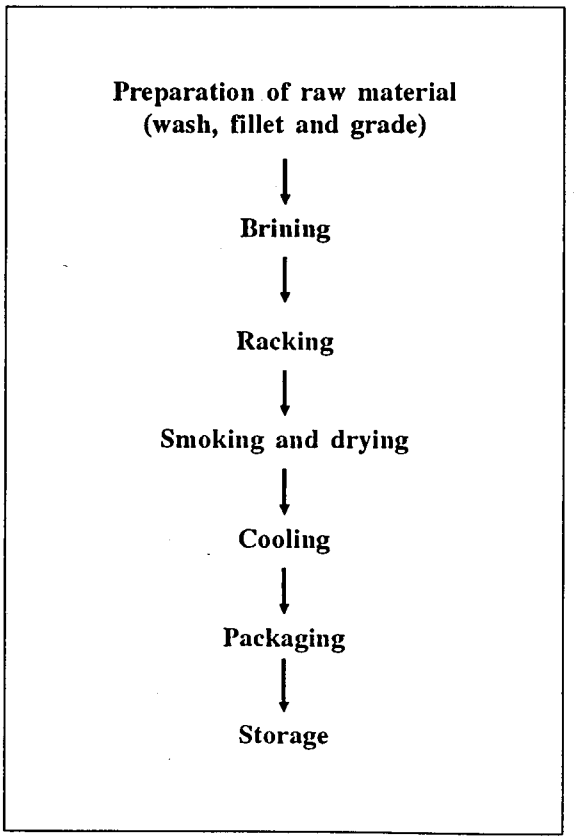

Fig. 2. Flow chart of the process

Chandra, C. V., and Samson L. 1991. Capelin pub snack project report. Canada/Newfoundland Inshore Fisheries Development Agreement, St. John's, Newfoundland.

Discussion

In the discussion, Mr Madakia explained that the capelin in these studies were harvested before the spawning season, and that desalting of the salted capelin was done by placing them in water at low temperature.

Since preservation made use of only 9% NaCl, Mr Madakia was asked whether there were cases of *Clostridium botulinum* poisoning in Newfoundland. He said that so far no cases had been reported. Dr Strom remarked that in Norway where analysis of the internal contents of the capelin were conducted, no case of *C. botulinum* infection had been reported but there had been some cases of bacillus infection.

Discussing the packaging of capelin pub snack, Mr Madakia explained that trials of vacuum-pack and modified atmospheric pack (MAP) did not show significant differences. However, the use of vacuum pack had been pursued because this method was cheaper than MAP. Furthermore, products in vacuum pack have kept well at room temperature for more than four months.

The Chairman commended the study for its successful utilization of a material formerly dumped as waste to produce fish products.

Energy Analysis Of Fishing And Processing Fish In Japan

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Introduction

The background to the energy problem is that we are living at the epoch of the use of fossil fuel in the history of man on the earth. Most human activities in the industrialized societies depend heavily on the consumption of fossil energy resourses. Even in agriculture, which is the sector of industry where solar energy is converted into food, increased productivity has been supported through a large amount of fossil energy input. In order to deal with energy management and energy policy, comprehensive understanding on energy use in the individual industry is needed.

When you go fishing, for example, you use not only fuel oil but also non-energy commodities such as fishing boat, pole and line, bait, fishing jacket, ice, ice box,etc. The consumption of energy commodities such as fuel oil and electricity is counted as direct energy input. On the other hand, consumption of non-energy commodities is counted as indirect energy input, because energy is used for the manufacture of non-energy commodities.

There are two methods for estimating the direct and indirect energy requirements of goods and services. One is 'Process Analysis' and the other is 'Input-Output Analysis'. The procedure of Process Analysis is:

- Examine the manufacturing process of the target product and estimate all the energy and non-energy inputs (amount of commodities) required for its production.
- The energy input at the final stage of manufacturing is tallied as the Direct Energy Input.
- Each of major non-energy inputs is examined in the same manner with their energy inputs being tallied as Indirect Energy Input.
- This process is repeated several times, tracing back down each subsequent stage of the goods and services pyramid.
- The process produces a series of gradually terminating energy contributions and is terminated at a point where the indirect figures become negligible.

'Process Analysis' is useful for a detailed study of specific goods or services. However, it is complicated and rather tedious, and sometimes impossible to proceed. On the other hand, 'Input-Output Analysis' is a good tool for macroscopic energy study as long as the Input-Output Table and related information are avallable.

'Input-Output Analysis' is a modeling technique initiated by Leontief (1941) who applied this to a dynamic analysis of economy. 'Input-Output Analysis' is performed on the Input-Output Table, a database in which all nationwide industrial activities are classified into several hundreds of sectors and the monetary flow among these sectors is stored. The monetary flow between the sectors may be converted into energy flow, and may offer information such as what amount of energy is supplied through non-energy commodities to a target product.

An Input-Output energy analysis of agriculture, fisheries, forestry and food processing in Japan has been performed by Tanaka and Udagawa (1981). The result is shown in Fig. 1. The column on the left shows the amount of production in price. The column at the center shows the energy requirement for these production. The column on the right

shows the percent of energy input direct as well as indirect (current and fixed).

A glance at Fig. 1 gives us three remarkable points:

1) Food processing sectors take up a prominent share both in production and energy consumption.
2) Fisheries (fishing and aquaculture) take up 18% of agriculture (crop+livestock) in production, but 50% in energy consumption. This means fisheries is an energy intensive sector.
3) Fisheries is a sector whose direct energy consumption (77%) prevails over indirect energy consumption.

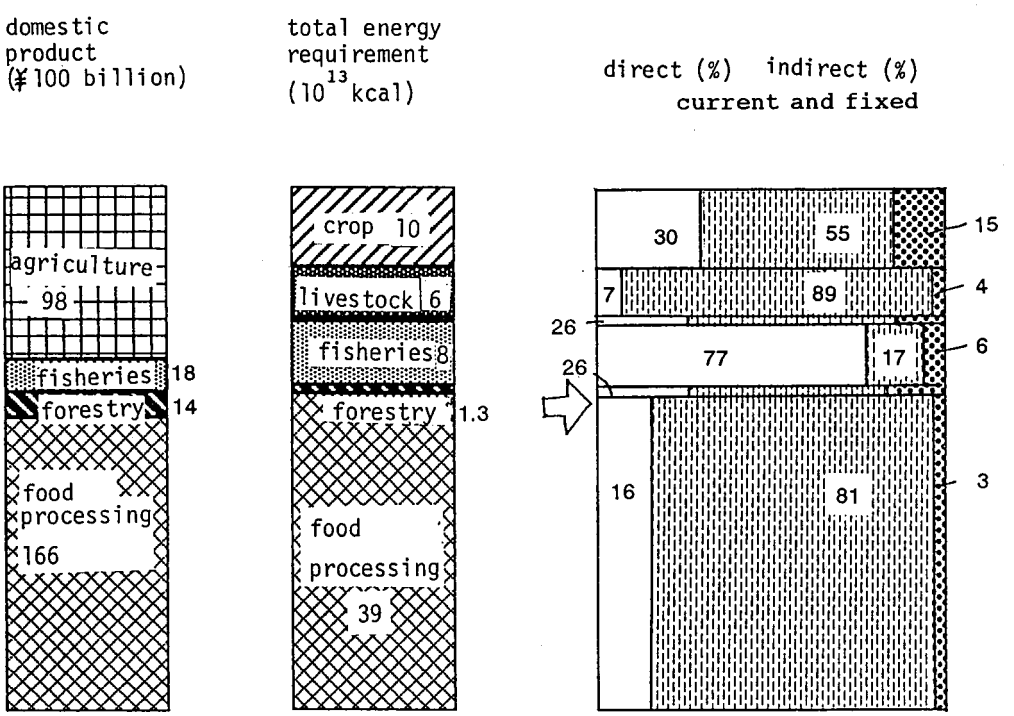
Fig. 2 shows the energy intensity index (in price unit) of selected sectors in Japan. Fig. 2 tells us that fisheries belongs to an energy intensive group of sectors. With all these results based on 'Input-Output Analysis', we have the question:

Why fisheries is energy intensive?

What part of seafood manufacturing process is energy intensive?

Unfortunately, however, 'Input-Output Analysis' is not able to answer these questions, because the Input-Output Table is not yet adequately developed for a detailed study of fisheries.

In this paper we therefore use a Hybrid Method. In the first step of our hybrid method, we examine the manufacturing process of Target Product and estimate the amount of energy input and non-energy commodity input required for its



Source: Tanaba & Udagawa, 1981.

Fig. 1. Energy analysis of agriculture, fisheries, forestry and food processing in Japan, 1975.

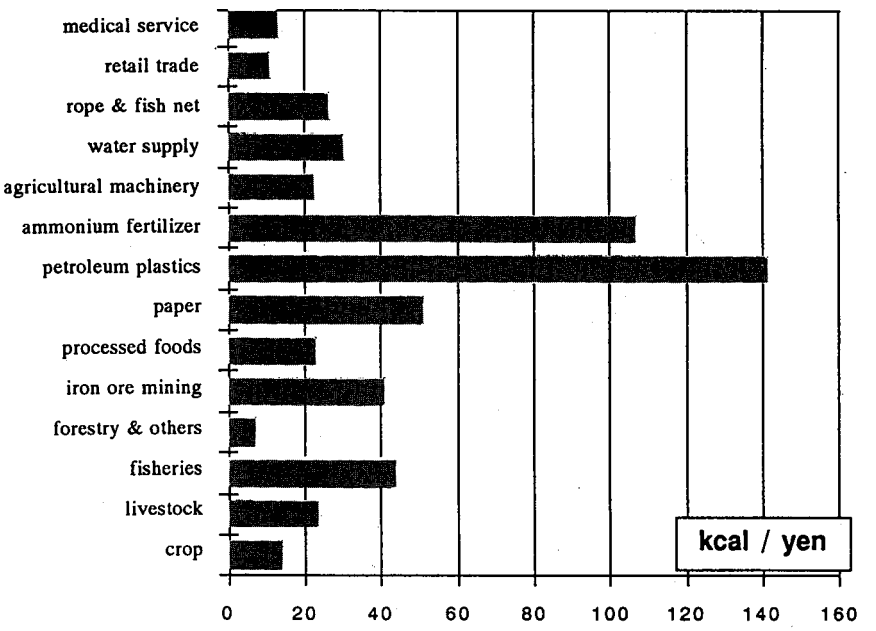


Fig. 2. Energy intensity index of Japanese industries in 1975.

production. In the second step, we estimate the amount of energy, with an aid of 'Input-Output Analysis', which may be used to manufacture the non-energy commodities counted in the first step.

Energy Analysis Of Fishing

Materials And Methods

We used the census data in 1980 published by the Japanese government: Economy of Fishery Establishments(EFE) and Fishery and Aquaculture Production (FAP). In EFE, annual fisheries expenditure per fishery management unit is available in detail as well as basic information concerning fisheries activities such as kind of fishery type, the tonnage of main boat, amount of catch, and the number of fishing days. The expenditure of energy and non-energy goods in price were converted into direct and indirect energy input, respectively. The detailed procedure for conversion is given in Watanabe and Okubo (1989). The sum of direct and indirect energy input per fishery management unit per fishing day was plotted against the tonnage of main fishing boat (Fig. 3). The energy input per fishing day was arranged in a single line for each fishery type. These lines, energy input per day charts (EPD chart) were used later to estimate ${}_{t}E_{j}$, the energy input per fishery management unit per fishing day for i-th type fishery operated on t-th level tonnage boat (kcal FMU^{-1} day^{-1}).

In order to estimate the total amount of energy use for the entire fisheries in Japan, we used data recordcd in FAP. In FAP, the amount of fisheries production is sorted by the tonnage of boats and by fishery type. The tonnage of boats were sorted into eleven levels: 0-3, 3-5, 5-10, 10-20, 20-30, 30-50, 50-100, 100-200, 200-500, 500-1000, and larger than 1000 GT. Fishery types were separated into thirty nine kinds: trawls (8 kinds), purse seines (6), lift nets (2), gill nets (2), seine nets (3), set nets (3), anglings (6), long-lines (4), and others (5).

The sum of energy input for each i-th type fishery management unit, Q_i, is given by

$$Q_i = \sum_{t=1}^{11} {}_tE_i \, {}_tp_i \qquad \text{— Eq. (1)}$$

where ${}_tp_i$ is the total fishing days multiplied by the number of the fishery management units (FMU) which operate the t-th level tonnage boat (day FMU). For each fishery type, ${}_tp_i$ is available in FAP, and ${}_tE_i$ was given by use of the corresponding EPD chart.

The overall average of energy input per catch (weight of round fish basis) for i-th fishery type, I_i (kcal/kg), is given by

$$I_i = \frac{Q_i}{F_i} \qquad \text{— Eq. (2)}$$

where F_i refers to the total catch by i-th fishery type. F_i is also available in FAP. In general, any one particular species of fish is captured by fisheries of two or more kinds of types. A coefficient referring to the catch of j-th species captured by i-th type fishery, g_{ij}, defined by

$$g_{ij} = \frac{f_{ij}}{F_j} \qquad \text{— Eq. (3)}$$

was calculated using the data recorded in FAP; where f_{ij} is the catch of j-th species by i-th type fishery and F_j is the total catch of j-th species. The overall average of energy input per catch for j-th species, I_j, is given by

$$I_j = \sum_{t=1}^{39} I_i \, g_{ij} \qquad \text{— Eq. (4)}$$

Direct And Indirect Energy Input

Direct and indirect energy input in 1980 per fishery management unit estimated for selected fishery types is shown in Table 1. Fuel oil input was the dominant energy input in most cases, occupying more than eighty percent. This result agrees

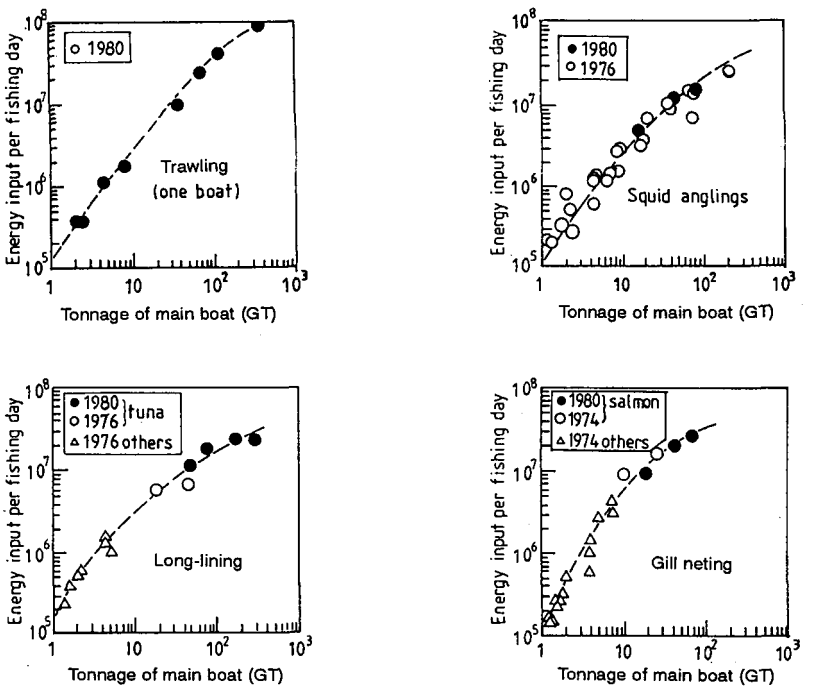


Fig. 3. The energy input per fishing day for selected fishery types. Energy input per fishery management unit per fishing day (kcal.FMU$^{1.d^{-1}}$) is plotted in the ordinate.

Table 1. The estimated annual energy input per fishery management unit for selected types of fisheries.

Item \ Type of fishery	Large trawl in North Pacific	Squid angling	Tuna long-line	Salmon drift gill net
Activity data				
Tonnage of main boat (GT)	362	46.8	294	19.7
Number of fishing days (d)	293	128	364	56
Amount of catch (10^4 kg)	261	13.0	26.9	7.41
Energy input (10^9 kcal)				
Fuel oil	20.2	1.63	9.92	0.399
Boat building & repair	0.503	0.041	0.22	0.028
Fishing gear manuf. & repr.	0.935	0.049	0.24	0.073
Bait	0	0	0.99	0
Ice	0.019	0.00	0.00	0.003
Casing	0.119	0.03	0	0
Miscellaneous goods	0.132	0.02	0.00	0.010
Building & facility	0.027	0.00	0.00	0.004
Total	21.9	1.77	11.4	0.516
Ratio of direct-energy input to total input (-)	0.92	0.92	0.87	0.77
Total energy input per FMU per fishing day (10^6 kcal·FMU^{-1}·d^{-1})	74.9	13.8	31.4	9.21
Total energy input per catch (10^4 kcal·kg^{-1})	0.84	1.36	4.24	0.70

favorably with the estimation by Tanaka and Udagawa (1981), as well as by Leach (1976). Most of indirect energy input was due to the manufacture as well as the repair of fishing boat and fishing gear.

Total Energy Input And Energy Input Per Catch For Each Type Of Fishery

The estimated values of the total energy input, Q_i ,as well as energy input per catch, I_i, for each fishery type is listed in Table 2. The grand total energy input for marine fisheries in 1980 was estimated to be 6.00×10^{13} kcal, the break down of which is 28% trawling, 19% angling, 18% long-lining, 10% purse sein and 10% gill net.

The overall average of energy input per catch (round fish basis) for entire marine fisheries was 0.61×10^4 kcal/kg, which is similar to or less than that in foreign waters. Hirst (1974) reported that 1.0×10^4 kcal of fossil energy input per kilogram catch were required in the entire fisheries industry of the United States of America. Leach (1976) reported 0.78×10^4 kcal of fuel oil input per kilogram catch (including trash fish) was required in fisheries of the United Kingdom. He also estimated that fuel oil input per catch was 0.86×10^4 kcal/kg in Maltese waters.

Tuna long-line in distant waters was the most energy intensive fishery type (3.5×10^4 kcal/kg). The energy input per catch of tuna long-line operated in offshore waters was half that in distant waters. The energy input per catch of costal tuna

Table 2. Energy input for marine fisheries of Japan in 1980.

Fishing method	Total energy input Q_i (10^{10} kcal)	Energy input per catch, I_i (10^4 kcal.kg^{-1})
Trawls	1666	
Mother ship	69.5	0.126
Large trawls in N. Pacific Ocean	227	0.340
Large trawls in Southern Ocean	137	0.676
Large trawls in East China Sea	267	1.34
Shrimp trawl	27.7	0.804*1)
Medium trawl on offshore waters		
(one boat operation)	643	0.804
(two boat operation)	64.4	1.07
Small trawl on coastal waters	230	0.672
Purse seines	618	
Large and medium purse seine		
(one boat operation-tuna & skipjack)	105	1.29
-sardine & others)	447	0.18
(two boat operation)	3.3	0.05
Small purse seine (one boat operation)	46.2	0.083
(two boat operation)	17.2	0.067
Lift nets	130	
Saury stick held dip net	89.4	0.496
Others	40.6	0.227
Gill nets	627	
Salmon drift gill net	40.0	1.54*2)
Others	587	1.54
Seine nets	169	
Beach seine	0.4	0.052
"Patch" seine	52.8	0.421
Boat seine	116	0.702
Set nets	214	
Salmon large set net	40.4*3)	0.678*3)
Other large set net	73.8*3)	0.299*3)
Small set net	99.5*3)	0.638*3)
Anglings	1138	
Skipjack pole-and-line in distant waters	240	1.16
Skipjack pole-and-line in offshore waters	165	1.15
Skipjack pole-and-line in coastal waters	35.0	1.48
Mackerel angling	2.66	0.386
Squid angling	694	1.54
Others	0.89	0.386
Long-lines	1092	
Tuna long-line in distant waters	735	3.47
Tuna long-line in offshore waters	183	1.72
Tuna long-line in coastal waters	28.9	1.25
Others	145	1.39
Others	349	
N. Pacific Ocean tanner crab fishery	16.4	2.08
N. Pacific Ocean long-line and gill net	18.3	0.391
Shellfish collecting	32.8	0.187
Seaweed collecting	33.5	0.187
Others	248	0.752
Total/average	6002	0.609

*1 Assumed same as that of medium trawls.
*2 Assumed same as that of other gill nets.
*3 Estimated from K. Matsuda: in Energy Saving in Fisheries (ed. H. Watanabe). Tokyo University of Fisheries, 1985, pp. 7-22.

Table 3. Energy input per catch for each species.

Common name		Scientific name	Energy input per catch ($\frac{10^4 \text{ kcal}}{\text{kg-round fish}}$)
English	(Japanese)		
Tunas average			2.41
Bluefin tunas	(Maguro)	*Thunnus thynnus & T. mackoyi*	2.93
Albacore	(Binnaga)	*Thunnus alalunga*	1.51
Big eye tuna	(Mebachi)	*Thunnus obesus*	3.07
Yellowfin tuna	(Kihada)	*Thunnus albacares*	2.20
Young tunas	(Meji)	*Thunnus* spp.	1.05
Marlins average			2.55
Striped marlin	(Makajiki)	*Tetrapturus audax*	2.54
Swordfish	(Mekajiki)	*Xiphias gladius*	2.46
Black marlins	(Kurokawa)	*Makaira* spp.	2.71
Sailfish	(Bashokajiki)	*Istiophorus platypterus*	1.97
Bonitos average			1.25
Skipjack	(Katsuo)	*Euthynnus pelamis*	1.28
Frigate/bullet mackerel	(Sodagatsuo)	*Auxis* spp.	0.71
Sharks	(Same)	*Elasmobranchii*[*1)]	1.88
Salmons	(Sake)	*Oncorhynchus* spp.	1.13
Pacific herring	(Nishin)	*Clupea pallasi*	0.86
Sardine average			0.20
Sardine	(Maiwashi)	*Sardinops melanostictus*	0.18
Round herring	(Urumeiwashi)	*Etrumeus teres*	0.14
Japanese anchovy	(Katakuchiiwashi)	*Engraulis japonica*	0.27
Whitebait	(Shirasu)	*Engraulis japonica*[*2)]	0.58
Horse mackerels average			0.19
Japanese horse mackerel	(Maaji)	*Trachurus japonicus*	0.22
Mackerel scads	(Muroaji)	*Decapterus* spp.	0.18
Mackerels	(Saba)	*Scomber* spp.	0.22
Pacific saury	(Samma)	*Cololabis saira*	0.51
Yellowtails	(Buri)	*Seriola* spp.	
excluding cultured fish			0.48
including cultured fish			2.82
Flounders average			0.66
Olive flounders	(Hirame)	*Paralichthys olivaceus*	0.97
Righteye flounders	(Karei)	*Pleuronectiformes*[*3)]	0.65
Codfishes average			0.52
Pacific cod	(Madara)	*Gadus macrocephalus*	0.62
Alaska pollack	(Suketodara)	*Theragra chalacogramma*	0.52
Arabesque greenling	(Hokke)	*Pleurogrammus azonus*	0.80
Ocean perches	(Menuke)	*Sebasters* spp.	0.47
Thornyhead	(Kichiji)	*Sebastolobus marcochir*	0.82
Argentines	(Nigisu)	*Argentina & glossanodon* spp.	0.80
Croakers	(Nibe, Guchi)	*Sciaenidae* spp.	1.26
Lizard fishes	(Eso)	*Synodotidae* spp.	1.04
Medusafishes	(Ibodai)	*Centrolophidae* spp.	1.30
Pike eels	(Hamo)	*Muraenexox* spp.	1.28
Cutlassfish	(Tachiuo)	*Trichiurus lepturus*	0.89
Searobins	(Hobo)	*Triglidae* spp.	1.36
Rays	(Fi)	*Rajiformes*	1.36
Spotted mackerels	(Sawara)	*Scomberomorus* spp.	1.00
Dolphins	(Shiira)	*Coryphaena* spp.	0.93
Sea breams average		*Sparidae* spp.	0.92
including cultured fish			1.09

*1 Excluding *Rajiformes*.
*2 Including *Sardinops* spp. and others.
*3 Excluding *P. olivaceus*.

Table 3. Energy input per catch for each species (*contd.*).

Common name		Scientific name	Energy input per catch ($\frac{10^4 \text{ kcal}}{\text{kg-round fish}}$)
English	(Japanese)		
Flyingfishes	(Tobiuo)	*Exocoetidae* spp.	0.99
Mullets	(Bora)	*Mugilidae* spp.	0.98
Japanese seabass	(Suzuki)	*Lateolabrax japonicus*	0.87
Sand lances	(Ikanago)	*Ammodytes* spp.	0.54
Sailfin sandfish	(Hatahata)	*Arctoscopus japonicus*	0.80
Shrimps/prawns/lobsters average			1.36
Spiny lobster	(Iseebi)	*Panulirus japonicus*	1.43
Tiger shrimp	(Kurumaebi)	*Penaeus japonicus*	0.83
Crabs average			0.79
King crab	(Tarabagani)	*Paralithodes camtschaticus*	1.07
Tanner crabs	(Zuwaigani)	*Chionoecetes* spp.	1.12
Swimming crabs	(Gazami)	*Portunus* spp.	0.98
Squids/cuttlefishes average			1.36
Squids	(Surumeika)	*Todarodinae* spp.	1.48
Cuttlefishes	(Kouika)	*Sepiidae* spp.	0.79
Shellfish average			0.41
Abalones	(Awabi)	*Haliotis* spp.	0.27
Horned turban	(Sazae)	*Turbo cornutus*	0.51
Hard clams	(Hamaguri)	*Meretrix* spp.	0.29
Littleneck clams	(Asari)	*Ruditapes* spp.	0.21
Yesso scallop	(Hotategai)	*Patinopecten yessoensis*	0.65
Giant Pacific oyster	(Kaki)	*Crassostrea gigas*	0.41
Sea weeds average			0.19

long-line was 30% smaller than that of offshore tuna long-line. As far as tuna long-line is concerned, the further the operation was located from the Japanese coast, the more energy-intensive it was. As for skipjack pole-and-line, on the other hand, the difference of waters on operation seemingly did not affect energy input per catch.

Small purse seine and beach seine required the minimum amount of energy per catch. The large and medium purse seine were energy intensive when they were for catching tuna or skipjack, but not energy intensive for catching sardine.

Energy Input For Catching Each Species Of Fish

The overall average of energy input per catch for j-th species, Ij, estimated by Eq.(4) is shown in Table 3. The most energy intensive species were marlins and tunas, which are four times larger than the overall average. On the other hand, sardines, horse mackerels, and mackerels were species which required relatively little energy.

Rawitscher and Mayer (1977) estimated the energy used for harvesting selected fish species in US waters; input energy per catch (round fish) was 0.46×10^4 - 2.0×10^4 kcal/kg for salmon, 0.43×10^4 - 0.81×10^4 kcal/kg for codfish, 0.53×10^4 kcal/kg for flounder, 1.6×10^4 kcal/kg for tuna, and 7.4×10^4 kcal/kg for shrimps. These values are similar to those in Japanese waters (Table 3). Concerning sardine or anchovy, however, energy input in Japanese waters (1800 kcal/kg) is significantly large; three times larger than that in US waters(580 kcal/kg) and 14 times larger than that in Peruvian waters (129 kcal/kg). The difference in these three could be partly due to the difference in scale of fishery engaged in fishing sardine or anchovy. In Japan sardine is capture mainly by large and medium purse seine with one boat operation, which requires two or three times more energy than that of small purse seines. In other words, the energy

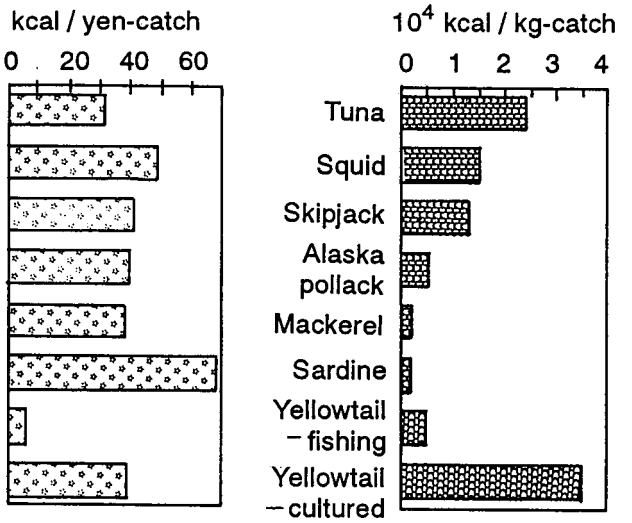


Fig. 4. Energy input per catch for selected species on the basis of price (Japanese yen) of catch as well as of kilogram of catch.

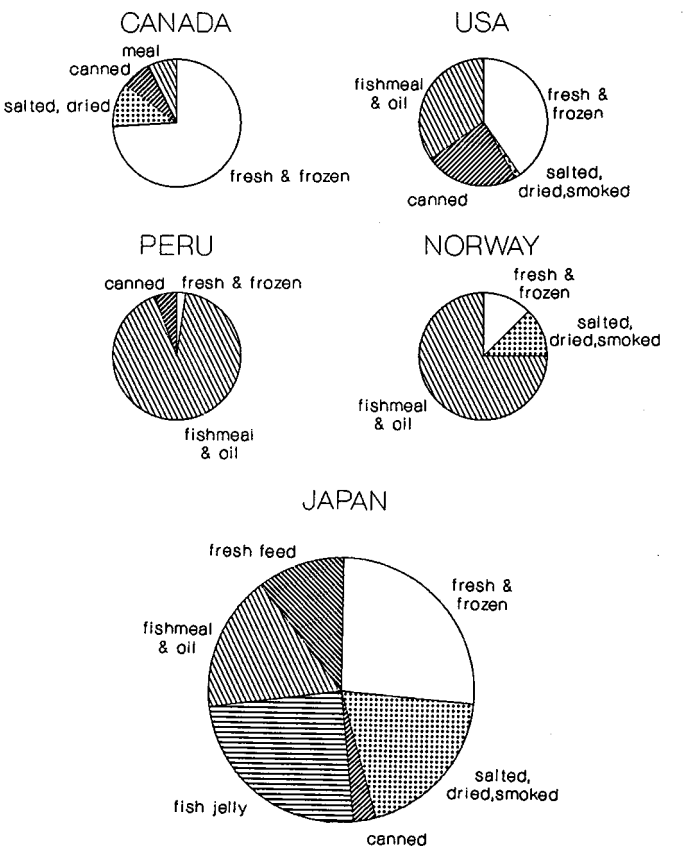


Fig. 5. How they used fish (1976).

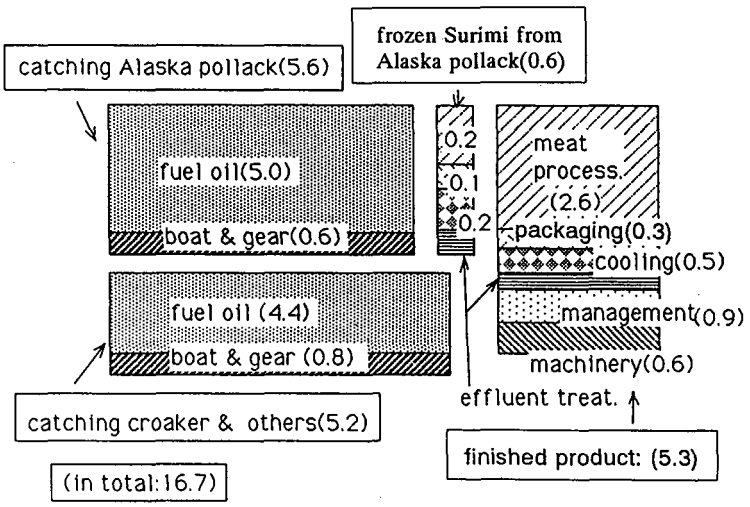


Fig. 6. Total energy input for fish jelly products in Japan (10^3 kcal/kg finished product), 1974.

input per catch of sardine in Japan captured by small purse seine is comparable to that in US waters. However,the difference in energy input between the small pure seine in Japanese waters and anchovy fishery in Peruvian waters is still large. The cause of this difference could be the difference in the use of non-powered vessels as well as the richness of fishing grounds in Peruvian waters.

Energy input per weight of fish for yellowtail culture was 3.6×10^4 kcal/kg, which is seven times larger than that for yellowtail by marine fishery (0.5×10^4 kcal/kg). The cause of large energy input for yellowtail culture is that yellowtail is fed with a lot of sardine, ie, 7.8 kg of sardine is consumed for one kg growth of yellowtail.

Energy input per catch for selected species are shown in Fig. 4 on the basis of price (Japanese yen) of catch as well as kilogram catch. This figure tells us that energy input per catch in price for most species level to the value of around 40 kcal/yen, although the value on kilogram basis differ greatly from one to another. This suggests that the fuel oil input per catch in price had worked as a guide line in the management of fishing. Sardine and yellowtail are exceptions in the capture fisheries. The low price of sardine is the cause for its large value of energy input per yen-catch. This low price is supported by its extraordinarily big catch today. The low value of energy input per catch for yellowtail was consequent to its high price as well as that it was captured mainly by an energy-saving method such as set nets or purse seines.

Energy Analysis Of Processing Fish

The Japanese have a variety of ways in utilizing fish (Fig. 5). Twenty percent of the total catch was processed into salted, dried or smoked products, 2% was canned, 25% went into jelly products, 17% went to fish meal and fish oil, 10% was used as fresh feed for fish culture, 27% was marketed as fresh fish at the fishmonger's. Energy requirement for each of these fish processing industries were estimated.

The result of energy analysis on fish jelly products is shown in Fig. 6 . We can see that fishing occupies a fairly large percentage of energy input; the percentage has become much larger these days. It also shows that the surimi manufacturing industry seems to be very successful in the efficient use of energy.

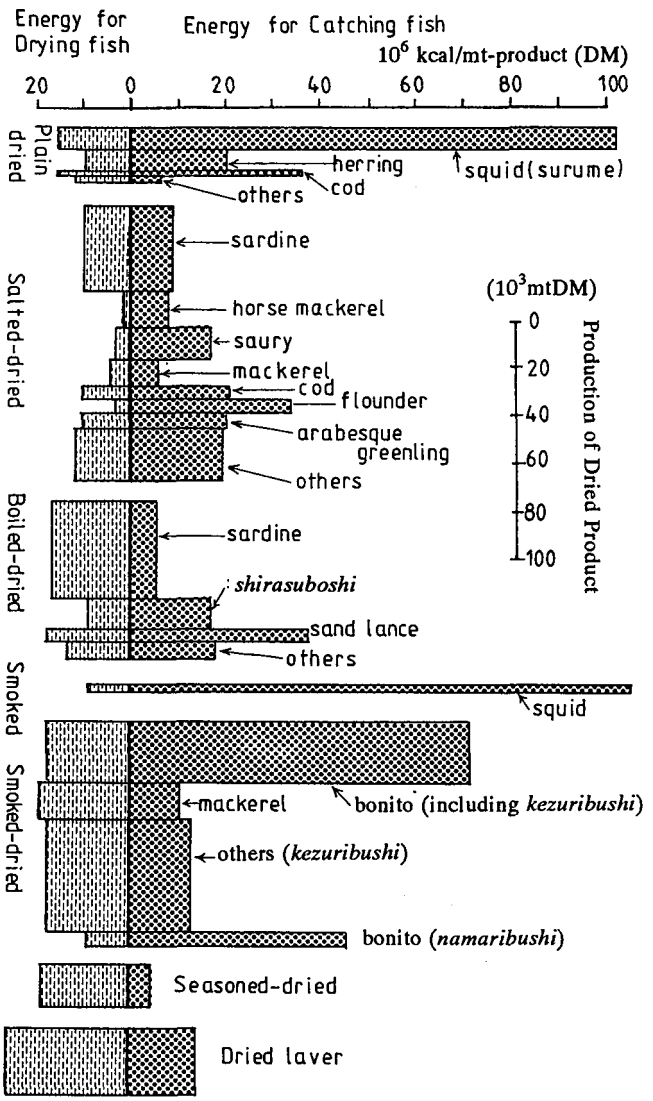


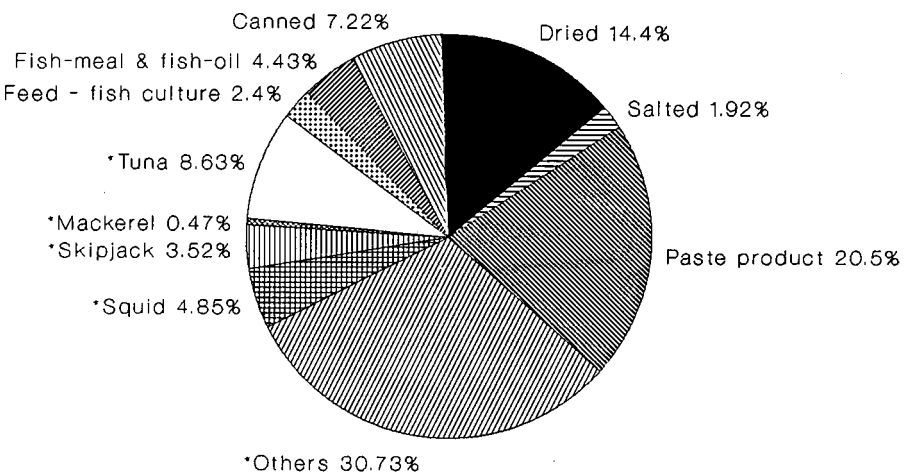
Fig. 7. The total energy requirement for individual item of dried marine products manufactured in 1980 in Japan.
The horizontal axis refers to the energy input (million kcal) per mt of product (dry matter, DM). The length of the bar stretching out from the base line to the right-hand side represents the energy for catching. The length of the bar stretching out to the left represents the energy for drying fish. The vertical axis refers to the production of dried products on dry matter basis. The area of each individual bar therefore refers to the energy required.

The energy requirement of dried marine products is shown in Fig. 7. The figure tells us that energy requirement for drying fish, which is within the range of 20 x 10^6 kcal/mt-DM*-product, is comparable to that for catching fish except bonitos and squids. Catching bonitos and squids are energy intensive (50 x 10^6 - 70 x 10^6 kcal/mt-DM-product). Since the dried products made of bonito and squid are very popular in the Japanese market, the large amount of energy used for the manufacture of these products could have been carried out because of their high prices.

The grand total of energy requirement for fishing and fish processing industry in Japan was 94 x 10^{12} kcal in 1980. Its breakdown is shown in Fig. 8.

Conclusion

The conclusion to be drawn is as follows: the process of catching fish is energy intensive, while fish processing is not. The amount of energy spent on catching a unit of fish depends on the type of fishing operation.



* Fresh (not processed) & frozen

Fig. 8. Total energy input in fisheries & related industry in Japan, 94 x 10^{12} kcal (1980).

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* DM = Dry matter

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Discussion

In the discussion, Dr Watanabe informed the meeting that an attempt had been made to include labour energy in the calculation of energy consumption. However, the idea of including human energy and food as energy had not proved to be acceptable and, so far, this controversy has not been resolved.

As regards the basis of energy calculation, Dr. Watanabe explained that the discussion was based on the total fossil energy input which was the sum of direct and indirect energy; for example, one kilowatt-hour of electricity was equivalent to 860 kcal in terms of net energy conversion. In this study, however, one kilowatt-hour of electricity was converted to 2000 kcal, considering the efficiency of the power station and the energy cost for building power station.

Asked whether work has been done on energy in waste products or waste treatment, Dr Watanabe replied that some aspects of waste energy known as scrap energy were considered in the study. However, in some parts of the investigation this was not considered. Thus this could be a new area of study in the future.

The Problems Of Quality And Food Hygiene Of Seafood Exported From Southeast Asia To Japan

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Introduction

Imported marine products (seafood) into Japan in 1989 exceeded 2.3 million mt, of which fresh, chilled or frozen fish accounted for 1.8 million mt (78.3%). The remainder were live, salted, dried or smoked, prepared or preserved fish and other marine products.

Table 1 shows the volume and value of marine products imported from 1984 to 1989. Table 2 shows the imports of principal products from major countries in 1989. This huge volume (2.3 million mt) constitutes approximately 18.5% of the gross Japanese marine products. Incidentially export of frozen, marine products from Japan in 1989 was approximately 0.27 million mt.

Before addressing the problems of the quality and food hygiene of seafood exported from Southeast Asia to Japan, I would like first to describe the current procedures in Japan.

Inspection Procedures For Imported Seafood

Fig. 1 shows the procedure for inspection of imported food used by the Ministry of Health and Welfare. (Note that the quarantine office is now part of the food sanitation inspector's office).

There are two forms of inspection: Governmental Inspection and Voluntary Inspection. Fifty-seven laboratories had been licenced as of 1989. The voluntary inspection laboratories issues examination certificates only to the applicant, who is a customs agent. The customs agent submits the examination certificate to the quarantine office, which decides if the commodity passes, or whether it is in violation of the regulations.

Inspection By The Ministry Of Health And Welfare (Government Inspection)

Food found requiring inspection will first undergo an on-the-spot inspection by a quarantine inspector.

During this on-the-spot inspection, an inspector goes into the designated bonded cold storage warehouse where the seafood is held, and inspects the following points, and then decides whether the seafood is passed or not.

1) Labelling
2) Organoleptic examination of color, brilliance, flavour, odour, texture, etc.
3) Inspection of adulteration due to foreign substances
4) Generation of mould
5) Condition of container-packages, etc.

If this on-the-spot inspection is inconclusive, the inspector can collect the seafood and transfer it to the quarantine office for further inspection. He can also send it to the National Institute of Hygiene Science for closer examination, if necessary.

When seafoods pass inspection, both the importer, and the customs office in charge of customs clearance are advised. At this point the importer may proceed to obtain customs clearance.

If seafood does not pass inspection, it is detained and a notification to that effect is sent to the importer who is requested to return or destroy

Table 1. Imports of marine products into Japan, 1984-1989.

Unit : Q = mt
V = US$1,000

Country	1984			1985			1986		
	Q	V	%	Q	V	%	Q	V	%
U.S.A.	275,068	678,275	15.33	351,889	915,015	18.52	391,453	1,151,144	16.86
S. KOREA	256,887	675,208	15.26	264,640	688,361	13.93	328,169	1,023,110	14.98
TAIWAN	92,764	503,379	11.37	106,944	578,462	11.71	146,615	947,449	13.87
THAILAND	41,626	162,026	3.66	49,985	181,689	3.68	69,115	304,330	4.46
CHINA	50,922	191,392	4.32	56,564	194,376	3.93	78,061	325,828	4.77
INDONESIA	32,951	236,324	5.34	36,221	226,212	4.58	41,697	312,446	4.58
CANADA	55,474	215,845	4.88	61,432	269,666	5.46	84,947	365,259	5.35
AUSTRALIA	18,142	176,841	4.00	19,736	198,812	4.02	19,631	219,160	3.21
U.S.S.R.	46,254	105,286	2.38	41,058	92,158	1.87	34,440	131,119	1.92
INDIA	42,213	254,771	5.76	41,150	232,668	4.71	42,458	282,262	4.13
PHILIPPINES	16,858	73,672	1.66	17,797	84,811	1.72	17,872	121,770	1.78
MAURITANIA	25,913	55,680	1.26	32,101	84,846	1.72	38,556	138,013	2.02
MOROCCO	37,434	85,015	1.92	38,660	97,262	1.97	41,048	134,156	1.96
SPAIN & CANARY	61,828	136,205	3.08	49,680	122,797	2.49	36,027	128,855	1.89
NORWAY	38,529	68,162	1.54	50,541	75,797	1.53	43,997	71,765	1.05
Other countries	300,459	807,321	18.24	358,901	897,867	18.17	454,434	1,172,970	17.17
Grand Total	1,393,322	4,425,402	100.00	1,577,299	4,940,799	100.00	1,868,520	6,829,636	100.00

Table 1. Imports of marine products into Japan, 1984-1989 (*contd.*).

Unit : Q = mt
V = US$1,000

Country	1987			1988			1989		
	Q	V	%	Q	V	%	Q	V	%
U.S.A.	457,927	1,561,436	18.39	542,069	2,197,480	20.10	465,997	1,893,987	17.96
S. KOREA	347,983	1,255,315	14.78	330,006	1,524,150	13.94	270,711	1,334,320	12.65
TAIWAN	170,848	1,209,780	14.25	139,984	1,058,638	9.68	127,599	990,926	9.39
THAILAND	80,375	394,664	4.65	107,495	609,908	5.58	129,282	750,713	7.12
CHINA	101,279	456,411	5.37	122,650	617,714	5.65	152,124	699,051	6.63
INDONESIA	52,871	370,504	4.36	66,624	517,118	4.73	86,480	578,932	5.49
CANADA	64,053	416,670	4.91	107,143	619,237	5.66	101,665	534,003	5.06
AUSTRALIA	22,075	288,238	3.39	22,793	345,801	3.16	21,654	371,457	3.52
U.S.S.R.	49,296	177,336	2.09	90,480	283,535	2.59	41,893	243,477	2.31
INDIA	43,416	299,751	3.53	36,539	277,132	2.53	37,334	232,324	2.20
PHILIPPINES	26,682	183,370	2.16	33,221	276,648	2.53	32,986	231,682	2.20
MAURITANIA	43,574	143,797	1.69	40,482	183,478	1.68	40,365	178,116	1.69
MOROCCO	32,038	108,211	1.27	37,219	176,880	1.62	39,340	177,719	1.68
SPAIN & CANARY	38,365	124,824	1.47	31,477	147,155	1.35	36,845	166,216	1.58
NORWAY	52,444	86,982	1.03	55,627	144,729	1.32	78,881	165,640	1.57
Other countries	492,042	1,414,588	16.66	650,359	1,954,456	17.88	625,075	1,999,296	18.95
Grand Total	2,075,268	8,491,877	100.00	2,414,168	10,934,059	100.00	2,288,231	10,547,860	100.00

Source: Japanese Imports of Marine Products (Statistics); Japan Marine Products Importers Association, Tokyo, Japan.

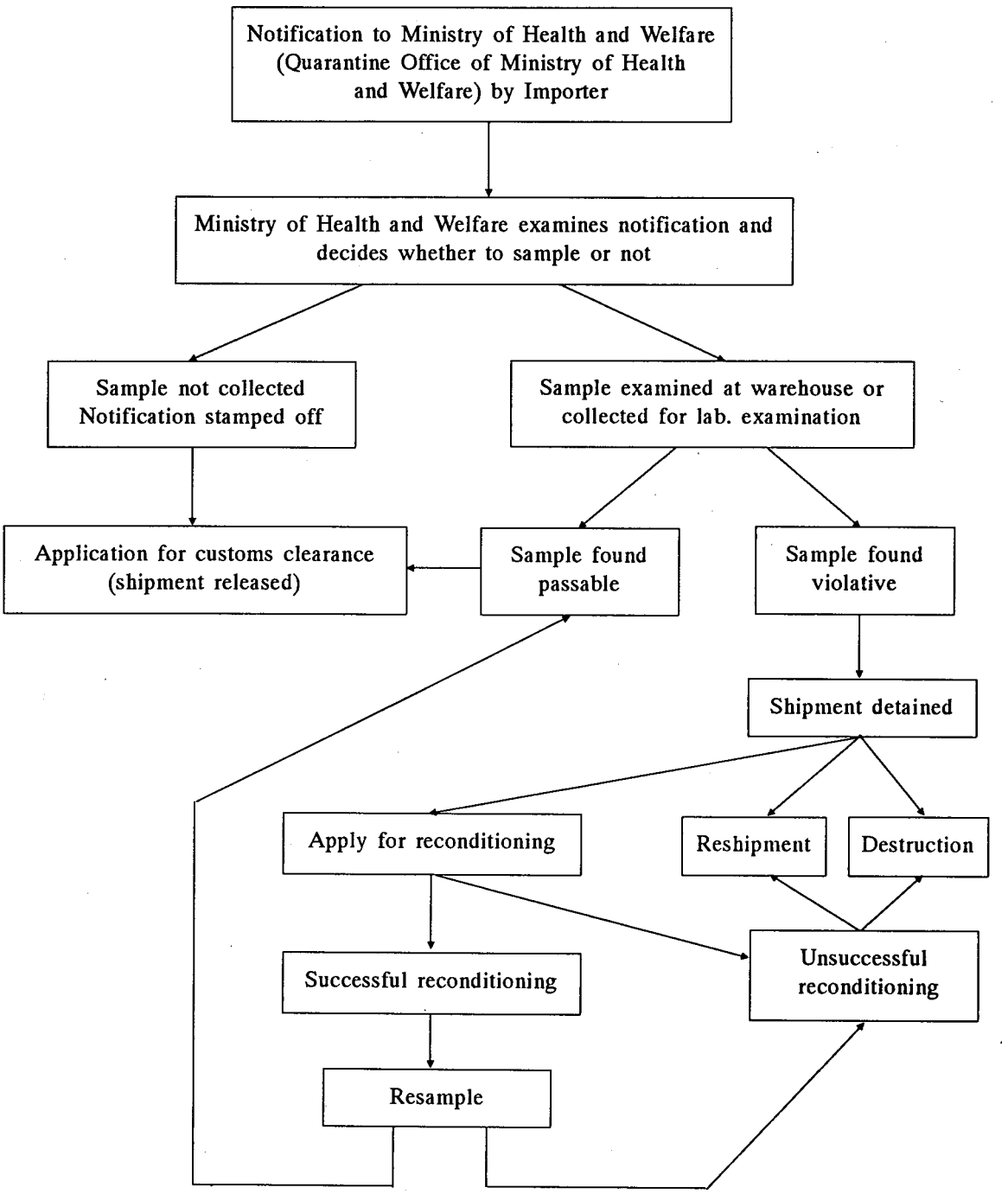

Fig. 1. Inspection procedure for imported foods.

Table 2. Imports of principal marine products by countries, 1989.

Shrimp, prawn, *ebi* : fresh, chilled or frozen				Albacore, yellowfin, bluefin, big-eye, other tuna, marlin : fillets, fresh, chilled or frozen				Crab : live, fresh,
Country	Q	V	%	Country	Q	V	%	Country
INDONESIA	50,086	444,624	19.5	S. KOREA	60,585	288,693	28.7	U.S.A.
THAILAND	38,785	389,584	17.1	TAIWAN	60,743	281,911	28.0	U.S.S.R.
CHINA	37,537	289,699	12.7	INDONESIA	24,572	85,496	8.5	CANADA
INDIA	29,701	192,759	8.5	U.S.A.	2,463	47,349	4.7	S. KOREA
PHILIPPINES	18,449	175,995	7.7	HONDURAS	8,241	39,657	3.9	CHINA
GREENLAND	16,215	130,966	5.8	PANAMA	6,730	29,135	2.9	N. KOREA
AUSTRALIA	8,572	120,416	5.3	SPAIN	2,625	25,137	2.5	TAIWAN
TAIWAN	8,925	84,922	3.7	MEXICO	18,033	24,436	2.4	U. K.
VIETNAM	15,938	62,420	2.7	SINGAPORE	6,200	23,070	2.3	AUSTRALIA
BANGLADESH	4,813	36,087	1.6	PHILIPPINES	6,136	22,801	2.3	VIETNAM
Total	224,309	2,227,139	100	Total	224,309	1,005,386	100	Total

Herring roe : fresh, chilled or frozen, salted, dried or smoked				*Mongo ika*, cuttle fish and squid : fresh, chilled or frozen				Octopus : fresh,
Country	Q	V	%	Country	Q	V	%	Country
CANADA	10,221	142,600	71.4	THAILAND	20,275	121,718	26.9	MAURITANIA
S. KOREA	1,081	13,757	6.9	MOROCCO	9,348	53,976	11.9	MOROCCO
IRELAND	1,805	13,466	6.7	SPAIN & CANARY	6,610	31,825	7.0	SPAIN & CANARY
U.S.A.	894	11,299	5.7	POLAND	13,406	26,709	5.9	GAMBIA
NETHERLANDS	1,617	11,025	5.5	S. KOREA	5,327	23,587	5.2	S. KOREA
POLAND	304	2,516	1.3	MAURITANIA	4,367	21,265	4.7	THAILAND
U.S.S.R.	262	2,394	1.2	GAMBIA	4,580	18,808	4.2	SENEGAL
U. K.	130	951	0.5	BULGARIA	10,360	16,880	3.7	CHILE
THAILAND	74	669	0.3	CHINA	3,004	14,052	3.1	CHINA
CHINA	21	339	0.2	MALAYSIA	2,465	11,851	2.6	PHILIPPINES
Total	16,515	199,671	100	Total	115,577	453,121	100	Total

Source: Japanese Imports of Marine Products (Statistics); Japan Marine Products Importers Association, Tokyo, Japan.

Unit : Q = mt, V = US$1,000

chilled or frozen			Salmon and trout : fresh, chilled or frozen				Herring : fresh, chilled or frozen			
Q	V	%	Country	Q	V	%	Country	Q	V	%
29,630	257,940	52.4	U.S.A.	104,033	630,891	67.7	U.S.A.	31,286	56,409	74.7
5,854	80,262	16.3	CANADA	20,346	139,500	15.0	NORWAY	5,048	5,354	7.1
5,203	45,241	9.2	NORWAY	7,778	64,485	6.9	ICELAND	4,167	4,828	6.4
5,454	38,591	7.8	CHILE	4,411	30,473	3.3	U. K.	3,955	3,394	4.5
12,657	36,765	7.5	SWEDEN	3,118	20,867	2.2	NETHERLANDS	2,588	1,880	2.5
10,011	17,853	3.6	DENMARK	1,306	8,768	0.9	CANADA	1,682	1,511	2.0
2,753	9,796	2.0	FINLAND	957	6,590	0.7	U.S.S.R.	792	1,324	1.8
139	1,633	0.3	NEW ZEALAND	964	6,255	0.7	S. KOREA	268	467	0.6
164	740	0.2	U.S.S.R.	2,632	5,114	0.5	IRELAND	356	255	0.3
168	532	0.1	U. K.	469	4,310	0.5	DENMARK	47	55	0.1
73,211	492,431	100	Total	148,983	931,528	100	Total	50,253	75,537	100

chilled or frozen			Halibut, plaice, sole, flat fish : fresh, chilled or frozen				Cod, pollack, hake, surimi : fresh, chilled or frozen			
Q	V	%	Country	Q	V	%	Country	Q	V	%
32,987	150,001	33.3	U.S.A.	44,659	103,712	48.6	U.S.A.	126,693	222,255	85.4
27,750	114,589	25.4	S. KOREA	13,926	42,003	19.7	U.S.S.R.	10,885	17,812	6.8
22,131	92,784	20.6	ICELAND	14,008	26,983	12.6	S. KOREA	3,441	8,763	3.4
16,943	63,349	14.0	CHINA	1,896	11,839	5.5	CANADA	2,497	4,531	1.7
3,085	16,181	3.6	PORTUGAL	3,000	4,709	2.2	CHILE	1,398	2,543	1.0
6,401	7,200	1.6	N. KOREA	1,128	4,323	2.0	N. KOREA	1,560	1,997	0.8
1,648	4,792	1.1	SPAIN	2,351	2,623	1.2	ARGENTINA	1,560	1,953	0.8
182	490	0.1	NETHERLANDS	1,170	2,398	1.1	CHINA	138	256	0.1
170	398	0.1	HONG KONG	152	2,260	1.1	NEW ZEALAND	8	23	0.0
76	223	0.0	CANADA	623	1,781	0.8	PANAMA	6	15	0.0
111,680	450,921	100	Total	88,765	213,583	100	Total	148,187	260,149	100

the cargo (or to take the necessary action while it is in bond).

At the same time, customs office in charge is notified that the said goods are in violation of the Food Sanitation Law and should not be imported into the country.

Voluntary Inspection By Designated Laboratories

It is desirable that all related information as to the seafood concerned should be available and ready for inspection. After unloading of the cargo and during the period of storage at a bonded warehouse, it is occasionally necessary to prove whether the seafood conform with the Japanese Food Sanitation Law or not.

In such cases, responsibility for the necessary analysis and inspection by a licensed laboratory in Japan is undertaken by the importer, who is also responsible for the security of the seafood.

When it is deemed necessary, an administrative inspection is conducted by a government inspector.

An importer who regularly engages designated laboratories to inspect and certify his cargo gains the respect of food sanitation inspectors as one who not only provides the information required, but also ensures safe seafood is released to the consumer.

The Food Sanitation Law In Japan, Criteria Or Standard For Food And Food Additives

If you want to export seafood to Japan, it is necessary to know the Food Sanitation Law in Japan. The criteria or standards for food and food additives are shown in Table 3.

The Problem Of Quality And Food Hygiene Of Seafood Exported From Southeast Asia To Japan

This is the main concern of this paper. Table 4 clearly shows the detentions or violations of imported seafood in 1989. We divided the data into two parts. Table 4-1 shows those of ASEAN Countries and Table 4-2 (1988) and 4-3 (1989) those of other countries.

Detentions or violations of imported food due to food sanitation inspections are decreasing from year to year as shown by Table 5. The decrease was due to improvements in quality and hygiene con-

Table 3-1. Standards and criteria of seafoods under the Food Sanitation Law, Japan.

Classification	Standards and Criteria	Remarks
Fish paste products (fish sausage & ham)	- Coliform organism : negative/g. - Nitrite radical : 0.05 g/kg or less.	There are also production & preservation standards.
Salted salmon roe	- Nitrite radical : 0.005 g/kg or less.	
Boiled octopus	- Viable bacteria count : 1.0×10^5/g or less. - Coliform organism : negative/0.01 g.	Only frozen octopus. There are also processing & preservation standards.
Raw oyster for uncooked consumption	- Viable bacteria count : 5.0×10^4/g or less. - *E. coli* MPN/100 g : 230 or less.	There are also processing & preservation standards.

Table 3-2. Standards and criteria of seafoods under the Food Sanitation Law, Japan.

Classification	Standards and Criteria	Remarks
Frozen Food	Frozen food that is eaten without heating : - Viable bacteria count : 1.0 x 10^5/g or less. - Coliform organism: negative/0.01 g.	Frozen foods are processed foods (except edible meat products, whale meat products, fish paste products, and sliced or shelled fishery products) that are frozen, packed and wrapped.
	Frozen food that is eaten after heating: (those heated just before freezing) : - Viable bacteria count : 1.0 x 10^5/g or less. - Coliform organism: negative/0.01 g.	Frozen foods that are eaten without heating are those produced or processed, frozen and which do not require heating before eating.
	Frozen food that is eaten after heating (except foods heated just before freezing): - Viable bacteria count : 3.0 x 10^6/g or less. - *E. coli* : negative/0.01 g.	Frozen foods that are eaten after heating are those foods that are produced, processed and frozen, other than those that are not heated before eating.
	Raw edible frozen fresh fishery products: - Viable bacteria count : 1.0 x 10^5/g or less. - Coliform organism: negative/0.01 g.	Raw edible frozen fish and fishery products are, among frozen foods, those that are sliced or shelled, and frozen.
	- Storage temperature: -15°C or less. - When preserving, should be packed with clean, sanitary synthetic resin film, aluminium foil, or water proof paper.	There are also processing standards.

Table 3-3. Prohibited additives for specific foods.

Commodity	Prohibited additives
Cured fish meat	Synthetic colour : tar, titanium dioxide
Fresh fish & shellfish	Synthetic colour : annato, water soluble sodium norbixin potassium norbixin β–carotene sodium iron chlorophyllin titanium dioxide natural colouring nicotinic acid nicotinicamide
Oyster for raw consumption Frozen fish & shellfish	Synthetic additives (except sodium hypochlorite, NaOCl)

Source : Ministry of Health and Welfare Notification No. 153, 27 August 1983. Final revision.

Table 3-4. Criteria of food additives.

Commodity	Additives	Criteria/Standard
Shrimp	Sodium hydrogen sulfite solution : sodium sulfite sodium hyposulfite potasium pyrosulfite sodium pyrosulfite sulfur dioxide	Peeled shrimp : less than 0.1/kg as $-SO_2$
Frozen fish & shellfish (except raw consumption fish, shellfish & oyster)	Anti-oxidant : butylated hydroxytoluene (BHT)	Less than 1 g/kg (immersion solution)
Processed fish & shellfish (except jelly fish products)	Sweetener : sodium saccharin	Less than 1.2 g/kg
Dried fish & shellfish	Preservatives : sorbic acid potasium sorbate Anti-oxidant : butylated hydroxytoluene (BHT) Sweetener : sodium saccharin	Less than 1 g/kg as sorbic acid Less than 0.2 g/kg Less than 1.2 g/kg
Salted fish & shellfish	Anti-oxidant : butylated hydroxytoluene (BHT) Sweetener : sodium saccharin	Less than 0.2 g/kg Less than 1.2 g/kg
Caviar	Preservatives : benzoic acid sodium benzoic acid	Less than 2.5 g/kg as benzoic acid

Table 3-4. Criteria of food additives (*contd.*).

Commodity	Additives	Criteria/Standard
Salted salmon roe	Colour fixative : sodium nitrate	Less than 0.05 g/kg as residual NO_2
Fish jelly products	Sweetener : sodium saccharin	Less than 0.3 g/kg
Fish jelly products (except surimi)	Preservatives : sorbic acid, potasium sorbate	Less than 2 g/kg as sorbic acid
Fish sausage & ham	Colour fixative : sodium nitrate	Less than 0.05 g/kg as residual NO_2
Fish sausage	Water binding agent : sodium chondroitin sulfate	Less than 3 g/kg
Sea urchin	Preservatives : sorbic acid, potassium sorbate	Less than 2 g/kg
Smoked squid & smoked octopus	Preservatives : sorbic acid, potasium sorbate	Less than 1.5 g/kg
	Anti-oxidant : butylated hydroxytoluene (BHT)	Less than 0.2 g/kg
	Sweetener : sodium saccharin	Less than 1.2 g/kg
	Quality improvement agent : propylene glycol	Less than 2% in squid & less than 0.6% in octopus
Fish boiled with sugar & soy	Preservatives : sorbic acid, potassium sorbate	Less than 1 g/kg as sorbic acid
	Sweetener : sodium saccharin	Less than 0.5 g/kg

Source : Ministry of Health and Welfare Notification No. 153, 27 Aug 1983. Final revision.

Table 4-1. Detention or violations of ASEAN origin, 1988 and 1989.

Country	Year	Commodity	Detention or Violation (kg)	Reason	Remark
Philippines	1988	Fresh rock cod (2 cases)	90	Poisonous fish	Moon-tail seabass (ciguatoxin)
		Frozen shrimp	1237	Decomposed, mould	-
	1989	Frozen octopus	360	Viable bacteria count & coliform group	Viable bacteria count : 1.0 x 10^5/g or less; coliform group : Negative/0.01 g
		Frozen bloody clams (for raw consumption)	275	Viable bacteria count	-ditto-
		Frozen food (crab claw)	1,572	Viable bacteria count	1.0 x 10^5/g or less
Thailand	1988	Dried shrimp	500	Prohibited colour	-
		Prepared shrimp	29	Benzoic acid	Prohibited
		Frozen food (prepared squid)	9,000	Viable bacteria count	1.0 x 10^5/g or less
	1989	Dried squid	2,000	Sodium cyclamate	Prohibited
		Dried ray-fin	4,275	Sulfur dioxide (-SO_2)	0.03g/kg or less
		Dried shrimp	2,500	Colouring agent : Orange II	Prohibited
		Frozen fishball (fish paste products)	400	Coliform group	Negative/g
		Frozen food (prepared squid)	10,700	Viable bateria count	1.0 x 10^5/g or less
Malaysia	1988	Frozen shrimp	1,986	Decomposed, mould	-
Singapore	1988	Dried shark fin	102	Sulfur dioxide	0.03g/kg or less
	1989	Fresh rock cod	12	Poisonous fish	-

Source : Imported Foods; Japan Food Hygiene Association (1988 and 1989)

Table 4-2. Detention or violations of fish and fish products, 1988.

Commodity	Country	Detention or Violation (kg)	Reason	Remark
Fresh puffer fish (*Shosai fugu*)	China	158	Foreign puffer fish	
Fresh puffer fish	Korea (5 cases)	73	Foreign puffer fish	
Frozen mackerel	Norway (2 cases)	64,220	Decomposed, mold	
Frozen puffer fish (*Karasu fugu*)	China	1,867	Decomposed, mold	
Frozen puffer fish (*Mafugu*)	China	304	Decomposed, mold	
Frozen puffer fish (*Nashi fugu*)	Korea	41	Foreign puffer fish	
Frozen puffer fish (*Saba fugu*)	Taiwan	60	Foreign puffer fish	
Fresh sea urchin	USA	21	Decomposed, mold	
Frozen shrimp	China (2 cases) Taiwan Brazil (4 cases)	796 2,148 123,120	Decomposed, mold Sulfur dioxide Sulfur dioxide	 0.1g/kg or less
Raw consumption chilled shrimp	Hong Kong	1,000	Boric acid	Prohibited
Dried shrimp	Taiwan	8,080	Sulfur dioxide	
Frozen fish for processing	N. Korea	22,894	Decomposed	
Frozen white clam	N. Korea	38,040	Shellfish poison	Diarrhetic
Dried otter-shell	China	10	Sulfur dioxide	0.03g/kg or less
Smoked salmon	Canada USA (3 cases)	57 196	Prohibited colour Nitrite radical ($-NO_2$)	Allura red, AC Prohibited
Dried shark fin	Taiwan Hong Kong	240 120	Hydrogen peroxide Sulfur dioxide	Prohibited 0.03g/kg or less
Frozen octopus	Peru	100	Viable bacteria count	1.0×10^5/g or less
Salted salmon roe	USA Korea	309 200	Nitrite radical Sorbic acid	0.005/kg or less Prohibited
Caviar	Iran Denmark Switzerland USSR Turkey	20 15 182 163 20	Boric acid Boric acid Boric acid Boric acid Boric acid	Prohibited Prohibited Prohibited Prohibited Prohibited
Frozen food (lobster)	Sri Lanka	160	Viable bacteria count	3.0×10^5/g or less

Source : Imported Foods 1988 : Japan Food Hygiene Association (1988).

Table 4-3. Detention or violations of seafood, 1989.

Commodity	Country	Detention or Violation (kg)	Reason	Remark
Fresh seabream	Hong Kong	789	Decomposed	
Fresh puffer fish (*Tora fugu*)	China	3	Foreign puffer fish	
Fresh puffer fish	China	6	-do-	
Fresh puffer fish	Korea (2 cases)	20	-do-	
Frozen flounder	USA	13,013	Decomposed	
Frozen red fish	Portugal	19,775	Decomposed	
Frozen puffer fish	China	2,061	Decomposed	
Frozen puffer fish (*Tora fugu*)	N. Korea (2 cases)	162	Foreign puffer fish	
Frozen puffer fish (*Karasu fugu*)	N. Korea China	16 60	-do- -do-	
Frozen puffer fish (*Nashi fugu*)	Korea	32	-do-	
Frozen puffer fish (*Sansai fugu*)	China (2 cases)	293	-do-	
Chilled frog legs	France	5	Decomposed	
Frozen lobster	Denmark	2,770	Decomposed	
Frozen shrimp	Macao Hong Kong Taiwan (2 cases) Sri-Lanka Surinam	4,558 3,989 14,584 840 48,860	Boric acid Boric acid Sulfur dioxide ($-SO_2$) -do- -do-	Prohibited -do- ≤0.1g/kg -do- -do-
Frozen blue crab	Canada	110	-do-	≤0.03g/kg
Frozen tuna (for raw consumption)	Korea (2 cases)	9,020	Coliform	Negative/ 0.01/g
Frozen sliced tuna	Taiwan	3,240	-do-	-do-
Frozen bloody clam (for raw consumption)	China	600	Viable bacteria count & Coliform group	≤$1.0x10^5$/g Negative/0.01/g
Frozen shrimp (for raw consumption)	Taiwan (2 cases)	144 972	-do- Coliform group	-do- -do-
Frozen Nami clam (for raw consumption)	Canada	10,220	Coliform group	
Frozen sliced flounder	Canada	1,632	Decomposed	
Frozen bigeye	Taiwan	950	Mixed Escolor (*Abura soko Mutsu*)	Wax, prohibited 18.5-20.8%
Dried shrimp	Vietnam	5,000	Colouring agent, Orange II	Prohibited
	Taiwan	3,500	Sulfur dioxide	≤0.03g/kg

Source : Imported Foods 1988 : Japan Food Hygiene Association (1988).

Table 4-3. Detention or violations of seafood, 1989 *(contd)*.

Commodity	Country	Detention or Violation (kg)	Reason	Remark
Dried herring	England	684	Colouring agent, Brown FK	Prohibited
Dried mackerel	England	1,349	-do-	-do-
Dried ray-fin	Hong Kong	684	Sulfur dioxide	≤0.03g/kg
	Urguay	1,980	-do-	-do-
	Tonga	178	-do-	-do-
	Vietnam	20	-do-	-do-
Dried skipjack (*Katsuobushi*)	Taiwan	1,500	Decomposed	
Smoked salmon	Denmark	375	Benzoic acid	Prohibited
Smoked swordfish	USA	20	Sodium nitrite (NO_2)	-do-
Salted jelly fish	China	21,624	Boric acid	-do-
Salted shrimp	Korea	1,260	Benzoic acid	-do-
Caviar	W. Germany	25	Boric acid	-do-
	Switzerland	233	-do-	-do-
Salted alaska pollack roe	Korea	100	Sorbic acid & potassium nitrate	-do-
Frozen fish (fried fish)	Canada (3 cases)	12,253	Decomposed	
Frozen fish (fried squid)	Taiwan	48	*E. coli*	Negative/0.01/g
Frozen fish (breaded shrimp)	USA	82	Coloring Allura red AC	Prohibited
Frozen food (roasted & prepared eel)	Taiwan	4,001	Viable bacteria count & Coliform group	$\leq 1.0 \times 10^5$/g
		4,990	-do-	Negative/0.01/g
		790	Coliform group	-do-
Frozen food (crab claw)	Vietnam	1,250	-do-	-do-
		826	Vaiable bacteria count	$\leq 1.0 \times 10^5$/g
Frozen prepared whelk	Hong Kong	328	-do-	-do-
Frozen food (prepared carp)	China	150	-do-	-do-
Frozen food (fishball)	Taiwan	3,936	*E.coli*	Negative/0.01/g

Source : Imported Foods 1988 : Japan Food Hygiene Association (1988).

Table 5. Food sanitation inspection of imported food.

Fiscal Year	Case of Import (notification)	Ratio of Previous Year	Case of Inspection	% Inspected	Case of Violation ( )%
1970	175,380	114.6 %	11,507	6.6	1,841 (16.0)
1971	188,587	107.5	12,278	6.5	1,138 (9.3)
1972	211,191	112.0	15,556	7.4	1,529 (9.8)
1973	241,160	114.2	14,926	6.2	1,647 (11.0)
1974	202,007	83.8	19,322	9.6	1,339 (6.9)
1975	246,507	122.0	21,461	8.7	1,634 (7.6)
1976	284,846	115.6	20,616	7.2	1,182 (5.7)
1977	311,957	109.5	22,079	7.1	1,205 (5.5)
1978	335,085	107.4	18,498	5.5	1,163 (6.3)
1979	345,462	103.1	38,678	11.2	1,088 (2.8)
1980	314,177	90.9	33,949	10.8	1,066 (3.1)
1981	346,711	110.4	41,415	11.9	964 (2.3)
1982	319,617	92.2	37,227	11.6	569 (1.5)
1983	334,829	104.8	41,448	12.4	469 (1.1)
1984	364,227	108.8	47,080	12.9	444 (0.9)
1985	384,728	105.6	49,046	12.7	308 (0.6)
1986	477,016	124.0	73,116	15.3	558 (0.7)
1987	550,568	115.4	93,769	17.0	572 (0.6)
1988	655,806	119.1	138,388	21.1	1,000 (0.7)

Source : Imported Foods 1988 : Japan Food Hygiene Association (1989).

Table 6. Detention of *Vibrio cholerae* in imported fresh and frozen fish (1987-1989).

No. of finding	Commodity	Origin	Types of *Vibrio cholerae*	Quantity of disposal (mt)	Method of disposal	Quarantine office location
1987						
7.3	F. shrimp	Bangladash	OGAWA	2.196	Incineration	Yokohama
16.3	-do-	Philippines	-do-	6.840	-do-	Tokyo
25.7	-do-	Thailand	-do-	0.003	-do-	Osaka, airport
3.8	F. cuttlefish	Philippines	-do-	0.018	-do-	-do-
2.9	F. shrimp	Taiwan	-do-	0.044	-do-	-do-
12.9	-do-	Vietnam	-do-	5.180	-do-	Tokyo
13.9	-do-	Sri Lanka	INABA	4.350	-do-	Naha
25.9	-do-	Taiwan	OGAWA	11.873	-do-	Yokohama
17.9	-do-	Indonesia	INABA	0.5184	-do-	Muroran
18.10	-do-	Taiwan	OGAWA	3.000	-do-	Tokyo
27.11	-do-	India	INABA	2.980	-do-	Tokyo
1988						
1.2	-do-	Thailand	OGAWA	13.200	-do-	Moji
1989						
20.9	-do-	Philippines	INABA	0.0044	-do-	Narita
20.9	F. crab	Thailand	INABA	0.003	-do-	Narita
26.9	F. fish	Indonesia	INABA	0.0131	-do-	Narita
27.9	Chilled tuna	Indonesia	INABA	2.327	-do-	Narita

From 1987 to 1989 : Total 16 cases, disposal weight : 52.5499 mt

Remarks : F = Frozen

Type of *Vibrio cholerae* : OGAWA, INABA : Biotype eltor

Source : Quarantine Office, Ministry of Health and Welfare (1989)

trol, resulting from governmental and voluntary inspection in the exporting countries.

Finally I'll touch on the *Vibrio cholerae* problem. As you are aware *Vibrio cholerae* is a lethal infectious disease. Table 6 shows detection of *Vibrio cholerae* in imported fresh or frozen fish and shellfish from 1987 to 1989. In each instance, the cargo was disposed of by incineration.

I suggest that on your part, much can be gained through a little more understanding of the microbiological and food additive standards in the Food Sanitation Law of Japan, and through improvements in quality and hygiene control, especially in the handling of seafood.

Acknowledgement

For information on the inspection procedures for imported seafood, I wish to thank Mr A Matsumura and Mr R Ito for citations from "Food Sanitation Inspection of Imported Food in Japan" (Published by Japan Food Hygiene Association, 1980).

Discussion

In the ensuing discussion, it was pointed out that the method of analysis for bacteria and *Vibrio cholera* used in Japan may be different from the method applied in Southeast Asia. It was therefore suggested that Japan introduce a standard method of analysis and that SEAFDEC disseminate it to the Member Countries.

The Chief of MFRD informed the meeting that the Laboratory Manual on Analytical Methods and Procedures for Fish and Fish Products published by MFRD in 1987 will be revised. The new edition will include unified criteria and a method for the analysis of the presence of bacteria and *Vibrio* in food.

The subject of antibiotics which are commonly used in the culture of shrimp was discussed. To ensure that there would be no antibiotic residue in the tissues of shrimp, Mr Yamagata suggested that continued caution should be exercised in the use of antibiotics in shrimp culture and a safe withdrawal period should be considered.

Advances And Technical Problems Of Fish Processing In Southeast Asia

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The fisheries and fish processing industry in Southeast Asia has shown tremendous growth over the past decade. This is reflected in the extension of cold chain distribution systems, diversification of fish processing techniques, and advances in quality control hygiene and sanitation management. However, progress has been uneven from country to country, with change taking place rapidly in some and slowly in others.

In general, the people of Southeast Asia are fond of seafood. Also, except for Singapore and Hong Kong, these countries depend more on primary industries such as agriculture, fisheries, forestry and mining than on secondary and tertiary industries.

Most high-quality and high-priced fishery products are exported to developed countries to earn foreign currency, and this dampens domestic demand for products such as prawns and molluscs. Fig.1 shows the total production, imports and exports of major fish-importing countries in Southeast Asia. Fig. 2 makes a similar breakdown for major fish-importing countries. Table 1 shows per capita supply of fish for this region (1984-

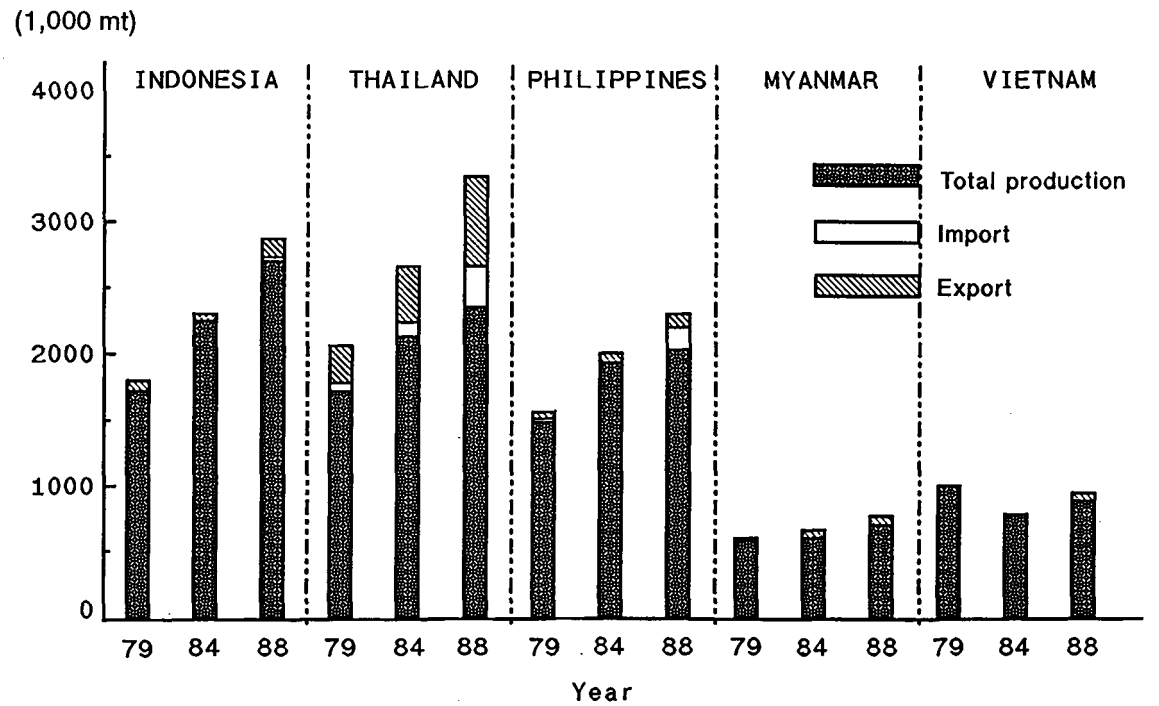


Fig. 1. Seafood export-oriented countries in Southeast Asia.

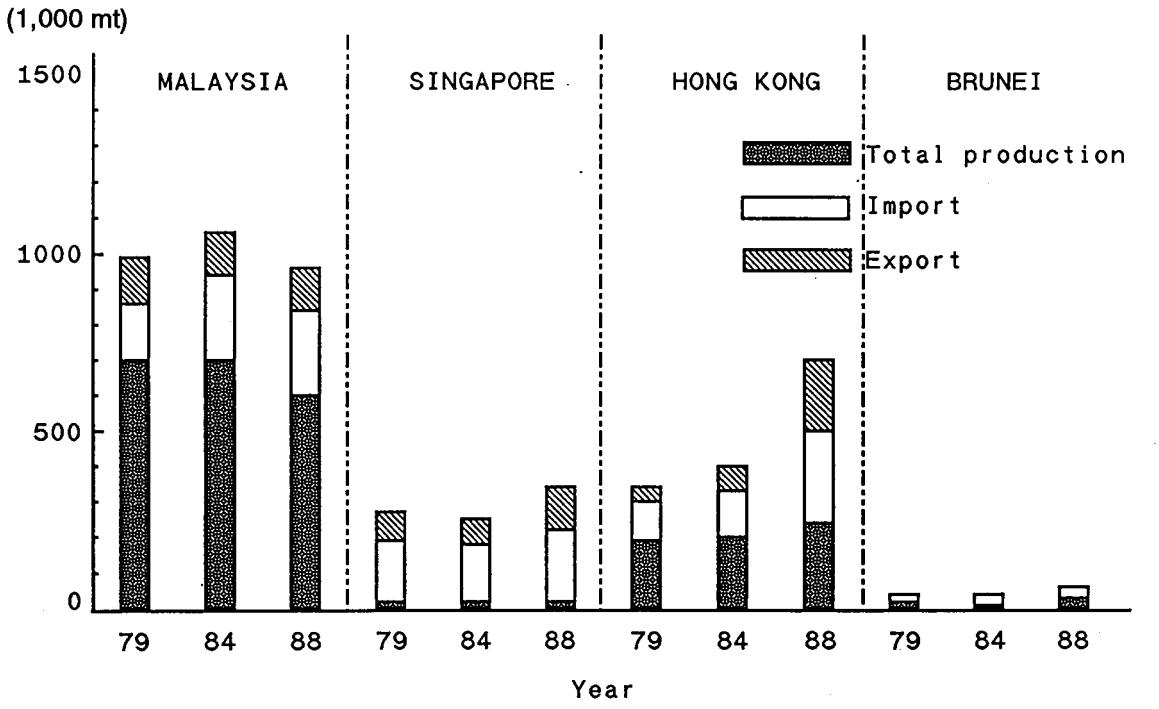


Fig. 2. Seafood import-oriented countries in Southeast Asia.

Table 1. Per capita supply kg/year* (1984 - 1986)

Country	Total catch (mt)	Non-food use (mt)	Import (mt)	Export (mt)	Population (1,000)	Per Capita supply (kg/year)
Major Exporter :						
Indonesia	2,370,720	12,726	5,879	102,185	166,421	13.6
Thailand	2,298,795	915,145	220,951	501,652	51,593	21.6
Philippines	1,907,366	0	14,805	72,105	185,721	33.7
Myanmar	626,074	20,000	0	8,464	37,544	15.9
Vietnam	-	-	-	-	-	12.5
Major Importer :						
Malaysia	638,077	110,225	246,644	208,499	15,450	36.6
Singapore	22,999	12,887	197,089	103,377	2,558	40.7
Hong Kong	203,808	12,762	205,715	145,478	5,462	46.1
Brunei Darussalam	2,657	0	7,159	245	224	42.7

* FAO Yearbook of Fishery Statistics, 1988 : (Total catch - Non-food use + Import - Export) ÷ Population

1986). Note that per capita supplies of the export-oriented countries are lower than those of the import-oriented countries. However, in every country the per capita supply is higher than the world average of 12.4kg/year.

It is generally accepted that the trawlable fishing grounds of tropical warm waters are narrower than those in temperate waters and that a richer variety of species is available in tropical waters. For this reason, the challenge of maintaining the marine fishery catch at the maximum sustainable yield (MSY) and of utilizing the trash fish catch will become more critical. On the other hand, the culture of fish and shellfish in tropical waters enjoys advantages over similar operations in temperate waters and can therefore be expected to develop rapidly.

Remarkable advances have been achieved in fisheries and fish processing in the Southeast Asian region in the following areas:

(1) tuna fisheries and processing,
(2) seaweed culture and processing,
(3) shrimp and prawn fisheries and processing, and
(4) surimi and comminuted products processing.

These improvements are discussed in greater detail below.

Tuna Fisheries And Processing

The total world tuna catch was about 3.2 million mt in 1984 and 3.8 million mt in 1988. In the same years the tuna catch in the Southeast Asian region was about 0.6 million mt and 0.9 million mt respectively, or 19 to 24 % of the world catch.

Table 2 shows the amount and species of tuna caught by countries of the region in 1984 and 1988.

The majority of tunas and skipjack are consumed as *sashimi*, canned food, steak and *katsuwobushi* in Japan, USA and Europe, and they accounted for about 80% of the total catch. There is a large market for *sashimi* and *katsuwobushi* in Japan while the USA and Europe are the main markets for canned tuna and frozen tuna block loins. The highest prices for tuna are paid in the *sashimi* and *katsuwobushi* markets; the prices of canned tuna, frozen tuna and frozen tuna block are at the lower end of the market.

Bluefin tuna, big-eye tuna and yellowfin tuna reach the *sashimi* market from Korea, Taiwan and Southeast Asian countries. Portions of the catch that lack freshness or that have been flawed by poor handling are transfered to the canned-tuna or other fish processing markets.

Longtail tuna, skipjack, eastern little tuna, albacore, bonitos and some yellowfin tuna are processed as canned products mainly in Thailand and the USA. The breakdown by country is shown in Table 3.

Recently, the pattern of canned tuna production has been changing with some of the U.S. and Japanese share being transfered to Thailand. In 1988, the share of Thailand was 21% of the world total; in 1990 it may be about 30%. The share of Philippines has been increasing slowly.

The majority of the raw material for canned tuna is imported into Thailand. The canned products are mainly exported to USA and EEC countries.

The light-coloured canned tunas manufactured from yellowfin tuna, longtail tuna and albacore are more expensive than the dark-coloured canned tunas manufactured from skipjack and bonitos. These raw materials are imported into Thailand from Japan, Taiwan, USA, Maldives, Papua New Guinea and the Solomon Islands.

There is also a similar trend in the processing of frozen tuna block loins in Thailand. The ASEAN region in general has several advantages in this area: proximity to good tuna fishing grounds, cheap and good labour, low operating costs, developed fish processing sector, reliable quality control, and political stability. Thailand enjoys the greatest advantage in the region, followed by Philippines and Malaysia.

So Thailand has now become the main center for tuna processing and output of canned products.

Most of the sailfish and swordfish caught by ASEAN countries are exported to Japan, and consumed as *sashimi*, steak and seasoned or fermented products.

Table 2. The catch of tunas in Southeast Asian countries, 1984 and 1988.

	Indonesia		Malaysia		Philippines		Thailand		Singapore	
	1984	1988	1984	1988	1984	1988	1984	1988	1984	1988
Total catch (mt)	256,827	349,668	34,063	37,739	244,805	296,058	87,202	161,633	836	575
Skipjack (*Katsuwonus pelamis*)	80,658	127,543			44,671	55,940			81	
Yellowfin tuna (*Thunnus albacares*)	30,697	42,979			54,924	57,060			417	549
Big eye tuna (*Thunnus obesus*)										
Eastern little tuna (*Euthynnus affinis*)			6,871	6,322	41,899	56,266	32,460	53,450		
Longtail tuna (*Thunnus tonggol*)			17,723	20,730	44,378	92,925				
Frigate tuna (*Auxis thazard*)				142	80,305	105,436				
Sailfish or swordfish (*Xiphias* & *Iseiophorus* spp.)				147	5,281	7,560				
King mackerel or narrow barred king mackerel (*Scomberomorus commerson*)	42,293	16,790	9,268	10,398	13,725	13,796	10,364	15,258	338	26

Source : FAO Yearbook of Fishery Statistics, 1988.

Table 3. Processing share of canned tuna (%).

Country	Year		
	1979	1984	1988
U.S.A.	46	37	27
Japan	15	16	11
Spain	10	7	7
Italy	7	7	8
France	4	5	5
Philippines	1	3	4
Thailand	0	5	21
Others	17	20	17
Total Production (mt)	602,213	783,022	996,603

Frozen tunas exported from ASEAN countries for the *sashimi* market must be very fresh with good meat colour. They must meet high standards of hygiene and they have to be frozen and stored under -40°C. The high level of technology needed to meet these requirements is currently available in the ASEAN region.

Although the raw material for canned tuna need not be as fresh or have as good meat colour as that used for *sashimi*, it must have uniform meat quality, good appearance, and be free of abnormal odour and extraneous substances. At the processing stage, in which dark meat is removed and the meat is put into cans, many labourers work together in the same place. At this point, quality control to preserve uniformity of the meat and to protect against contamination by extraneous substance, is most important. Utilisation of the by-products of canned tuna, such as the dark meat, and the raw waste, is an important aspect of the operation. The dark meat is generally processed as canned pet food.

As for local tuna products, smoked tuna has been processed in Malaysia and Philippines using small tuna. About 22 thousand mt were produced in 1988.

Smoked fish products are popular in the Southeast Asian region, especially in Philippines. Boiled tuna has been processed in the Tagalog region of Philippines, but because it is expensive, it is not processed widely.

Advances In Aquaculture And Related Processing Activities

Total aquaculture production by sub-sector and by country in Southeast Asia is shown in Fig. 3. In the Southeast Asian region, commercial aquaculture has developed vigourously under favourable conditions including the ready availability of solar energy and warm water. Primary aquaculture activities include mariculture of red algae in Philippines and Indonesia, brackishwater culture of milkfish in Philippines and

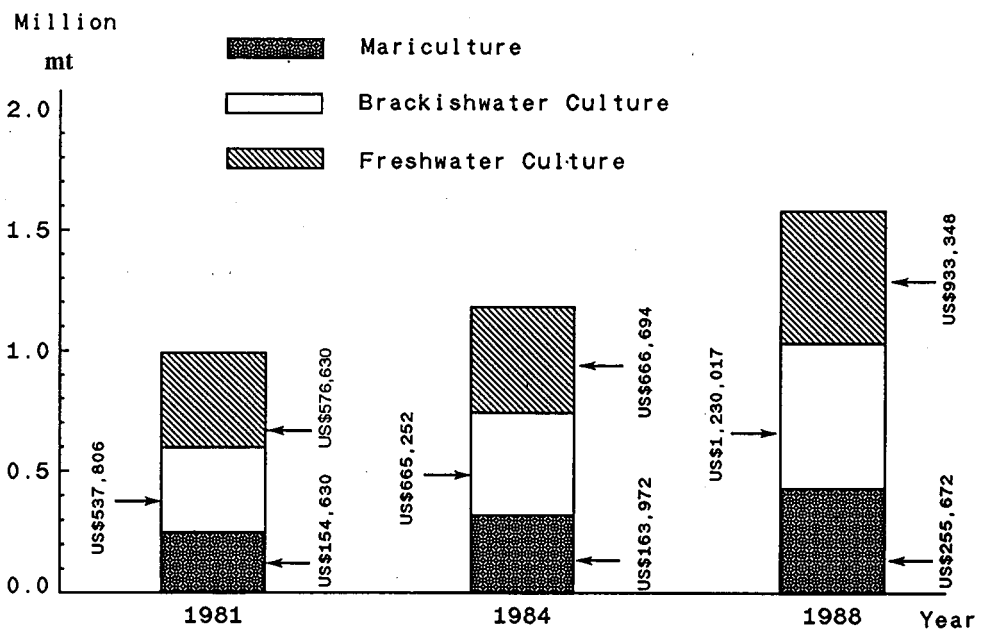


Fig. 3. Aquaculture production in Southeast Asia.

Indonesia, brackishwater culture of tiger prawn and white prawn in all Southeast Asian countries, freshwater culture of tilapia in Philippines, Indonesia, Thailand and Malaysia, and freshwater culture of freshwater prawn in Thailand.

Red Algae

Red algae production in the main harvesting countries is shown for 1985 and 1988 in Table 4. Total world red algae production was about 1.1 million mt in 1985 and about 1.3 million mt in 1988. About 60% is *Porphyra* spp. which is used mainly as human food. The remaining 40% comprises *Galidium, Gracilaria and Eucheuma* spp., and is mainly for industrial use.

Red algae cultured in Philippines and Indonesia are mainly *Eucheuma* and *Gracilaria*.

Table 4. Red algae production in the main harvesting countries.

(Wet weight : mt)

Country	Use	Year	
		1985	1988
China	Food Consumption	123,670	155,790
Japan		361,808	452,755
Korea Rep.		114,783	125,841
U.S.S.R.		10,804	11,538
Indonesia		427	540
Thailand		2	10
Indonesia	Industrial Consumption	55,250	90,800
Philippines		184,410	257,305
Thailand		4,231	990
Mexico		7,542	8,110
Chile		146,377	95,466
World Production		1,076,971	1,250,677

Source: FAO Yearbook of Fishery Statistics, 1988.

From these algae carrageenan and agar are extracted, respectively, and dried. Estimated world production of seaweeds used for colloids by region is shown in Fig. 4.

Alginate, agar and carrageenan are competitors with each other for a share of the international colloid market. Carrageenan has very similar characteristics to agar, and is sometimes called western agar. Carrageenan is more popular than agar in Europe and North America.

Southeast Asia produces about half of the world's supply of the raw materials of agar and carrageenan, and most of this is exported to USA and Europe. Nearly 70% of the world market for agar and carrageenan is in the food sector, where they are used as suspension, thickening and gelling agents. Residual non-food uses include the manufacture of bacteriological medium, toothpaste, cosmetics, glue of silk and solid air fresheners.

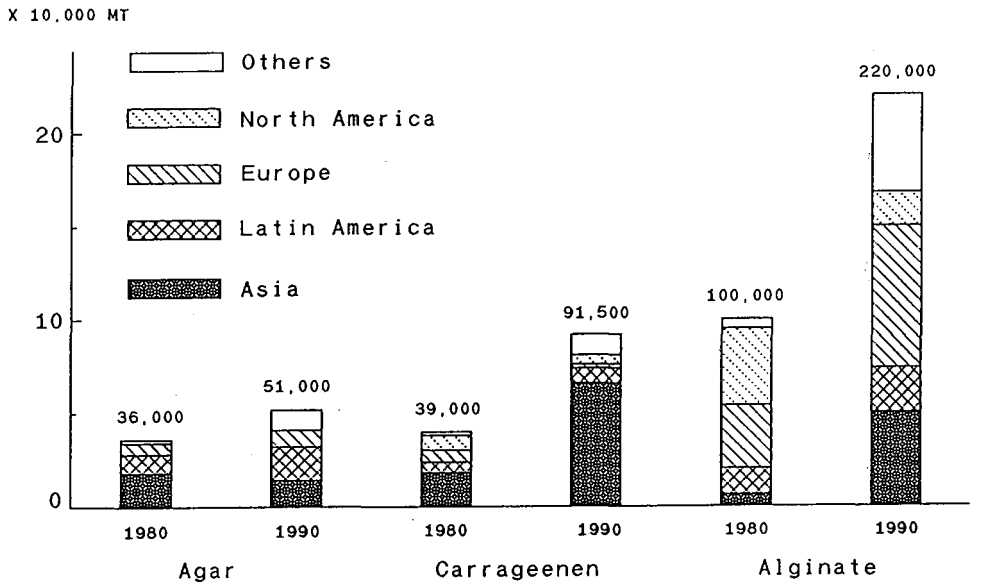
Because growth in demand for these products is slow, increased production has lowered the price of dried red algae. It is therefore necessary to encourage the production of value-added products incorporating this algae in producing countries. A red algae powder factory will probably be built in the region within this year.

Shrimp And Prawn

World shrimp and prawn production was about 2.3 million mt in 1984 and about 2.7 million mt in 1988. Shrimp and prawn production in the ASEAN region was about 560 thousand mt (marine catch 413,800 mt and aquaculture 146,300 mt) in 1984. It was about 664 thousand mt (marine catch 426,400 mt and aquaculture 237,400 mt) in 1988. These totals make up 24-25% of world production.

Aquaculture production has been increasing rapidly year by year. The species of shrimp and prawn caught and cultured in the ASEAN region are mainly tiger prawn, banana prawn and other *Penaeus* prawn.

Metapenaeus prawn, sergestid shrimp, and other species are also caught in the region. The main international markets for shrimp and prawn are the USA, Japan and the EEC, where warm-



Source: INFOFISH

Fig. 4. Estimated world production of seaweeds used for colloids by region in 1980 and 1990 (dry weight).

water prawns are considered separately from cold water prawns. Although it had been assumed that shrimp and prawn demand in the developed countries had peaked, demand has continued to grow. Most of the supply has been provided by warm-water shrimp and prawn.

Most of the shrimp and prawn supplied to the international market takes the form of frozen whole, frozen headed, and frozen, headed and cooked. Recently, transportation of live prawn has been increasing in the ASEAN region.

Improved equipment for the freezing of tuna is being introduced in some of the more advanced factories for production of IQF and for the prevention of prawn blackening. But the majority of cold storage rooms of commercial plants are about –20°C, so they are not suitable for long periods of cold storage.

Exporters of frozen tuna and frozen prawn are often expected to take the lead in adopting new and advanced technology. However, governments and the relevant organizations within the ASEAN region should emphasize the consolidation of food standards, the implementation of reliable inspection systems and ensure the safety of food products.

Within the region, Thailand has been taking positive steps in this direction. In 1988 about 60 thousand mt of canned shrimp was produced in Thailand, and this accounted for about 60% of the canned shrimp production of the world. The canned shrimp markets are in USA and EEC, but the demand is not large. ASEAN is in a very advantageous position for canned shrimp production.

Shrimp paste and shrimp sauce made of small shrimp such as *Acetes* spp. are very tasty and popular traditional fish products in this region, and are mainly manufactured in Thailand and Malaysia. Technical development in this area has been very slow, but it can be further improved by food packaging techniques.

Frozen Surimi And Surimi-Based Products Industry

Frozen threadfin bream surimi production in Thailand started in 1984 in earnest and its production reached about 25 thousand mt in 1988. Of this, about 20 thousand mt, was exported to Japan. The remainder was exported to Singapore and other Southeast Asian countries.

In 1988, world frozen surimi production was about 490,000 mt with ASEAN production accounting for about only 5% of the total. The quality of frozen threadfin bream surimi remains very stable during cold storage.

In 1988, trawl-by catch made up about 10% of the total marine fish caught in Thailand, and about 20% of the total marine fish caught in Malaysia.

Selected by-catch species could be used as raw materials for surimi and comminuted products; these include threadfin bream, croaker, big eye snapper and lizard fish. Minced fish meat is produced in many Asian countries including Taiwan, Hong Kong, Singapore, Malaysia and Myanmar now.

Many kinds of surimi-based comminuted products are manufactured in Southeast Asian countries, as shown in Table 5. Several fish species, including demersal fish, pelagic fish, molluscs and shrimps are used as raw materials of the comminuted products. Fish cakes mixed with coconut milk such as *otak otak*, are very popular. Since the shelf lives of the comminuted products are normally only two or three days at 5°C, distribution of the products is limited.

In Singapore, the cold chain of food distribution is quite well developed and in recent years a greater variety of comminuted products has been manufactured. The main use of raw materials for comminuted products has shifted from fresh fish to frozen surimi, and the supply of raw materials has been stable. Due to the shortage of labour in Singapore the next step is in the development of automatic manufacturing equipment to increase productivity.

Because comminuted products are generally sold in supermarkets the products must be packaged. Food packaging technology in Southeast Asia has shown remarkable advances recently, but technical competence varies significantly amongst the ASEAN countries.

Problems And Solutions

Improvements In Traditional Fish Processing Technique

Improvements in fish processing techniques and equipment are important in commercial production. High value, processed products such

Table 5. Comminuted products in Southeast Asia.

Country	Products
Brunei	Fishball, fishcake
Indonesia	Fishball
Malaysia	Fish sausage, prawn sausage, cuttle-fish ball, prawn *wantan*, prawn burger, prawn dumpling, scallop flavoured fishcake, fish burger, cuttlefish sausage and cocktail, fishball, fishcake, *otak-otak*
Philippines	Native sausage, fishball, fish burger
Singapore	Fishball, fishcake, cuttlefish/squid balls, imitation crab sticks
Thailand	Fishball, fish noodles, frozen surimi, imitation crab sticks

Source: Southeast Asian Fish products, 2nd ed., 1991. MFRD/SEAFDEC.

as exported frozen tuna, frozen prawn, frozen molluscs, canned tunas and canned shrimp, normally require the use of new, imported equipment. At the same time it is necessary to access current international information on such matters as fish processing techniques, quality control techniques, sanitary management of the factory, etc. The exporting industry has systems for the collection of this information.

On the other hand, traditional fish products are manufactured by small-scale producers and the rate of technical advance here is very slow. In this sector, the collection and transfer of technical information is difficult. If the price of the traditional fish products increased, their consumption will gradually decrease. So improvement to the quality of these quality has to be achieved by the use of low-cost methods. This is very difficult technically and more experimentation and research is needed.

Scientists and technicians working in the government and relevant organizations should therefore concentrate on improving the technology of the traditional fish processing sector.

Transfer Of Technology And Dissemination Of Information

The technical differences between ASEAN countries is very great and this may be a political and economic problem. But economic and technological development can be accelerated by cooperation and competition.

The Marine Fisheries Research Department has been providing extension services for the transfer of post-harvest technology to the Southeast Asian region since 1980. These have covered surimi and surimi-based product processing techniques and fish handling and fish preservation procedures. I believe the regional training courses have been useful for technologists, and that demonstration courses have been useful for fish processors. Study tours of fish markets, retailer markets and fish processing factories in advanced nations have been most useful for traditional fish processors. Such tours should also be planned for the processors of each country.

Variety Of Frozen Surimi

The main raw material used for making frozen surimi is the threadfin bream. In Thailand, limited supplies of demersal fish such as threadfin bream, big-eye snapper, and lizard fish make it difficult to maintain the amount of frozen surimi for export. Since consumption in the ASEAN region is low, this is not a severe problem. But the variety of frozen surimi is a current feature of the world surimi market. There are few data on the gel-forming ability of warm water fish.

We must collect more data about their suitability as fish jelly products. The quantity and quality of underground and tap water is very important to the fish processing industry, especially in frozen surimi processing.

The processing of frozen surimi requires twelve times as much water as the processing of raw fish and the quality of water affects the gel-forming ability and microbiological quality of the product. It is therefore important to pay attention to the microbiological and chemical quality of the water.

Large Scale Fish Processing In Southeast Asia

Large fish processing bases appear to be developing in Thailand and Philippines.

The necessary raw materials needed are often imported while the final products are exported throughout the world. One problem is that by-products and waste waters are often discharged untreated. There is a need to look into the treatment and effective utilisation of these processing wastes and it can be expected that these will become important research themes in the future.

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Discussion

In the discussion of per capita fish consumption, it was noted that estimation may vary from country to country in the region. It was suggested that a standard method of computing the per capita consumption be used based on the FAO method of estimation.

From Basic Research To New Industries Within Marine Biotechnology: Successes And Failures In Norway

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Introduction

In this paper we present a summary of the development within "marine biotechnology" in Tromsoe/Norway, covering

a) Infrastructure in Tromsoe
b) R & D programmes (main areas)
c) R & D results
d) New commercial companies, and
e) Experience from development of these companies.

In the city of Tromsoe, Norway, a network of academic research, higher education and commercial activities within fisheries and aquaculture has been developed, creating a good environment for the development of new biotechnological industries.

Development Of Infrastructure In Tromsoe/Norway

As a result of overall planning at governmental levels in Norway during late 60's and early 70's, combining:

a) Norway's strong position and interest in harvesting fish from the sea and improving our production of food products, and
b) politics for regional development,

the Norwegian government decided to establish the following new institutions:

- The University of Tromsoe, with the Norwegian College of Fishery Science (NFH) (1972),
- The Norwegian Fishery Research Council (NFFR) (head office in Trondheim), (1973),
- Institute of Fishery Technology Research (FTFI) (1974). Since 1991, it has become the Norwegian Institute of Fisheries and Aquaculture (Tromsoe).

Tromsoe is located far north in Norway, where fishing and, frequently aquaculture are the backbone activities of commercial life. Approximately two-thirds of the total catch in Norway is caught in the sea off the coast of northern Norway. The city is a center of higher education and research; in relation to areas such as marine biotechnology and aquaculture it has the status of a national center. The Norwegian College of Fisheries Science under the University of Tromsoe, and the Norwegian Institute of Fisheries and Aquaculture are the two institutions in Tromsoe which are responsible for education, research and industrial innovations. The Institute has the primary purpose of transfering the results from basic and applied research into practical applica-

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Note: This paper was presented at the Seminar by Dr Strøm.

tion and to formulate problems, tasks and challenges which may influence the research priorities within the University. These two institutions have throughout the last 15 years worked closely together, both with regards to personnel and research projects. This has been one very important factor for a successful transfer of research results into commercial products and processes.

The development in Tromsoe has been financed by R & D grants from the Research Council, by funds directly from the Norwegian Ministry of Fisheries for investments in infrastructure (offices, laboratories, etc) and by funds for regional development from other governmental ministries.

R & D Programmes

The social environment and affiliated commercial activities of Tromsoe and northern Norway were (and are) strongly dominated by fisheries. Recently aquaculture is also playing an important role. The exposure of the R & D institutions and their researchers to the daily realities of these activities, has influenced (and influences) strongly the choice of R & D. With the advantage of starting new activities in the mid 70's from scratch, a concentration of R & D in a few selected areas was easily accomplished, thereby making good use of limited funds.

Two initial areas of research with major implications for academic research and establishment of commercial companies in the marine biotechnology sector of Tromsoe were:

- utilization of fish processing waste, primarily fish viscera, and
- fish diseases and the microbiology of marine bacteria which are pathogenic to fish (*Vibrio* spp.).

The first project was a joint R & D project between NFH and FTFI, wherein the researchers at NFH concentrated on fundamental questions related to fish silage and its application, and in which FTFI developed processes for industrial production and applications.

Scientists at NFH were also involved in R & D related to aquaculture, including disease prevention by vaccination and other aspects of fish health. Thus, with the development of aquaculture in Norway, an overall approach to R & D within marine biotechnology, combining activities/possibilities in fisheries and aquaculture, was gradually developed (See Fig. 1).

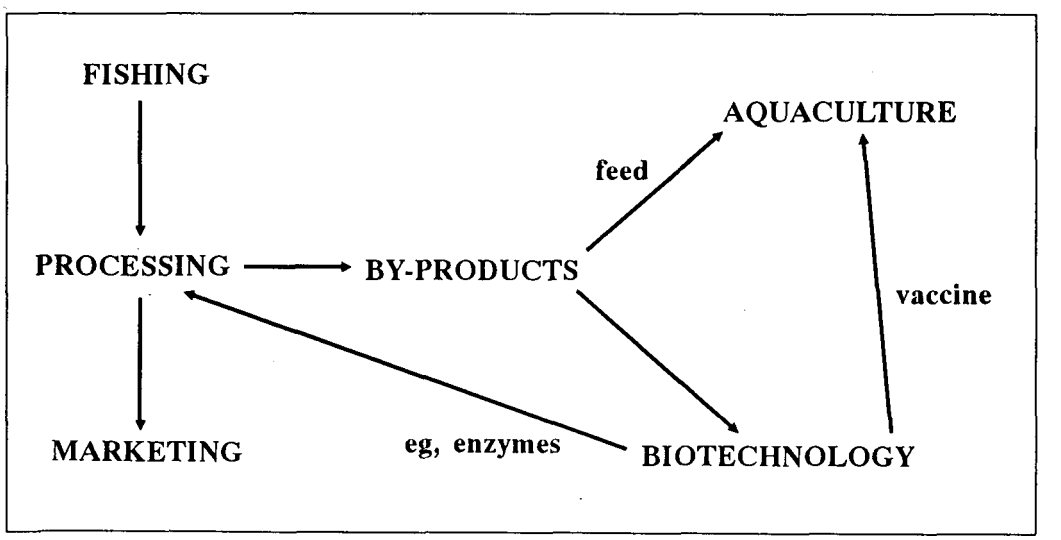

Fig. 1. Schematic illustration of fish processing and utilization of by-products in fish processing and aquaculture.

R & D Results And Commercial Applications

Some of the R & D results from the activities in Tromsoe will be described in the following with reference to application and commercial production. More details of the commercial companies involved are given in a later chapter.

Biochemicals From Fish Waste

Utilization of fish processing waste; the silage technology

Fish processing waste, and in particular fish guts, was a pollution problem in Norway when NFH/FTFI started to look into the potential applications of this very interesting raw material, containing enzymes and other interesting biomolecules. The first product to be developed was a deoiled fish silage which was used as feed for domestic animals, including farmed fish. For review see Raa and Gildberg (1982).

A silage of fish guts preserved by adding acid will be digested by enzymes present in the gut and thereby become liquid with a layer of oil on the surface. Studies of the biochemistry of this autolytic process (Raa and Gildberg, 1976) and of the enzymes involved (Gildberg, 1982) indicated new possible uses of fish viscera. A process for the industrial production of silage concentrate was developed (Raa, Gildberg and Strøm, 1983). Basic studies on the mode of attack by fish enzymes on various biological tissues of fish and other organisms gave rise to ideas for new applications of fish enzymes in the processing of food (Gildberg and Almås, 1983).

Liquid Fish Protein Concentrate

Based on the silage technology, A/S Rieber & Co produced a concentrate (45% dry weigth) of the aqueous solution which results from autolysis of fish waste. This concentrate is used in extruded fish feeds and is added as a liquid prior to the extrusion process. The feed pellets which contain this concentrate have good functional properties and there is less dust both in the production plant and in the final product. The concentrate has a protein value corresponding to the best quality LT-fish meal (low temperature dried) and apparently also contributes to the attractant properties of the feed. The production plant in Tromsoe has a capacity to produce 20,000 mt per year.

Proteases and peptone

Enzymes and peptone from fish viscera are produced by Marine Biochemicals A/S in a process which involves

- acidification
- autolysis by enzymes present in the fish guts, and
- ultrafiltration and purification of the aqueous phase, yielding a mixture of enzymes (mainly pepsins) and an ultrafiltrate containing a mixture of amino acids and peptides.

Pepsins in the stomach of fish are stable in acid and can be filtered off after complete liquefaction of an acid silage of fish viscera. The properties of pepsins from fish differ significantly from those of pepsins from warm-blooded animals; fish pepsins will therefore not necessarily compete with other pepsins on the market.

The ultrafiltrate, after removal of enzymes from acidified and autolysed fish viscera, is rich in amino acids, peptides and other extractives of fish. When the ultrafiltrate is neutralized, the clear liquid is spray-dried to produce a peptone powder. This powder dissolves completely in water and forms a clear solution that is a better growth medium for certain bacteria than other commercial growth media (Clausen, Gildberg and Raa, 1985). This marine peptone particularly favours growth of marine bacteria and of lactic acid bacteria (Vecht-Lifskitz, Almås and Zomer, 1990). Therefore potential commercial applications are in the production of fish vaccines and of lactic acid bacteria used as starter cultures in preservation of

grass silages, and eventually also of a fermented fish silage.

Nucleotides/nucleosides

In a joint venture with the fish processing industry in Norway, Marine Biochemicals A/S produces DNA from fish milt, and nucleosides from the same DNA by enzymatic hydrolysis (Gildberg and Almås, 1986). The market for the former product is the cosmetics industry; the latter is used as raw materials in the biochemical industry.

Enzymes from shrimp; alkaline phosphatase

When frozen blocks of shrimp are thawed in water before processing, enzymes are eluted. One of these enzymes is alkaline phosphatase. After removal of particles, the water is ultrafiltered and the alkaline phosphatase purified by an exchange chromatography (Olsen, Johansen and Myrnes, 1990). This enzyme has properties that are important in its use as a tool in diagnostic analysis. Sales have begun to producers of diagnostic kits.

The Use Of Enzymes In Fish Processing

The pepsins and other proteolytic enzymes (trypsins, chymotrypsins, peptidases) present in fish and other marine organisms differ significantly from their counterparts in warm-blooded animals and offer distinct advantages for certain applications(Gildberg, 1982). For example, the fish pepsins have a higher pH optimum than other pepsins and they are active at low temperature and they are very resistant to autolysis at low pH. It has also been demonstrated that fish enzymes may have distinctly different pH optima when acting on different tissues. Lysozymes of scallops and blue mussels are active at acid pH and they retain 40% of maximal activity at 4°C. Moreover, these lysozymes are able to attack the cell wall of Gram-negative bacteria without the presence of chelators (Myrnes, 1991).

Fish tissues and the tissues of marine invertebrates differ very much from corresponding tissues of warm-blooded animals with regard to sensitivity to various enzymes. This understanding of the mode of action of marine enzymes on various tissues, combined with knowledge of the sensitivity of various tissues of marine organisms to a long series of enzymes, also of plant and animal origin, formed the basis for a very specialized expertise in Tromsø. Specifically, this relates to the use of enzymes as processing aids, and the abilities to biochemically dissect and separate biological tissues.

A number of such enzymatic processing methods have been further developed by the company KS Biotec-Mackzymal to a state of high sophistication. This company can now provide complete processing lines, designed according to the specifications given by the enzyme technologists. Some of these processes are summarised below.

Enzymatic caviar production

The eggs of fatty fishes are firmly attached to the connective tissues of the roe sacs. Even though mechanical processing of roe is feasible with several fish species this does not apply to many fatty fishes whose eggs are too fragile to survive the treatment. Mechanical caviar production of roe from such fishes normally involves rubbing the roe against a sieve or screen. This results in high damage and poor yield. Thus, there are a number of fish species from which the roe cannot be converted into caviar, but in which the extent of roe maturation may also make processing impossible. The raw materials available for the production of high value caviar for the delicatessen market are therefore limited.

However, the eggs can be released from the connective tissues using enzymes that selectively degrade the connective tissues without damaging the eggs. The strength of individual eggs can also be adjusted at will to meet the requirements of various markets. KS Biotec-Mackzymal supplies the enzymes necessary for performing that process

and the processing lines where such caviar is produced.

The main advantages of enzymatically produced caviar compared with that produced mechanically can be summarized as follows:

- Better recovery (up to 92%, depending on species).
- Less damage to the eggs (makes production of other roe types and a wider variety of maturity possible).
- Cleanliness of product with no residues of connective tissues.
- Less drip loss during thawing if the resulting caviar is frozen.
- Less labour is required for processing.
- Good hygiene in production.

KS Biotec-Mackzymal has demonstrated the viability of the technology with the following salmonid fishes:

- Chum salmon (*Oncorhynchus keta*)
- Rainbow trout (*Oncorhynchus mykiss*, previously *Salmo gairdneri*)
- Pink salmon (*Oncorhynchus gorbuscha*)
- Atlantic salmon (*Salmo salar*)
- Coho salmon (*Oncorhynchus kisutch*)
- Sockeye salmon (*Oncorhynchus nerka*)

The method can most likely also be used to produce caviar from flying fish (*Hilsa* spp.), ocean catfish (wolffish) (*Anarhicaslupus*), paddlefish, sturgeon, catfish, mullet, carps (eg, *Cyprinus carpio*), whitefish and bowfin.

Complete processing units are delivered for the production of caviar by the enzyme method, and outside Norway the technology is being licenced to customers in the Soviet Union, Finland, Denmark, Faroe Islands, United Kingdom, Australia, USA and Canada.

Enzymatic removal of squid skins

Specific squid skin degrading enzymes have been found in the intestine of the squid itself, and in various plants. However, preparations of such enzymes also contain proteases which degrade the muscle. For practical use it was therefore necessary to make an enzyme preparation in which the protease activity was low. With such a preparation an industrial squid deskinning line which produces skinless tubes, wings and tentacles from various squid species could be established.

KS Biotec-Mackzymal in collaboration with the Danish company Carnitech, has developed a processing line for deskinning of squid. The method can be used on the following types and genera of squid:

- *Illex* spp.
- Flying squid
- *Todarodes* spp.
- *Nototodarus* spp.
- Cuttlefish

The muscle and tentacles of many squid species are too tough to be accepted well on certain markets. By including more of the proteases in the same enzyme preparation used for deskinning, the product can be tenderised simultaneously. The enzymatic tenderising process also results in improved taste of the product, in particular of the tentacles.

Some other enzyme processes

Some enzyme processing methods other than those described above have been shown to work in practice and to have clear economic advantages. But development work necessary for market introduction has not yet been carried out. Examples of such processes are the use of enzymes to remove scales from fish, to remove or tenderise skin of herring and tuna. One process which has been developed, namely loosening of shrimp shells from the muscle, is now ready to be adopted in industrial peeling of shrimp (patent pending).

The Use Of Enzymes In Fish Feeds

Studies of the digestive processes of fish suggest certain applications of enzymes as digestive aids in feed for fish.

Feed pellets disintegrate quickly in the stomach of fish. The slurry which is formed passes on through the pylorus node after a relatively short time of exposure to the stomach pepsins. It is therefore assumed that a large proportion of protein particles rather than soluble peptides are transported to the gut when fish consume pelleted feeds. Natural preys are, in contrast, digested from the surface and inwards in a process which releases a soup of peptides. It is further assumed that protein particles in the gut may create an overloading of its digestive capacity. To compensate for the short exposure time in the stomach, fish pepsins may be added to the fish feed as a digestive aid. The pepsins produced by Marine Biochemicals A/S have been shown to enhance growth of fish, and the company manufactures and exports pepsins for this application.

Fish Vaccines, Adjuvants And Prophylactic Agents

Vaccines

Studies of the microbiology of marine vibrios that cause disease in farmed salmonids were made at the University of Tromsoe in 1973. Cold-adapted strains of *Vibrio anguillarum* were isolated from farmed fish in north Norway and it was shown that environmental contaminants reduce the resistance of fish to vibrioses (Egidius *et al*, 1982; Olafsen, Christie and Raa, 1981). A novel disease in Norwegian fish farms was discovered in 1979. Researchers in Tromsoe and at the Marine Institute in Bergen were, in 1981, able to demonstrate that the disease was caused by a hitherto undescribed *Vibrio* species. The disease, which has been called "Hitra-disease", soon became the most serious threat to the Norwegian salmon farming industry, causing losses, which, in 1987 amounted to more than 200 million Norwegian kroner (30 million US$).

The research community in Tromsoe had the necessary qualifications and experience to quickly develop a vaccine against this disease (Espelid, Hjelmeland and Jørgensen, 1987). After a thorough description of the biochemistry and growth characteristics of the disease causing organism, which researchers in Bergen designated *Vibrio salmonicida*, the time was ripe for pilot-scale production and efficacy-testing of a vaccine. This was produced on a commercial basis by Apothekernes Laboratorium A/S, a pharmaceutical company which diversified into this sector when it established the fish vaccine production plant in Tromsoe.

The vaccine against "Hitra-disease" is very efficient, causing a more than 90% protection against the disease. As a result, the use of antibiotics in Norwegian fish farms dropped drastically and fish farmers have avoided potential losses in the range of 300-400 million Norwegian kroner a year. In other words the economic gain from this project is of an order of magnitude higher than the total costs of the research and development work which formed the basis for the vaccine.

Furunculosis in salmon, caused by *Aeromonas salmonicida*, first became a serious problem for Norwegian fish farmers a few years ago. The bacterium quickly develops resistance to antibiotics and, moreover, has the ability to escape the action of the immune system of fish. Conventional vaccines against this disease have therefore not been very effective.

Adjuvants/immunostimulants

Recently a new adjuvant and general immunostimulant has been developed in Tromsø and is now being produced commercially by the company KS Biotec-Mackzymal. The immunostimulant is a ß-1.3/ß-1.6-glucan derived from yeast. Its trade name is MacroGard.

A series of experiments have demonstrated that MacroGard alone causes a substantial increase of resistance in fish to a number of different diseases (Robertson *et al*, 1990). The compound is effective, both after injection and when administered in the feed. When used as an adjuvant

in a vaccine prepared from killed *Aeromonas salmonicida*, the degree of protection has been about 90%. A furunculosis vaccine with MacroGard as adjuvant has recently come in commercial production in Norway.

MacroGard induces increased resistance against many diseases simultaneously, by activating the macrophages. When animals are treated with glucans, their macrophages produce more interleukin, a polypeptide which activates B- and T-lymphocytes. The lymphocytes then produce interferone-like molecules which activate the macrophages so they become more active in engulfing and killing of bacteria. This in turn leads to a cascade of events which results in higher general resistance to infection by both bacteria and viruses.

Scientific Expertise In Tromsoe

Based on the activities in Tromsoe over the last 15 years a strong scientific network has been established. Applied fundamental research is carried out as well as applied R & D within:

- *Enzyme biotechnology*; purification, industrial production and application of enzymes.
- *Fish health*; production of vaccines against bacterial fish diseases and application of feed additives (eg, glucans) in preventive health treatment.
- *Fish immunology*; research on defence mechanisms against fish diseases.
- *Fish nutrition*; development of feed, eg, starter feed for marine larvae and fry, fermented feed and fish silage.
- *Microbial ecology*; studies of the influence of the environment on micro-organisms and fish health.

New Commercial Companies In Tromsoe

In the previous chapter we have given a brief description of some R & D results from projects carried out in Tromsoe. These projects have given results that have been and are being commercialized. Initially, the researchers studied the possibility of improving the utilization of fish raw material, eg, fish waste. Some of these options looked commercially promising and the companies involved are scaling up for production based on market opportunities and requirements.

Commercial Production And Companies In Tromsoe

In Tromsoe (and northern Norway generally) few companies have the financial resources, know-how and production of products to take commercial advantage of these R & D results. In fact, very few companies in all of Norway are strategically and finacially able to do so. In the mid-80's the environment favoured the starting up new businesses, in high-technology production fields, including marine biotechnology and aquaculture. Contacts at personal and institutional levels resulted in the establishment of the companies in Tromsoe as shown in Table 1.

The products that these companies are producing and developing on commercial scale which have been presented in the earlier chapter, are summarized below:

1. KS Biotec-Mackzymal	Enzymatic processing, adjuvants, others
2. Marine Biochemicals	Biochemicals: pepsin, peptone, DNA, ALP
3. Apothekernes Lab.	Vaccines

Additionally, the production of fish silage concentrate is carried out by Rieber & Co, Tromsoe. This company has long been involved in small scale production of marine lipids. The combined production of lipids and silage concentrate is carried out in a large scale operation (20,000 mt per year).

These Tromsoe companies represent a powerful base for expansion into viable commercial operations. This opens the door to possible production of a wide range of products made from marine raw materials, for use in fish processing, in pharmaceuticals and in other items.

Table 1. Marine biotechnology companies established in Tromsoe.

Company	Year	Owners
AS Biotec	1984	- Professor J. Raa and graduate students
	1985	- 90% Selmer Sande Biocomp. (SABICO)
	1990	- Initial owners 100%
Mackzymal	1986	- AS Biotec and L. Macks Brewery, Tromsoe
KS Biotec-Mackzymal	1990	- AS Biotec, L. Macks Brewery and Provesta (Phillips Petroleum Company)
Marine Biochemicals AS	1985	- Norsk Hydro (largest Norwegian Company)
	1991	- Employees: T. Strøm and J. Raa
Apothekernes Lab. Production unit in Tromsoe (vaccine)	1986	- Apothekernes Lab. AS

Factors For Success And Failure

Documentation/Markets

The overall aim in commercial applications is to meet market requirements. For new products, extensive documentation is required to convince potential buyers to make their first purchases. The new companies in Tromsoe have found that documentations compiled in collaboration with scientists from universities or R & D institutes have high credibility and build confidence in the new enterprises.

Production

Production of the vaccine developed in Tromsoe against salmon disease began after a heavy investment in a modern production plant. With close cooperation from government agencies in approving the vaccine and by strong marketing efforts, full scale production and sales quickly developed.

The other companies experienced a more traumatic development, resulting in financial difficulties after 2-5 years and final sale of the companies to new owners. These included the founders and key personel of these companies. One reason for this outcome was lack of investment in production facilities; the financers required reliable cash flow analyses prior to investment, which the project leaders were not able to give. Without this investment, the companies could only "sell" potential production on the basis of laboratory-scale production. This slowed down the demonstration of commercial applications to actual customers.

Both KS Biotec-Mackzymal and Marine Biochemicals AS have now industrial production facilities for their products.

Time From R & D To Positive Results

New companies in Norway have generally found that the time required for developing R & D results into commercially viable production is 5-10 years. This is a longer period than expected by

researchers and economists in the mid-80's. In addition, the general situation in aquaculture was not so promising in 1990, as it had been a few years previously. As a result, the economists who had supported foundation of two of the new companies lost faith in their investment possibilities. This resulted in sale of the companies to new owners.

Equity Capital

The new Tromsoe companies have made heavy investments in equipment, in the order of 100 million NOK (15-20 million US $). Only companies with strong financial base are willing to invest in such high risk/long term projects, as the projects above admittedly are.

However, no industry can be developed without risk capital to finance the final preparations for pilot-scale and industrial productions. And more money is needed when the time comes to invest in production facilities, product control and market introduction.

Summary Of Our Experience

On the basis of 15 years' experience in R & D and industrialization, we offer the following summary of requirements important to success:

1. Development based on natural advantages related to resources and industrial traditions
2. Network with academic R & D groups
3. Entrepreneurs with innovative strength, intuition and profound knowledge of the products and its applications
4. Investment in pilot plants and industrial production facilities prior to reliable cash-flow analysis
5. Government funding support
6. Long term investors (5-10 years)
7. Personal involvement in the companies of key employees.

In addition, our work in Tromsoe since 1975 indicates that there are very few short cuts to success. Success requires hard work at every stage, from research to commercial-scale production and marketing.

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Discussion

Dr Strøm informed the meeting that the enzymes used in the production of high-quality caviar are commercially available and are distributed by a Norwegian company.

Because very few peptones are produced worldwide, documentation on peptones is required.

Storage Lives Of Chilled And Frozen Scampi

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Introduction

Scampi are a highly prized seafood and the discovery of a potential resource off the north-west shelf of Australia by CSIRO (Anon,1983) was greeted with excitement by the industry. Further research on the extent of the grounds by CSIRO was supported by the Fishing Industry Research Committee and this provided the unique opportunity to do post-harvest research on a fishery before it was fully commercially exploited.

The north-west shelf area of Australia lies between 10° and 20° south of the equator and is hot and remote with a coastal region that is sparsely populated and which has no processing infrastructure. Unlike the European fishery for *Nephrops norvegicus*, where the scampi are trawled or trapped inshore in shallow waters and may arrive live at the processors, the Australian resource is found in deeper offshore waters and is trawled for at depths of 200 to 500 metres or more (Davis and Ward, 1984). As a result they are landed dead and warm, having travelled slowly up through the hot surface waters. It is industry practice to sort, clean and freeze the scampi as soon as practical. The tails are removed from any damaged scampi and also frozen in separate packs. The trade is thus in frozen packs of whole scampi or scampi tails. Therefore it was important to determine whether significant changes occurred during frozen storage and on subsequent chilled storage after thawing.

This paper summarises work reported in detail previously (Bremner 1988a, 1988b) in which three species of scampi (*Metanephrops andamanicus, M. australiensis and M. boschmai)* were held frozen for up to 12 months and were evaluated in subsequent chilled storage after thawing. Results of chilled storage trials on *M. andamanicus* (Bremner, 1985) are also included.

Approach

Experiments that evaluate the changes that occur to fish stored in ice are a recognised baseline in seafood technology research and, as in all storage experiments, the initial results are critical in determining the inherent properties of the species and in providing the basis for measuring both absolute changes and rates of change. Logistics prevented this approach on all but one of the scampi species since they are caught on different grounds some days steaming apart (Davis and Ward, 1984) and the distance from the laboratory (3000 km) meant that four days elapsed before they could be evaluated.

The scampi were evaluated at all stages of the experiments by visual inspection, microbiology, nucleotide changes, chemical analysis and by sensory evaluation of the cooked flesh both hot and cold.

Materials And Experimental Outline

A full description of the materials, experimental outline and sensory techniques has been given previously (Bremner, 1985, 1988a,b) and only a brief outline will be included here.

The scampi were caught off the north-west shelf of Australia during February 1984 by the FRV *Soela* using a modified Engel prawn trawl. After sorting, measuring and weighing, they were hand-washed and both whole animals and tails, which had been removed by hand, were frozen on board in a blast freezer to a temperature near -30°C. They were transferred to a holding freezer (-20°C)

until the ship berthed in Hobart six weeks later, when the boxes were transferred to the storage freezer (-18°C). Whole *M. andamanicus* from the last haul on the return to port were packed in ice and air freighted to Hobart.

Analytical Methods

Protein, moisture, fat, and ash (AOAC methods), glycogen and saline extractable protein (SEP) were estimated. Nucleotides were determined on neutralized $HClO_4$ extracts of 10 g of flesh by HPLC using paired ion chromatography to separate homarine from the nucleotide peaks. Bacterial estimations were made on tryptone soy yeast agar using saline extracts of 10g scampi flesh and Gram-negative isolates were identified.

Sensory Methods

Visual inspection was done according to a demerit point scheme developed in the laboratory. Scampi cooked in boiling water were served hot to the taste panel. Odour and flavour profiling was done by the free choice method where panellists could score for a large variety of descriptive terms on a scale ranging from 0(absent) to 9(strong). In addition, it was compulsory for tasters to score for the attributes of typical odour, off-odour, typical flavour and off-flavour on 0-9 scales and also for the acceptability of odour, flavour and overall acceptability on the 1-7 hedonic 'Smiley' facial scale (Street and Carroll, 1972). Textural properties were also assessed using a 1-9 scale ranging from very wet(1) to very dry(9), very soft(1) to very firm(9), not springy(1) to very springy(9), very tender(1) to very tough(9), reduces water in the mouth(1) to increases water in the mouth(9), and not fibrous(1) to very definite fibres(9). All the tasters were very experienced at tasting seafoods by this profiling method; however two round table familiarisation sessions were held before the start of the experiment.

An acceptability panel also evaluated chilled cooked scampi served on lettuce for flavour, texture and overall acceptability on the seven point 'Smiley' scale.

Ice Storage Of *M. andamanicus*

Immediately after catch the scampi were washed and placed in ice. They were sampled 4, 7, 11, 13 and 17 days after catch and evaluated by pH measurement, microbiological count, visual assessment and by profile and acceptability panels.

Frozen Storage Trials

The scampi were evaluated after 2, 6 and 12 months storage (-18°C) using visual assessment, pH measurement, nucleotides and profile and acceptability panels.

Chill Storage Of Thawed Scampi

Scampi which had been frozen for 2 months were thawed at 8, 4 and 0 day intervals before assessment by pH, nucleotide and microbial measurement and by profile and acceptability panels.

Results

Ice Storage Of *M. andamanicus*

There was continued deteriorative change in appearance over the time of storage (Table 1) with an increase in flesh pH (Fig. 1) and an increase in total plate counts at 27°C from about 3×10^3 colony forming units (CFU)/g for the initial samples taken when first caught (on board) to 10^6 after 7 days up to 5×10^6 after 17 days. Spreading organisms made counts erratic but 60% of the initial isolates were *Bacillus* spp. and about 25% were *Moraxella* spp. There was no growth at 4°C in the initial samples, indicating absence of psychrotrophes.

The taste panel recorded increases in off-odours and off-flavours and concomitant decreases in typical odours and flavours along with a marked decrease in acceptability (Table 2). Unpleasant odours such as acrid, mousey, ammonia and sulphide were detected and flavour notes such as rubber, blood, greasy, soapy and astringent were reported (Table 2).

The overall results indicate that although there are considerable changes in appearance in

Table 1. Appearance and odour of *M. andamanicus* stored in ice.

Time of storage (days)	Appearance	Odour
0	Bright colour, clear eyes.	Only slight amount of fresh sea odour.
4	Blackish green head, eyes opaque, dark patches where legs join body, soft inside head, soft meat on butt of tail.	Fresh seaweed, freshfish.
7	Yellow green patches on carapace, black patches on uropods, very dark in gill area, digestive gland intact but soft.	Fishy, seafoody, but no off odours.
11	Continued darkening and yellow stains on shell, yellow fluid in head area, brown gills.	Very little odour.
13	Black patches over whole of carapace more noticeable in moulting animals, eyes clouded and loose on their stalks, some tails very loose, dull general appearance.	Astringent, antiseptic, oyster like, sour odours in heads.
17	Eggs of berried females loose and bleached in colour, legs easily shed.	Antiseptic (iodine), strong sulphide, stale old smell when tailed, ammoniacal, old drains, dog faeces.

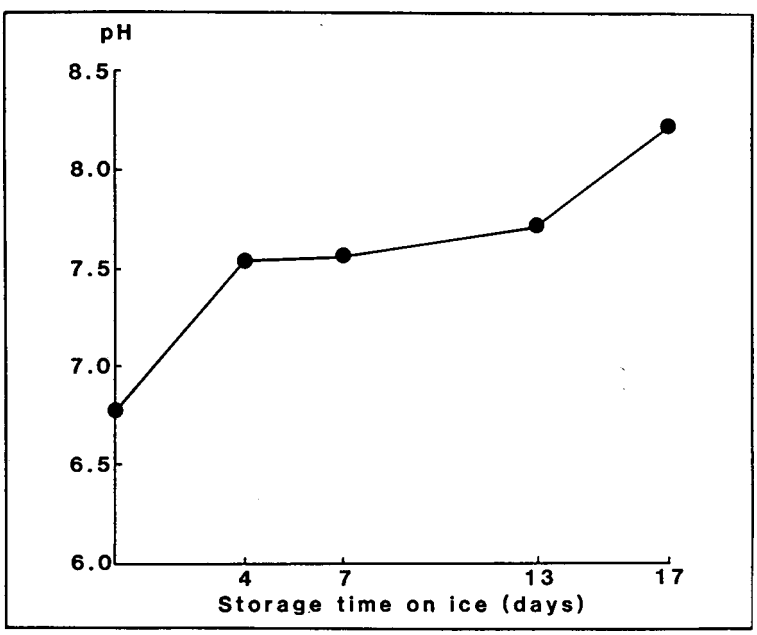


Fig. 1. pH of tail flesh of M. andamanicus *stored in ice.*

Table 2. Odour and flavour profiles of *M. andamanicus* stored in ice.

	Days post-catch stored in ice			
	4	7	13	17
Odour				
• Typical odour	5.5	4.5	2.8	2.6
• Off odour	0.5	0.8	2.5	3.2
Seaweedy	2.4	3.0	3.0	3.0
Shellfish	3.6	4.4	3.2	3.3
Boiled clothes	-	3.0	3.0	3.5
Wet straw	2.0	1.8	2.8	3.0
Mousey	-	-	2.0	4.0
Grassy	-	-	-	2.5
Sulphide	1.0	-	-	4.0
Ammonia	-	1.0	2.0	2.5
Acrid	-	1.0	1.3	2.0
•+ Odour acceptability	4.7	4.8	2.8	2.7
Flavour				
• Typical flavour	4.4	5.0	2.8	2.1
• Off flavour	0	0.3	1.4	4.0
Sweet	4.6	4.6	3.1	2.9
Salty	3.0	2.9	1.3	1.3
Butter	1.5	-	2.5	3.7
Carrots	3.2	2.2	3.0	2.0
Astringent	1.0	2.0	2.5	3.0
Soapy	-	-	2.5	2.5
Greasy	-	-	4	3
Creamy	3.2	2.8	2.0	2.0
Sulphide	-	-	-	4.0
Rubber	-	2.0	2.0	3.0
Blood	2.0	2.0	4.0	2.3
•+ Flavour acceptability	5.6	5.3	3.7	2.7
•+ Overall accaptability	5.5	5.2	4.3	3.0

• Mandatory score

\+ 7-point Smiley scale

this species within four days storage in ice they are mostly external and the flesh is little affected. Substantial change in the sensory properties does not occur until after seven days storage in ice.

Frozen Storage Trials

Appearance

On arrival at the laboratory the frozen scampi were perfect in appearance. After six months frozen storage slight purple patches were found on the carapace of *M. andamanicus* and yellow discolouration on both sides of the head of *M. boschmai* some of which also showed slight staining of the flesh. No off-odours were detected and the flesh smelt clean and fresh. After 12 months frozen storage the carapace colour in all three species had faded as had the colour of the eggs of berried females. The fading is most likely oxidative in nature and could be prevented by glazing or impermeable wrapping or treatment with sulphite or other approved antioxidant.

SEP And Nucleotides

Over the 12-month storage period the SEP decreased only slightly for all three species from near 83 g/100g protein to 72 g/100g protein indicating that the scampi proteins are remarkably stable in frozen storage. The total nucleotide pool was stable for the first six months but deteriorated by about 10% after 12 months storage. There was a steady increase in K-value from near 15% after two months to 40% after 12 months (Fig. 2).

Profile Panels

The off odour and off flavour scores for *M. andamanicus* and *M. boschmai* increased slightly but consistently with time of storage, with corresponding decreases in typical odour, flavour and overall acceptability.

The results for the free choice panels on scampi stored 2 months are reported as bar graphs for those attributes which panellists found important, with the data for the stored material shown at

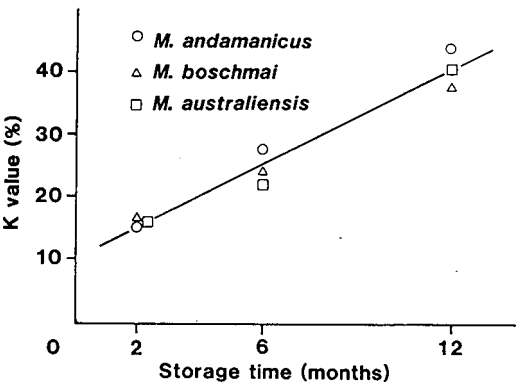


Fig. 2. Increase in K-value with period of frozen storage. A change in K-value of 8% is significant at the P≤0.001 level.

the right as differences in these profiles (Fig. 3). The development of undesirable odour and flavour characteristics and the decrease in desirable attributes is obvious.

Acceptability Panel

There were no percieved differences in acceptability between the species (Table 3). The samples stored for 12 months had significantly less flavour ($P \leq 0.01$), poorer texture ($P \leq 0.001$) and were less acceptable overall ($P \leq 0.05$) than those stored for only 2 or 6 months.

Chilled Storage Of Thawed Scampi

There was progressive deterioration of all three species in chilled storage similar to that reported in Table 1 for *M. andamanicus* and the pH increased for both whole scampi and for tails (Fig. 4). The total nucleotide pool slowly decreased and K-value increased (Fig. 5).

Few bacteria were detected on the thawed scampi, generally less than 100 cfu/g. Bacterial growth was slow, scarcely reaching 10^6 cfu/g after 8 days at 4°C. The main organism present was *A. putrefaciens,* with *Moraxella* spp. or coryneforms being the other major components of the flora.

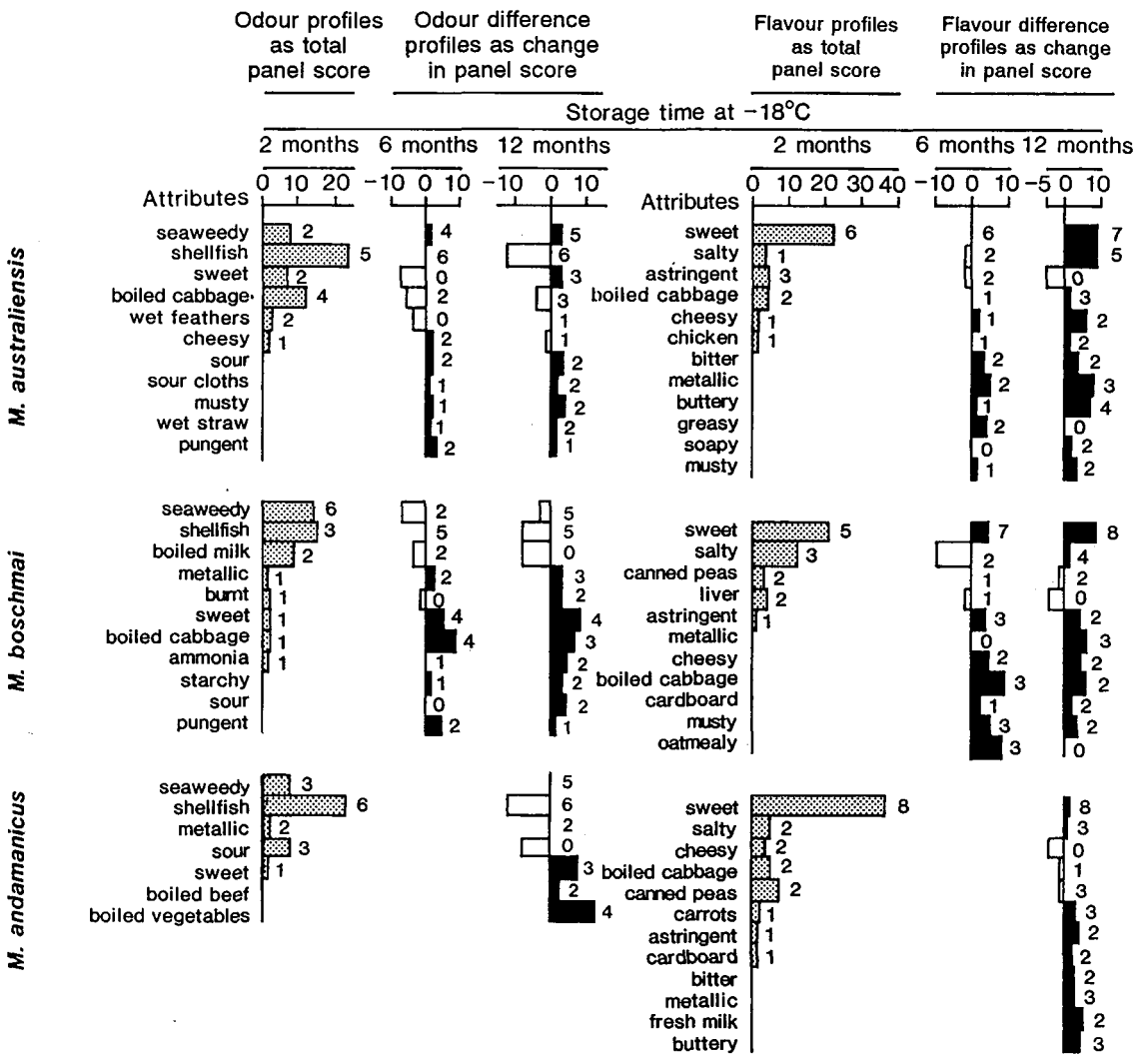


Fig. 3. Free choice odour and flavour profiles as total panel scores for 3 species of scampi frozen stored at −18°C for 2 months (shaded), and odour and flavour difference profiles showing changes in the attributes as ☐ *decrease and* ■ *increase or developing attributes for whole scampi stored at −18°C for 6 and 12 months. Numbers at right of each bar report the number of panelists contributing to the total panel score. Total possible score 90 (9 tasters X 10 point scale).*

Table 3. Scores for acceptability of frozen stored whole scampi boiled and served cold.

	Storage time (months)		
	2	6	12
Flavour acceptability			
M. andamanicus	5.47[a]	5.69[a]	4.52[b]
M. boschmai	5.47[a]	5.48[a]	5.07[b]
M. australiensis	5.44[a]	-	5.07[b]
Texture acceptability			
M. andamanicus	5.15[a]	5.44[a]	3.96[b]
M. boschmai	5.09[a]	5.33[a]	4.52[b]
M. australiensis	5.29[a]	-	4.46[b]
Overall acceptability			
M. andamanicus	5.33[a]	5.42[a]	4.31[b]
M. boschmai	5.27[a]	5.37[a]	4.92[b]
M. australiensis	5.30[a]	-	4.75[b]

Values differing signficantly ($P \leq 0.05$) across the table are marked by different superscripts. Least significant differences calculated from analysis of variance are 0.40 for flavour, 0.54 for texture and 0.51 for overall acceptability.

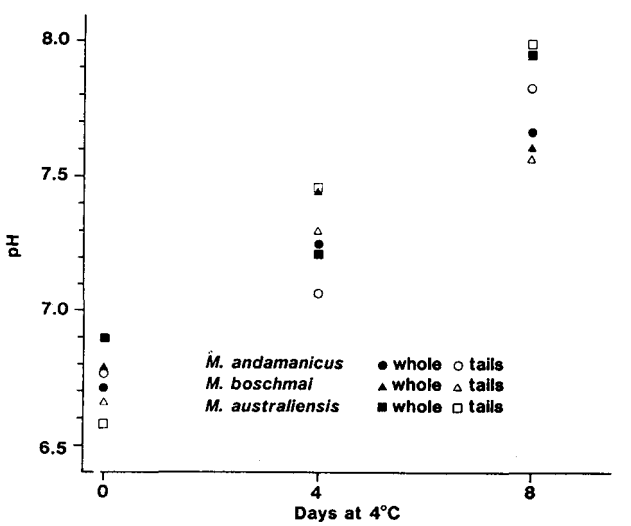
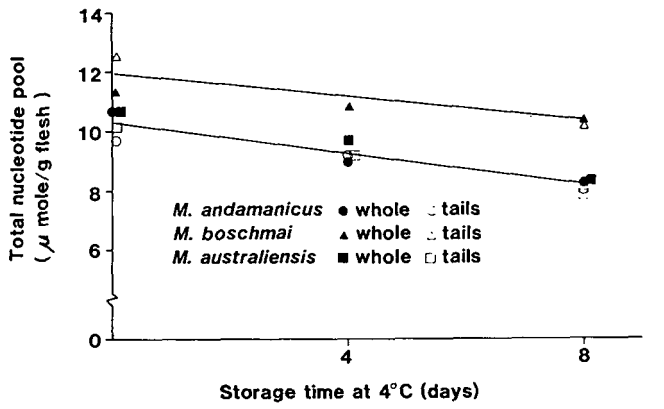
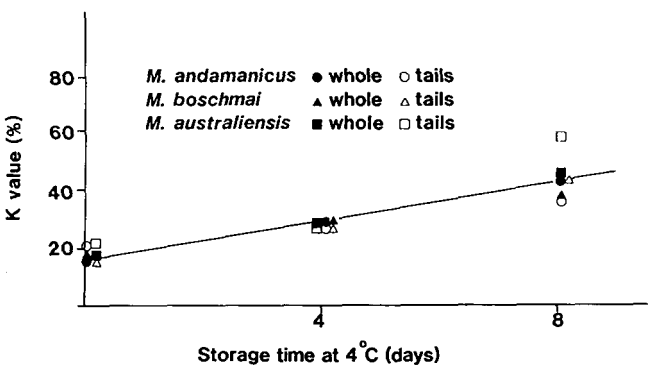


Fig. 4. pH of chill-stored scampi and scampi tails.



A



B

Fig. 5. (A) Change in total nucleotide pool for scampi at 4°C after thawing. Difference of 0.6 μmole are significant at the P≤0.05 level, both between species and with storage time. (B) K-value for scampi stored at 4°C after thawing. A change in K-value of 5.8% is significant at the P≤0.05 level.

Free Choice Profiles

There were considerable changes in the odour profiles during 8 days chilled storage particularly in *M. andamanicus* (Fig. 6) where odours described as ammonia, sour cloths, dirty socks, and wet feathers were reported. Similar changes (not shown here) were found in flavour profiles particularly with *M. australiensis* where undesirable attributes such as metallic, astringent, sour, liver and cardboard were reported. Similar deteriorative changes were also shown in the panel scores for the compulsory variates (Table 4).

Storage as tails resulted in fewer textural changes than occurred in the whole animals (Fig. 7) which generally softened, presumably due to the action of enzymes from the digestive gland.

Acceptability Panel

The three species were rated similarly and generally the scores given to the tails stored for 8 days (4°C) were not significantly lower than the initial scores. Storage in the whole form resulted in significant deterioration although some anomalies

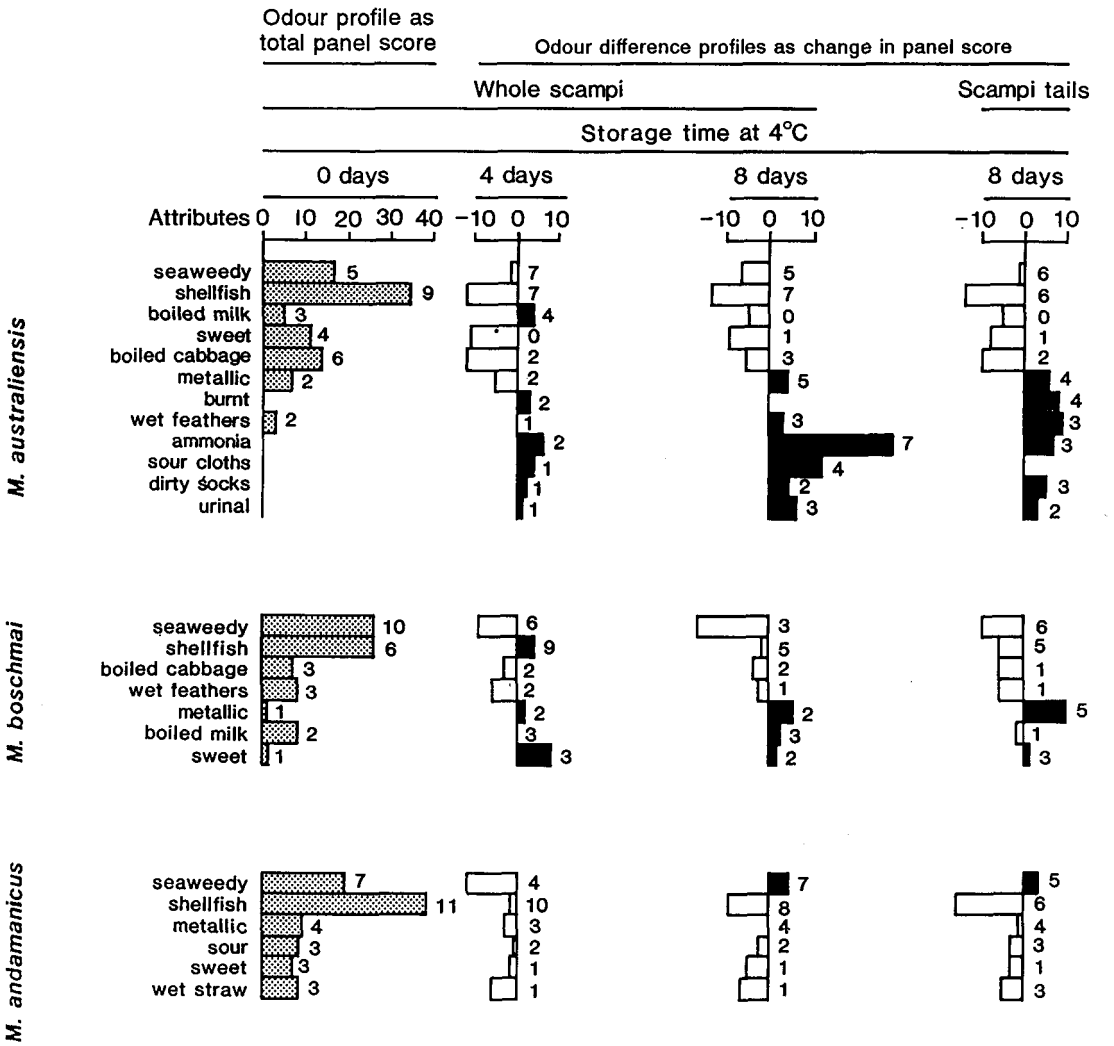


Fig. 6. Free choice odour profiles for three species of whole scampi freshly thawed (shaded), showing the main inherent attributes as total panel score and odour difference profiles showing changes in these attributes as □ decrease and ■ increase or developing attributes for whole scampi stored at 4°C for 4 and 8 days and scampi tails stored at 4°C for 8 days. Numbers at right of each bar report the number of panelists contributing to the total panel score. Total possible score 150 (15 tasters X 10 point scale).

occurred. It is obvious that scampi tails are the more stable in chilled storage.

Despite the obvious changes that occurred all the samples were acceptable to the panel even after 8 days storage at 4°C.

Flesh with levels of *Alteromonas putrefaciens* as high as these samples stored for 8 days (approx 10^6cfu/g) would normally be considered to be spoilt, yet the taste tests did not indicate this. It is likely that the *Alteromonas*

Table 4. Profile panel mean scores for those attributes it was compulsory to score.

	Storage time at 4°C (days)				
	Whole scampi			Tails	Trend with storage time
	0	4	8	8	
M. andamanicus					
Off odour	0.69[a]	1.38[b]	2.94[c]	2.63[c]	Increase
Off flavour	0.38	1.31	1.31	0.94	Increase
Typical odour	4.63	3.88	3.81	3.38	Decrease
Odour acceptability	4.69[a]	4.06[b]	2.74[c]	3.31[c]	Decrease
Typical flavour	5.25[a]	4.12[b]	3.64[b]	4.15[b]	Decrease
Flavour acceptability	4.94[a]	3.50[b]	3.75[b]	4.50[a]	Decrease
Overall acceptability	5.06[a]	3.38[c]	3.35[c]	4.50[b]	Decrease
M. boschmai					
Off odour	2.15[ab]	1.83[a]	2.51[b]	3.11[b]	Increase
Off flavour	0.91	0.59	1.46	1.11	Slight increase
Typical odour	3.71	4.55	3.16	3.37	Decrease
Odour acceptability	4.13[b]	4.60[a]	3.50[c]	3.26[c]	Decrease
Typical flavour	5.14[a]	5.01[a]	4.65[a]	5.15[a]	Slight decrease
Flavour acceptability	4.73[a]	4.69[a]	4.29[a]	4.01[b]	Slight decrease
Overall acceptability	4.40[a]	4.72[a]	4.23[a]	4.26[a]	Decrease
M. australiensis					
Off odour	0.58[a]	1.81[b]	1.75[b]	1.55[b]	Increase
Off flavour	0.35	0.88	0.88	1.56	Increase
Typical odour	5.13	4.69	5.31	4.56	No change
Odour acceptability	4.69[a]	4.00[b]	4.19[b]	3.81[b]	Decrease
Typical flavour	5.56[a]	4.56[b]	4.75[b]	4.69[b]	Decrease
Flavour acceptability	5.25[a]	4.35[bc]	4.69[b]	4.06[c]	Decrease
Overall acceptability	4.63[ab]	3.94[C]	5.00[a]	4.50[b]	Decrease

Values differing significantly ($P \leq 0.05$) (estimated by analysis of variance) across the table are marked by superscripts a, b or c.

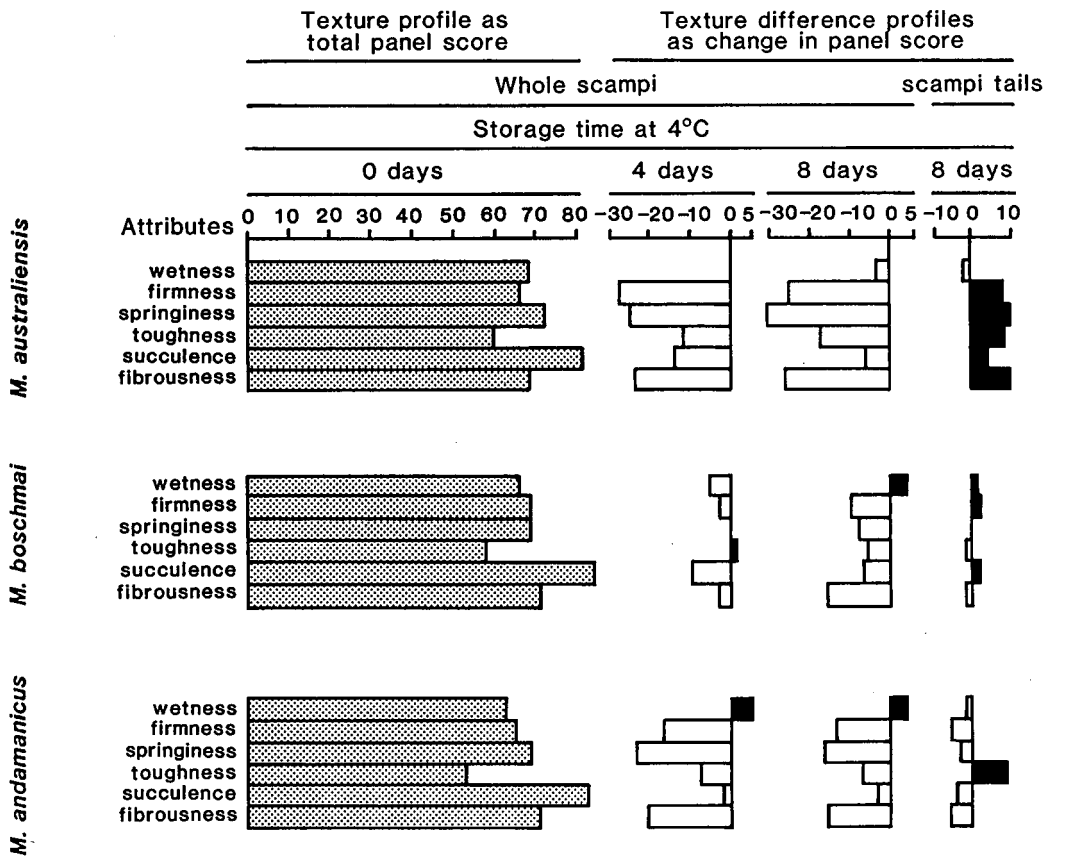


Fig. 7. Texture profiles for three species of whole scampi as total panel scores for freshly thawed (shaded) and texture difference profiles showing changes in these attributes as ☐ *decrease and* ■ *increase, for whole scampi stored at 4°C for 4 days and 8 days and scampi tails stored at 4°C for 8 days. Total possible score 135 (15 tasters X 9 point scale).*

utilised the carbohydrate present to meet its growth needs and hence fewer undesirable off-odours and off-flavours were produced than if it were utilizing free amino acids.

The strong positive character of the inherent scampi flavour, the stable sweet-salty flavours and the high IMP and low Hx levels were sufficient to maintain acceptability. This agrees with results calculated from a predictive equation linking acceptability positively to IMP levels and negatively to Hx levels (Fletcher *et al.*, 1990).

Conclusions Of The Experimental Work

Scampi stored in ice deteriorates in appearance turning blackish green at the head with gradually increasing yellow-green stains on the carapace and darkening black patches but is quite acceptable even after 7 days and just acceptable

after 17 days. They are quite stable in frozen storage with the superficial external changes having little effect on the flesh and only some slight decreases in acceptability and in sensory attributes after 12 months storage (-18°C) were noted.

In chilled storage nucleotide breakdown is slow and sufficient IMP to enhance the flavour remains even after 8 days at 4°C. While there is no difference between storage in the form of tails or as whole scampi in changes in pH, the bacterial count and composition, or to the rate of nucleotide breakdown the texture of the tails does not deteriorate whereas that of the whole scampi changes markedly.

The Current State Of The Fishery And Extension Of This Work To Industry

This work was done at the outset of the fishery and the results of the ice storage trial and preliminary results from the chill storage trial were communicated to the industry via the journal 'Australian Fisheries' (Bremner,1985) and through personal contact. There was considerable optimism in the industry for the future of this fishery, but it became apparent that the resource was limited and the remotenes made it an expensive fishery in which to operate. This situation has not changed and the fishery has stabilised at just under 100 mt per annum. In fact scampi tend to be more of an incidental catch of the deepwater prawn fishery on the NW shelf. The catch is cleaned and frozen on board in cartons containing 3 kg of whole scampi, or near 12 kg if tails only are packed. There is a ready market for the highest grade material in Japan where it fetches A$22/kg and on the US east coast where graded tails can bring near US$14/lb (A$40/kg.). The publicity about scampi in Australia generated a local demand which has been met by the importation of scampi from Scandinavia.

No technological problems with the Australian product have been encountered and further work has not been necessary, although this extensive set of experiments have provided a solid groundwork had it been required. The experimental design provides a model for comparable experimentation on other species under other circumstances. The features of the design were the extensive evaluation by free choice profile, combined with systematic visual appraisal, nucleotide analysis and microbiological investigation. In this way a composite picture of the properties of the flesh of the three species was built up which was useful for recommending storage and handling practices and for diagnosing potential problems which may arise in the future.

Acknowledgement

The author acknowledges the skilled assistance of Maria Ottenschlaeger with the taste panel work, Peter Kearney with the analyses, Dr. Jo Statham with the microbiology and Dr. D.A. Ratkowsky with the statistical analyses. The assistance of the CSIRO Division of Fisheries was greatly appreciated and the work was supported by grant 83/46 from the Australian Fishing Industry Research Committee.

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Discussion

Mr Bremner informed the meeting that a study had not been designed to compare the storage performance of prawns caught together with scampi, with that of scampi on board, but to investigate scampi only. However, there was a need for similar work to be done on the many species of prawns.

Mr Bremner also explained that the melanosis in scampi was enzymic and caused by the tyrosinase enzyme acting on tyrosine in the cuticle. As is done with prawns, scampi could be dipped in sodium metabisulphite to prevent melanosis. He added that changes in haemocyanin in blood was due to the presence of copper.

COUNTRY REPORTS

Five country reports were presented on the status and problems of the fish processing industry in Southeast Asia.

The text of these papers are reproduced, each followed by a summary of the discussion which took place.

Development Of Fishery Post-Harvest Technology In Indonesia

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Directorate General of Fisheries
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Introduction

Indonesia is an archipelago comprising approximately 17,000 islands with a vast coastline extending some 36,600 km, and with abundant natural resources – all in an ideal climate.

The islands have a land area of over two million sq km and 5.8 million sq km of marine waters, 3.1 million sq km of which comprise archipelagic and territorial waters. The remaining 2.7 million sq km is in Indonesia's Exclusive Economic Zone (EEZ). About 775,000 sq km of marine waters are productive coastal areas of less than 200 metres deep.

Marine fish comprised 75.5% of the total fish production in 1987. Inland fisheries has shown considerable progress during the last five years and still has great potential for expansion (Table 1).

The population of Indonesia was about 175 million in 1988 and more than half is concentrated on a few islands of the west part of the country namely Java, Bali, Sumatra, Madura and Lombok.

Majority of fishermen can be found in the most densely populated areas, with localised coastal areas being over-exploited. The Indonesian fishing industry is generally dominated by small-scale operations, characterized by low technical inputs and low productivity. However the small-scale fisheries contribution to the national fish production is substantial, accounting for about 95% of the total fish production.

Marine fishing engaging 1.37 million fishermen mainly operating in the inshore waters, particularly along the coast of the densely populated areas. There are about 334,072 fishing boats, two third (222,233) of which are non-powered boats while the rest are powered boats, the majority of which are less than 10 GT.

Thousands of fishermen fish in lakes, reservoirs, rivers and other open waters on a part-time basis combined with other agriculture activities. Indonesia has also inland and coastal ecosystem providing high potential resources for aquaculture. There are about 1.1 million fish farmers operating brackish-water ponds, fresh-water, paddy-cum-fish, cage and mariculture.

Fish has traditionally been the main source of animal protein in the Indonesian diet.

It was estimated that fish provides about 62% of the domestic animal protein supply. The average annual per capita consumption of fish has been demonstrating a general increase in recent years. However, the level varies from as little as 6 kg to about 35 kg per capita per year. High consumption rates are found in Kalimantan, Sulawesi, Maluku, Irian Jaya and Sumatra, with the average exceeding the national target of 18 kg per capita per year. The lowest rate is found in Java, Bali and Nusa Tenggara which is below 10 kg per capita per year.

Fisheries Resources

With 3.1 million sq km of archipelagic and territorial waters and 2.7 million sq km of EEZ, the country has great potential yield of marine living aquatic resources. This has been estimated to be 1.5 million mt in the archipelagic and territorial waters and 2.1 million mt in EEZ waters.

As in other tropical waters of South East Asia the marine fishery resources include many different species. There are over 22 popular demersal

fish species, 23 pelagic species, and over five different shrimp species. The remainder are classified as "others", in the national fishery statistics.

Evaluation of marine fisheries resources exploitation indicates that the level of exploitation in 1987 was still at a low level - estimated at about 30%. This means that a great deal of potential remains to be exploited, although the amount varies substantially from one area to another for each species. From the existing freshwater ponds, covering 54,082 ha, a production increase of 136,300 mt could be expected from semi or fully intensive culture technology beyond the existing production of 211,000 mt.

The areas of potential freshwater culture cover 180,000 ha and the yield here could be expected to reach some 675,000 mt. From areas of brackish water ponds ranging from 420,000 to 840,000 ha, production of 761,000 to 1,155,200 mt could be expected, if semi or fully intensive culture is applied.

Fisheries Production And Projected Expansion

During the fourth five-year development plan (1984-1988), fish production increased from 2,260,989 mt of total production in 1984, 76% of which being marine products, to 2,881,169 mt in 1988, an increase of approximately 6% each year on the preceeding year (Table 1).

Fish was estimated to provide about 60% of the domestic animal protein supply. The average annual per capita consumption of fish has been demonstrating a general increase in recent years although the level is still below the national target of 18 kg per capita per year.

Export of fisheries products increased from 84,601 mt valued at US$259 million in 1985, to 228,658 mt valued at US$832 million in 1989 - an average increase of about 25% by volume each year. Export commodities consist primarily of high-market value products, such as shrimp and tuna (Tables 2A and 2B).

The trade balance of fishery commodities increased from a value of US$236 million in 1985 to US$808 million in 1989 (Table 3).

Indonesia is now in the beginning of the third year of its fifth five-year development plan (1989-1993); the current plan is still geared towards increasing fishery production and export, providing employment opportunities, promoting income of fishermen and fishfarmers and increasing consumption of fish.

Fish production is projected to reach 3,765,700 mt in 1993, an average increase of about 6% per year (Table 4).

With an average increase of 11.42% in volume and of 16.33% in value per year, exports are projected to reach 291,400 mt at a value of US$1,286 million in 1993 (Table 5).

Total consumption of fishery products is expected to reach 3,415,000 mt and consumption per capita to reach an estimated 17.71 kg per capita per year in 1993. This would be about 98% of the national target of 18 kg per capita per year.

Table 1. Fisheries production.

Unit : mt

Sub-Sector	1984	1985	1986	1987	1988
Marine Fishery	1,712,804	1,821,725	1,922,781	2,017,350	2,169,557
Inland Fishery	548,185	573,837	607,109	653,063	711,612
Total	2,260,989	2,395,562	2,529,890	2,670,413	2,881,169

Source : Directorate General of Fisheries, Indonesia.

Table 2A. Export volume of fisheries products.

Unit : mt

Commodity	1985	1986	1987	1988	1989
Shrimp	30,984	36,101	44,267	56,552	62,710
Tuna/Skip Jack	17,889	24,236	33,995	40,753	95,640
Aquatic Products	9,110	10,582	18,695	28,182	38,945
Frogleg	2,802	3,752	3,076	3,814	4,729
Jelly Fish	1,875	4,762	3,372	4,181	6,184
Ornamental Fish	335	859	530	657	815
Etc	21,606	27,151	36,442	47,078	49,635
Total	84,601	107,443	140,377	181,218	228,658

Source : Directorate General of Fisheries, Indonesia.

Table 2B. Export value of fisheries products.

Unit : 1,000 US$

Commodity	1985	1986	1987	1988	1989
Shrimp	202,729	284,875	352,435	500,312	556,662
Tuna/ Skip Jack	13,770	18,128	30,961	73,619	102,668
Aquatic Products	4,611	4,894	11,486	39,583	63,081
Frogleg	6,571	13,139	8,939	17,995	16,723
Jelly Fish	2,716	7,869	7,370	16,453	8,669
Ornamental Fish	471	1,238	1,609	4,905	9,971
Etc	28,576	43,974	62,409	59,332	74,938
Total	259,444	374,117	475,209	712,199	832,712

Source : Directorate General of Fisheries, Indonesia.

With its abundance of potential fisheries resources Indonesia has an excellent opportunity to improve both productivity and production and to achieve economic returns through intensification and extension of ventures in fishery. The high market value of exported products such as tiger shrimp, tuna and skipjack is one of the main forces driving the effort to increase production.

Development Of Post-Harvest Technology

Of the total fish production, 60% is distributed fresh, and the rest as processed products (Table 6).

There are at least 4,271 traditional processing units engaged in salting/drying, steaming/cooking, smoking and fermentation. Also in operation are

Table 3. Trade balance of fishery commodities.

Unit : 1,000 US$

Specification	1985	1986	1987	1988	1989
Export Value	259,444	374,117	475,209	840,959	840,959
Import Value	23,891	28,177	27,839	20,704	32,884[x)]
Balance	235,553	345,940	447,370	697,627	808,075

[x)] Tentative Data

Source : Directorate General Of Fisheries, Indonesia.

Table 4. Projection of fish production.

Unit : 1,000 mt

Sub-Sector	1989	1990	1991	1992	1993	Increase Rate Per Year %
Marine Fishery	2,293.1	2,426.8	2,566.6	2,714.4	2,867.0	5.74
Inland Fishery	714.8	757.8	802.9	848.8	898.7	5.89
Total	3,007.9	3,184.6	3,336.5	3,563.2	3,765.7	5.78

Source : Directorate General of Fisheries, Indonesia.

Table 5A. Export volume of fisheries products.

Unit : 1,000 mt

Commodity	1990	1991	1992	1993
Shrimp	65.1	72.3	80.3	89.2
Tuna/Skip Jack	44.8	50.0	55.2	60.4
Aquatic Products	29.2	33.1	37.0	40.9
Frogleg	6.3	6.9	7.6	9.3
Jelly Fish	10.2	11.6	13.0	14.4
Ornamental Fish	1.8	2.1	2.4	2.6
Etc	55.4	61.8	68.2	74.6
Total	221.8	237.8	263.7	291.4

Table 5B. Export value projection of fisheries products.

Unit : US$ million

Commodity	1990	1991	1992	1993
Shrimp	625.0	730.2	859.2	1,016.9
Tuna/Skip Jack	44.8	50.0	55.2	60.3
Aquatic Products	17.5	19.9	22.2	24.5
Frogleg	19.5	21.4	23.6	25.7
Jelly Fish	17.3	19.7	22.1	24.5
Ornamental Fish	5.2	5.8	7.0	7.5
Etc.	94.2	105.2	115.9	126.8
Total	823.5	952.2	1,105.2	1,286.2

Source : Directorate General Of Fisheries, Indonesia.

Table 6. Treatment of fishery products.

Unit : mt

	Treatment	1984	1985	1986	1987	1988
TOTAL		1,712,804	1,821,725	1,922,781	2,017,350	2,169,557
	Fresh	853,647	878,607	928,944	1,061,060	1,188,406
TRADITIONAL	Dried/Salted	561,493	636,556	665,298	626,887	667,373
	Boiled	121,210	121,599	125,248	119,554	84,036
	Paste	33,152	40,834	39,004	45,262	51,723
	Fermanted	10,536	9,599	15,095	7,706	6,619
	Fish Sauce	118	564	969	2,005	1,145
	Smoked	44,531	44,294	52,867	54,998	43,186
	Others	16,113	17,389	19,568	17,412	16,439
MODERN	Freezing	46,183	58,573	66,851	65,163	81,541
	Canning	16,504	7,772	5,587	13,015	11,991
	Fish Meal	9,317	6,001	3,350	4,288	17,096

Source: Directorate General Of Fisheries, Indonesia.

modern processing plants; they comprise 169 freezing (mainly shrimp) and 22 canning plants. The distribution of freezing and canning factories are as shown in Tables 7 and 8 respectively.

Both domestic and international markets seem to be bright for fishery products. As earlier mentioned, fisheries contributes over 60% of the total animal protein supply of the Indonesian diet. With a national growth rate of just 2% per year projected for the next few years, the domestic market will easily absorb the increase in fishery products.

Industrial processing has been accorded high priority for the export market. The main export commodities include shrimp, tuna/ skipjack, froglegs, ornamental fish, seaweed and jelly fish. By 1993 exports are projected to reach 290.4 thousand mt, up from 181.2 thousand mt in 1988, an increase of 11.42% per year, while values are projected to US$1.3 billion in 1993. This would represent an average increase rate of 16.33% per year, from the 1988 value of US$712.2 million.

The market for shrimp is primarily Japan, which accounted for 71.43% by volume in 1988. Other countries of destination in 1988 included Singapore (8.59%), Hongkong (4.27%), USA (3.05%), Netherlands (3.33%), Belgium and Luxemburg (2.78%) and France.

The main species marketed include:

- Tiger Shrimp (*Penaeus monodon*)
- White Shrimp (*Penaeus merguiensis*)
- Pink Shrimp (*Metapenaeus* spp.)
- Flower shrimp (*Metapenaeopsis* spp.)
- Kuruma Ebi (*Penaeus japonicus*)
- Freshwater Shrimp (*Macrobrachium rosenbergii*)
- Lobster (*Panulirus* spp.)

Shrimps are presented to the market either alive, fresh, frozen, canned or dried. Product forms include: headless shell-on, head-on, peeled and deveined, peeled and undeveined, individually frozen, blocked frozen according to the requirements of the intended market.

Species of tuna and skipjack include big-eye (*Thunnus obesus*), albacore (*Thunnus alalunga*), yellowfin tuna (*Thunnus albacares*), bluefin (*Thunnus thynnus*), and skipjack (*Katsuwonus pelamis*). These are marketed in fresh, frozen, canned or dried form for domestic use and for export.

In addition to shrimp and tuna/skipjack other fishery commodities with potential economic importance include froglegs, seaweed, jellyfish, ornamental fish etc (Table 9).

Measures In Promoting Post-Harvest Technology Development

Since the enactment of the Foreign and Domestic Capital Investment Laws, the development of industrial fisheries in Indonesia has progressed significantly, particularly in the establishment of integrated fishing industries.

The fishing industry is dominated by small-scale operations, a situation which has led to imbalanced utilization of fishery resources between western and eastern waters of the archipelago. This has been the basis for a recent policy decision to develop both small and large-scale fisheries simultaneously. In order to synchronize the development of both small-scale and export-orientated industrial fisheries, a "nucleus estate and small holder system" (NES) has been formulated in which the large-scale operation serves as the nucleus company. Remarkable progress has been made, particularly in shrimp industry development and also in the achievements of the tuna/skipjack fisheries under the NES set-up.

In an attempt to enhance competitive capacity in the international market efforts have been directed to, among other goals, reduction of production cost of commercially important species, improvement of the quality of fishery export commodities and further diversification of both export commodities and export markets. In order to maintain high quality exported products, a mandatory programme of inspection and quality control compliance has been adopted, and is sup-

Table 7. Number of cold storage and capacity in provinces.

Province	No. of Cold Storage	Capacity (mt)
Aceh	2	850
North Sumatera	16	7,835
Riau	5	5,130
South Sumatera	6	1,670
Bengkulu	1	25
Lampung	1	*N.A.
DKI Jakarta	20	5,780
West Java	7	*N.A.
Central Java	10	2,170
East Java	36	4,900
Bali	7	900
NTB	1	120
NTT	1	100
East Kalimantan	7	1,420
Central Kalimantan	1	100
South Kalimantan	4	800
West Kalimantan	4	500
North Sulawesi	2	350
South Sulawesi	15	2,290
Southeast Sulawesi	2	500
Maluku	13	1,870
Irian Jaya	8	2,900

*N.A. - Figures not available.

Table 8. Number of canning factories in each province.

Province	Canning Factories
North Sumatera	2
Central Java	1
East Java	10
Bali	4
West Kalimantan	1
North Sulawesi	2
Irian Jaya	1
Southeast Sulawesi	1
Total	22

Table 9. Fish and fishery products.

Existing resources	Species	Treatment	Form	Countries of destination
Shrimp				
Tiger	*Penaeus monodon*	Fresh/chilled	Raw/cooked	Japan
White	*Penaeus merguiensis*	Frozen	Head on shell on	Singapore
		IQF	Headless shell on	HongKong
Pink	*Metapenaeus* spp.	Canned	Peeled & deveined	USA
Flower	*Metapenaeopsis* spp.	Dried	Peeled & undeveined	Europe
Kuruma	*Penaeus japonicus*	Live	Butterfly	Australia
Freshwaters	*Macrobrachium rosenbergii*			
Lobster	*Panulirus* spp.		Dry packed	
Tuna				
Big eye	*Thunnus obesus*	Fresh	Whole	Thailand
Albacore	*T. alalunga*	Frozen	Gutted	Japan
Yellowfin	*T. albacares*	Canned	Chunks in brine	USA
Bluefin	*T. thynnus*	Dried	Chunks in oil	Singapore
Skipjack	*Katsuwonus pelamis*		Solid in brine	
			Solid in oil	
			Tuna in dressing sauce	
Froglegs				
Bullfrog	*Rana catesbiana*	Live	Froglegs	Singapore
Stone frog	*Rana macrodon*	Frozen		France
Green frog	*Rana rana*	IQF		Benelux
				Korea
Sardine				
Balinese sardine	*Sardinella longiceps*	Canned	Solid in tomato sauce	
		Fish meal	Solid in oil	
			Solid in oil	
Seaweed				
Brown	*Sargassum* spp.	Dried		Japan
Red	*Eucheuma spinosum*	Agar		
	Gelidium spp.			
	Gracilaria spp.			
	Hypnea spp.			
Anchovies		Chilled dried		Japan
		Dried unsalted/ dried salted	Whole	Singapore
Jelly fish		Dried		HongKong
Others				
Grouper		Fresh	Whole	
Red snapper		Frozen	Fillet	
Pomfret		Live	Wet packed	
Crab		Canned	Dry packed	
Sand goby		Dried		
Snail		Canned		Europe
		Frozen		

ported by certification procedure. The certifications required are as follows:

1. A Good Manufacturing Practices Certificate (GMP) required by the processing plant.
2. A Certificate of Competence required by the Plant Quality Control Supervisor.
3. A Certificate of Quality required for exported products.

To facilitate the implementation of such a programme the Government has provided infrastructure, institutions and qualified personnel in sanitary and hygienic inspection and quality control in an effort to improve the post-harvest activities such as handling, processing, packaging, storage, transportation and distribution. Measures include the

1. Establishment of 26 provincial quality control laboratories to carry out evaluation and supervision of provincial laboratories.
2. Establishment of a reference laboratory to carry out evaluation and supervision of the provincial laboratories.
3. Establishment of cold storage chains and ice plants at landing areas.
4. Provision of training for fish inspectors, analysts, plant supervisors and those dealing with inspection and quality control of fish and fishery products, including fishermen and fish farmers.

To carry out the mandatory inspection, the Directorate General of Fisheries conducts periodic routine plant sanitary and hygienic inspection of all major processing and cold storage facilities.

Many conditions favour expansion of Indonesia's fisheries. Resource availability is good. Market prospects - domestic as well as foreign - are bright. Production is projected to reach 3,765,700 mt in 1993 and export value to reach US$1,286 million. In anticipation of this expansion, the development of Indonesia fishing industry is now taking an integrated activities approach. The goal is to maximize the utilization of the nation's huge fisheries resources without destroying the stock, and to minimize post-harvest losses.

Discussion

Asked whether there were any processing plants producing agar from *Gelidium* sp. in Indonesia and about the method of production in use, Dr. Wiryanti replied that the industry is small-scale with minimal production, and added that there is no culture production of the seaweed in Indonesia.

During the paper presentation, Dr. Wiryanti had mentioned that Europe disallowed the importation of canned sardines made from non-cold water species. Noting that the main market for canned sardines from Indonesia is Europe, Dr. Wiryanti who was asked what happened to the surplus, responded that Indonesia continues to export canned sardines to Europe through a third country.

On the topic of the tuna catch in Indonesia, Dr Wiryanti was asked whether there were any landings in the province of Aceh. She replied that previously, landings had not been significant but that they are gaining importance and that a landing port is now being established in that province.

Dr Wiryanti explained that the nucleus estate and small holder system (NES) was geared towards synchronizing the development of both small-scale and large-scale industries. Under this system, remarkable progress has been achieved, especially in the shrimp industry.

Present Status Of Fish Processing In Malaysia

GAN BON HUA

Department of Fisheries
Malaysia

Introduction

Malaysia is known as a fish-eating nation; and with good reason. Fish is one of the main sources of animal protein available to the country and accounts for about 60 per cent of the population's total protein intake.

In 1989, total production by the marine-capture and aquaculture sectors combined was 935,610 mt. This represented a value of M$1,784 million.

Of this total, marine-capture fishery accounted for the bulk of production and value: for 882,492 mt and M$1,665.8 million. Aquaculture's share was 53,118 mt valued at M$118.2 million.

In the same year, total fish production accounted for about 2.3 per cent of Malaysia's Gross Domestic Product (GDP).

Sixty-three per cent of the total volume of fish landed was consumed fresh, 13 per cent was processed, and 24 per cent was classified as "trash".

In 1989, 109,610 people or 1.7 per cent of Malaysia's work force, were employed directly in the industry as fishermen and fish farmers. This figures does not include people engaged in secondary fisheries activities, such as processing, freezing and boat-building.

Post-Harvest Losses

Post-harvest losses occur at two main points, on board fishing vessels and between landing centres and retail centres. Use of ice and insulated facilities on board fishing vessels and at various outlet points is minimal. Losses due to post-harvest handling, according to a survey, are estimated at 25%. Of these losses, 20% are due to fish spoilage and 5% to pilferage. At the current marine capture harvest of 882,492 mt valued at M$1,665.8 million, post-harvest losses due to spoilage may well be approximately 176,000 mt valued at M$330 million. This is considerably higher than the value of fish import which is M$206 million.

Status Of Fish Processing

Except for fish-canning factories and prawn and fish freezing plants, most of which are situated inland, the majority of Malaysia's fish processing is carried on by small operations with capital assets of less than M$100,000. These plants are located in coastal areas, close to fish-landing ports. They produce dried fish, fish crackers, shrimp paste, fermented fish, fish satay, canned tuna/sardine, frozen prawn/fish/squid, and fishmeal for animal feed.

Dried fish

The species most commonly processed into dried fish are Queen fish (*Chorinemus lysan*), Red snapper (*Lutianus malabaricus*), Spanish mackerel (*Scomberomorus guttatus*) and Jewfish (*Sciaena* spp). Dried products are still prepared in the traditional way: the fish is either submerged in 30 % brine-solution, or salt is spread over the cut body of the fish. Drying under the sun takes from one to five days. Some entrepreneurs have experimented with the use of machines to generate hot dry air for the drying of fish during the monsoon season when sunshine hours are reduced by rain. However, because of the high costs associated with this technique, few processors use it.

In terms of quality control the industry has not changed much over the years. Since there is no standard method of preparation, products of the same kind can vary in colour, taste and chemical content. Some processors use a higher percentage of salt than others, and some may even spray insecticide on the fish to prevent the growth of blow-fly larvae.

Dried Anchovy

Dried anchovy (*Stolephorus* spp) is the most important Malaysian dried fish product and in 1989 amounted to 7,510 mt. A quality standard has been established for dried anchovy. The factors considered are size, species, degree of breakage, smell and colour.

Processing methods depend on the equipment available on the fishing vessel. On crafts equipped with the necessary processing facilities, the fish are put in rattan baskets and are dipped in boiling seawater or in ten per cent brine solution for three to five minutes. After this they are sun-dried for about six to ten hours. Some vessels based in the east coast states of Peninsular Malaysia have no on-board facilities for boiling. Fish caught by these boats are boiled at the landing sites, sometimes many hours after being caught. As a result the quality of these products is inferior to that of fish processed aboard.

Recently, some processors in Kedah have began using hot-air driers to dry their anchovy, and they keep the dried products in cold rooms to maintain quality. These measures have been made possible by the high price commanded by dried anchovy.

Dried Squid

Common squid (*Loligo* spp), cuttlefish (*Sepia* spp) and octopus (Octopodidae) are cleaned and washed with sea water and then dried under the sun on wooden racks. Most processing is done by the wives of fishermen. Production in 1989 was 121 mt.

Fish Cracker

Fish crackers, packaged in sealed plastic bags, are a popular snack in Malaysia. For the most part, these products are made from pelagic species, including the Wolf herring (*Chirocentrus dorab*), herring (*Clupea/Sardinella* spp) and trevally (*Selaroides* spp).

Most fish cracker processors are located in the east coast states. The level of modernisation varies. Although most plants have mechanised mixers and mincers, some still use traditional manual methods for the forming of products. In this operation a mixture of fish meat and sago or tapioca flour, combined in a 1:1 ratio, is shaped into cylindrical form by hand. (The Malaysian Agriculture Research and Development Institute (MARDI) has been encouraging the use of a forming machine for this process). The product is then either boiled or steamed for one to one and a half hours after which it can be eaten fresh, or dried and then fried in oil.

There are variations in the quality and colour of fish crackers. These reflect the use of different species of fish, flour, recipes and processing methods. Deep fried fish crackers, packed in plastic package are available as snack food.

Fish Satay

This is a new product and one that is growing rapidly in popularity. The main species used are goatfish (*Upeneus sulphureus*). Small jewfish and anchovy have been tried but the results have not been quite as acceptable.

There are two levels of processing. The primary processors gut, clean and dry the fish, which is then sold to a secondary processor who rolls the fish and adds sauce. The fish is then roasted in the oven for 25-40 minutes. The quality of fish satay differs according to the species of goatfish and the sauce used. Only 665 mt were produced in 1989.

Shrimp Paste

Local shrimp paste is orange/red or chocolate in colour and most of it is made by smallscale processors in the traditional way. The raw material is *Acetes* spp. to which salt is added at eight to ten percent by weight. The mixture is drained for five to eight hours to reduce the water content and then pounded. It is kept in wooden boxes for seven days. Before being sold the paste is shaped into oval or rectangular blocks, packed in paper and labelled.

Fish Sauce

Most of the fish sauce was produced and consumed by people in the states of Peninsular Malaysia. The species used are anchovy, small goatfish or herring. The fish is gutted and cleaned before being put in brine solution in concrete tanks where it is kept for six to twelve months. The fermented solution is filtered and then boiled with brown sugar and lime juice. It is cooled before being bottled.

There has been little change in the method of preparation. A suggestion has been made by MARDI that the industry use starter culture/enzymes to reduce the fermentation time.

Shrimp Sauce

This product is produced with a process in which cleaned *Acetes* are mixed with 20% salt and 6% cold rice. The mixture is kept in airtight earthern pots for 20-30 days.

Processors are now adding colour to their products to enhance their consumer appeal. Production in 1989 was 34 mt. This product is commercially produced in Malacca and is popular with the local people.

Fishball-Fishcake

Most fishball plants are on the west coast of Peninsular Malaysia. The majority are partially mechanised, that is, they are equipped with at least a deboner and a mixer. Larger plants may also have ball-forming machines. The smaller ones shape the product by hand.

The recipe of the mixture is always a trade secret. Usually fish is mixed with salt, flour, chilli powder, onions, sodium borate and polyphosphate. The fishball is left to set in cold water for two to three hours. Production in 1989 was 2,905 mt.

Tuna/Sardine Canning, Prawn/Fish Freezing

These are the products of large companies. These firms are subject to the standards of the foreign countries to which they export most of their production, and they usually practice strict quality control. In 1989, a total of 3,177 mt of fish and prawn were frozen while 14,184 mt of fish, prawn, molluscs and cuttlefish were canned. Except for the cleaning and filling of raw materials, most of the other activities of these factories are mechanised.

Fish Meal

Most unwanted fish is converted into fishmeal; 41,082 mt of it was produced in 1989. The technology and the product quality are low compared with that of other advanced countries.

Problems Faced By The Industry

Fish landings in Malaysia have remained constant over several years but is expected to increase with the development of the offshore fishery. This should open up opportunities to increase the output of value-added fish products. However, this may be offset by the tendency of processors in the same area to rely on just one species of fish, a practice that leads to fierce competition for that species.

The quality of landed fish varies according to the handling method and the quantity of ice used. Unless sufficient ice is available on the vessel, it is difficult to prevent deterioration of the fish. And, since fishermen do not get good prices for their catch, they cannot afford to use as much ice as they should.

Although the processors know that mechanisation can improve their efficiency and product quality, they usually cannot afford the equipment. As a result, they are forced to use low-level technology and traditional methods. This often contributes to higher production costs and to excessive wastage of product.

Another problem is that no single government agency is responsible for product quality. Various agencies, viz, the Department of Fisheries, the Fisheries Development Board of Malaysia and MARDI, have different roles to play but no one agency is responsible for coordinating or for follow-up. As a result, very little R & D is done in this area, and extension work is limited.

Future Development

The government will embark on a programme to modernise the fish processing industry while at the same time, introduce improvement to the traditional processing sector. Research and development on fish processing will aim at bringing the Malaysian processing industry more into line with modern processing industry in other countries. At the same time, improved post-harvest handling and increased use of ice will be widely encouraged in both the commercial and traditional processing sectors.

In the traditional fish processing sector, more emphasis will be placed on hygiene; specifically on the cleanliness of handlers and premises. The programme will aim at all-round improvement of traditional processes as a means of boosting productivity and improving the income level of these largely family-owned businesses.

Significant extension and training services for the processing industry will commence with the establishment of regional extension centres being set up in Peninsular Malaysia and Sarawak.

Recommended Activities In Processing Technology

Although the processing industry is still largely traditional in Malaysia, demand for processed fish products will cause it to grow and to develop along commercial lines. Because of fierce and competitive pricing, higher-grade products are essential. Processing will have to be conducted under conditions more conducive to a high level of quality. The elements of this environment must include plentiful ice and cold stores, a reliable supply of good raw materials, good equipment and efficent processing lines.

Reseach and development on fish processing should be given top priority. Also needed is a concerted government-supported extension effort to transmit information to the private sector.

Regular training should be made available to both the trainers (extension workers) and the

Summary table of processed marine fish products in Malaysia, 1989

Item	Production (mt)
Fish meal	41,082
Dried anchovies	7,510
Fish crackers	1,639
Salted/dried fish	4,735
Manure fish	20,993
Frozen prawn	3,019
Shrimp paste (*belacan*)	4,456
Frozen fish	2,118
Boiled fish	12
Fish ball	2,905
Dried prawn	1,378
Frozen cuttlefish	158
Dried jellyfish	367
Dried cuttlefish	121
Fish satay	665
Prawn paste (*otak udang*)	68
Fish sauce (*budu*)	199
Shrimp sauce (*cincaluk*)	34
Prawn crackers	14
Dried shellfish	13
Total Production	91,486

processors. These are both areas in which the SEAFDEC/MFRD can provide useful service to member countries.

Introduction of new, proven technology, imported and domestic, should also be given a high priority. Foreign machinery of proven capability is often subject to high import duties which effectively put it out of reach of the average processor. A reduction of duties on machines for which no local equivalent is available, would help domestic processors overcome this handicap.

Also needed, if the processing industry is to expand, are loan facilities at low interest rates. This would allow processors to expand their operations and to become more competitive.

Conclusion

Malaysia's industry has the potential to develop, particularly through the improvement of marketing channels for fresh fish. As a cottage industry, the processing sector has catered to and improved the living standards of rural people. Malaysia intends to develop this sector further.

Discussion

During the discussion, a query was raised about the use of sodium borate in fish ball in Malaysia. Mr Gan replied that although the use of sodium borate in food is no longer permitted, small-scale fish ball processors continue to use the additive.

On the comment that, generally, enzyme from fish gut is an important factor in fish sauce manufacturing, and when asked why in the Malaysian process, the fish gut was excluded, Mr Ismail explained that the use of whole fish including the viscera is unacceptable to the Muslim community. This is a recognized setback to the manufacturing process; however the use of refined enzyme is being encouraged.

In reply to a query about the total number of canning plants and prawn-freezing factories in Malaysia, Mr Gan estimated that there are 30 - 40 canning and freezing plants and promised to supply a precise figure at a later date. (Update from Mr Gan: there are 15 canning and 35 prawn freezing plants).

Responding to the request for an elaboration of the method of production for manure fish, Mr Gan said that since this industry has not yet been modernised, the traditional way of mixing fish with agricultural produce before crushing and drying was used.

When asked whether the same kind of fish used in the manufacture of fish meal is used in the manufacture of fish "manure" (fish of minimal quality), Mr Gan replied that, most probably, similar fishes are being used but that the fish quality used in fish manure is much lower.

Status Of The Philippine Fish Processing Industry

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Status Of The Philippine Fish Processing Industry

Introduction

The Philipine Archipelago is composed of more than 7,000 islands with an irregular coastline of almost 18,000 km. Its territorial water including the EEZ is 220 million hectares with a shelf area of more than 18 thousand hectares and a coral reef area of 27 thousand sq km. Inland resources include swamplands of about 338,393 hectares and freshwater fishponds of about 224,527 hectares. Other inland resources include lakes, rivers and reservoirs with a total area of 250,000 hectares. About 2,000 species of fish, molluscs, crustaceans, echinoderms, coelenterates, corals, and many other aquatic flora and fauna inhabit the Philippine waters.

In view of the current call for productivity to sustain the Philippine economy amidst the pressing economic crisis, the fishery sector holds a considerable promise. The annual growth rates achieved by the Philippine fishery sector from 1980 to 1989 were 4.0% and 16.5% in quantity and value respectively. In 1989, the total fish production was valued at ₱45 billion accounting for almost 5% of the Gross National Product (GNP). Production is largely contributed by municipal capture fisheries (46.6%) followed by commercial fisheries (26.9%) and the rest by the aquaculture sector (26.5%), as shown in Table 1.

As of 1987 the Philippines per caput consumption of fish was estimated at 40.0 kg/annum which is quite high as compared with per caput consumption of other products as shown in Table 2. The country has among the fastest growing populations in Southeast Asia with the present population of 60.5 million and an average growth rate of 2.4% per annum.

Fish has always been an important food item in the Philippine diet. About 50% of the animal protein intake of the average Filipino is derived from fish. About 1 million Filipinos are directly or indirectly employed in the fishery industry.

Table 1. Total fish production by sector, 1989.

	Quantity ('000 mt)	%	Value ($x10^9$ ₱)	%
Aquaculture	0.629	26.5	15.7	34.8
Municipal fisheries	1.105	46.6	18.4	40.8
Commercial fisheries	0.637	26.9	11.0	24.4
TOTAL	2.371	100.0	45.1	100.0

Table 2. Per capita consumption of fish and other products as of 1987.

Food Group/Sub Group	Total
Fish	40
a) fresh fish	25
b) dried fish	4
c) processed fish	4
d) crustaceans and mollusks	7
Dairy	15.7
Poultry meat	3.3
Eggs	3.7
Fresh meat	9.7
Organ meat	1.5
Processed meat	2.2

Source : Based on the 3rd National Nutrition Survey conducted by the Food & Nutrition Research Institute (FNRI) in 1987.

Considering its contribution to economy in terms of GNP share, external trade and foreign currency earnings, employment opportunities and nutritional benefits, the fish processing industry is here to stay.

Fish Supply Situation

Not all of the domestic production of fish and other fishery and aquatic products are consumed in the Philippines in like manner that not all fish consumed in the Philippines are produced locally. Conidering external trade in fisheries, fish supply available for human consumption is computed at 1.87 mt for 1988 and 1.98 million mt for 1989.

The Philippines ranked the 12th largest fish producer in the world in 1986 and is located along a major tuna-migration path which yields half of the skipjack and one third of the yellowfin catch of the world.

Aquaculture has promising growth potential considering its fast profit turnover, stability of its inputs, high value and export potential of its products and employment opportunities in the rural communities.

Among the aquaculture species, seaweeds dominate the produce and their contribution to total catch is shown in Table 3, together with the other major species cultivated.

A large volume of the total catch is consumed fresh and chilled while the rest are processed as cured, canned, frozen as fillets or disposed of live. Cured fish and fishery products are mostly consumed locally, although small quantities are exported.

Today, the fishery sector continues to provide the much needed food supply both for local and export markets. A five-year fish production with an increasing trend is shown in Table 4.

Product development and new technologies play a major role in converting the raw materials into various food items with varying product characteristics, consumer acceptability, nutritional and economic values.

Table 3. Major species of fish and fishery products, 1989.

Species	%
Marine Commercial and Marine Municipal Fisheries	
1. Tuna and tuna-like species	19.89
2. Roundscad	13.81
3. Sardines	8.06
4. Anchovies	8.05
5. Slipmouth	4.18
6. Indian mackerel	3.40
7. Threadfin bream	2.83
8. Big-eyed scad	2.54
9. Round herring	2.11
10. Squid	1.75
11. Others	33.38
	100.00
Inland Municipal Fisheries	
1. Snails	55.89
2. Tilapia	8.99
3. Carp	5.10
4. Freshwater sardine	4.79
5. Freshwater clams	4.46
6. Small shrimps	3.65
7. Freshwater goby	3.34
8. Others	13.78
	100.00
Aquaculture Fisheries	
1. Seaweeds	42.69
2. Milkfish	30.65
3. Tilapia	12.98
4. Shrimps/prawns	7.61
5. Mussel	2.61
6. Others	3.46
	100.00

Table 4. Five-year (1985-1989) fish production trend.

Year	Quantity(mt)	Value('000 ₱)
1989	2,371,109	45,093,712
1988	2,269,744	42,118,213
1987	2,213,040	37,349,479
1986	2,089,484	37,331,483
1985	2,052,111	31,297,268

Post Harvest Technologies

Fish Curing

Old methods of fish curing such as drying, smoking and salting predominate in the regions. These methods have long been practiced and were proven to be effective in immediately preserving the fish after catch. These methods enable the distribution of fish products widely especially to areas where supply is inadequate. Most of the fish curing operations are done in the fishing regions where there is a ready supply of raw materials. Operations vary from small cottage industries to medium scale. Per caput consumption of dried fish is estimated at 4.0 kg/year.

Chilling And Freezing

For a tropical country like the Philippines, preserving fish by chilling and freezing is necessary. Chilling is effective in preserving the fish prior to subsequent handling after catch and during transport to the wet markets. The locals do not mormally require frozen fish for their supply. There is a marked preference for freshly caught uniced fish among Filipinos. Freezing as a method of fish preservation has a long way to go especially now that there is an increasing demand for high-quality tuna meat for *sashimi* and *sushi* in the Japanese market. In terms of value, our frozen fishery products show the greatest bulk of expor-

tation. For shrimp alone, a total of 26,768 mt were exported in 1989 which earned a total of more than ₱5 billion. Principal exports of fish and fishery products for 1989 are shown in Table 5.

Thermal Processing

Canning is still limited to a few species of fish, viz tuna, sardines, mackerel, roundscad, and milkfish. Canned tuna production is mostly for the export market while a small volume is consumed locally. Shortage of raw material is often the problem of the local canners such that importation of cannable species is oftentimes resorted to.

The use of heat-resistant bottles to pack fish for thermal processing has gained recognition and products preserved in bottles or glass jars have penetrated the local market. The use of retortable pouches for thermal processing of fish and fishery products has not yet found commercial application in the local canning industry.

Manufacture Of Minced Fish Products

The manufacture of products like fishballs, squid balls, fish *quekiam*, fishburger, fish noodles, salami, *kroepeck* and fish sticks show a growing potential in the local market. These products are now becoming popular and there is consequent increasing demand for them.

The growing demand for minced fish products in Europe and other developed countries indicate a bright future for these products.

Shellfish Processing

Aside from shrimps and prawns, other more popular crustaceans and molluscs are processed as chilled or frozen for the export market. This includes lobster tails, crabmeat, abalone, cuttlefish/squid, arkshell and octopus. A few of these species are processed and exported as dried products.

Table 5. Principal exports of fish and fishery products in terms of value, 1989.

Products	Quantity (mt)	FOB Value ('000 ₱)	('000$)
Shrimp/Prawn	26,768	5,035,080	833,635
Tuna	57,057	2,809,659	129,986
Seaweeds, dried	30,994	804,546	37,245
Shellcraft articles	2,163	275,665	12,774
Cuttlefish/squid	3,221	269,308	12,477
Fish transport alive	6,347	156,944	7,284
Capiz shells	4,797	121,890	5,639
Bangus(Milkfish)	1,336	85,580	3,944
Natural and cultured pearls	246	66,317	3,080
Sea cucumber	1,022	31,735	1,465

Source : Fisheries Policy Research and Economics Division, BFAR, Quezon City, 1989

Fishmeal Processing

Scraps and offal from canning and freezing operations and by-catch are absorbed by the local fishmeal industry. Rejects in the dried and smoked fish products are likewise utilized for this purpose. Due to insufficient fishmeal production, supply is supplemented by importation. In 1989, import of fishmeal was 56,474 mt.

Other Fishery Products

The abundance of catch of certain fishery products in some areas has promoted the development of various food preparations using traditional methods with some modifications. However, production is influenced by regional and cultural characteristics which significantly affect the consumption and distribution of the finished products. Thus, fermented clams, oysters, mussels and salted jellyfish are popular only in the Visayan region, while fermented mudcrab, boiled tuna and fermented freshwater fishes are a specialty in some provinces of the Tagalog regions. Boiled dried fish are also produced in small quantities.

The production of deboned milkfish in its raw, fresh, marinated and smoked forms is becoming popular not only in Metro Manila area but also in other milkfish producing regions of the country. It is a labor-intensive industry which had generated employment opportunities for the population.

Advances In Fish Processing Technology

Fish Handling

One important area of concern in the fish processing industry is the application of appropriate fish handling practices in order to maintain or improve the quality of the catch and minimize wastage.

In an effort to meet this goal, the government, through the Bureau of Fisheries and Aquatic Resources and other research agencies has conducted studies and implemented programs geared towards the improvement and development of the fish processing industry.

Ballo, Camu, Abella and Guevara, (1989) studied the handling and transport of live mud crab, *Scylla serrata* Forskal. Abella, Repito and Olavides (1989) studied the handling and transport of live grouper *Epinephelus tauvina*. The acceptability and shelf-life of frozen cooked mussel meat was studied by Ballo, Ragasa, Abella and Guevara(1989). Studies on handling, transport and depuration of green bay mussel *Mytillus smaragdinus* was conducted by Guevara, Abella, Canonizado, and Ballo, (1978).

The Bureau of Fisheries and Aquatic Resources has also introduced the use of high density polyethylene(HDPE) plastic containers in the handling and transport of fish and fishery products, particularly of aquaculture products. Today, the HDPE containers and similar types of plastic containers are widely used in the fish processing plants and their use aboard a commercial fishing boat is a continuing subject for study.

Dumping the catch on floors at the landing sites still is a common practice resulting in serious losses in quality. Physical damages and bacterial contamination become inevitable and considering the great loss both in quality and value, the use of fish sorting trays was also introduced. Because of this, sorting the fish has become more convenient and the fish are being handled in a more hygienic manner. However, as the trays are prone to loss and some fish traders consider them as an additional investment cost, there is a need for a more extensive demonstration of the use of the fish sorting trays in order to make the fish traders and handlers realize their relative advantages.

Manufacture Of Value-Added Products

The excellent dietary quality of fish and its relatively high economic value have long been recognized. Presently, the demand of convenience products has stimulated awareness of the manufacturers to develop value-added products like IQF, battered/breaded stir-fried, ready-to-cook convenience foods. These products suit the consumers' need for innovations in food taste and appearance. This is one innovation in the fish processing industry which a local manufacturer has

recently ventured into after extensive research in product development. Among the value-added products that the country is now exporting are shrimp dumpling (*Ha-kiaw*), shrimp *shu-mai*, nuggets made from shrimp, cuttlefish and white-meat fish, patties, breaded shrimps and *tempura*.

Comminuted or fish jelly products such as fishballs, fishburger, fish sausage, and *chikuwa* are likewise produced.

Seaweeds Processing

The seaweed industry is currently earning some ₱900 million (US $45 million) a year. Presently, there are two big manufacturing companies engaged in the processing of *Eucheuma* spp. into dried powder form for export. *Gracilaria* spp. and *Gelidium* spp. are also processed into agar.

Drying of seaweeds is done in most of the production areas. The dried seaweeds are then collected and are sold to the processing plants for further processing. Because of the financial opportunities, prospects for creating employment and vast income potential, the promotion and culture of seaweeds is currently being encouraged.

The country has now a new seaweed processing plant located in Zamboanga which is the only one in the country that produces a high value culture media from agar.

Infrastructure And Laboratory Support Services

The Bureau of Fisheries has also established the following aquaculture demonstration centers that provide facilities and support services to the industry. These aquaculture centers located in the different parts of the country are now under the direct supervision of the Department of Agriculture.

1. Pagbilao Brackishwater Aquaculture Demonstrations and Training Center, Pagbilao, Quezon.

2. Butong Fish Farm and Experimental Station, Taal, Butong Batangas.

3. Tanay Research Laboratory Station, Tanay, Rizal.

4. National Freshwater Fisheries Center. Munoz, Nueva Ecija.

5. Bohol Aquaculture Development and Training Center, Bohol, Cebu.

6. Lala Demonstration and Training Center, Lala, Lanao del Norte.

7. The BFAR-IDRC Fish Health Laboratory.
This laboratory conducts fish disease diagnosis, prevention and control, parasitological examination, biological examination and water quality analysis to ensure that high quality fish and disease-free fishery products are produced.

8. The BFAR Post Harvest Technology Division Laboratory.
This laboratory conducts studies on fish handling, processing, product development, chemical and microbiological examination of fish and fishery products for quality assurance.

9. The National Commercial Fisheries Development Center (NCFDC) formerly the Fisherman's Training Center, Naval Base, Sangley Point, Cavite City.
This was established to provide a common base for development and upgrading the manpower needs of the marine fishing industry. The center provides laboratory facilities for the development and testing of improved fishing technologies and design of appropriate curriculum for effective technology transfer of fishing technology concepts, principles and techniques. Fish handling is one of the major courses offered to fishermen, fish handlers, fishery instructors, and extension officers in order to disseminate proper fish handling practices.

10. The (BFMC) Bayawan Fishermen's Marketing Cooperative, Inc.
Located in Negros Occidental, this cooperative has created a marketing alternative which works to the advantage of the local fishermen, and fish processors and which has enhanced the involvement of women in development. The fish processing facility is equipped with a smokehouse, blast freezer, sizing machine, block-ice machine, refrigerated containers, fish boxes and other materials which are needed by the local industry.

In addition, the Philippine Fish Development Authority has established fishing ports and fish processing complexes in most of the fishing regions of the country. These are briefly described below.

11. The Navotas Fishing Port Complex (NFPC) located at Navotas, Metro Manila is the first and largest fishing port in the country and in Southeast Asia. The port accounts for about 40% of total commercial fish landings in the country and supplies about 80% of the total fish needs of Metro Manila. An average of 600 mt of fish is traded nightly. The flow of catch landed at NFDC is shown in Fig. 1, and the distribution of fish landed is shown in Table 6.

Table 6. Distribution of fish landed at Navotas Fishing Port Complex (NFPC).

% of Catch	Distribution
50	Wet market, Manila
30	Fish processors
15	Provincial markets
1	Fish meal production
4	Fish smokers/dryers

Source : (King, 1988)

12. The Iloilo Fishing Port and Processing Complex also provides facilites for processing cuttlefish, shrimps and prawns and boneless milkfish, fish fillets and other exportable species.

13. A similar operation takes place at the Zamboanga Fishing Port and Processing Complex located at Sanggali, Zamboanga City. Squid balls, shrimps and prawns, cuttlefish and fish fillets are processed here. Other fishery ports are also located at Mercedes Camarines Norte, Camaligan, Naga City, General Santos City and at many other small fishery ports in strategic locations of the country.
These facilities help improve the quality of the catch and maximize its utilization by minimizing transport costs and quality losses.

Problems And Needs Of The Industry

Like any other food processing industries, the fish processing industry is not free of problems. The Philippines is still beset by the following difficulties :

Insufficient Supply Of High Quality Raw Materials

Despite being a fish producing country, the Philippines has insufficient raw materials of high quality. This can be traced to the fact that only the high-value exportable species receive the highest degree of attention from catch to distribution. Losses of approximately 25% to 30% of the total catch are incurred due to poor handling practices. The problems include lack of quality-consciousness among fishermen and non-hygienic and sanitary conditions at landing sites and markets. As a result, other more serious problems crop up such as inferior quality in some fishery products. This include mould growth and insect infestation during storage of dried and smoked products, bacterial spoilage, reddening and souring of cured fish, contamination of fishery products and low yield in canned tuna products due to poor quallty raw materials. Inevitably, an insufficient supply of

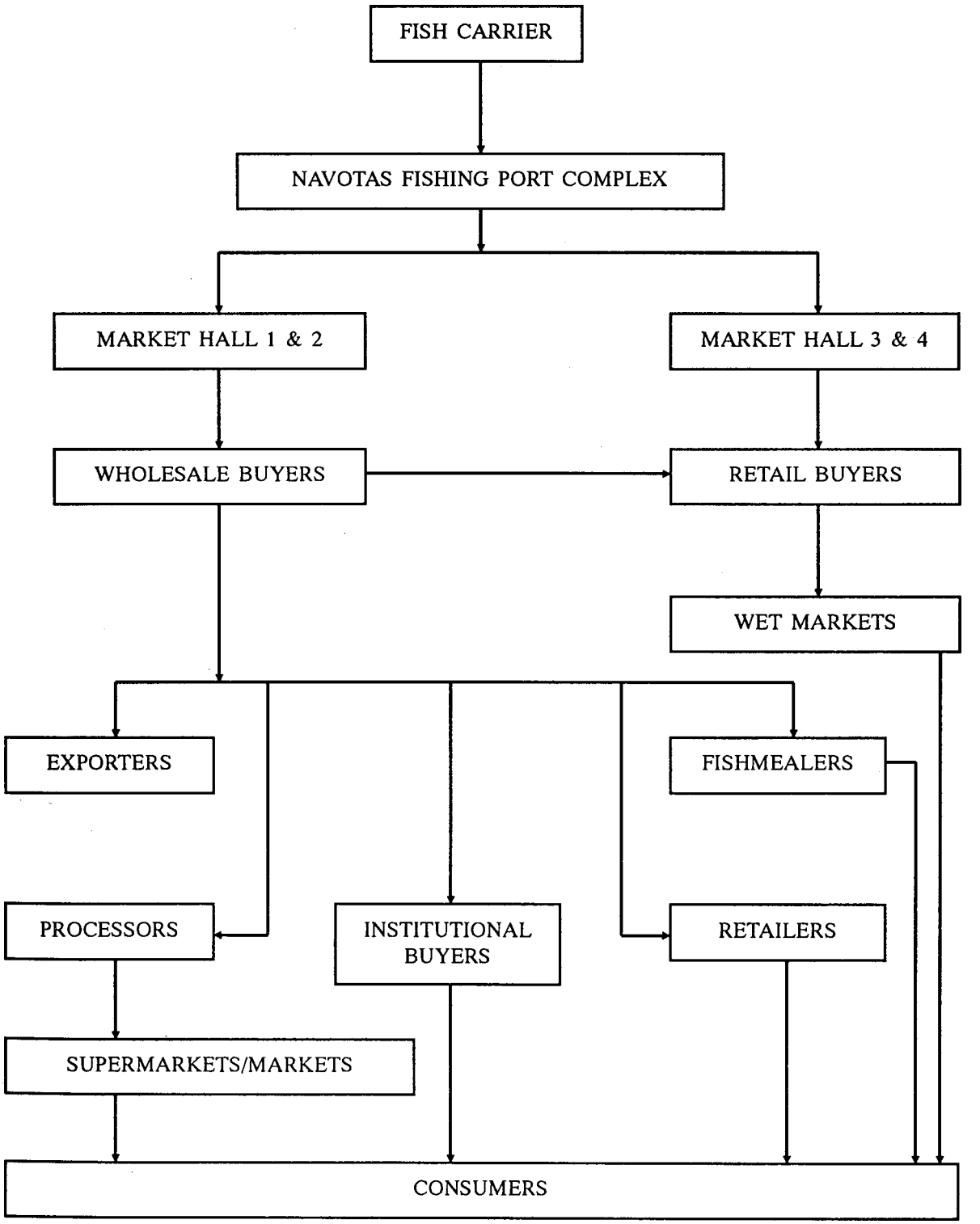

Fig. 1. Flow of catch landed at Navotas Fishing Port Complex, Metro Manila area.

high-quality raw material leads to reduced product yield, both in volume and in value. Conversely, as a general rule, high quality raw materials give high-quality finished products and they fetch better price.

Inadequate Supply Of Ice In Many Fish Producing Areas

While ice is considered to be the most effective means of preserving the catch especially in a tropical country like the Philippines, a lack of ice, due to high costs, particularly in remote fishing villages, is often the primary cause of poor quality in the catch, if not outright spoilage. In addition, the absence of ice plants and cold storage and transport facilities aggravates the situation. Consequently, in times of glut, some fishermen resort either to selling their catch at very low prices or preserving them by curing. Therefore, there is a need to build new plants in some regions and to rehabilitate existing plants and cold storage facilities.

Limited Capital Among Small And Medium Scale Operators Hinder Technology Transfer/Acceptance

Evidently, only the large-scale fish processors can afford to provide their own quality control facilities and to hire adequately trained manpower to monitor their operations for quality assurance. These are the processors that cater to the needs of the export market. They can afford to adopt new techniques, and purchase new equipment to improve and expand their product range. Unlike them, the lowly, small and medium scale processors of cured fish products are constrained by capital. As a result, opportunities for further expansion and improvement and adoption of new technologies are often not taken up.

Inadequate Infrastructure Facilities

Additional infrastructure facilities like the fishing port and processing complexes in Iloilo, Zamboanga and other fish processing areas have enhanced the distribution and marketing of the catch. Such facilites are needed to achieve distribution of better grade catch and to promote the country's export products. However, these facilities are still inadequate to accomodate the landings nationwide. Similarly infrastructure such as farm-to-market roads, and new or rehabilitated ice plants and cold storage facilities are absolutely necessary.

The Need For Effective And Extensive Technology Transfer Activties

The severe problems in the industry resulting from poor handling practices, hygiene and sanitation, poor product quality and other causes can be improved by an effective and extensive technology transfer mechanism.

Lack Of Standardized Procedure For Traditional Products

This results in non-uniform product quality, which limits their sale to domestic market only. There is a need to develop standards and codes of practice for processing traditional products.

Inadequate Fish Marketing Information For Information And Services

Inadequate fish marketing information and services, working together with inadequate fish supplies (which was discussed earlier), often create great differences in fish prices in some parts of the country.

Summary And Recommendations

The most important roles that the fish processing industry plays in socio-economic development are to provide for adequate food and nutritional needs of the people, the creation of employment and the building of trade relationships between nations through exports.

Intensive efforts have been made to increase the volume and value of raw materials and finished products. Product research and development

studies have been carried out on the utilization of available resources in order to minimize wastage and optimize utilization of resources. Traditional fish processing techniques are still practiced widely and new techniques are slowly finding acceptance in the commercial level. Considering the growing demand for convenience food items and value-added products and innovation in food processing, new products and new markets are not far from being established.

In spite of the many problems that the industry is currently facing it has shown considerable improvement and development over the past years. In order for the industry to survive and to realize its goals it will need strong support from both the government and the private sector.

In response to the various problems and needs of the industry, the following steps are strongly recommended :

1. Implementing a massive extension service program on good fish handling practices, quality-consciousness and good manufacturing practices in the fish processing industry for quality assurance and for effective and immediate transfer of technology.

2. Priority for the establishment of infrastructure facilities and the rehabilitation of existing ones in the fish producing areas of the country. This will help regulate the supply and distribution of catch while assuring better quality raw materials at reasonable costs to the consuming public.

3. Providing fish inspection services and trained fisheries extension service specialists, in the fish producing areas to render technical and advisory assistance on matters pertaining to fish quality control, processing and utilization.

4. Expanding and strengthening existing fish processing and quality control laboratories by providing additional equipment/ machineries in order to make their services more responsive to the needs of the industry. There is a need to establish more fish inspection and quality control laboratories in the regions.

5. Encouraging and supporting basic and applied research on the efficient utilization of indigeneous resources, especially those with export potential, and the development of new high-value products and appropriate technologies for increased productivity.

6. Implementing and promoting product development activities with income generating potential.

7. Developing a directory of fish processing plants and products. This could be used to determine the future development and improvement needs of the industry, to identify problem areas and solutions. The directory would also serve as a reference resource for researchers, development planners, and the industry.

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Discussion

The meeting noted the growth of the fish product industry in the Philippines. Responding to a question about the source of surimi being used for surimi-based products, Miss Camu said that the surimi are produced locally.

Responding to the observation that there was a lack of standards for traditional products in the Philippines, and asked whether there was any indication from the small-scale industry that such standards are required, Miss Camu said that there had been no such signals from the industry but she felt that local consumers would benefit from such standards.

The Fish Processing Industry In Singapore

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Introduction

Singapore is a small island with limited natural resources and a small population of about 2.6 million people. The ultra-modern city state tends to be generally associated with high-tech industries and entreport services. The marine fishery industry is therefore relatively small and contributes only about 10-15% of the total fish requirements of the country. Fish, however is an important source of protein and the annual per capita consumption of seafood is the second highest in Asia after Japan.

Table 1. Fresh fish supply (mt) to Singapore.

Year	Total	Local Production
1986	109,529	20,497
1987	112,079	15,310
1988	109,310	13,110
1989	118,000	12,240

Source: Primary Production Department (PPD), Singapore.

Singapore's favoured geographical position and excellent infrastructure and services have enabled the island to become an important seafood entreport trade and processing centre in the region. Its excellent wholesale market complex plays an important role as a landing point for foreign fishing vessels and trucks bringing in fish from neighbouring countries like Indonesia, Malaysia and Thailand.

Although Singapore has little natural marine resources, the flourishing seafood industry have been able to source its raw materials from neighbouring countries in the region and to add value to the products, building a reputation for quality in a wide range of export markets. The acquisition of advanced processing and freezing technology has therefore enabled the Singapore seafood industry to remain internationally competitive despite higher labour and operational costs. This has successfully attracted overseas investments from Japan, Taiwan, USSR and the USA. In 1990, Singapore exported 127,854 mt of fish and fish products valued at S$672 m whilst imports amounted to 181,805 mt at S$624 m (Table 2.).

Status Of The Fish Processing Industry

The fish processing industry comprises export-oriented companies, and the domestic-based traditional fish products factories. All fish processing companies exporting their processed products overseas are licensed and inspected by the Primary Production Department (PPD). The PPD conducts on-line monitoring of the processing lines and provides advice and services to the industry to assist them to produce high quality and safe seafood products. The Department also provides health certificates for products from these factories.

The Export-Oriented Fish Processing Industry

In 1990, a total of 18 factories produced 25,362 mt of processed products of which 4,939 mt were consumed locally (Table 3). Amongst these 18 factories, 8 companies processed for export,

Table 2. Import and export of fish and fishery products.

Year	Imports		Exports	
	Quantity (mt)	Value (S$'000)	Quantity (mt)	Value (S$'000)
1986	153,313	507,445	89,203	379,963
1987	153,129	607,667	105,444	533,491
1988	176,800	691,136	116,743	638,351
1989	164,311	671,801	115,638	623,727
1990	181,805	624,461	127,854	671,746

Source: PPD, Singapore.

Table 3. Processed fish products in Singapore, 1990 (mt).

Item	Processed	Exported	Local Consumption
Whole fish	9877	7660	2217
Fish fillet	7056	6746	310
Prawn	2611	2141	470
Squid, octopus	1649	1446	203
Cooked prawn	1549	1547	2
Fish ball, fish cake	539	0	539
Cooked fish	467	0	467
Imitation crab stick	440	398	42
Cuttlefish ball, finger, paste	328	22	306
Prepared prawn crackers	210	120	90
Prepared cuttlefish	179	112	67
Cuttlefish	119	26	93
Lobsters	118	83	35
Prawn meat	55	41	14
Prawn ball, finger	49	2	47
Breaded fish	47	47	0
Fish dumpling	40	28	12
Sharksfin	23	0	23
Mussel, scallop	9	7	2
Fish finger	0.9	0	0.9

Source: PPD, Singapore.

frozen fish and fish fillet mainly of tuna, swordfish, marlin, red snapper, shark and Spanish mackerel. The bulk of the frozen horse and Indian mackerel imported were reprocessed for local consumption. The 3 major prawn processing factories together with other factories produced about 4,160 mt frozen prawns for export mainly in the form of head-on, headless, peeled and cooked, using IQF nitrogen freezing tunnel systems. Two other factories process mainly cuttlefish and prawn balls for local consumption, but are now going into export to the Japanese market. The remaining factories process fish balls and fish cakes, imitation crab stick, prepared squid and prawn crackers and sharkfins.

These products are exported to a large number of countries including Malaysia, Brunei Darussalam, Thailand, Hong Kong, Japan, Taiwan, South Korea, the USA, Canada and Australia.

The Domestic Traditional Fish Processing Industry

The domestic traditional fish processing industry caters to the needs of the local domestic market, and comprises small to medium-sized factories processing fish balls and fish cakes, chilled and frozen fish, snack seafood products (dried squid, fish satay) and seafood delicacies (sharksfin, sea-cucumber etc).

There are now about 50 fish ball/fish cake factories producing about 50 mt of products per day (Table 4). In the past the industry was basically backyard and traditional family-run concerns without much technical or management expertise. Their operations relied heavily on the daily availability of cheap and abundant fish, manual heading and gutting of fish, separation of meat, mixing of minced meat in wooden containers and forming of products by hand. All these activities are labour intensive and operations are often not entirely hygienic. Due to improper handling, the products are easily contaminated. Our high local air temperatures also contributes towards the short shelf-life of these products. The handling and retailing of the cooked products therefore needed improvement. The industry also faced a problem of insufficient raw materials, fishes like coral fish and dorab (traditional raw materials) were becoming increasingly expensive and short in supply.

Table 4. Number of fish jelly products factories in Singapore.

Types of Factories	No. of Factories	Total Production/Day (kg)
Fish ball, fish cake, *yong tau foo*, *ngoh hiang*, fish fillet	33	36,339 - 36,979
Cuttlefish ball, prawn ball, fish burger, prawn stick, prawn chip, prawn roll	8	4,222 - 4,322
Fish dumpling, fish roll	2	736
Minced meat	5	6,350 - 7,200
Fish *otak-otak*	2	500
Imitation crab stick	1	1,800
Total	51	49,947 - 51,537

Source: Survey on Fish Jelly Product Factories in Singapore by Ng M. C. (unpublished).

For large scale production, processors depended heavily on fish landed by foreign trawlers, often of low quality and availability subjected to seasonal changes, price fluctuations etc.

Changes In The Fish Jelly Product Industry

Over the last 10 years or so, many of the backyard operators were relocated to the government flatted factories around the housing estates, where there is now improvement in facilities such as better flooring, drainage and general cleanliness. Taking the opportunities for change under these circumstances, the PPD/MFRD provided technical guidance to manufacturers to upgrade in terms of mechanisation, output and quality improvement. Various processing equipment and processing techniques were introduced and recommended to enable processors to increase production capacities and to mechanise the forming of fish cakes.

Demonstration courses were conducted and processors were invited to view and evaluate the technology and equipment available. Subsequently, detailed processing trials were also conducted with manufacturers to test the suitability of equipment for their product lines. The concept of product development was introduced and processors were encouraged to market a wider range of products to consumers.

Raw material sourcing is always a problem to the processors and in 1980, the Department introduced the use of frozen surimi which not only provides a more stable supply of raw materials but also increases productivity by reducing the need to handle fresh fish. In 1981, Singapore imported 0.5 mt of frozen surimi. This has now increased to about 2600 mt in 1990, mainly from Thailand (Table 5). A new intermediate product in the form of chilled minced meat (washed) from West Malaysia and Thailand has also increased recently.

The use of frozen surimi as a semi-processed raw material has enabled fish ball manufacturers to concentrate on production and product development. Several large processors are now using the silent cutter which enables them to handle a larger volume of fish paste and achieve better product quality compared to the traditional paddle-mixers. These processors are now able to produce about 1.5 to 2 mt of products each day. Various types of fish cake forming machines are also now being used by the manufacturers, further reducing the dependence on cheap labour and increasing the production capacity.

Table 5. Import of frozen surimi into Singapore.

Year	Quantity (mt)	Value (S$1000)
1981	0.5	0.6
1982	445.1	1145.7
1983	1087.4	2989.9
1984	1055.2	2751.9
1985	1390.3	3226.1
1986	1455.1	3590.1
1987	1916.3	5277.3
1988	1745.2	4898.5
1989	1936.6	5342.8
1990	2601.9	7176.5

Source: PPD, Singapore.

There has been substantial growth in the local fish ball processing industry with 21 new factories established since 1985 mainly with production capacities of between 500-1000 kg/day (Table 6). There has also been an increase in the factories

Table 6. Production capacities of factories.

Production Capacities	No. of Factories	
	1985	1989
< 500 kg/day	11	16
500 - 1000 kg/day	5	17
> 1000 kg/day	14	18
Total	30	51

Source: Survey on Fish Jelly Product Factories in Singapore by Ng M. C. (unpublished).

producing more than 1 mt/day. This can be taken as a result of the increased use of frozen surimi and the use of machinery such as large capacity silent cutters, both of which increased production capacity.

There has also been efforts to further increase productivity and the Seafood Industries Association of Singapore (SIAS) in collaboration with the Singapore Institute of Standards and Industrial Research (SISIR) and PPD have started a project to develop a fully automated fish ball/fish cake machine to form, cook, steam (or fry) and chill the products ready for packaging.

This will not only reduce the use of manual labour but will also reduce handling, thereby extending the shelf life of the products. The equipment is expected to be ready by the end of the year.

The Department's efforts to encourage product development has also resulted in an increase in the range of fish jelly products available in Singapore. In addition to the traditional fish ball, fish cake, *yong tau foo* and *ngoh hiang* (spiced fish roll), some manufacturers have now specialised in breaded fish burger, fish fillet, fish dumpling, prawn chips, etc. One processor purchased in 1989 a S$250,000 *chikuwa* forming machine from Japan with production capacity of 3,500 pcs/hr to produce *chikuwa* for the domestic market.

The fish jelly product industry is also gearing up for exports of fish jelly products to markets in Japan, Europe and USA. Products like cuttlefish balls have already been successfully exported to Japan and Europe.

Frozen fish balls are also a potential export item especially to the Asian communities in USA and Canada.

Problems Of The Industry

a) The sourcing of raw materials for further processing is a major problem facing both the export-oriented factories as well as the domestic traditional fish processors. The advantage of Singapore as a trading center however has enabled processors to source raw material from China and Indonesia for prawns, fish from New Zealand, USA and other parts of the world.

   The fish jelly products processors now rely heavily on the use of frozen surimi as a semi-processed raw material and imports have been increasing steadily as more processors use it. The supply and cost of surimi from Thailand however is affected by fluctuation in the international supply and demand of surimi. The processors therefore have to source for additional supplies from Malaysia especially in the form of chilled leached meat.

b) To remain competitive Singapore processors have to produce high-value added products and to actively explore such markets in Japan, Europe and USA.

   Because of the high cost of labour, processors have to automate to increase productivity and to ensure high and consistent quality products. The support of the PPD in providing on-line monitoring services and a good health certification system for the products have established Singapore's reputation for high quality seafood products.

   The Economic Development Board of Singapore also provides loans and funding assistance for research and development in automation and upgrading of small and medium size industries. Coupled with the technology assistance from the PPD/MFRD many of the smaller factories have taken the opportunity to upgrade and to use higher production-capacity machinery.

c) The fish jelly products industry needs to further upgrade their technology and improve standards of hygiene and quality control. One of the constraints is the limitation of factory space and availability of labour. The fish jelly products produced under present processing conditions have a short shelf-life

Table 7. Types of products.

Product	Price Range (S$)	Total Production/Day (kg)
Fish ball	$2.30 - $9.00/kg	14,315 - 14,471
or	0.04 - 0.10/pc	
Fish cake	$1.10 - $6.00/kg	15,363 - 15,633
or	0.04 - 0.55/pc	
Yong tau foo	$5.00/kg	1,405
or	0.05 - 0.08/pc	
Ngoh hiang	$2.00 - $2.50/kg	2,956 - 2,970
or	0.16 - 0.22/pc	
Fish roll	$6.00/kg	670
or	0.07 - 0.08/pc	
Fish dumpling	0.07 - 0.08/pc	536 - 636
Imitation crab sticks	$5.00 - $8.00/kg	1,800
Fish burger	$3.90 - $5.50/kg	380
Fish fillet	$9.00/kg	150
Cuttlefish ball	$6.00 - $10.00/kg	3,650 - 3,750
Prawn ball	$6.00 - $9.00/kg	402
Prawn stick	$5.00 - $5.80/kg	30
Prawn chip	$5.00 - $6.70/kg	20
Otak-otak	0.07 - 0.15/pc	500
Minced meat	$2.40 - $9.00/kg	6,450 - 7,300
Leached meat	$4.00/kg	200
Prawn roll	-	700 - 800
Cooked fish	-	20

Source: PPD, Singapore.

of 2-4 days under chilled storage. Improvements in post-processing handling and chilling of the products are necessary pre-requisites to packaging of these products to extend shelf life for local consumption and export. The PPD/MFRD will continue to work with the industry to accomplish this objective.

Discussion

When asked whether it was economical to use liquid nitrogen instead of other freezing methods, Mr Tan answered that although liquid nitrogen is expensive, it is produced locally and used only for high-value products.

The Fish Processing Industry In Thailand

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Status Of The Thai Fishery Industry

The fish processing industry of Thailand is economically important as it provides job opportunities, incomes and foreign currency and the Government has put strong emphasis on the development of this sector in the National Economic and Social Development Plans. The current Sixth 5-year plan will end in the year 1991; the processing industry and related sectors, viz fish production and processing sectors, have progressively grown and developed throughout the period.

In the past five years, though capture fisheries have grown at a slow rate and have a tendency to be stagnant, aquaculture production has grown dramatically to serve the demand of the country (Tables 1 and 2). Fish supply for local consumption is decreasing because of population and export growth. Yet, local demand is to some extent met by freshwater aquaculture species. The fish processing industry, especially factories of export scale, has became one of the top world exporters despite trade barriers and competition, and Thai exports are recognized as quality products. Comparing the years 1985 and 1988, the country's exports grew by 71% in quantity and 140% in value (Table 3). Lack of supply seems to be a major problem of the industry. The Government has been trying to offset the problem by promoting freshwater and coastal aquaculture as well as joint-venture fisheries. However, the industrial sectors have had to import supplementary raw material. Imports of fish grew by 128% in quantity and 281% in value from the year 1984. Support from the government has also taken the form of technical services to maintain self-sufficiency in the supply of fish by reducing post-harvest losses and maximizing utilization. In the up-coming Seventh National Economic and Social Development Plan these activities remain in focus. The government realizes that the collabora-

Table 1. Growth rate of Thai fisheries.

Unit : 1,000 mt
Annual growth : %

Year	Capture	Growth	Culture	Growth
1988	2,418.7	-7.85	211.0	39.00
1987	2,624.7	8.26	151.7	18.14
1986	2,407.9	15.22	128.4	-16.00
1985	2,089.4	3.2	152.8	36.6
1984	2,022.9	-	111.9	-
Average Growth 84:88;%	-	19.56	-	88.56

Source: Fisheries Record of Thailand, 1990.

Table 2. Fisheries production in quantity by subsectors.

Unit : 1,000 mt

Year	Total	Capture		Culture	
		Marine	Freshwater	Coastal	Freshwater
1988	2,629.7	2,337.2	81.5	108.9	102.1
1987	2,779.1	2,540.0	84.7	61.9	89.8
1986	2,356.3	2,309.5	98.4	39.1	89.3
1985	2,225.2	1,997.2	92.2	60.6	75.2
1984	2,134.8	1,911.5	111.4	61.5	50.4

Source: Fisheries Record of Thailand, 1990.

tion between the government and private sector is the key factor in the development of the industry. Thus, the improvement and strengthening of service and assistance to the people involved in fish processing are included as specific items in the Plan.

Fish Production

Total fish production in 1988 was 2,629,700 mt of which 88% was from the marine capture fisheries, 3.1% from freshwater fisheries, 4.1% from coastal aquaculture and 3.9% from freshwater aquaculture (Department of Fisheries, 1990).

Marine Fisheries Production

In 1988, the total production of marine fisheries including coastal aquaculture was 2,446,100 mt. This quantity can be classified as fish 1,867,700 mt, shrimp 137,300 mt, cephalopods 114,200 mt and molluscs 227,200 mt (Table 4).

Among the fish, trash fish accounted for the highest quantity 956,100 mt or 39% of the total landings. Pelagic fish accounted for 638,000 mt or 26% of the total landings. Pelagic species landings comprised Indo-Pacific mackerel 111,700 mt (1,111.5 million bahts), tonggol 92,900 mt

Table 3. Thailand's international trade in fishery commodities.

Quantity : mt
Value : million bahts

Year	Import		Export	
	Quantity	Value	Quantity	Value
1988	347,666	14,713	798,572	44,437
1987	227,327	7,016	603,650	32,654
1986	268,089	7,590	602,486	26,829
1985	152,707	3,857	466,219	18,527
Average growth 85:88;%	127.7	281.4	71.28	139.8

Source : Fisheries Record of Thailand, 1990.

Table 4. Marine fish landings - major species.

Unit : 1,000 mt

	1988	1987	1986	1985	1984
Total	**2,446.1**	**2,601.9**	**2,352.2**	**2,057.7**	**1973.0**
Fish	**1,867.7**	**2,017.4**	**1,798.9**	**1,570.4**	**1514.1**
Pelagic	638.0	629.6	570.1	588.1	572.7
Demersal	141.2	152.7	131.5	97.5	88.5
Other food	132.4	129.4	121.1	108.4	95.3
Trash fish	956.1	1,105.7	976.2	776.4	757.6
Shrimp	**137.3**	**127.7**	**141.2**	**151.6**	**165.9**
Tiger	41.2	10.8	1.2	0.5	0.5
Banana	18.9	19.1	19.7	19.1	19.9
School shrimp	12.9	14.1	13.5	14.0	13.5
Sergistid	23.0	20.0	19.4	18.8	18.8
Others	41.3	63.7	97.4	99.2	113.2
Crab	**41.9**	**40.4**	**35.6**	**26.8**	**27.0**
Swimming	37.1	34.7	30.4	22.2	22.4
Mud	4.5	5.0	4.6	4.5	4.3
Others	0.3	0.7	0.6	0.1	0.3
Cephalopods	**114.2**	**132.5**	**134.4**	**116.0**	**129.3**
Squid	67.2	75.4	71.3	64.0	66.3
Cuttlefish	45.3	45.7	51.6	42.8	56.4
Octopus	6.6	9.2	12.0	11.4	11.7
Molluscs	**227.2**	**217.8**	**164.3**	**188.5**	**153.6**
Baby clam	115.4	131.2	101.2	83.7	50.5
Green mussel	66.8	46.8	31.8	61.0	62.2
Horse mussel	30.7	15.7	8.4	8.0	14.3
Others	14.3	24.1	22.9	30.8	26.6
Seaweed	**0.8**	**1.7**	**1.2**	**4.3**	**0.7**
Others	**18.4**	**40.5**	**76.1**	**29.0**	**153.6**

Source: Fishery Record of Thailand, 1990.

(1,784.2 million bahts), little tuna 53,500 mt (736.8 million bahts) and sardinellas 123,700 mt (394.1 million bahts). Demersal fish accounted for 141,200 mt valued at 1,515,500 bahts. The catch mainly comprised 3,200 mt grouper (238.7 million bahts), 29,600 mt threadfin bream (201.1 million bahts), 4,000 mt sand whitings (183.3 million bahts) and 22,600 mt bigeye (105.8 million bahts).

Shrimp, which are of the highest economic value per unit, accounted for 137,300 mt or 5.6% of the total production. Among these, tiger shrimp and banana shrimp were major species landed at 41,200 mt (6,650 million bahts) and 18,900 mt (2,621 million bahts) respectively.

Cephalopods accounted for 114,200 mt or 4.7% of total production. Major species comprised 67,200 mt squid (1,994 million bahts) and 45,300 mt cuttlefish (1,474 million bahts).

Molluscs accounted for 227,200 mt or 9.3% of the total landings. The major economic crab species were swimming blue crab and mud crab. Other marine species included jelly fish and sea cucumber (18,400 mt) and seaweed (800 mt), or 0.7% and 0.03% of the total production respectively.

Capture fisheries have been an important source of supply for domestic consumption. Yet it is recognized that the marine fisheries, which accounted for 89% of the total landings, cannot be expanded much further due to various limits described in the country report in 1987 (Sundaravipat and Suwanrangsi, 1988). Therefore, coastal aquaculture will play an increasingly important role in meeting the demands of domestic consumption and the export industry.

Thailand is blessed with 2,600 km of fertile coastline where 78,200 hectares are devoted to coastal aquaculture, mainly shrimp, reef fish (sea bass and grouper) and molluscs. Thirty-eight per cent of this area is under intensive shrimp cultivation. The annual shrimp production doubled its 1979 production of 7,064 mt in about six years. Within the time span of 10 years, shrimp production rose ten-fold. The latest figure (1989) was 100,000 mt, of which up to 90,000 mt were processed for export (Table 5).

Table 5. Shrimp aquaculture statistics.

Year	No. farm	Area (ha.)	Production (mt)
1989	10,347	78,209	100,000
1988	10,347	77,680	75,000
1987	7,264	52,148	25,000
1986	5,534	45,367	17,855
1985	4,939	40,769	15,841
1984	4,519	36,792	13,007
1983	4,327	35,537	11,550
1982	3,943	30,972	10,090
1981	3,657	27,459	10,728
1980	3,572	26,036	8,063
1979	3,378	24,675	7,064

Source : Suraswadee, 1990.

Freshwater Fisheries

In recent years total freshwater fish production has grown slowly but freshwater aquaculture growth has risen more than 50% above the level of 1984. The reason for this is that the wild catch has been continually declining. Total production of freshwater fish in 1988 accounted for 183,600 mt or 7.0% of the total production, of which 56% was produced by aquaculture (Table 6).

The quantity and value of major freshwater species are as follows :

Tilapia accounted for 27,600 mt or 15% of the total freshwater fish production and were valued at 361.3 million bahts.

Catfish (*Pangasius* spp.) accounted for 25,400 mt and were valued at 237.6 million bahts.

Local carp (*Puntius gonionotus*) accounted for 21,900 mt and were valued at 406.8 million bahts.

Sepat Siam (*Trichogaster pectoralis*) accounted for 17,600 mt and were valued at 265.9 million bahts.

Fish with low production volume but high value were, in order of importance, freshwater prawn, snakehead (*Ophicephalus straitus*) and catfish (*Clarius* spp.).

Table 6. Freshwater species production.

Unit : 1,000 mt

	1988	1987	1986	1985	1984
Total	**183.6**	**177.1**	**187.8**	**167.5**	**161.8**
Tilapia	27.6	27.3	23.3	15.41	21.5
Other food fish	27.6	21.1	35.5	24.1	26.9
Catfish (*swai*)	25.4	16.5	15.8	18.2	11.3
Local carp	21.9	16.9	21.8	16.0	20.1
Sepat Siam	17.6	20.2	23.0	23.1	18.9
Catfish (*duk*)	17.2	16.8	18.9	18.0	14.9
Snakehead fish	15.8	19.6	23.5	21.8	20.4
Freshwater prawn	13.1	13.0	6.4	7.2	4.7
Climbing perch	7.7	7.4	7.9	9.6	9.2
Common carp	4.7	6.4	4.0	3.6	4.6
Swamp eel	1.6	6.4	1.6	2.6	2.4
Others	3.4	5.5	6.1	7.9	6.9

Source: Fisheries Record of Thailand, 1990.

Fish Utilization

It is interesting to observe (as in Table 7) the fish supply available for consumption in Thailand from 1984 to 1988. The total production minus trashfish landings, which are regarded as non-edible fish products; post-harvest loss which is always estimated at 15%; and total exports/imports; gives the total domestic supply. When that figure is divided by the population, one arrives at annual per capita fish supply. To convert per capita fish supply to average consumption it is necessary to consider the weight of fish bones and viscera, losses in processing and preparation, and plate waste at the time of consumption. The average conversion factor used here is 60%; ie, the edible portion of fish is approximately 60% of its whole, ungutted weight. The edible portion of molluscs and crustaceans is smaller (Floyd, 1985).

In the past five years per capita fish supply was approximately 12-13kg and average consumption was a rather low 7-8kg. However, consumption varied from region to region and fish produced through fish ponds and small-scale fisheries have not been taken into account in the fisheries statistics. Nevertheless, this estimated figure gives some indication of the so-called limited supply.

The pattern for fish utilization remains the same. Fish are mainly consumed fresh and cured (salted, dried, steamed, smoked and so on). Canned products are consumed locally in smaller quantities compared with export volume and most of the frozen products are for export. Tables 8 and 9 illustrate the utilization of marine and freshwater fish. In the past three years marine fish available for fresh marketing has declined from 26.3% in 1985 to 19.95% in 1988, while the amount of fish used in freezing and canning increased to 14.28% and 13.28% or by 34% and 36%, respectively. On the other hand, fish used in curing decreased to 9.7% in 1988 or by 40% from 1985. The main reason for this change in the pattern of fish utilisation could be the increasing cost of raw material resulting from limited supply. This would make small entrepreneurs less competitive in securing their raw material for production. Cured products produced from marine fish included dried salted fish, fish sauce, dried shrimp, dried squid, smoked

Table 7. Supply available for consumption in Thailand.

Unit : 1,000 mt

	1988	1987	1986	1985	1984
Total domestic production	**2,446.1**	**2,601.9**	**2,352.2**	**2,057.7**	**1,973.0**
Non-edible fish products	956.1	1,105.7	976.2	776.4	757.6
15% post-harvest loss	366.9	390.3	352.8	308.7	296.0
Total exports	798.6	603.7	602.5	486.2	411.7
Total imports	347.7	227.3	268.1	152.7	119.1
Total domestic supply	672.2	729.5	688.8	639.1	626.8
Population (million)	54.96	53.87	52.97	51.80	50.54
Annual per capita supply (kg)	12.36	13.54	13.00	12.34	12.4
Estimated av. consumption (kg)	**7.42**	**8.12**	**7.80**	**7.40**	**7.44**

Source : Fisheries Record of Thailand, selected years

* To convert per capita fish supply to average consumption, it is necessary to consider the weight of fish bones and viscera, losses in processing and preparation, and plate waste at the time of consumption. The average conversion factor used here is 60%.

Table 8. Utilization of marine fish.

	1988		1987		1984	
	mt	%	mt	%	mt	%
Marketed	488,002	19.95	497,749	19.13	560,900	26.3
Frozen	349,307	14.28	325,501	12.51	201,000	9.4
Cured	236,051	9.65	279,447	10.74	346,700	16.21
Canned	324,845	13.28	318,476	12.24	181,300	8.5
Other	1,047,920	42.84	1,185,178	45.55	844,900	39.6
Total	**2,446,125**	**100.00**	**2,601,929**	**100.00**	**2,314,800**	**100.00**

Table 9. Utilization of freshwater fish.

	1988		1987		1984	
	mt	%	mt	%	mt	%
Total	**183,607**	**100.00**	**177,142**	**100.00**	**161,819**	**100.00**
Marketed	144,498	78.7	152,342	86.6	117,555	72.7
Frozen	-	-	-	-	-	-
Cured	39,108	21.3	24,827	14.0	44,264	27.3
dried/salted	22,583	12.3	11,542	6.5	21,022	13.0
steamed/smoked	6,242	3.4	4,960	2.8	5,669	3.5
fermented	8,630	4.7	7,617	4.3	13,455	8.3
fermented paste	184	0.1	354	0.2	212	0.1
fish sauce	1,469	0.8	177	0.1	2,583	1.6
dried shrimp	-	-	177	0.1	166	0.1
others	-	-	-	-	1,157	0.7

Source : Fisheries Record of Thailand, 1984, 1987 and 1988.

fish, steamed fish, fishball, dried mussel, fish crackers and *budu* sauce.

Most freshwater fish is utilized domestically, 87% of it, in fresh form. Curing absorbed 21% of total raw material. Dried and salted took 12.3% (of total freshwater production) or 22,538 mt, followed by fermented fish which utilized 4.7% or some 8,630 mt.

Fish Processing Industry

Since 1984 the number of fish processing plants has not substantially increased but their capacity has increased, except for plants processing certain traditional products (Table 10).

Freezing Plants And Cold Storage

In 1987, there were 80 registered freezing and cold storage plants. Their main activities were preparing, freezing and holding products including fresh products destined for local consumption. Many of these plants have increased their production capacity in response to demand in the international markets between 1988 and 1990.

During 1989, there were shortages of cold storage holdings as shrimp aquaculture products dramatically increased. Since then, the Board of Investment has regranted investment privileges to investors in this area, including those producing value-added products. This has contributed to a great expansion of cold storage holdings, production capacity and to diversification of processing.

Major species utilized by this industry are miscellaneous fish (27%), cephalopods (27%), shrimp (16%), Indo-Pacific mackerel (10.4%) and tuna (10%). The last two were stocked for local consumption and for further processing respectively. The processors normally produced block frozen products, eg shrimp are processed in the form of head-on, headless, peeled, deveined, undeveined. Cephalopods are processed in the form of whole cleaned and uncleaned, squid tube, cuttlefish fillet, squid rings and tentacles. Fish, for the most part, are processed into fillet form.

Thai processing establishments that ship their products overseas are up to international standards in design, construction, equipment and processing practice. The Department of Fisheries inspects these plants at least twice a year. Lists of the approved plants (they must achieve at least 'B'

Table 10. Number of fish processing factories.

Type of plant	1987	1986	1985	1984
Cold storage	80	84	80	78
Cannery	41	41	39	38
Fish sauce	110	111	114	113
Fish meal	95	93	92	95
Shrimp paste	nd	nd	2,725	2,860
Salted fish	671	943	978	800
Dried shrimp	176	165	148	284
Dried squid	711	828	879	865
Dried mussel	580	613	674	776
Steamed fish	78	94	115	138
Smoked fish	86	180	171	184
Fish-shrimp cracker	65	107	76	78
Fishball	79	69	54	64
Budu sauce	23	30	33	37

Source : Statistics of Fisheries Factories, 1989.

grade on the plant rating scale) are sent to importing authorities overseas to provide reasonable assurance that fish and fishery products from Thailand have been processed under hygienic conditions and practices and also meet standard requirements of authorities in importing countries.

A major industrial development in this line is the production of battered and breaded products using various seafoods as base, and the introduction of some other value-added products in terms of new product development and packaging diversification.

Canneries

The number of canneries has not increased in recent years because the existing factories have not reached their full capacity. There are at the moment 41 factories. Twenty-two of these produce, mainly, canned tuna. The rest are engaged in the production of canned shrimp, crabmeat, baby clam, cephalopods, sardine and mackerel.

Major species utilized by the industry are tuna (38.6%), tonggol and little tuna (18.3%), sardinella and scad (17%), shrimp (6.42%) and crab (6.71%) (Department of Fisheries, 1990).

Canneries in Thailand are up to international standards. Process control is the key critical control point of the industry. The Department of Fisheries has stringently inspected retort equipment, cooking time, post-process handling and seam defects in order to assure the safety of the products. Emphasis has been given to the training of retort operators and personnel involved in heating processes.

The industry has made efforts to increase production yield and efficiency, improve product quality, styles of pack and packaging. On the production line, new equipment has been extensively used to increase production efficiency. Most companies have hired well-trained production and

quality control personnel. In addition to conventional packing media, various new packing media have been developed to add value to the products. The traditional three-piece can has been replaced by two-piece cans and by easy-open end-cans. Some canneries produce their own cans.

A large-scale cannery has already invested in technology for the utilization of the processing wastes, for example, the processing of sauce from tuna cooking water. Canned petfood is another way to utilize waste from the canneries. (But 50% of canned petfood is made of fresh sardine.)

Surimi And Surimi Based Products Processing

There are, at the moment, nine active surimi processors, but according to the Board of Investment, 14 processors have applied for investment privileges related to surimi production. Among these are two plants that process imitation crabmeat. A third imitation crabmeat plant is being established. According to the owner, 75% of the surimi it will use will be imported.

Total surimi production capacity is 50,000 mt/year and one major producer claimed his share of it was 70% . Most of the surimi plants produce secondary products such as fishball, breaded fish cake and cuttlefish ball.

Value-Added Products Processing

Production of value-added seafood products started with the production of surimi (frozen minced fish block) in 1967 and cooked and peeled shrimp at about the same time. Later major developments in value-added products were consumer-pack frozen seafood, surimi products (eg, fishball, imitation crabmeat and Japanese-style fish jelly products) and semi-processed products (eg, spring roll, battered and breaded products). In the early stages of development, the industry faced problems in the form of inadequate product development technology, capital investment shortfalls, and the lack of market access to end consumers, the latter due to importer resistance and import regulations.

To date, 40% of exported seafood products (as estimated by processors) are either processed and packed into consumer packs or made into prepared seafood products for direct institutional/retail sale in major world markets. This is done through upgrading quality, using new technology or improving packaging. Diversifications are mainly based on shrimp, cephalopods and fish. Currently shrimp is value-added into the following forms: cooked and peeled shrimp, cooked whole shrimp, peeled butterflied, tail-on, peeled *tempura*, battered and breaded shrimp, shrimp skewer and processed products. The processed products include shrimp *shaomai, hargao*, shrimp spring roll, shrimp on sugar cane, shrimp dumpling, shrimp patties and *tom yam kung* (Thai-style shrimp soup). Today, most cephalopod products have undergone at least primary processing. Many are also processed to convenience products and delicacies such as cooked squid ring, squid/cuttlefish skewer, stuffed squid and breaded squid ring.

Traditional Products Establishments

Processing of traditional products is done by small entrepreneurs. To date, even though they do not use much modern technology, they have made progress in upgrading quality standards and are packing more and more in response to their customers' requirements for quality. However, there is still much room for improvement in processing practices, equipment and hygiene. It is estimated that 275,159 mt of raw material or 10.5% of total fish production were utilized in producing traditional products in 1988. Improvement in any of the abovementioned areas would result in better utilization of resources, and, indirectly increase fish supply for local consumption.

Export Of Fish And Fishery Products

Thailand is currently one of the world's major exporters of fish and fishery products, and seafood is one of the country's most important and successful industries. Due to excellent product quality and competitive prices, the industry has been able to expand and diversify its markets, which now in-

clude over 60 countries throughout the world. Over the past two years, frozen shrimp and canned seafood have been among the leading fishery exports (Table 11) and ranked 9th and 10th among Thailand's major export earners.

Exports of fishery products accounted for more than 50,000 million bahts in 1989 (Department of Business Economics, 1991). Types of products exported have been diversified from traditional shrimp, fish and cephalopods. There are now 17 major fish and fishery products which earn foreign currency income. These include frozen shrimp, canned tuna, canned seafood, frozen tuna loins, frozen cephalopods, frozen fillet and surimi and others. Exports grew by 139.8% from 1985 to 1988, and increases in both volume and value are expected to continue. In 1989, fish and fishery product exports were valued at 55,000 million bahts and the value in 1990 is estimated at 63,000 million bahts. The 1991 export target is 65,000 million bahts.

The present status and prospects of some major items are described below :

Frozen Shrimp

Over the past years, during which shrimp aquaculture boomed, the shrimp market has also shown tremendous flexibility in sourcing and product development in terms of country of origin

Table 11. Export target of fish and fishery products - major commodities

Quantity : mt
Value : million bahts

	1991*		1990**		1989	
	Quantity	Value	Quantity	Value	Quantity	Value
Shrimp	82,500	19,560	80,100	18,200	76,979	16,432
+/- (%)	3.0	7.47	4.05	10.76	42.11	60.11
Tuna	344,000	22,400	335,000	21,500	307,877	19,767
+/- (%)	2.61	4.02	8.10	8.05	10.45	5.51
Cephalopod	70,300	5,970	73,790	6,225	79,084	7,622
+/- (%)	-4.73	-4.56	-6.69	-17.93	14.67	22.69
Fish	289,000	6,970	247,500	6,000	202,975	4,308
+/- (%)	16.77	16.17	21.94	39.36	26.29	19.08
Value-added	85,000	5,600	56,000	3,700	22,053	1,165
+/- (%)	51.9	51.35	153.93	217.49	-6.42	-20.05
Pet food	140,000	3,300	130,000	3,000	122,473	3,045
+/- (%)	7.69	10.0	6.15	-1.47	10.19	27.26

* Target figure

** Estimated figure

Source: Department of Business Economics, 1991.

Table 12. Export target of fish and fishery products - by commodities.

Quantity : mt
Value : million bahts

	1991*		1990**		1989	
	Quantity	Value	Quantity	Value	Quantity	Value
Frozen shrimp	81,000	19,200	77,600	17,850	74,298	16,059
+/- (%)	3.09	7.57	4.44	11.16	49.11	65.53
Canned tuna	260,000	16,000	250,000	15,000	225,123	13,797
+/- (%)	3.84	6.67	11.05	8.72	12.01	6.41
Canned seafood	15,000	4,800	45,000	5,000	44,281	4,564
+/- (%)	-66.67	-4.00	1.60	8.72	-5.48	-3.16
Tuna products	60,000	4,300	33,000	2,500	118	8.2
+/- (%)	81.82	72.00	27,866	30,387	145.83	446.67
Frozen cehalopods	62,000	4,300	65,000	4,500	69,054	5,238
+/- (%)	-4.62	-4.44	-5.87	-14.10	17.51	34.64
Fillet and surimi	80,000	4,000	70,000	3,5000	42,192	2,080
+/- (%)	14.29	14.29	65.91	68.26	3.32	9.41
Pet food	140,00	3,300	130,000	3,000	122,473	3,045
+/- (%)	7.69	10.00	6.15	-1.47	10.19	27.26
Chilled fish	192,000	2,400	160,000	2,000	143,712	1,726
+/- (%)	20.00	20.00	11.33	15.87	32.19	34.57
Value-added	25,000	1,300	23,000	1,200	21,935	1,157
+/- (%)	8.70	8.33	4.86	3.70	-6.73	-20.53
Canned fish	15,000	700	15,000	750	15,982	781.2
+/- (%)	0	-6.67	-6.14	-3.99	-0.54	19.30
Canned sardine	30,00	900	25,000	750	22,491	626.1
+/- (%)	20.00	20.00	11.16	19.79	51.54	55.32

* Target figure

** Estimated figure

Table 12. Export target of fish and fishery products - by commodities (*contd.*).

Quantity : mt
Value : million bahts

	1991*		1990**		1989	
	Quantity	Value	Quantity	Value	Quantity	Value
Dried squid	4,300	1,050	4500	1,100	3,900	1,505
+/- (%)	-4.44	-4.55	15.38	-26.93	-20.75	-4.12
Seasoned squid	4,000	6,200	4,290	655	6,130	878
+/- (%)	-6.67	-5.34	-30.02	-25.41	16.08	16.11
Dried fish	15,000	400	16,000	350	15,166	340
+/- (%)	-6.25	14.29	5.50	2.91	60.08	16.11
Cooked/peeled shrimp	1,100	170	1,000	150	979	146
+/- (%)	10.00	13.33	2.15	2.53	-57.75	-50.03
Live fish and fries	2,000	170	1,500	150	1,905	162
+/- (%)	33.33	13.33	-21.26	-7.52	12.39	14.71

* Target figure

** Estimated figure

Source: Department of Business Economics, 1991.

and species. A notable example is the recent success of black tiger shrimp (*Penaeus monodon*). Initially shrimp importers like Japan were reluctant to procure large quantities of this species whose colour and texture differ sharply from their traditionally-preferred species. However, the price at which this species was offered, and its quality and availability soon overcame importer resistance. Within five years, the species has become a major market determinant in a niche previously monopolized by white shrimp.

After years of continuous expansion caused by aquaculture, Thailand is now one of the top five major suppliers of frozen shrimp in the international market. Thailand ranks second in the Japanese market, third in the US market and is the top supplier of warm-water shrimp to various EC countries. The species of economic importance are black tiger shrimp (estimated to be 56% of the total shrimp export), white shrimp and freshwater prawn. The popular product forms among traders are raw headless shell-on, constituting 70% of the total world trade, and head-on shrimp which account for about 10%. About 10-15% consists of peeled shrimp and breaded shrimp.

Thailand has been able to gain a significant market share in those countries because

(a) The country has increased production of frozen shrimp with the expansion of its aquaculture, which is dominated by *P. monodon*, and with increased demand from the market. In 1988, Thailand was able to hold a strong market share in Japan, USA and even in the EC countries which have now become familiar with cold water shrimp.

(b) Total shrimp consumption in the main consuming countries has continually expanded. Imports of farmed shrimp into Japan and the US have increased to 33% of their total shrimp imports.

(c) Processors are able to control size and quality from the point of catching to processing.

(d) Although exporters to the US are often handicapped by automatic detention-for-inspection by the USFDA, most Thai exporters have overcome this problem and they can supply shrimp which meet the USFDA quality requirements.

A particular problem faced by the industry in major markets has been competition from suppliers in other developing countries. To offset this, processors have intensified efforts to build a quality image and to diversify markets and product forms. New ready-to-cook products and packing styles have been developed along with new chemical- and drug-free products.

Canned Tuna

The success of the Thai canned tuna industry has caught the world by surprise. The country now holds 70% market share in the USA, 50% in the EC countries including Britain, West Germany and Switzerland, and 60% in Canada. Exports rocketed from 1,854 million bahts in 1984 to close to 13,800 million in 1989. They are expected to reach 16,000 million bahts or 260,000 mt in 1991 (Department of Business Economics, 1991).

Thai processors use both domestic and imported tuna for canning, and the domestic catch consists of tonggol and little tuna. The Department of Fisheries has estimated that each year's domestic catch is approximately 60%-70% tonggol and 30%-40% little tuna; these are fish locally-caught in the Gulf of Thailand and the Andaman Sea. The majority of tuna that Thailand imports are skipjack (approximately 85-90%), followed by yellowfin (8-12%) and some albacore (2-3%). Imports now account for over 70% of the tuna used in the processing. In 1989, imports rose from approximately 275,000 mt in the prior year to approximately 325,000 mt.

The reasons for this success are

(a) The industry's ability to meet quality standards in major importing countries eg, USA, Japan, Canada and European- producer countries.

(b) The processors' ability to penetrate the Canadian market, where the import authority applies stringent quality standards to imported fishery products, especially canned tuna. This has given exporters the confidence to enter other new markets.

Since 1990, the world tuna industry has struggled with the dolphin issue, which has now spread from the USA to western Europe. Thai processors have adopted 'dolphin safe' policies by which the processors agree not to purchase, process and sell tuna caught in association with dolphin and to monitor tuna fishing in the Eastern Pacific to ensure that tuna purchased, processed and sold by the Thai processors is not associated with dolphin death or injury. In addition, the processors have ceased purchasing any tuna caught in highseas driftnets.

The dolphin controversy between the environmentalists and the tuna catchers is not likely to be resolved soon. However, the demand for canned tuna is expected to increase further. Thai canneries are working continuously to maintain their high quality standards. Improved quality control and standardization are emphasized to raise consumers' positive perception of the quality and reliability of the products.

Frozen Cephalopods

Compared with shrimp and tuna, the cephalopods' volume of trade is much smaller. In 1989, exports accounted for 69,054 mt and were valued at 5,238 million bahts. However, in 1990 it is estimated that exports decreased to 65,000 mt, valued at 4,500 million bahts. This would repre-

sent a decrease of 5.87% and 14.10% in volume and value respectively. Exports are expected to decrease to 62,000 mt (4,300 million bahts) in 1991 (Department of Business Economics, 1991).

The principal markets for these species are Japan and southern Europe. Thailand is a major supplier of cuttlefish and octopus to both markets to which it shipped 15,600 mt. Also, the country has successfully penetrated the Italian market. Italian demand for Thai loligo squid and cuttlefish is strong despite the stringent regulation on cadmium and biotoxin.

For the past three years, Thai processors have suffered from limited supply of squid and octopus, a situation which has resulted in high prices, uncompetitive products, and decreased export quantities and values. Consequently, since 1989, export volume has fallen and this trend is expected to continue.

In addition to shortage of raw material, the industry faces the problem of poor-quality raw material - particularly that supplied by trawlers. Import regulations, quotas and inspection procedures have also retarded the expansion of the market.

In response to the shortage of raw material, the Department of Fisheries has carried out research on cuttlefish aquaculture. The experiments have been successful at both the pilot and commercial scales.

Fish

Chilled fish have been major export items over the past five years. The volume of trade soared from 1,726 million bahts in 1989 to almost 2,000 million bahts in 1990. This trend is expected to continue in 1991 (Department of Business Economics,1991).

Prepared fish products, particularly surimi and frozen fillets, are increasingly important. Fish fillet is a standard item of the international trade and with a high potential for growth, and many processors have diversified into this area. Production capacity, at present, is about 10,000 mt/year. Ninety per cent of the raw material is imported.

Another interesting item is frozen tuna loins. In the past, loin operation was considered to be an intermediate form of processing and the technology had not been extensively developed and perfected. In 1987, Thai processors acquired new processing techniques which allow fish to be cooked and frozen in ways that retain odour and flavour. Under this system, labour-intensive gutting, cleaning and initial cutting of tuna will be done in Thailand. The output - frozen tuna loins - will then be shipped to the US and Europe for the capital-intensive packing operation. The volume of trade has greatly expanded from 118 mt valued at 8.2 million bahts in 1989 to 33,000 mt valued at 2,500 million bahts in 1990. In 1991, the trade is targeted to be around 60,000 mt (value: 4,300 million bahts). Importers now appear to be confident that frozen loin quality is comparable to fresh loin. In addition, the canning of loins is indeed a solution to the problem of the US and European industry since it allows those canning industries to capitalize on the low wage rates in those countries where the loining takes place.

Value Added Seafood Products

Changes in major importing countries such as improving economic status, changing life styles, consumption patterns and various socio-economic influences, have made current favourites of high-value and value-added seafood products. Thailand has enjoyed an advantage, during this period, because of the favourable quality image in terms of product standard and processor reliability. The trade volume of value-added products has increased substantially; however figures on all products traded are not presently available. It is estimated that value- added products trade in 1990 accounted for 56,000 mt, valued at 3,700 million bahts (Table 11). A 50% increase in volume and value is targeted for 1991. This figure includes imitation crab meat, breaded fish and fishball and excludes cephalopods and shrimp products. To penetrate new markets and to increase the export of value-added products, both government and the private sectors have carried out a programme of continuous product development, product adapta-

tion, technology development and quality control as well as a packaging development programme.

The problems faced by this industry are:

a) More stringent standards for consumer pack and ready to eat products by importing countries.

b) The market for value added products is highly competitive, involving changes in type of products, forms and packaging as well as consumer behaviour. Often, importers are disadvantaged by the complexity of health and quality regulations. Exporters must be aware of market requirements, regulations and standard of importing countries including any possible changes and should check with the authorities of importing countries before shipping their products.

Problems Faced By The Industry

As the fishery industry expands, the industry faces the following problems:

Shortage Of Raw Material

The Thai industry has faced this problem for more than half a decade with supplies remaining limited as capacity increased. The industry has tried to overcome this problem by importing raw materials such as tuna and other fish, and by using raw materials from aquaculture and joint venture fisheries.

Quality Of Raw Material

The industry cannot fully control the quality of raw material, especially from capture fisheries. Even though it has applied strict standards in the purchase of raw material, competition among processors has forced them to be more flexible to maintain their share of supply. Control of the quality of aquaculture products is easier. Some processors own aquaculture farms along with refrigerated trucks and sufficient ice to apply to the catch as soon as it is taken out of water. However, there are some cases in which processors cannot know whether or not the catch is drug-free or chemical-free. For this reason, strict monitoring procedures are presently implemented by both the processors and the Department of Fisheries to ensure that raw materials and products are free from drug and chemical residue. These monitoring systems also cover heavy metals and biotoxin in wild catch species.

Trade Competition

Competition among developing countries is becoming intense. As a result these countries need to embark on new products which will give higher profit. The competition can be briefly listed as follows :

- Competition between different sources of supplies (eg, between domestic and imported products and among foreign suppliers)
- Competition between types and species (eg, squid versus cuttlefish, *Illex* versus *Loligo*; among tiger shrimp/white shrimp and cold water shrimp, etc.)
- Competition between different sizes and forms.

Trade Barriers

Barriers to the processors and exporters can be classified as:

Technical barriers to trade, for example:-

- Sanitary inspection
- Marketing standards and regulations
- Labelling requirements
- Food additives residue, chemical and drug residue
- Biotoxin and contaminants.

Law and legislations such as:-

- Quotas and tariffs
- Marine animal conservation legislation eg, marine mammal protection acts

(USA), turtle conservation legislations (USA), highseas driftnets legislations (USA, Canada and Australia)
- EC single market.

Technical Capability

Packaging technologies are needed for the further development of the industry. At the moment, the industry depends on imported technology in the area of processing techniques and equipment acquired from joint-venture and equipment suppliers. Self-developed technologies are also employed but progress is slow in this area. Faster progress is being made on technology adaptation. Improved packaging is crucial, not only to protect the products but also to market the products.

Role Of Government

In the Sixth Economic and Social Development Plan (1986-1991), the government is emphasizing rural development, poverty eradication and export promotion. The Department of Fisheries, in pursuit of these objectives and to deal with the problems facing the industry, has prioritized the activities as follows :

Promoting Aquaculture To Secure Fish As Animal Protein For People In Rural Areas

The Department encouraged fish farming through village fish pond and school fish pond programmes in northern and north-eastern Thailand. The people were taught fish rearing, hatchery techniques, preservation and processing.

Promoting Aquaculture For Export

Recognizing the need for raw materials for the fish processing industry, the Department has boosted research, development and extension work on shrimp, fish and cuttlefish aquaculture in order to meet the needs of the growing industry.

Negotiating Joint Venture Fisheries

Joint ventures with neighbouring countries, eg, Myanmar, Vietnam, ASEAN countries and India are promoted by the government to obtain fish for the export industry.

Ensuring Quality Of Fish And Fishery Products

In this area the Department has emphasized the upgrading of fish processing plants and fishery products for export. The Department's prime emphasis is on the inspection of fish processing plants and fishery products.

The Department of Fisheries, through the Fishery Technological Development Division (FTDD), provides service to the fish export industry. The aims are to :

- promote production and export of safe and high quality products.
- provide reasonable assurance that fish and fishery products from Thailand will be safe and of good quality and will otherwise meet standard requirements of authorities in importing countries.
- ensure that any problems due to quality of products are quickly identified and dealt with.
- collaborate with authorities in importing countries to create confidence and to upgrade the system so as to minimize the need for extensive sampling.

The current seafood safety and quality control programme is based on Good Manufacturing Practices (GMP) and the Hazard Analysis and Critical Control Point (HACCP) principles. The programme emphasizes continuous problem solving and prevention, from the water to the consumer, rather than a reliance on analysis of product samples prior to exporting. Although this programme is voluntary, the Ministry of Commerce requires that fishery products for export be certified for their

safety and quality by the Department of Fisheries. In addition, the certificate for fish processing plant hygiene required by importing countries must be issued by the Department of Fisheries. Services provided through this programme are as follows :

a. Plant Inspection

The Division carries out plant inspections at the rate of 2-4 times/year based on the standards and recommendations of the CODEX Alimentarius Commission and various importing countries. The inspection is done by inspectors specialized in raw material handling, process operations and plant hygiene and the inspection team is made up of at least three inspectors. The inspection focuses on the condition and maintenance of construction, equipment, processing operations, plant hygiene and personnel. Processing plants must score at least a 'B' grade to obtain a sanitary certificate. If the plant is found to be not in compliance with the requirements, it is given one to three months to make the necessary corrections.

b. Product Certification

The Division provides analytical, microbiological and sensory evaluation services, by well-trained scientists and panelists, to the fishery industry. Certifications are made according to the established standard and grades and requirement of different importing countries. Examples include Sanitary Certificate, Certificate of Analysis and Health Certificate.

c. Shrimp Farm Inspection

This programme was launched to serve shrimp farmers and exporters, to ensure good farming practices and farm sanitation. The goal is to be able to identify quality and safety problems of shrimp either for export in fresh chilled form or for further processing for export as frozen products. The programme is designed to monitor levels of chemical (pesticide and antibiotics) and microbiological contaminants. It also covers farm hygiene and the gathering and establishment of parameters for upgrading practices and standard.

d. Process Analysis

This service is provided upon the request of the fish canning industry. The service includes heat distribution testing, assessment of cooking time and temperature for various canned products, etc.

Carrying Out Research And Development On Fish Handling, Processing And Quality Control

Following are some areas of research conducted by the FTDD.

a. Fish Handling

- Development of technology to prolong product life, eating quality and freshness of live, chilled and frozen fishery products,
- Development of economic methods for fish handling at sea, on shore and for fish transportation and distribution systems,
- Improvement of hygiene of fish handling, pre-processing and distribution,
- Development of shellfish depuration and control programmes, and
- Fundamental research on product composition, nutritional value,

application of preservatives in fish and fishery products.

b. Traditional Product Development

- Modernization of the processes by introduction of technology,
- Improvement of product form and style of pack,
- Improvement of quality and techniques,
- Improved understanding of chemical and biochemical processes involved, and
- Establishment of processing and product standards.

c. New Product Development

- Improved utilization of by-catch and low value species,
- Improvement of product form and quality,
- Development of value-added products, and
- Development of convenience foods and nutritive snack foods.

d. Engineering

- mechanization of fish-landing, handling, processing and transportation systems,
- development of small-scale equipment.

e. Development

The Division plays an important role in the improvement of the local fishery industry with the emphasis on the following areas :

- Improvement and maintenance of product quality and safety,
- Improvement of processing practices,
- Expansion of output through diversification of products,
- Improved utilization of fish as a protein source, and
- Improvement of the technical competence of personnel involved in the fishery industry.

The development programmes include :

- Rural development,
- Small-scale industry development,
- Industrial development, and
- Training for fishermen, entrepreneurs, quality control and production personnel.

Promotion And Support Of The Fish Processing Industry Through Domestic And International Collaboration

- participation in the drafting of Standards, Guidelines and Code of Practices at the national and international level, eg, at the CODEX Commission meetings,
- participation in the GATT Negotiating Group on Agriculture on Sanitary and Phytosanitary Issues, in order to lessen the technical barriers to trade, and
- cooperation with research, marketing and inspection institutes to develop technology and techniques for fish handling, processing and quality control.

Future Development

The Department of Fisheries' most recent thinking on future plans for the development of the fish processing industry stems from the 7th National Economic and Social Development Plan (1992-1996) and centers around the following objectives:

'Development and management, in co-operation with the industry, of the processing and quality assurance techniques needed to secure optimum and economic benefits for the nation and to promote the export of quality fish and fishery products'.

Specific objectives are to:

- improve the income of small-scale fishermen and fish processors, achieve and maintain self-sufficiency in the supply of fish to the domestic market, by reducing wastage and spoilage losses and increasing utilization,
- maximize the participation of rural population in commercial fish processing activities, assist the industry in controlling the quality of fish and fishery products, and
- increase export earnings from the sale of fish and fishery products.

Specific items in future plans for fish processing development include:

- assistance to small-scale fishermen and villagers to help them organize themselves for fish processing and fish distribution activities. This includes provision of technical and marketing assistance,
- establishment of regional R&D centers and fish inspection and quality control centers to carry out technology development and services, geared to the needs of each region,
- establishment of information centers to serve as sources of information on fish processing and marketing, and
- strengthening of research and development in the areas of fishery food safety, biotechnology and packaging.

In the industrial sector, future plans for development include:

- diversification of fish and fishery product exports to new markets,
- implementing quality management program based on HACCP principles, and
- utilization of industrial waste.

Discussion

When asked what type of machines were used to process cooked peeled prawns in Thailand, Miss Suwanrangsi said that 90% of these products are processed manually. In response to a query about the utilization of shrimp by-catch in Thailand, Miss Suwanrangsi replied that the Department of Fisheries had started a development work on by-catch utilization about ten years ago, and that the surimi and fish jelly product industry are now utilizing these by-catch. An indication of the extent of usage is that the average fish size of the by-catch is now much smaller than before.

Regarding the utilization of shrimp by-catch, a question was asked about the raw material used in the production of fish meal in Thailand. The reply was that, in addition to the local by-catch, production waste from the fish processing industry is being used.

Asked about the technology for producing tuna concentrate, Miss Suwanrangsi said that cooking water from tuna canning industry was concentrated by a reversed phase.

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RESEARCH PAPERS

Fourteen papers were presented at the Seminar. The text of these papers are reproduced, each followed by a summary of the discussion which took place.

Technology For Fish Cracker *(Keropok)* Production

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Abstract

The paper describes two levels of technology that can be used for *keropok* production.

Keropok are popular snack foods in Malaysia and the ASEAN countries, and are produced by gelatinization of starch with water, to form a dough which is shaped, cooked and then sliced. The slices are dried and expanded into a low-density porous product upon immersion in hot oil. However, production methods used are heavily dependent on manual labour, resulting in inferior quality products which have uneven expansion, dark objectionable colours and varying shapes, sizes and thicknesses. A mechanized method (modified method) has been developed to upgrade *keropok* technology. Products from this method were superior in terms of appearance, shape and linear expansion and were more acceptable to taste panellists.

Keropok was also successfully prepared by extrusion. The degree of expansion was measured as a function of extruder temperature and for products extruded at 100°C and above panelists found no significant difference between extruded samples and those prepared using the modified method.

Introduction

Crackers (in Malaysia known as *keropok*) are popular snack foods in Malaysia and the ASEAN countries. In the West, they would be classified as 'half-products' or 'intermediate' (Lachmann, 1969) and expanded snack products (Cumminford & Beck, 1972). Basically, they are produced by gelatinization of starch with water to form a dough which is shaped, cooked and then sliced. The slices are then dried and expanded into a low density porous product upon immersion in hot oil. Fish, prawns or other food ingredients are usually added.

Keropok production in Peninsular Malaysia is usually confined to the coastal fishing areas along the east coast states (Siaw & Yu, 1978). In the states of Trengganu and Kelantan, *keropok* production is a seasonal activity and is usually processed during the months of April to October. September and October are the peak production periods. A considerable proportion of the population is involved in *keropok* production in these two states (Maarof, 1976). Basically, production still follows traditional methods and remains a cottage industry.

The fish is deboned manually and mixed with flour. Generally, sago flour *(Metroxylon sagu)* and/or tapioca flour *(Manihot utilissima)* is used. Salt, monosodium glutamate, water and sometimes sugar are added. This mixture is then kneaded manually or pounded using long wooden poles in a wooden mortar, 30-50 cm in diameter and 20-25 cm in depth, placed on the ground.

After the appropriate consistency has been obtained, the dough is shaped manually by rolling into cylindrical rods, 25-30 cm long and 4-6 cm in diameter. To facilitate the rolling process, more flour is added to the dough during this procedure. The rolls are then boiled for about 1.5 hr until cooked. The cooked roll is then allowed to cool at room temperature. On the east coast of Peninsular Malaysia, the dough at this stage can be either fried

or sliced. The fried product is known as *keropok lekur* and the sliced *keropok* is *keropok hiris*. The sliced variety is more popular.

Slicing is carried out manually using a knife and each slice has a thickness of 3-5 mm. The sliced pieces of dough are then dried in the sun. The drying period varies and can be as long as 2-3 days, depending on prevailing weather conditions.

It is hardly surprising then that *keropok* produced this way are of poor quality. Product compositions vary among processors and are largely dependent on the desired profit margin. If fish is expensive, less fish or less expensive species will be used. There is no form of control for consistency or quality. The mixing process does not ensure a homogeneous dough and the rolls subsequently produced are of varying diameters. The centres of the rolls very often remain uncooked after boiling. Manual slicing results in pieces of cooked dough with different thicknesses within and between slices, and the irregular diameter of the rolls causes different shapes and sizes to be produced. The process of sun drying is also uncontrollable and variable. This results in fluctuations in the moisture content of the dried slices. Usually, the moisture content is high as the product is sold by weight.

Preparation Of *Keropok* Using The Modified Method

The fish *(Clupea leiogaster)* was obtained fresh from the market. After deboning, the flesh and other ingredients were processed as outlined in Fig. 1.

The formulation used was 1:1 fish to flour, 2% salt, 1% sugar and 25-30% water. The fish : flour mixture and the other ingredients are mixed in a bowl mixer until a homogeneous mixture is obtained. The dough-like mixture is then stuffed into cellulose casings using a sausage stuffer (Dick, West Germany). The stuffed rolls are then steamed to gelatinize the starch granules for 60-90 min under ordinary pressure, when the temperature of the granules reaches 90-95°C. After steaming, the cooked roll is immersed in iced water in order to prevent shrinkage, reduce cook loss and to facilitate separation from the casing. It is then chilled overnight at 5-10°C before being sliced, using a gravity slicer. A thickness of about 3 mm was found to be more acceptable in terms of packing, drying and expansion properties. For oven drying, an initial lower temperature of 40-45°C was used to prevent case hardening which leads to poor expansion. A final temperature range not exceeding 65-70°C was used and the product dried to a final moisture content of 8-9%.

Examination Of Product

Chemical Analyses

Analyses for moisture, fat, crude protein, ash and salt contents were carried out according to Pearson (1970).

Linear Expansion

The linear expansion was obtained on deep frying the dried *keropok* in palm oil at 200°C. The unpuffed *keropok* were ruled with five lines across using a fine oil pen. Each line was measured before and after puffing. The percentage linear expansion was calculated as follows:

$$\text{Percentage linear expansion} = \frac{\text{Length after puffing} - \text{Length before puffing}}{\text{Length before puffing}} \times 100$$

Organoleptic Evaluation

The samples were evaluated after frying at 200°C by twenty-one experienced panellists who were asked to rate the colour, crispness, flavour and overall acceptability of the products using a rating test of 5 for excellent to 1 for poor. The results were analysed using the Duncan's multiple range test (DMRT).

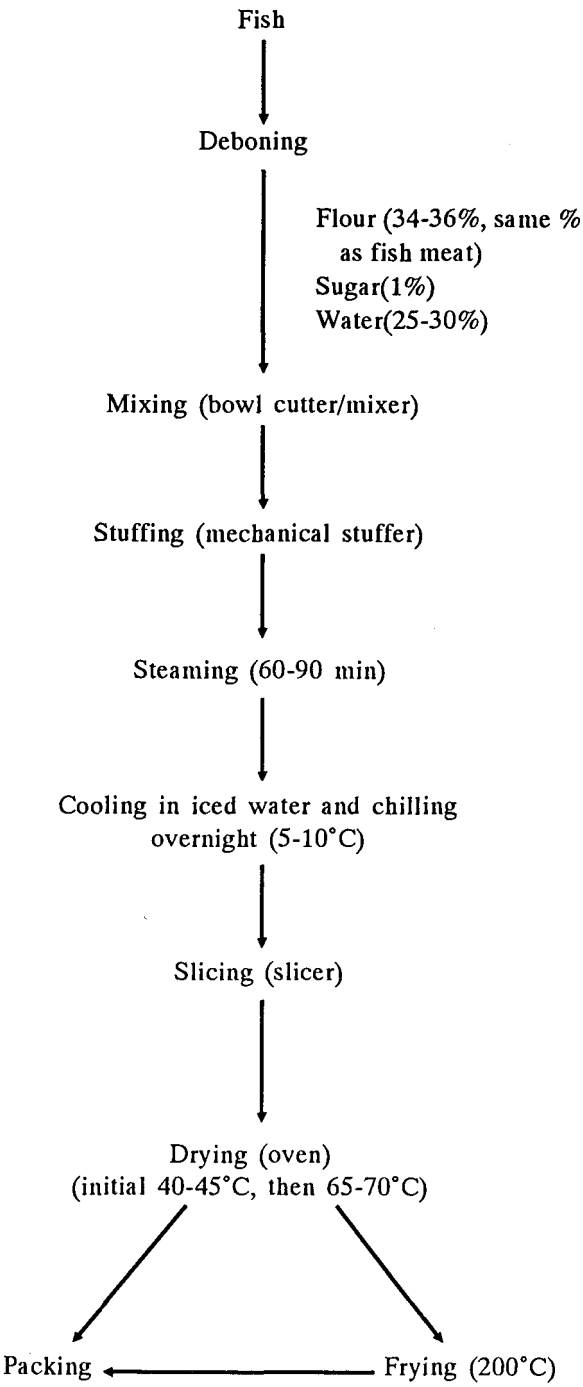

Fig. 1. The modified method of keropok *processing.*

Results

Chemical Composition And Expansion Characteristics

The chemical analyses and expansion properties of four samples of *keropok* processed traditonally, compared with those prepared using the modified method, are shown in Table 1.

There is slight variation in chemical composition whereas linear expansion varies considerably. Chemical composition depends on formulation whereas linear expansion depends on the physical properties of the fish-flour mixture. Traditional products (A-D) have much lower expansion and this is due to poor mixing, variation in the thicknesses of the sliced product and uneven drying. Basically this results from poor understanding of the functional properties of the ingredients utilized and processing technology involved. *Keropok* processing by the modified method begins with a homogeneous mixture of fish and flour that can only be achieved mechanically. A well-mixed structure will result in smooth texture and good expansion. Mixing that is not homogenous causes decreased gelatinization and therefore the expansion ratio is lowered. Processors should realize that only a well-mixed structure will gelatinize fully when cooked. Ungelatinized or semi-gelatinized starch granules will result in poor expansion characteristics. In the modified method, controlled cooking also ensures adequate gelatinization of the starch granules.

Organoleptic Evaluation

From Table 2, it can be seen that the appearance and shape score for *keropok* prepared by the modified method was rated higher and was more acceptable compared with those prepared traditionally. Samples were round and flat and obtained the highest mean score. In contrast, the shape of traditionally processed *keropok* varied considerably, from elongated and pointed to an oval shape. This inconsistency is due to the use of the hand rolling method as no casings or moulds are used to standardize shape. Hand slicing also causes variation in thickness. The main advantage of using a mechanical slicer is that thickness can be controlled.

Table 1. Chemical composition and linear expansion of fish *(Clupea leiogaster) keropok*. Samples A - D are traditional products.

		Samples				
		A	B	C	D	Modified Method
Chemical composition	Moisture	13.3	11.9	12.8	13.1	9.5
	Crude protein (N x 6.25)	20.3	20.6	20.0	21.7	21.6
	Fat	1.4	1.5	1.1	1.0	1.6
	Salt (Cl)	2.0	2.6	2.6	2.4	2.6
	Ash	2.9	2.4	2.8	2.7	2.8
Expansion property	Linear expansion	77.7	46.9	34.3	64.3	95.4
	S.D. (±)	7.2	9.2	9.8	8.1	6.7

Table 2. Mean score for appearance and shape of *keropok*. All samples showed significant difference at P ≤0.05.

	Samples				
	A	B	C	D	Modified Method
Mean score	3.4	2.4	2.9	3.9	4.5

The crispiness ratings for *keropok* prepared using the Modified Method were also much higher (Table 3) compared to most traditional samples. For the latter, poor cooking procedures and uneven drying in the sun causes the samples to crinkle upon frying. This is caused by the fact that some portions expand to a greater extent than others. The starch in the unexpanded portion has not been fully gelatinized. Starch granules that are fully gelatinized will result in better rupture of the starch cells during frying. A linear expansion greater than 77% was found to be the ideal level of crispiness. This was achieved in all samples prepared using the modified method. In comparison, less than 20% of the traditional samples had expansion ratios greater than 60%.

Preparation Of *Keropok* By Extrusion

The minced fish and flour were mixed at room temperature (~24°C) employing a Kenwood mixer equipped with a paddle beater. During the mixing stage 2% NaCl and 1% sugar were added to the formulation.

A Brabender (model 20DN) laboratory extruder was employed, fitted with a spiral screw with 1:1 compression ratio. A ribbon type die with a 23 mm x 0.5 mm discharge slit was used. A screw speed of 120 rev/min was employed. The material were fed through a feed hopper equipped with a continuous agitator. For all experiments no heating or cooling was applied to the first stage of the barrel and the die section was maintained at a temperature of 100°C. The temperatures for the second stage were varied from 60 to 140°C. After extrusion the product was dried in a forced-air cabinet drier (Apec, U.K.) at 70°C for 6 hr to give a final moisture content of 8-9%.

Results

Linear Expansion On Frying

Fig. 2 shows the percentages of linear expansion of *keropok* as a function of varying temperatures at the second stage of the extruder barrel. Expansion at 60°C was negligible (<5%) but increased with increasing temperature up to a

Table 3. Duncan's multiple range text (DMRT) for crispiness ratings of *keropok*. Samples joined by lines are not significantly different at 0.05 under the DMRT.

	Samples				
	A	B	C	D	Modified Method
Mean score	2.6	2.6	2.7	3.2	3.3

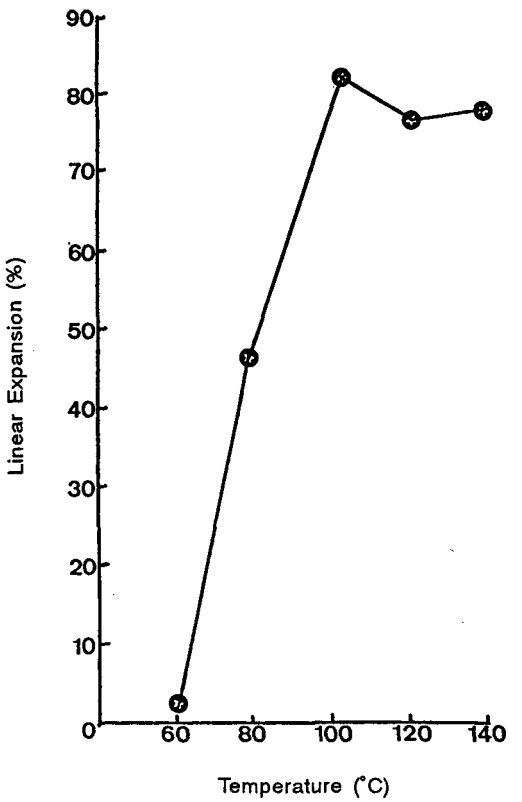

Fig. 2 Effect of extruder temperature on the linear expansion of keropok.

mixiumum at 100°C. Further increases of temperature did not affect expansion levels. The control sample prepared by modified method, however, showed an expansion of 101% which is some 20% greater than the maximum obtained with the extruded samples.

Organoleptic Evaluation

The results of the organoleptic evaluation are shown in Table 4. It can be seen that, provided the extruder temperature was 100°C or greater, the taste panellists detected no significant differences in colour, flavour, crispness or overall acceptability between the extruded product and *keropok* prepared by the modified method.

Chemical Analysis

Chemical analysis (Table 5) indicated that the extruded and the control samples had similar protein contents.

Extrusion appears to be a promising alternative method for preparing *keropok*. For the product extruded at temperatures of 100°C and above, panellists found no significant difference between the samples prepared using the modified method and the extruded samples. From the point of view of manufacture the extrusion method has several advantages. Since no extra water need be added to the original fish and flour mixture, the subsequent drying time is reduced. This variant of the process also cuts down labour requirements because extensive manual mixing of the dough, shaping and

Table 4. Effect of extruder temperature on colour, crispiness, flavour and overall acceptability of *keropok*. Figures with the same letter are not significantly different at the 0.05 level using the DMRT.

Temp.(°C) at 2nd stage of extruder	Colour	Crispiness	Flavour	Overall acceptability
60	1.76b	2.19b	2.24b	1.67b
80	2.10b	2.38b	2.24b	1.86b
100	3.05a	3.24a	2.95a	2.95a
120	2.76a	3.29a	3.10a	3.00a
140	2.90a	3.29a	2.85a	3.10a
Control (modified method)	2.86a	3.29a	2.76a	3.10a

Table 5. Protein and moisture contents of *keropok*.

Sample	Protein (%)	Moisture %
Extruded samples	20.86	8.6
Control (modified method)	21.60	8.4

subsequent boiling or steaming are no longer necessary. The process is faster and can be operated on a continuous basis as opposed to the traditional batch process. The product produced by extrusion is also more hygienic and homogenous.

Application Of The New Technologies For *Keropok* Production

There are 386 *keropok* factories in Peninsular Malaysia (Table 6). Total production in 1987 was 10,641 mt. (Din, 1988). The small-scale processors each produce 50-100 kg per month, medium-scale processors 150-200 kg per month and those that use machinery can produce 12,000 kg per month (Lembaga Kemajuan Ikan Malaysia, 1989).

The Fisheries Development Board of Malaysia (LKIM) trains *keropok* processors to upgrade their production capacity by teaching technical skills and introducing the use of machinery. Approximately five courses are held every year, with 15 participants per course. These courses are conducted in Mersing and Kuala Sedili in Johore, Malaysia. Up to 1988, 211 processors have been trained (Din, 1988) and 110 factories have purchased various types of equipment to boost production. The method most commonly

Table 6. Number of *keropok* factories in the states of Peninsular Malaysia.

State	No. of Factories
Perlis	-
Kedah	21
Pulau Pinang	1
Perak	4
Selangor	1
Negeri Sembilan	-
Melaka	3
Johor	82
Pahang	37
Trengganu	137
Kelantan	100
Total	386

used is the modified method as this is still cheaper than the extrusion method.

Table 7 shows the approximate cost for equipment outlay in a factory using the modified method. The production capacity is estimated to be 11,820 kg a month.

Table 7. Estimated cost for equipment outlay for *keropok* production using the modified method.

	Unit : M$
1. Containers for fish (8)	4,000.00
2. Deboner (1)	8,000.00
3. Mixer (1)	3,000.00
4. Stuffer (1)	7,500.00
5. Steamer (1)	10,000.00
6. Slicer (2)	15,000.00
7. Packing machine (1)	500.00
8. Stainless steel tables (2)	1,000.00
9. Oven (1)	25,000.00
10. Racks & others	3,000.00
Total:	77,000.00

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Disscussion

In the discussion, a question was asked about the percentage of fish meat and type of flour used in fish crackers, and the amount of shrimp meat in the shrimp cracker, in the recommended modified method. Dr Yu replied that tapioca flour was used and in both cases 50 percent of either fish meat or shrimp meat was used. As regards the conditions of the first and second stages of oven drying, Dr Yu replied that in the first stage, the *keropok* was dried at 40-45°C for 1 to 1.5 hr. In the second stage the temperature was 65-70°C for up to 8 hours. The final product had a moisture content of 8-9%.

Regarding the critical factors during processing and important ingredients influencing crispness and linear expansion, Dr Yu said that a well-homogenized dough would result in good linear expansion and crispness. The addition of proteins actually decreases linear expansion as *keropok* made solely from starch has greater linear expansion.

Asked about criteria used for the organoleptic assessment of quality, Dr Yu said that hedonic scale of 1 to 5 was used with 2.5 to 3 as the cut-off point.

A participant commented that boiling has a more efficient heat transfer than steaming and asked whether there was a special reason why steaming was selected, Dr Yu said that in these studies, there appeared to be some migration of materials into the boiling water; steam was selected to reduce this effect.

Asked whether rancidity was a problem and if any antioxidant was used, Dr Yu said that rancidity was not a problem and that no antioxidant was required.

A participant wanted to know whether the linear expansion is dependent on the variety of starch used or on some other factor. Dr Yu replied that the starch granule is mainly responsible for this linear expansion and added that starches with low protein content such as tapioca and sago, would have good linear expansion results.

Effects Of Modified Atmosphere Packaging On Storage Stability Of Dried Salted Sardines (*Sardinops neopilchardus*)

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Abstract

Australian sardines (*Sardinops neopilchardus*) were salted, dried and packaged with (1) air (LDPE bags) (2) under vacuum, and (3) nitrogen gas-flushed and stored at 30°C, 75% RH for 12 weeks. Storage time was the most important factor affecting the quality of the fish. TBARS values of every sample decreased when storage time increased. Fluorescent products increased dramatically during storage of control-packed (air) samples but remained constant in vacuum and nitrogen-packed samples. Vacuum packaging improved appearance of the products. Nitrogen packaging reduced the leaking of oil from the fish flesh. The appearance of control-packed and nitrogen-packed samples were judged unacceptable after the fourth week of storage while vacuum-packed samples remained acceptable up to 12 weeks of storage. Vacuum and nitrogen packaging did not show any effect on flavour, texture and overall acceptability of the cooked samples. Rancidity scores showed a significant negative correlation ($P \leq 0.05$) to TBARS value and a positive correlation to the level of fluorescent products.

Introduction

Dried salted fish is produced and consumed widely in Southeast Asia due to its simplicity of processing, low investment requirements and agreeable taste.

One problem encountered in dried salted fish is quality loss during storage and distribution, especially in fatty fish which is susceptible to oxidation. An estimated 25% of all dried fish is lost due to spoilage during storage (Bakar, 1983).

Sardines are small, pelagic fatty fish. They can contain up to 22% fat, depending on species, sex, season, age, etc. The shelf life of dried salted sardines is short due to the rapid rate of deterioration, especially from oxidation. Proper packaging must be used to minimize loss. Specifically this must be done to exclude oxygen (a major cause of oxidation and rancidity) to prevent the product from reabsorbing water, and to protect it from dust and undesirable microorganisms.

Typical packaging materials used for wholesale distribution of dried fish in the region are bamboo baskets, cardboard cartons, wooden boxes and hessian sacks. Contamination by dust, moulds and insects cannot be avoided, especially at the retail level where the products are sold unprotected in the markets.

Modified atmosphere packaging (MAP) has been used successfully with fishery products to extend their shelf life. MAP, including vacuum and gas-flushing in a hermetically seal package, can be used satisfactorily with products that are susceptible to oxidation. The products can then be stored at ambient temperature. The exclusion of oxygen can be achieved by vacuum packaging or replacing the air inside the package with oxygen-free nitrogen, and/or by the use of oxygen scavengers. MAP is expected to be an ideal method to extend the shelf life of dried salted fish. It must be kept in mind that high quality raw materials and proper handling must also be used, and that poor quality

products cannot be avoided through the use of packaging materials and methods alone.

The aims of this study are to evaluate the effects of vacuum and nitrogen packaging on the storage stability of dried salted sardines and to determine the correlation between chemical and organoleptic acceptability of the product.

Materials And Methods

Fish Handling

Fresh sardine (*Sardinops neopilchardus*) were purchased and iced for transportation to the laboratory.

Fresh fish were washed and then salted at ambient temperature (17°-22°C) in saturated sodium chloride solution for 12 hr. The ratio of brine to fish was 2:1 (w/w). Additional salt was added to make sure that the solution remained saturated. The salted fish were then dried in a mechanical dryer for 12 hr with air velocity 2 m/sec, temperature 45°C and 30% RH.

Dried salted fish were divided into 3 parts for 3 treatments. Each treatment used 6 fish per bag and 3 bags were prepared. For treatment 1 fish were packed in LDPE bags (305 x 200 mm, 80°-100°C, thickness # F 86/26 purchased from Cello-Pack, Dee-Why, NSW, Australia) which were heat sealed. For treatment 2 fish were vacuum packed in a Vacumatic 282 (Vacumatic Pty Ltd) using Transpak Vacuum Pouch (O_2 transmission @25°C/75% RH-47 cc/m^2/24 hr, moisture transmission @ 38°C/93% RH-8 g/m^2/24 hr purchased from Vacumatic Australia) the package were evacuated to 90% vacuum and sealed for 1.8 sec weld time. For treatment 3 bags, the same type as used in treatment 2, were nitrogen flushed for 8 sec after evacuation to 90% vacuum and sealed for 1.8 sec.

All samples were stored in a relative humidity cabinet which was set to maintain 75% and 30°C for 12 weeks. Samples were removed after 0, 2, 4, 8 and 12 weeks for sensory and chemical analysis.

Analytical Methods

Moisture content

The procedure of the AOAC (1984) was followed.

Water activity

The water activity value of the product was measured by use of a Vaisala humidity meter.

Fat content

A Soxhlet reflux apparatus was used to determine the fat content of dried samples.

Protein

Kjeldalh method was employed where a Kjeltex 1030 Protein Analyser unit was the equipment used.

Ash

The method N[illegible]4009 (AOAC, 1984) was followed.

Salt content

The method used is specified in FAO (1981).

TBARS value

The method of Ke, Cervantes and Martinez (1984) was followed.

Oil extraction

The method of Sheppard, Iverson and Weihrauch (1978), Wills, Balmer and Greenfield (1980) and Lubis (1985) were slightly modified and employed.

Fluorescent product

A slight modification of the method of Fletcher, Dillard and Tappel (1973) was followed.

Free fatty acid

The method used is specified in Paquot (1979).

Sensory evaluation

Uncooked whole dried salted sardines were placed on a white tray, and 15 panelists were

chosen for their familiarity in eating dried salted fish evaluated them for physical damage, sheen, discolouration and overall acceptability. The fish were cut into pieces and deep fried in vegetable oil at 150°C for 3 min. The fried fish were left in air for 15 min to cool then presented to the same group of panelists. The attributes for cooked segments were rancidity, texture, flavour and overall acceptability. The samples were identified by random numbers and rated by the panelists indicating intensity of each attribute on a 100 unstructured line anchored at the end (non to intense).

Statistical analysis

The MANOVA was used to analyse the data obtained through SYSTAT computer software.

Results And Discussion

The characteristics of fresh sardine used for producing dried salted products were 142.1±6.1 mm length, 23.2±3.2 g weight (means from 20 samples), approximately 67.3% moisture, 11.7% fat, 18.7% protein and 2.1% ash (wet basis).

The proximate composition of the dried salted sardines were approximately 45.8% moisture, 12.6% fat, 26.5% protein and 13.8% ash (wet basis).

The characteristics of the dried salted sardine during storage are given in Table 1. In the second week of storage, fish were found floating in oil in the packages due to the separation of oil from the muscle tissue. Much more oil was found in control-packed and vacuum-packed samples than in nitrogen-packed samples. It appears that nitrogen gas-flush packaging was able to reduce the leaking out of oil from dried salted sardine. It is in accordance with a finding by Post *et al.* (1985) that for nitrite-free bacon-like products stored at 8°, 12° and 26°C, nitrogen packaging improved the shelf life by retarding discolouration and minimising exudate. However, odour of these nitrogen-packed products became unacceptable earlier than in vacuum-packed samples.

Table 1 Characteristics of dried salted sardine during storage.

Storage time (weeks)	Packaging type		
	Control	Vacuum	Nitrogen
0	Flesh firm, skin dry and glossy	As control	As control
2	Oil and water (yellow-brown) in the packages, flesh firm	Oil and water (yellow-brown) in the packages, flesh slightly soft	Small amount of oil and water (yellow-brown) in the packages, flesh fairly firm
4	Much oil and water in the packages, flesh very soft, skin and flesh damaged, rancid odour	Oil and water in the packages, flesh soft, skin and flesh damaged	Small amount of oil and water in the packages, flesh slightly soft, pale discolouration
8	Oil and water dried, flesh firm, skin and flesh damaged strong rancid odour	Much oil and water in the packages, flesh very soft, skin and flesh damaged, slightly rancid odour	Oil and water in the packages, flesh slightly soft, pale discolouration, fishy odour
12	Oil and water dried, flesh dry and firm, skin and flesh damaged, very strong rancid odour	Much oil and water in the packages, flesh very soft, skin and flesh damaged, slightly rancid odour	Oil and water in the packages, flesh soft, pale discolouration, fishy odour

Texture change is one of the major problems of cured fish (King, Kamara and Wood 1985). In the present study, the fish turned soft after 2 weeks of storage, and earlier in control-packed samples than in the other two. All the products were damaged mostly by stacking together in the storage chamber.

The process of evacuation of the air inside the packages partly pressed and damaged the vacuum-packed samples. Nitrogen-packed samples seemed to fare better since the gas inside the bags protected the products from compaction. The products in LDPE plastic bags were also damaged from skin sticking to the bag inner walls, while this did not happen to the other two samples. As long-term storage proceeded, the level of oil in control-packed samples decreased, possibly because of the high oil permeability of the plastic. Therefore, LDPE is not recommended as a suitable packaging material for high moisture dried salted fish. Durairaj and Pitchiah (1981) stated that the packaging of dried samples in HDPE required a sample moisture content below 35%, a level impossible for fish with a high fat content.

Rancid odour occurred in control-packed samples from the fourth week of storage, followed by vacuum-packed samples, with a strong fishy odour found in nitrogen-packed samples. Pale skin colour was found in nitrogen-packed samples starting from the fourth week. Presumably, nitrogen gas caused this pale discolouration through a reaction between nitrogen gas and natural pigments in dried salted sardine after a period of time during storage. This is contradictory to the observations of Post *et al.* (1985) who stated that nitrogen packaging used for bacon-like products retarded discolouration. However, more research needs to be done to understand such an effect in dried salted fish.

However, it should be noted that all of the characteristics presented in Table 1 were observed and recorded for the raw fish by the experimenter, and not by the panelists who evaluated the products in only some aspects, ie, the raw samples already taken out of the packages and the cooked samples.

Effects Of Modified Atmosphere Packaging On Chemical Parameters

Significance of F value for several chemical parameters of dried salted sardines are given in Table 2. Two factors, packaging type and storage time, were examined. Packaging type did not significantly affect ($P \leq 0.01$) a_w, salt content and TBARS value while storage time did significantly affect every ($p \leq 0.01$) parameter. The interaction of storage time and packaging type significantly affected moisture content, fluorescent products and FFA. Therefore, it cannot be concluded at this stage that packaging type did not affect the moisture content at all since the significant differences shown in Table 2 may be due to either main effects

Table 2. Result of significance tests (F value) for chemical parameters of dried salted sardines.

Source of variation	Moisture content	Water activity	Salt content	TBARS	Fluorescent products	FFA
Packaging type	NS	NS	NS	NS	S	S
Storage time	S	S	S	S	S	S
Packaging type x Storage time	S	NS	NS	NS	S	S

S = Significant ($P \leq 0.01$)
NS = Not significant

and/or interaction; however, specific conclusions about the main effects are not possible.

Moisture Content, a_w And Salt Content

The average moisture contents of all samples during storage are shown in Table 3. The moisture contents were not constant throughout the storage but were affected significantly ($P \leq 0.01$) by the interaction between storage time and packaging type. These findings were contradictory to other studies, eg, Lubis (1989) found small differences in moisture content of dried salted sardines packed in PE bags and stored at different temperatures for 24 weeks, but they were not significant ($P \geq 0.01$).

All the samples gradually gained about 4-5 % moisture. It was obvious that products packed in LDPE bags gained moisture content faster than did the other two samples starting from the second week and maintained those levels up to the end of storage. Obviously the LDPE bags were more permeable than were the laminated ones.

In this present study, the RH in the storage chamber was not controlled constantly, falling sometimes below 75% RH to between 55-60% RH. If the RH were controlled at 75% constantly throughout the storage time, the products could have gained more moisture than those examined in this study. However, at the twelfth week, the moisture content of control-packed samples was lower than the other two. The water absorbed by product in laminated bags used for vacuum- and nitrogen-packed samples may arise from the condensation of water vapour in the packages since, after drying, fish were left in air for a short period of time then packed. It was concluded that the fish might not have been completely cooled.

The a_w values of all the samples during storage are given in Table 4. The a_w values were significantly affected ($p \leq 0.01$) by storage time. The longer the storage time, the lower the a_w values, in contrast to the moisture contents which increased as storage time proceeded. These results also contrasted with other studies. Lubis (1989) conducted a study on dried salted sardine packed in PE bags and stored at 5°, 20° and 30°C for 24 weeks and found stable a_ws throughout the storage. The cause of this peculiar trend is probably due to the variability of the Vaisala probes used in the experiment. The use of a probe different from that used for a previous analysis may cause a significant difference in the values. Even the same probe can give different readings at different times and consistency also depends on care in handling and calibration of the instrument.

Table 3. Means[A] of moisture content (%) of dried salted sardines during storage.

Storage time (weeks)	Packaging type		
	Control	Vacuum	Nitrogen
0	45.8 ± 0.0a	45.8 ± 0.0a	45.8 ± 0.0a
2	48.5 ± 0.5cd	47.5 ± 0.2bc	46.6 ± 0.1ab
4	48.6 ± 0.3de	47.0 ± 0.1b	46.8 ± 0.0ab
8	49.4 ± 0.4def	49.6 ± 0.5ef	50.7 ± 0.2g
12	49.3 ± 0.2def	49.8 ± 1.2fg	50.7 ± 0.2g

[A]Means of two replicates ± standard deviation.
Means followed by identical letters are not significantly different ($P \geq 0.01$).

Table 4. Means[A] of water activity of dried salted sardines during storage.

Storage time (weeks)	Packaging type		
	Control	Vacuum	Nitrogen
0	0.80 ± 0.01d	0.80 ± 0.01d	0.08 ± 0.01d
2	0.81 ± 0.00e	0.82 ± 0.01f	0.81 ± 0.00e
4	0.82 ± 0.01f	0.81 ± 0.01e	0.81 ± 0.01e
8	0.74 ± 0.01a	0.74 ± 0.00a	0.75 ± 0.00b
12	0.74 ± 0.01a	0.74 ± 0.00a	0.76 ± 0.01c

[A]Means of two replicates ± standard deviation.
Means followed by identical letters are not significantly different (P≥0.01)

Table 5. Means[A] of salt content (%) of dried salted sardines during storage.

Storage time (weeks)	Packaging type		
	Control	Vacuum	Nitrogen
0	16.3 ± 0.5abc	16.3 ± 0.5abc	16.3 ± 0.5abc
2	15.6 ± 0.2abc	15.3 ± 0.1a	15.7 ± 0.4abc
4	15.5 ± 0.1ab	16.5 ± 0.4abcd	15.1 ± 0.5a
8	17.6 ± 0.0de	17.8 ± 0.3e	17.7 ± 0.4de
12	16.6 ± 0.7bcde	16.8 ± 0.6cde	16.7 ± 0.9bcde

[A]Means of two replicates ± standard deviation.
Means followed by identical letters are not significantly different (P≥0.01).

Salt contents of all samples during storage are shown in Table 5. Storage time significantly affected (P≤0.01) the salt content. There was no precise trend (increase or decrease) among the data. The fluctuation in salt content may be caused by a lack of uniformity of the end-point colour during the analysis since even small amounts of $AgNO_3$ can alter the result dramatically. One would expect, as a trend, that the longer the storage time, the lower would be the salt content since the moisture content of the samples increases with storage time. However, the actual trend was small and can be neglected.

TBARS Value

Tables 1 and 6 indicate that only storage time significantly affected (P≤0.01) TBARS values. In the first four weeks of storage, the TBARS values declined dramatically. Similar results have been

Table 6. Means[A] of TBARS value (%mol/kg) sample of dried salted sardines during storage.

Storage time (weeks)	Packaging type		
	Control	Vacuum	Nitrogen
0	6.54 ± 1.20c	6.54 ± 1.20c	6.54 ± 1.20c
2	4.07 ± 0.38b	5.24 ± 0.42bc	4.05 ± 0.70b
4	1.62 ± 0.39a	1.95 ± 0.49a	1.76 ± 0.38a
8	1.34 ± 0.10a	1.35 ± 0.03a	1.28 ± 0.19a
12	1.24 ± 0.07a	1.17 ± 0.08a	1.52 ± 0.07a

[A]Means of two replicates ± standard deviation.
Means followed by identical letters are not significantly different ($P \geq 0.01$).

found by several scientists. Lubis (1989) reported a decrease of TBARS values of dried salted sardines packed in PE bags and stored at 5°, 20° and 30°C for 24 weeks, and the samples stored at the higher storage temperature showed a faster decrease. In the present study, the samples were stored at 30°C and 75% RH which was quite a severe condition, hence the values declined rapidly. The decline in TBARS values can be explained by the slower rate of autoxidation of unsaturated fatty acids and the instability of the malonaldehyde produced or malonaldehyde reacted with amino groups or other carbonyls, or oxidation of this aldehyde during storage yielding the lower TBARS values (Gokalp *et al.*, 1983). In the case of frozen sardine, Numbudiry (1980) reported a constant increase in TBARS values in stored sardine frozen at -5°C through 40 days of storage. In the present study, after the fourth week of storage, TBARS values were constant or not significantly different ($P \geq 0.01$) up to the twelfth week, indicating that TBARS value is not a reliable means of assessing the degree of rancidity in dried salted fish products in long term storage. However, many scientists insist on the use of TBARS value as a good index for measuring the extent of lipid oxidation. Therefore, it can be concluded that TBARS value is probably not a reliable means for measuring lipid oxidation in products stored at high temperature for long term storage, but that it can be used successfully for products stored at low temperatures.

Packaging type did not significantly affect ($P \geq 0.01$) TBARS values in the dried salted sardine in this study. The results are contradictory to those of Hwang, Bowers and Kropf (1990), who found that TBARS values ($P \leq 0.01$) were higher for air-packed cooked beef loin slices than for vacuum and gas mixture-packed (80% N_2 and 20% CO_2) samples stored at -20°C for 11 weeks. The overall mean TBARS values of air-packed beef slices were four to five times higher than that of vacuum- and N_2/CO_2 packed beef. However, the temperature used for storage was much different to the present study. If there was a difference in the rate of oxidation among packaging types in this present experiment, TBARS value was not a good indicator for following lipid oxidation. On the other hand, during high temperature storage vacuum and nitrogen packaging did not significantly affect the rate of oxidation of the products.

Fluorescent Products

Table 7 shows the significant effect ($P \leq 0.01$) of packaging type and storage time on fluorescence values of dried salted sardines. Packaging type,

Table 7. Means[A] of fluorescent products (%g/g dry sample) of dried salted sardines during storage.

Storage time (weeks)	Packaging type		
	Control	Vacuum	Nitrogen
0	5.79 ± 0.31a	5.79 ± 0.31a	5.79 ± 0.31a
2	14.26 ± 2.93cd	8.00 ± 0.52b	14.91 ± 0.16d
4	10.68 ± 3.08bc	10.33 ± 1.11bc	10.44 ± 1.33bc
8	19.51 ± 2.53e	10.30 ± 0.33bc	11.07 ± 1.23bcd
12	25.09 ± 0.16f	9.14 ± 1.63b	7.38 ± 1.25b

[A]Means of two replicates ± standard deviation.
Means followed by identical letters are not significantly different (P≥0.01).

storage time and their interaction significantly affected the fluorescence level. The level of fluorescent products in control-packed samples significantly increased from the fourth week and constantly increased up to the end of the storage period.

For the vacuum-packed samples, the level of fluorescence increased in the first 2 weeks then remained stable through 12 weeks of storage. The level in nitrogen-packed samples fluctuated slightly in the first 4 weeks, however, after that the values remained low and constant. It can be concluded at this stage that, the longer the storage time, the higher the level of fluorescent products produced in dried salted sardine packed in LDPE bags. Vacuum and nitrogen packaging can retard fluorescent products production in these products.

It is contradictory that TBARS values of the products were found constantly low after the fourth week of the storage in every type of packaging but levels of fluorescent products increased rapidly in only control-packed samples after the fourth week. The trend of TBARS value reduction in samples packed under three packaging atmospheres were similar, but for the level of fluorescent products a rapid increase was found only in control-packed products, while a constant level was revealed in vacuum and nitrogen-packed samples. Lubis (1989) recommended the use of the level of fluorescent products for the measurement of rancidity in dried salted sardines since it has been used successfully as an analytical method for quantification of peroxidation damage to biological tissue (Fletcher *et al.*, 1973).

The level of fluorescent products is probably a more sensitive indicator than is the TBARS value in the assessment of lipid oxidation in dried salted sardine in long term storage, because this parameter distinguishes the differences in oxidation rate among different packaging types while TBARS value just showed the same trend of reduction in the values as storage time proceeded. Further research on the sensitivity of these two methods is needed to confirm these findings.

Free Fatty Acid

Table 8 reveals that the interaction of packaging type and storage time significantly affected (P≤0.01) the FFA contents of the products. After week 4 to week 8 of storage, FFA contents significantly increased while during the first 4 week there was no significant difference in FFA content. The same trend was observed in the level of fluorescent products but was contrary to that for TBARS value. After the eighth week, the FFA contents decreased rapidly. This phenomenon was quite peculiar. Numbudiry (1980) conducted a

Table 8. Means[A] of FFA content (%) of dried salted sardines during storage.

Storage time (weeks)	Packaging type		
	Control	Vacuum	Nitrogen
0	4.98 ± 0.23ab	4.98 ± 0.23ab	4.98 ± 0.23ab
2	5.10 ± 0.11ab	5.23 ± 0.34abc	4.91 ± 0.11a
4	5.76 ± 0.33abc	5.95 ± 1.05c	4.93 ± 0.07a
8	10.19 ± 0.25e	11.25 ± 0.22f	10.39 ± 0.08ef
12	6.14 ± 0.34c	7.42 ± 0.61d	4.77 ± 0.28a

[A]Means of two replicates ± standard deviation.
Means followed by identical letters are not significantly different ($P \geq 0.01$)

study on frozen storage of sardine and showed that an increase in FFA content indicates hydrolytic cleavage of the glycerides in lipid and that the longer the storage time the higher the content due to the hydrolysis. The rapid decrease of FFA content after eight weeks was probably caused by an interaction between FFA and other compounds, or by experimental error as the pH meter used to determine the end point of the reaction between acid and base in the last week was not the same as the one used in the previous analysis. Hence, more study needs to be done in order to confirm or reject these results.

Although FFA content showed a similar trend to the level of fluorescent products, no clear trend can be concluded about the effect of packaging type. However, it is quite clear that the critical storage period of the products is the fourth week since all parameters used for oxidation measurement show significant differences around this period of time.

Effects Of Modified Atmosphere Packaging And Storage Time On Sensory Evaluation

Significant F values for several sensory evaluation attributes of dried salted sardine are given in Table 9. Storage time and packaging type significantly affected ($P \leq 0.01$) the appearances of uncooked whole fish but did not affect some attributes in cooked fish segments, ie, texture, flavour and overall acceptability. Only rancidity was significantly affected by storage time.

Uncooked Whole Fish

Four attributes were involved in this evaluation, ie, physical damage, sheen, discolouration and overall acceptability. Table 10 shows that storage time and packaging significantly affected ($P \leq 0.01$) physical damage of the products. There is a clear trend revealing that the longer the storage time, the higher the damage score. Control-packed samples seemed to possess a higher damage level than did the other two samples.

Since the physical damage in control-packed samples was caused by skin sticking to the inner wall of LDPE bags, this type of plastic bags is not recommended for use with these products. The damage found in vacuum packed samples may partly be due to the vacuum packaging process. The major cause of physical damage in these products is stacking-together of the packages in the storage chamber.

All the sensory evaluation scores reveal that the panelists differed in terms of their sensory judgement. Standard deviations show the scatter

Table 9. Significance (F value) for sensory evaluation scores of dried salted sardines during storage.

Source of variation	Uncooked whole fish				Cooked segments			
	Physical damage	Sheen	Discolour-ation	Overall accept-ability	Rancidity	Texture	Flavour	Overall accept-ability
Packaging type	S	S	S	S	NS	NS	NS	NS
Storage time	S	S	S	S	S	NS	NS	NS
Packaging type x Storage time	S	S	S	S	NS	NS	NS	NS

S = Significant (P≤0.01)
NS = Not significant

Table 10. Means[A] of physical damage score[B] of dried salted sardines (uncooked whole fish) during storage.

Storage time (weeks)	Packaging type		
	Control	Vacuum	Nitrogen
0	36.1 ± 24.5abcd	36.1 ± 24.5abcd	36.1 ± 24.5abcd
2	51.4 ± 24.2cde	40.4 ± 21.6abcd	34.2 ± 24.1abc
4	54.1 ± 25.0def	32.2 ± 18.6ab	50.4 ± 22.3bcde
8	71.3 ± 13.9f	25.6 ± 16.9a	49.1 ± 13.4bcd
12	48.5 ± 23.6bcd	53.4 ± 23.7def	67.9 ± 23.0ef

[A]Means of scores from 15 panelists ± standard deviation.
[B]O = absent, 100 = extreme.
Means followed by identical letters are not significantly different (P≥0.01).

of the scores. It should be noted that the judges may not be able to distinguish between samples if the samples do not obviously differ from each other. Panelists must be selected and trained to reduce errors. All the panelists participating in this sensory evaluation were familiar with dried salted fish, nevertheless, their opinions or hedonic responses varied extensively.

Evaluation on sheen scores are presented in Tables 9 and 11. The results fluctuated throughout the storage period even though both storage time and packaging type significantly affected (P≤0.01) the sheen scores of the products. Nitrogen-packed samples possessed significantly lower scores than the other two from week 0 to week 4, but from week 4 to the end of the storage period the scores were not significantly different by LSD test. It may be concluded that nitrogen atmosphere affected the sheen of dried salted sardine.

Table 11. Means[A] of sheen score[B] of dried salted sardines (uncooked whole fish) during storage.

Storage time (weeks)	Packaging type		
	Control	Vacuum	Nitrogen
0	68.6 ± 14.4g	68.6 ± 14.4g	68.6 ± 14.4g
2	43.4 ± 20.8de	46.6 ± 22.3ef	53.6 ± 21.8ef
4	57.8 ± 20.5efg	58.7 ± 16.6fg	27.0 ± 16.1ab
8	31.1 ± 9.9abc	60.8 ± 15.4fg	32.0 ± 18.0abcd
12	53.1 ± 24.0ef	38.1 ± 14.0bcd	20.7 ± 15.1a

[A]Means of scores from 15 panelists ± standard deviation.
[B]O = dull, 100 = bright.
Means followed by identical letters are not significantly different (P≥0.01).

Discolouration scores are given in Table 12. Storage time and packaging type significantly affected (P≤0.01) the scores. The scores given by the panellists were very scattered although the results show an increasing trend as storage time increased, but the scores cannot be judged significantly different by LSD test.

Overall acceptability scores of uncooked whole fish are shown in Table 13. Packaging type and storage time significantly affected the scores. If a score below 50 is regarded as unacceptable, control- and nitrogen-packed samples were unacceptable from the fourth week of storage, while the vacuum-packed samples were unacceptable in the last week. It can be concluded that vacuum-packaging may more greatly enhance the appearances of dried salted sardine than packaging in LDPE bags or nitrogen gas-flushed packaging. A specific recommendation on the shelf life of the products is not possible at this stage because, even though some scores were lower than 50, they did not differ significantly from some scores beyond 50 based on LSD test. However, a rough judgement can be made, viz, the control and nitrogen-packed samples should not be kept longer than 2 months because of undesirable appearance, and vacuum-packed samples should not be kept over 3 months. The major cause of undesirable appearance was the stacking-together of products resulting in damaged fish bodies.

It should be noted that none of the samples in this study were either mouldy or obviously spoiled throughout 12 weeks of storage. The same control-packed samples had been produced and stored under the same conditions by Lubis (1989) spoiled after 8 weeks of storage. Sen *et al.*, (1961) mentioned that sun-dried salted mackerel need to be dried to a moisture content below 37.5% for protection against mould growth. They found that PE bags could not protect this product from fungal attack. For a product with an initial moisture content of 39.7%, fungal growth was observed after 62 days storage at 26°C and 78% RH, and after 85-106 days storage at 37°C and 92% RH. Differences in type, composition, freshness of fish, salting, drying, and storage processes may affect the shelf life of dried salted fish. Many more batch experiments must be conducted to investigate and confirm the estimated shelf life of fishery products.

Cooked Segments

Four attributes used in this study represented sensory characteristics of fried dried salted sardine, ie, rancidity, texture, flavour and overall acceptability.

Lipid becomes rancid as a result of oxidation. Rancidity is considered to be caused by the objectionable tastes and flavours that result from the accumulation of decomposition products of oxidation reactions (Gray, 1978). To minimise bias or human errors, a multi-numbered panel is used.

Tables 9 and 14 show that only storage time significantly affected ($P \leq 0.01$) the rancidity score while packaging type did not show any effect. There were no rancid scores greater than 50 found during storage except for control-packed samples at week 12. However, even though the samples were scored greater than 50 they were not significantly different from the same type of samples at week 8 when LSD test was considered. There was a tendency for an increase of the rancidity score of all the samples when the storage time increased. The scores were not significantly dif-

Table 12. Means[A] of discolouration score[B] of dried salted sardines (uncooked whole fish) during storage.

Storage time (weeks)	Packaging type		
	Control	Vacuum	Nitrogen
0	30.3 ± 19.0ab	30.3 ± 19.0ab	30.3 ± 19.0ab
2	44.8 ± 26.0bcd	30.1 ± 12.5ab	31.1 ± 16.5ab
4	49.0 ± 27.0cd	24.9 ± 14.0a	50.1 ± 21.8cd
8	51.9 ± 23.1d	33.5 ± 20.5abc	40.1 ± 20.0abcd
12	38.8 ± 23.7abcd	46.4 ± 23.0bcd	55.2 ± 24.7d

[A]Means of scores from 15 panelists ± standard deviation.
[B]O = absent, 100 = extreme.
Means followed by identical letters are not significantly different ($P \geq 0.01$).

Table 13. Means[A] of overall acceptability score[B] of dried salted sardines (uncooked whole fish) during storage.

Storage time (weeks)	Packaging type		
	Control	Vacuum	Nitrogen
0	58.6 ± 16.7def	58.6 ± 16.7def	58.6 ± 16.7def
2	45.9 ± 19.2bcde	51.8 ± 15.6cdef	60.2 ± 15.1ef
4	39.7 ± 23.7bc	58.1 ± 15.0def	39.9 ± 13.6bc
8	35.4 ± 14.9ab	64.1 ± 13.7f	49.1 ± 15.7bcde
12	45.1 ± 21.0bcd	37.4 ± 16.0b	21.2 ± 14.7a

[A]Means of scores from 15 panelists ± standard deviation.
[B]O = very unacceptable, 100 = very acceptable.
Means followed by identical letters are not significantly different ($P \geq 0.01$).

Table 14. Means[A] of rancidity score[B] of dried salted sardines (cooked segments) during storage.

Storage time (weeks)	Packaging type		
	Control	Vacuum	Nitrogen
0	10.6 ± 9.5a	10.6 ± 9.5a	10.6 ± 9.5a
2	21.2 ± 14.3abc	13.8 ± 7.5ab	15.5 ± 9.9ab
4	25.7 ± 19.3abcd	20.1 ± 19.4abc	28.2 ± 23.7bcd
8	48.4 ± 21.3ef	32.8 ± 19.1cde	27.8 ± 14.5bcd
12	52.6 ± 31.1f	35.1 ± 27.6cde	40.7 ± 24.1def

[A]Means of scores from 15 panelists ± standard deviation.
[B]O = absent, 100 = extreme.
Means followed by identical letters are not significantly different (P≥0.01).

ferent by LSD test at week 8 up to week 12. Lubis (1989) found that at the end of 24 weeks for dried salted sardine packed in PE bags and stored at 5°C and 20°C, the rancidity score decreased. Possibly at this stage of storage, the non-enzymic browning (NEB) products produced had sufficient inhibitory effect to inhabit lipid oxidation.

Lubis (1989) reported that dried salted sardine stored at 30°C in PE bags became rancid at a faster rate than the samples stored at 5°C and 20°C, and that the rancidity of the 30°C stored samples started with the fourth week of storage. All samples at every storage condition became rancid between 4-6 weeks of storage.

In the present study, it is difficult to interpret the data in order to indicate a specific shelf life of the products by rancidity score because the panelists participating in the sensory testing sessions had not been trained before and had different threshold for rancidity; as can be seen by the standard deviations which varied extremely. However, it could be roughly concluded that the samples revealed a rancid smell after the fourth week of storage. It should be kept in mind that rancid smell is not necessarily an undesirable indicator for all consumers.

Table 15 shows the results of texture scores. Storage time and packaging type did not significantly affect (P≤0.01) the scores in the samples. In this study, the panellists hardly detected the differences, since they examined the cooked samples only after frying. The cooking method resulted in the fish samples losing some water, leading to difficulty in evaluation. A soft texture of the raw samples was observed and recorded by the experimenter (Table 1). Hence, the panelists should be allowed to evaluate the softness of the raw samples as well.

Storage time and packaging type did not show any effect on the flavour of the dried salted samples during storage (Table 16).

Overall acceptability scores are given in Table 17. Storage time and packaging type did not significantly affect (P≥0.01) overall acceptability of the samples. Even though the scores of the products were less than 50 from week 8 for control- and vacuum-packed samples, and at week 12 for nitrogen-packed samples, they were not significantly different (by LSD test) from samples at the previous storage period.

High moisture content is not a desirable characteristic in some kinds of dried salted fish since it leads to unacceptability, even though the quality of dried salted sardine during long term storage were improved or masked by frying. It should be kept in mind that consumers buy the uncooked, not the

Table 15. Means[A] of texture score[B] of dried salted sardines (cooked segments) during storage.

Storage time (weeks)	Packaging type		
	Control	Vacuum	Nitrogen
0	50.6 ± 28.7b	50.6 ± 28.7b	50.6 ± 28.7b
2	46.8 ± 26.1b	51.1 ± 20.7b	37.1 ± 24.7ab
4	46.8 ± 28.4b	35.1 ± 22.8ab	50.1 ± 16.3b
8	45.0 ± 19.7ab	25.4 ± 18.1a	39.3 ± 23.5ab
12	46.5 ± 28.2ab	43.9 ± 28.2ab	46.0 ± 25.8ab

[A]Means of scores from 15 panelists ± standard deviation.
[B]O = soft, 100 = firm.
Means followed by identical letters are not significantly different (P≥0.01).

Table 16. Means[A] of flavour score[B] of dried salted sardines (uncooked segments) during storage.

Storage time (weeks)	Packaging type		
	Control	Vacuum	Nitrogen
0	59.3 ± 21.9a	59.3 ± 21.9a	59.3 ± 21.9a
2	53.4 ± 18.8a	51.9 ± 20.9a	46.0 ± 20.6a
4	56.5 ± 19.2a	56.5 ± 15.9a	57.9 ± 13.2a
8	42.8 ± 21.9a	45.4 ± 18.2a	52.1 ± 17.9a
12	35.7 ± 23.6a	48.7 ± 21.4a	45.2 ± 21.2a

[A]Means of scores from 15 panelists ± standard deviation.
[B]O = very poor, 100 = very good.
Means followed by identical letters are not significantly different (P≥0.01).

fried product, hence it is clear that the appearance of the uncooked products initially must be acceptable, although the acceptability of some products appears to be improved by frying.

Regression Analysis

Guadogni (1968) stated that at our present state of knowledge, it is impossible to list a complete set of rules or requirements which would always ensure success in relating sensory and instrumental results. However, regression analysis does make it possible to interpret relationships between subjective and objective measurements. Table 18 shows simple correlations of rancidity scores with three chemical indices for assessing oxidation of dried salted sardine. Means were calculated from the total scores and values of every

Table 17. Means[A] of overall acceptability score[B] of dried salted sardines (cooked segments) during storage.

Storage time (weeks)	Packaging type		
	Control	Vacuum	Nitrogen
0	56.0 ± 20.9b	56.0 ± 20.9b	56.0 ± 20.9b
2	51.6 ± 15.5b	54.8 ± 21.5b	54.8 ± 19.9b
4	50.7 ± 21.5b	53.2 ± 20.1b	56.1 ± 13.4b
8	44.8 ± 20.9ab	45.6 ± 19.2ab	51.2 ± 16.2b
12	33.8 ± 23.6a	49.5 ± 21.3ab	45.5 ± 19.1ab

[A]Means of scores from 15 panelists ± standard deviation.
[B]O = very unacceptable, 100 = very acceptable.
Means followed by identical letters are not significantly different ($P \geq 0.01$).

Table 18. Correlation coefficients between rancidity scores and TBARS value, level of fluorescent products and FFA content of dried salted sardines during storage.

	Correlation with rancidity score
TBARS	-0.900*
Fluorescent products	0.807*
FFA	0.584

* Significant ($P \leq 0.05$)

packaging type at the same storage time. Means of rancidity scores as well as TBARS values, levels of fluorescent products or FFA contents were plotted against storage time (weeks) as shown in Fig. 1-3.

TBARS showed a significant negative relation ($P \leq 0.05$) with rancidity score. The level of fluorescent products did show a positive significant relationship with the scores. There is considerable evidence for the correlation between sensory evaluation results and TBARS value or the level of fluorescent products; Lubis (1989) found and recommended that the level of fluorescent compounds was a good index for following oxidation in dried salted sardines during storage because of its high positive correlation with rancidity score. He also reported that TBARS value showed only the third highest correlation with rancidity score; fluorescent products was first and polyene index second. The correlation was negative, instead of positive as found by other researchers, possibly because most of the samples used in their experiments were fresh and stored frozen compared to dried slated fish in his study. The trend found is similar to the results in this present study. MacDonald *et al.* (1982) stated that TBARS value

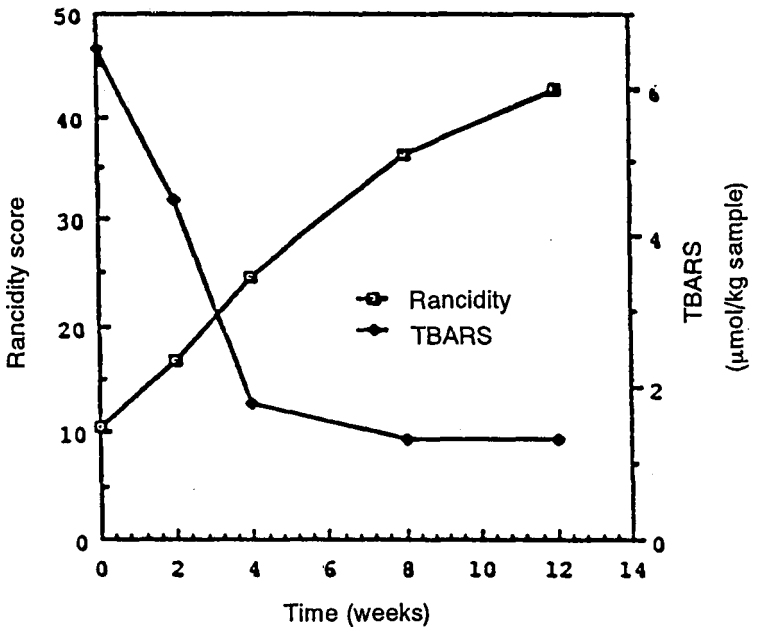

Fig. 1. Rancidity score and TBARS value of dried salted sardine during storage.

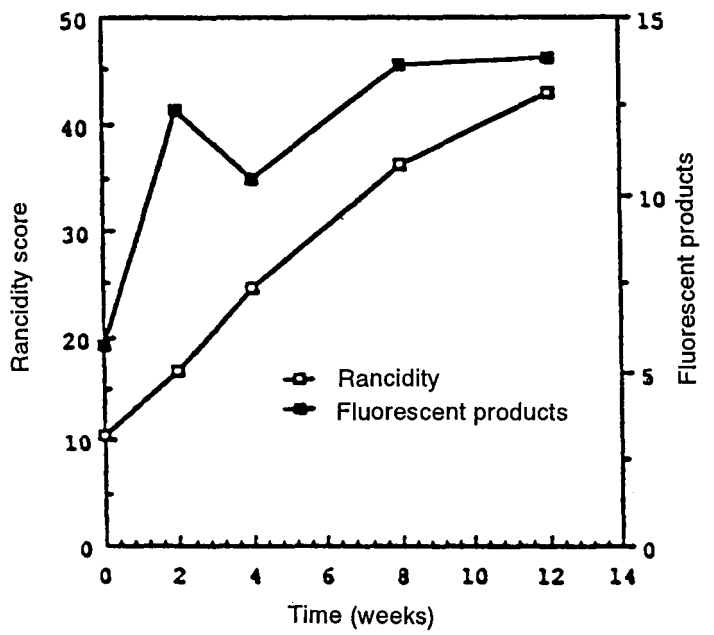

Fig. 2. Rancidity score and fluorescent products of dried salted sardine during storage.

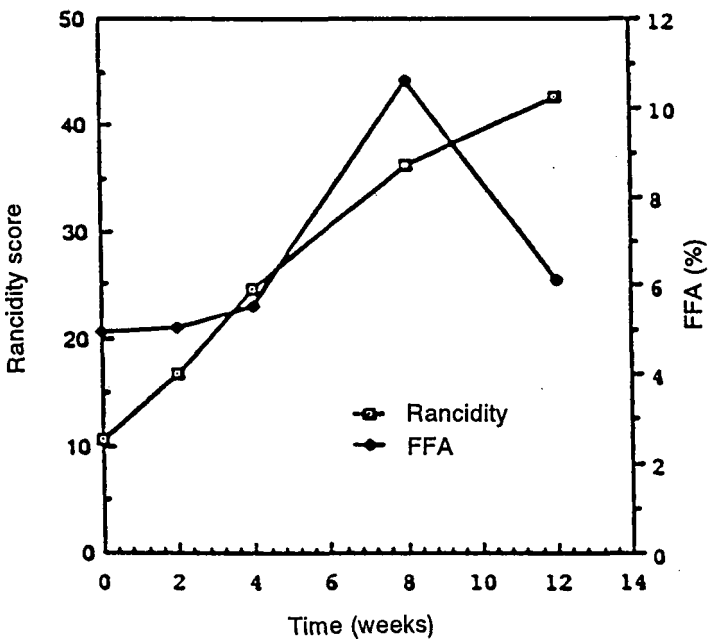

Fig. 3. Rancidity score and FFA content of dried salted fish during storage.

had a significant high positive correlation with both off-odour and off-flavour formation during aerobic storage of pork at 4°C. The controversy can only be resolved by the examination of many batches of samples, to avoid misleading interpretation.

FFA did not reveal any correlation with rancidity score, probably due to the significant decrease in FFA after the eighth week.

Conclusion And Recommendation

Modified atmosphere packaging has shown some effects on the storage stability of dried salted sardine. Storage time mostly affected chemical values and sensory scores of the products.

Storage at 30°C and 75% RH resulted in the fish samples floating in oil inside every package type after the first two weeks of the storage. Further research on storage at the refrigerated temperatures is needed to overcome this problem.

Three different types of packaging had no significant effect ($P \geq 0.01$) on the TBARS values, but storage time showed a significant decrease in this parameter for every sample, especially in the first four weeks of storage. The longer the storage time, the lower the TBARS value. The level of fluorescent products was significantly affected ($P \leq 0.01$) by both packaging type and storage time. TBARS values remained stable after the fourth week of storage in every sample, while the level of fluorescent products increased rapidly after such time in control-packed samples. Small differences in the level of fluorescent products of vacuum- and nitrogen-packed samples were found throughout the storage period. It can be concluded that the level of fluorescent products is a more sensitive indicator than TBARS value of lipid oxidation in

dried salted sardine. Vacuum and nitrogen packaging reduced the rate of lipid oxidation of dried salted sardine due to the exclusion of oxygen in the packages evidenced by the level of fluorescent products. However, the difference was not obviously indicated by TBARS value, FFA content and sensory evaluation. FFA content was significantly affected ($P \leq 0.01$) only by storage time. The longer the storage time, the higher the FFA content in the first eight weeks of storage. However, FFA was not considered a reliable means by which to evaluate lipid oxidation in this study, since a rapid decline was noted after the eighth week in contrast to sensory evaluation results.

The appearance of uncooked whole fish was significantly affected ($P \leq 0.01$) by both storage time and packaging type. The longer the storage time, the more significant the deterioration of the appearance of the products. Nitrogen packaging reduced the leaking-out of oil from the fish flesh and also decreased the sheen of the fish skin. Control-packed samples were mostly damaged by the fish skin sticking to the inner wall of the bags. Vacuum-packed samples were judged to have the best appearance. Since appearance is the most important factor influencing a consumer's decision, it may be concluded that nitrogen-packed samples cannot stay longer in a market than four weeks, control-packed samples not more than 4-6 weeks and vacuum-packed samples about 12 weeks. It is expected that if low temperature storage is involved, it would improve the appearance and extend the shelf life of the products.

Rancidity score was found to be affected significantly ($P \leq 0.01$) by storage time. The longer the storage time, the higher the rancidity score. The panelists were not able to distinguish between the samples of different packaging types since the samples did not differ markedly from each other and the panelists participating in this study had limited sensory judgement because they had not been previously trained. For better results, panelists must be selected and trained before an experiment commences, and the use of *ad hoc* panelists should be avoided.

Other attributes for the cooked samples, ie, texture, flavour and overall acceptability, were found to be improved by frying.

Both TBARS values and the level of fluorescent products showed a significant correlation ($P \leq 0.05$) with rancidity score. In this study, the level of fluorescent products associated with obvious rancid off-flavour was between 16-20 μg/g dry sample, or a TBARS value less than 1.5 μmol/kg sample. Further research is required to determine the possibility of using vacuum packaging with lower-moisture dried salted fish stored at ambient temperature or under refrigeration. The problem of product damage by stacking in the storage chamber must be overcome.

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Discussion

A comment was made that in the presentation, the results of the moisture content and water activity appeared to be contradictory; Miss Sophonphong said that she realized that there may possibly have been experimental error.

When asked why the TBARS values decreased during storage and what was responsible for the increase in free fatty acid in storage, Miss Sophonphong said that the increase in free fatty acid could be due to a combination of autoxidation and microbial lipase activity.

Asked why LDPE packing was used as the control rather than unpacked samples, which reflected the actual commercial practice, were not selected, Miss Sophonphong explained that it would be difficult to control the storage conditions of unpacked samples.

Freezing Effects Of Raw Materials On Threadfin Bream Surimi Gel Quality

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Abstract

Threadfin bream (*Nemipterus* spp.) were bought from the landing pier and used as raw materials for frozen surimi production. The fishes were frozen at -36°C until the center of the fish was cooled to -18°C. The frozen fish were kept at -18±1°C for 0,20,40 days, then the fish were taken and processed to surimi. The frozen surimi were kept at -18±1°C for 0,1$\frac{1}{2}$ and 3 months. The results showed that surimi made from 40 days cold-stored fish have more yellowness in colour than the zero- day fish. Gel forming ability of surimi was affected by the storage time of both frozen fish and frozen surimi. Gel strength of *kamaboko* made from prolonged-storage surimi was lower than zero-month-stored surimi. However, the folding test still registered AA after prolonged storage of surimi made from frozen fish of 21 days to 3 months. It is recommended that frozen threadfin bream can be used for surimi processing; this surimi should be directly processed to fish jelly products as soon as possible in order to obtain good gel-forming ability.

To improve the gel-forming ability of minced fish, ascorbic acid was added at 0.1 and 0.2% by weight during the mixing process. After production, surimi were kept frozen for 1$\frac{1}{2}$ months. It was found that 0.1% by weight of ascorbic acid improved the gel quality of frozen stored surimi. Increasing the amount of ascorbic acid to 0.2% resulted in lowering the pH of surimi. It also lowered the gel strength of prepared *kamaboko*.

Introduction

Threadfin bream (*Nemipterus* spp.) are widely used for surimi production in Thailand. Surimi processors believe that frozen fish cannot be used as raw material for surimi processing. However, in Singapore some processors use frozen blocks of threadfin bream to make mince meat, from which they then produce fish jelly products. Reports from many groups of scientists indicated that iced fish or frozen fish that had undergone prolonged storage showed a decline in *kamaboko*-forming ability. Such experiments were conducted on different species as follows : lizard fish (Yasui *et al*, 1987), sardine (Ichikawa *et al*, 1977, 1978, cited from Harrd and Warren, 1985) Alaska pollock (Scott *et al*, 1988), Atlantic cod (Harrd and Warren, 1985) and *Tilapia* (Somboonyarithi, 1987). The rate at which loss of gel strength occured appears to vary between and within fish species. Recently, there have been reports on the use of reductants ie cysteine, sodium metabisulfite mercaptoethanol and ascorbic acid, to improve gel forming ability of freeze-thawed protein (Jiang *et al*, 1986, Somboonyarithi, 1987). Therefore, it was the purpose of this study to investigate the effect of freezing of threadfin bream on the sub-

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Note: This paper was presented at the Seminar by Dr Wunwiboon.

sequent quality of surimi. The effects of ascorbic acid on the quality of frozen surimi made from 40 days frozen fish were also investigated.

Methods

Threadfin bream were bought from the landing pier in Samutprakarn province. Fish were deheaded, gutted and then block frozen at -36°C by contact plate freezer. The freezing time was 2 hours where the temperature at the center of the fish was lowered to -18°C. The frozen blocks were kept frozen at -18±1°C for 40 days.

Determination Of The Effect Of Freezing Of Threadfin Bream On Surimi Quality

Frozen blocks of threadfin bream were sampled at 0, 20, 40 days of storage and processed to surimi using the process shown in Fig. 1. Surimi were block frozen and kept at -18±1°C for 3 months.

Frozen blocks of surimi were sampled at 0, $1\frac{1}{2}$, 3 months of storage time, and used for surimi quality determination where pH, color, gel strength and folding test were determined. For pH, 1:1 ratio of surimi to distilled water was blended and pH measurement was obtained by Corning pH Meter 120. *Kamaboko* was prepared according to the method of MFRD (1988). The color of *kamaboko* was determined by Macbeth Munsell Disk Colorimeter. An Instron 1000, equipped with a spherical plunger of 10 mm diameter, running at crosshead speed of 50 mm/min, was used to determine *kamaboko* gel strength. Four test pieces were measured. The mean value of work (gm-cm) required to break the test piece was determined. Folding test were conducted according to the method of MFRD (1988) by using 10 test pieces.

Determination Of The Effect Of Ascorbic Acid On The Quality Of Frozen Surimi

Surimi were prepared from 40-day-frozen-stored fish according to the method shown in Fig. 1. Ascorbic acid was added at 3 different levels, 0, 0.1, 0.2% by weight during mixing process. Frozen surimi were stored at -18±1°C for 1 month. Surimi were subjected to quality assay (pH, color, gel strength and folding test) as described previously.

Statistical Analysis

Completely randomized design (CRD) was employed in the gel strength experiment. Analysis of variance (ANOVA) was used to test for significant differences. Then the differences among mean values were indicated by Duncan's multiple range test (DMRT).

Results And Discussion

Effect Of Freezing Of Threadfin Bream On The Quality Of Surimi

As indicated in Tables 1 and 2, pH of surimi varied from 6.57 to 7.04 but showed no tendency to increase or decrease with storage time. This was true of both frozen fish and frozen surimi.

Munsell color system was used to indicate *kamaboko* colour. In the case of surimi prepared from unstored threadfin bream when making *kamaboko*, the colour hue is green-yellow, with lightness closest to white (10=white). After three months of storage the colour hue of surimi changes to yellow with a little decrease in lightness (from 8.9 to 8.06), and no trend of change for chroma. Freezing of threadfin bream caused very little change in *kamaboko* colour for 20-day stored fish, but the colour of *kamaboko* from 40-day stored fish tends to be more yellow with lightness around 8. These changes in degree of yellowness and lightness are believed to be due to a browning reaction in the surimi during frozen storage. This browning effect was also reported by Harrd and Warren (1985).

Grade of folding test remained AA throughout, except for samples made from 40-day stored fish whose surimi were in cold storage for $1\frac{1}{2}$ and 3 months. The gel strength of samples showed a decrease in value with prolonged storage

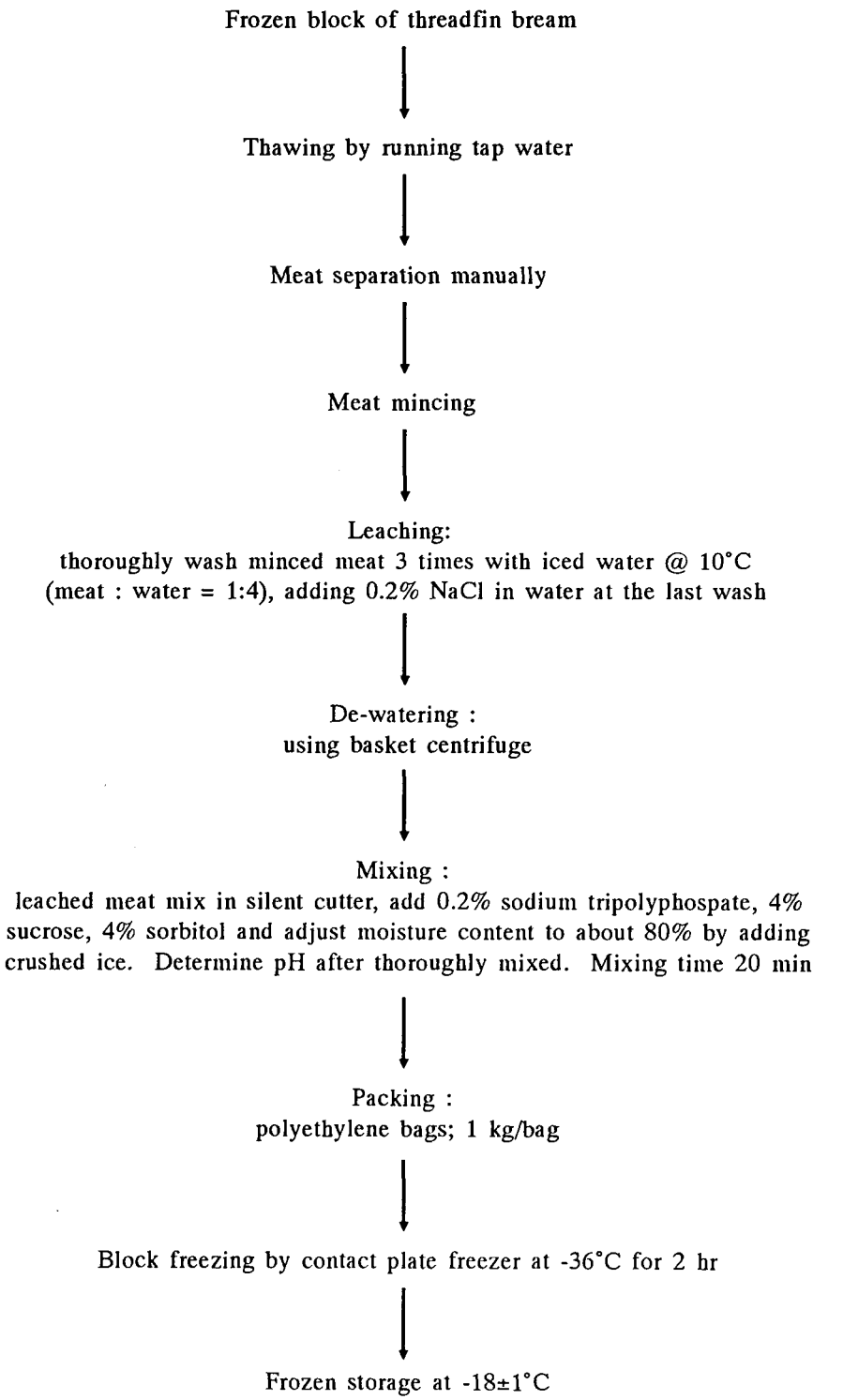

Fig. 1. Diagram showing surimi processing steps used.

Table 1. Effect of freezing of threadfin bream on the quality of frozen surimi.

Storage Time of Surimi (month)	pH of Surimi			Colour of *Kamaboko*[1]			Folding Test[2]		
	Storage Time of Fish (day)			Storage Time of Fish (day)			Storage Time of Fish (day)		
	0	20	40	0	20	40	0	20	40
0	6.57	6.91	6.87	7.25GY 8.90/0.22	7.50GY 8.75/1.23	10.00Y 8.76/1.52	AA	AA	AA
1.5	6.64	6.98	6.84	-	5.00GY 8.82/0.55	10.00Y 8.05/3.43	AA	AA	A
3.0	6.60	7.04	6.93	5.15Y 8.06/2.86	0.40Y 8.28/1.69	-	AA	AA	B

[1] colour value of *kamaboko* reported as hue value and chroma in Munsell Color System.
"-" means missing data.
[2] grade of folding test.
AA = no breakage in any of five samples when folded in quarter.
A = slight tear in anyone of five samples when folded in quarter.
B = slight tear in any of five samples when folded in half.

Table 2. Effect of freezing of threadfin bream on the gel strength of frozen surimi.

Storage Time of Surimi (month)	Gel Strength (gm-cm)		
	Storage Time of Fish (day)		
	0	20	40
0	3398.2 a[1]A[2]	2942.8 bA	1739.7 cA
1.5	2928.0 aB	2392.8 aB	1284.0 bB
3.0	2202.1 aC	2255.2 aB	773.4 bC

[1]values bearing unlike lowercase letters in the same row differ significantly P≤0.05.
[2]values bearing unlike uppercase letters in the same column differ significantly P≤0.05.

of fish and surimi. It has been shown that some fish, once frozen, can never be used for high-quality surimi products due to the denaturation of muscle proteins during freezing and frozen storage (Jiang *et al*, 1986).

On the basis of data obtained in Tables 1 and 2, it is concluded that threadfin bream for surimi processing can be kept frozen at -18±1°C for up to 30 days. When such fish are made into surimi, the produced surimi should be directly processed to fish jelly products as soon as possible in order to get good quality products.

Effect Of Ascorbic Acid On The Quality Of Frozen Surimi Made From 40 Days Stored Fish

According to Tables 3 and 4, the addition of ascorbic acid in surimi caused a small drop of pH of surimi. When 0.2% level was added, the surimi

Table 3. Effect of ascorbic acid on the quality of frozen surimi made from 40 days frozen stored fish.

% Ascorbic acid	pH		Colour of *Kamaboko*[2]		Folding Test[1]	
	Storage Time of Surimi (months)		Storage Time of Surimi (months)		Storage Time of Surimi (months)	
	0	1.5	0	1.5	0	1.5
0	6.53	6.59	8.45Y8.38/1.60	3.43Y8.74/1.65	AA	AA-A
0.1	6.51	6.40	8.33Y8.34/1.43	6.44Y8.29/2.03	AA	AA
0.2	6.47	6.13	7.50Y8.36/1.47	7.50Y8.44/1.44	AA-A	A

[1] folding test of 10 test pieces showed 3 test pieces as A grade and 7 test piece as AA grade.
[2] colour value of *kamaboko* reported as hue value and chroma in Munsell Colour System

Table 4. Effect of ascorbic acid on the gel strength of *kamaboko* prepared from frozen surimi. Surimi were made from 40 days stored fish[1].

% Ascorbic acid	Gel Strength (gm-cm)	
	Storage time of surimi (months)	
	0	1.5
0	2796.4 a[2] AB[3]	1337.6 b A
0.1	3228.6 a A	1799.4 b B
0.2	2433.6 a B	1166.0 b A

[1] Fish used for these data were obtained from frozen fish industry.
[2] Values bearing unlike lowercase letters in the same row differ significantly $P<0.05$.
[3] Values bearing unlike uppercase letters in the same column differ significantly $P<0.05$.

pH dropped more than 0.1% level (Table 3). The colour hue of *kamaboko* tended to increase in redness after $1\frac{1}{2}$ months storage of surimi, with addition of ascorbic acid 0.1%, compared with freshly made surimi with no addition of ascorbic acid. However, addition of 0.1% ascorbic acid improved the colour hue of *kamaboko* made from prolonged-stored surimi. The folding test grades of *kamaboko* samples were maintained at AA at $1\frac{1}{2}$ months in storage when adding 0.1% ascorbic acid. Addition of 0.2% ascorbic acid in surimi did not improve grade or gel strength. It is speculated that the higher acid content may cause some denaturation of fish protein. The gel-strength of samples treated with 0.1% ascorbic acid differed significantly from that of no-ascorbic-acid samples

($P \leq 0.05$) after $1\frac{1}{2}$ months in frozen storage. The increasing gel-strength of samples with 0.1% ascorbic acid suggested that ascorbic acid at 0.1% level can improve gel-forming ability of fish protein when subjected to freezing and frozen storage. As stated by Jiang (1986) the addition of reducing agents during surimi processing recovered the reactive SH- group and subsequently increased the gelation of freeze-thawed fish meat.

Conclusion

Threadfin bream can be stored in the frozen state (-18±1°C) for approximately 30 days before being processed to surimi. High quality *kamaboko* can be prepared from freeze-thawed threadfin bream by adding 0.1% ascorbic acid during the early stage of mixing. Surimi thus processed can be kept frozen for about one month; however the gel strength of *kamaboko* decreases gradually with storage time.

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MFRD. 1988. Handbook on the processing of frozen surimi and fish jelly products in Southeast Asia. Marine Fisheries Research Department, Southeast Asian Fisheries Development Center, Singapore. 30pp.

Scott, D.N., R.W. Porter, G. Kudo, R. Miller, and B. Koury. 1988. Effect of freezing and frozen storage of Alaska pollock on the chemical and gel-forming properties of surimi. Journal of Food Science, 53(2) : 353-358.

Somboonyarithi, V. 1987. Quality of surimi from fresh and frozen sardines and *Tilapia*. Master's Thesis. Chulalongkorn University. Bangkok Thailand. 122 pp.

Yasui, A. and Pang Yong, Lim. 1987. Changes in chemical and physical properties of lizard fish meat during ice and frozen storage. *Nippon Shokuhin Kogyo Gakkaishi* 34(1) : 54-60.

Discussion

In response to a comment that gel strength is correlated to fish freshness and asked whether fish freshness was considered in the study, Dr Garnjanagoonchorn said that the freshness of the raw material was assessed organoleptically.

A participant wanted to know what sampling procedure for gel strength was used in the study. Dr Garnjanagoonchorn replied that one gel strength reading was obtained from each sausage and that four sausages were prepared for each treatment.

Asked why the effect on the gel strength of 0.1% ascorbic acid was better than that produced by 0.2% ascorbic acid, she said that perhaps high acidity affected the protein property of the fish meat.

Regarding the basis for selecting ascorbic acid as an additive in the study, the author informed that recent scientific papers had reported that adding reductants caused an increase in the gel strength of frozen storage surimi. For this reason, ascorbic acid, as a common food processing reductant, was selected.

In this study, the pH values of the three treatments were different. It was recommended that in future studies the final pH of the surimi from the different treatments be made equal to reduce the influence of pH on the gel-forming ability of surimi.

It was also recommended that a survey of the stability of gel-forming ability be made in both iced storage and frozen surimi on a large number of species of fish.

Effects Of Type And Quantity Of Flours Used On The Quality Of Frozen Fish Balls

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Abstract

Fish balls were produced from thread-fin-bream based surimi. Three types and quantities of flours were used in this study: tapioca flour, Purity 4 and National Frigex. Three, 5 and 8% were added during kneading. The cooked fish balls were then frozen by nitrogen tunnel and stored at -18°C in order to determine their quality during storage. Samples were removed to determine total viable count (TVC), total volatile base (TVB), gel strength, drip loss, moisture and protein content and for sensory assessment. The addition of 8% National Frigex reduced drip loss up to 50% compared to control samples (fish balls without addition of flour) and gave better results than the use of tapioca flour. Type and quantity of modified starches did not affect general appearance, surface, succulence, texture, glossiness and flavour of the fish ball samples. The samples stored more than 60 days caused outer surface dryness and reduced glossiness resulting in unacceptability by the panelists.

Introduction

Fish balls are popular minced fish-based products in the Southeast Asian region especially in Thailand and Singapore. Good quality fish balls should possess white colour, no fish smell and soft-but-elastic texture.

Fish balls are perishable, thus they must be stored at low temperature in order to retard bacterial growth. Yamprayoon, Suwansakornkul and Kiatkungwalkrai (1980) studied the quality of fish balls during storage at various temperatures; the results revealed that the samples could be kept for 1 and 7 days at 30°C and 4°C respectively. However, the texture of fish balls stored at between -9°C and -18°C became sponge-like and dry because of an expansion of ice crystals during frozen storage which subsequently damaged the texture of the products. When the frozen products were thawed, dramatic drip loss could occur (Lawrence, *et al*, 1986).

Freezing is known to be the best method of preserving food since it inhibits bacterial growth. However, an important problem always encountered is the subsequent damage of food texture. The quality of frozen food depends on the rate of freezing. The size of the ice crystals is directly related to freezing methods. If slow freezing is employed, it causes the formation of very large and sharp ice crystals resulting in damaged texture of the products. The most rapid freezing method is the use of liquid nitrogen (Love, 1968).

In the past, flours were used in fish balls to thicken the texture and as a source of carbohydrate, but they are now used extensively as stabilizers, texturizers, water or fat binders and emulsifiers. They also increase gel strength and freezing-thaw stability of the products if appropriate modified

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Note: This paper was presented at the Seminar by Mrs Jirawan.

starches are added at proper content (Luallon, 1985).

The objectives of this study are to determine the appropriate type and quantity of flours to be used in frozen fish balls and to study the quality of frozen fish balls during storage.

Materials And Methods

Frozen surimi made of threadfin bream containing 4% sorbital and 4% sucrose as cryoprotectant was used to produce fish balls.

Various types and quantities of flours were added, as follows:

- 0, 3, 5 and 8% tapioca flour
- 0, 3, 5 and 8% of National Frigex (modified tapioca starch, freeze thaw stability 7-8 cycle), purchased from National Starch and Chemical Corporation, and
- 0, 3, 5 and 8% of Purity 4 (modified tapioca starch, freeze thaw stability 3-4 cycle), purchased from National Starch and Chemical Corporation.

Therefore, there were 10 treatments to be studied.

The frozen surimi was thawed at room temperature for two hours and then cut into pieces by a silent cutter. The following flow chart shows the fish ball production process (Chart 1).

The fish balls were frozen in a nitrogen tunnel. The temperature of nitrogen during spraying was -170°C, tunnel temperature was between -50°C and -60°C and freezing time was 10-12 min per sample.

Two hundred grams of frozen fish balls were packed in a 7" x 9" polypropyrene bag and stored in a freezer at -18°C to study their quality during frozen storage.

Chemical and microbiological analyses:

- The fish balls prior to freezing and after freezing at week 0 and week 10 were analyzed for protein content (AOAC, 1980) and total viable count TVC (ICMSF, 1978).

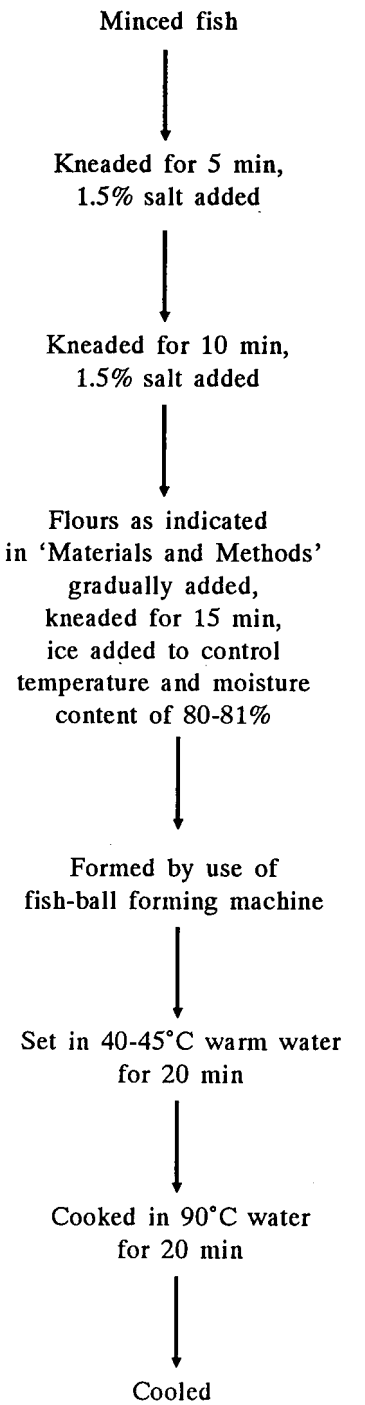

Chart 1. Fish ball production method and procedure.

The samples were removed every fortnight to determine

- Total volatile bases (Uchiyama, 1978).
- Moisture content (AOAC, 1980).
- Gel strength (MFRD, 1979).
- Drip index (Jiang, N.D.).

Sensory Assessment : Eight members of a trained sensory panel were asked to describe the appearance, texture and flavour of the fish ball samples using the hedonic scale.

Statistical Analysis : Results for individual treatments were pooled for statistical analyses using a statistical analysis system (SAS) of Bar *et al* (1976). Analysis of variance and Duncan's New Multiple Range Test were performed with significance accepted at 5% level of probability ($P \leq 0.05$).

Results And Discussion

Tables 1 and 2 show effects of the type of flours on the frozen fish balls during storage. It was found that tapioca flour, Purity 4 and National Frigex did not affect TVB value, protein and moisture contents and gel strength of the samples but that they did affect drip loss. The drip loss was significantly affected ($P \leq 0.05$) by flour type. The frozen fish balls containing National Frigex had the lowest drip loss after thawing (Fig.1). This indicates that flours which have been modified are better than normal flours in this aspect.

For sensory evaluation, eight trained panelists judged that flour type did not affect general appearance, gel strength, outer surface, succulence, texture, glossiness, cut surface and flavour of the samples but did affect hardness.

The hardness of samples containing tapioca flour and Purity 4 were not significantly different but they were found to be harder than the sample containing National Frigex. Flour types did not affect the flavour of fish ball samples as shown by the scores, nor did the TVC which possessed the average of 6.9×10^3 colonies/gram sample.

Tables 1 and 2 show that the flour contents used viz. 0, 3, 5 and 8%, did not affect moisture content since during the fish ball processing, the moisture content was adjusted to maintain 80-81%. Protein contents were reduced in the fish balls containing more than 5% flours but remained constant in the samples containing no more than 3% flours.

The higher the content of flours added, the less the drip loss (Fig.1). It can be concluded that 8% flour gave the best result. Presumably, the flour molecules were attached to the myofibrillar protein molecules after the heating process, resulting in an increase of capability to retain water after thawing. This is in accordance with the study of Jiang (N.D.).

In the sensory evaluation, the percentages of flours used did not significantly affect texture and cut surface score of the samples. The samples containing flours showed better attributes ie, outer surface smoothness, glossiness and succulence than the samples without additional flour; however, levels of the flours added did not significantly affect the score given by the panelists. The samples with additional flours were judged harder but less elastic than the control. Types and contents of flours added did not affect elasticity score; nor did the results given by Rheometer (Table 1). Possibly the flours used contained quite the same amylose. Amylose in flours gives elasticity to food products, hence different amylose content will affect the products' texture (Laullen, 1985). The samples containing flours were more acceptable in flavour than the control sample; presumably, the flours have masked or reduced fish smell.

TVC were not significantly different at any levels of the flours added.

The frozen fish balls stored at -18°C and sampled fortnightly for about 75 days showed no significant difference in gel strength measured by Rheometer (Table 1 and Fig. 2). There were contradictory to sensory assessment results which showed the fish balls kept for more than 40 days were scored as significantly different ($P \leq 0.05$) from the samples kept for 60 and 75 days (Fig. 3). The drip loss of the fish balls before freezing and after freezing and storage for 2 days up to 75 days were significantly different. The longer the storage time, the higher the drip loss after thawing (Fig. 1). The addition of modified starches helped

Table 1. Pooled mean TVB, protein, moisture, drip loss, gel strength and TVC against type and quantity of additional flours and storage time of frozen fish balls.

Treatment	TVB (mg%)	Protein (%)	Moisture (%)	Drip Loss (%)	Gel Strength g/cm	Total Viable Count (colony/g)
Type of Flour						
- Tapioca flour	3.35±0.78^{a}	11.09±1.35^{a}	80.58±1.18^{a}	9.98±3.12^{a}	452.01±145.00^{a}	6.9x10^{3}±10.30^{a}
- Purity 4	3.33±0.73^{a}	11.24±1.22^{a}	80.17±1.13^{a}	7.97±3.24^{b}	450.01±139.82^{a}	6.6x10^{3}±9.80^{a}
- National Frigex	3.41±0.77^{a}	11.21±.211^{a}	80.13±1.28^{a}	6.88±3.45^{c}	449.57±139.60^{a}	7.1x10^{3}±9.80^{a}
Quantity of flour						
- 0 %	3.59±0.76^{a}	11.78±2.02^{a}	81.03±1.41^{a}	11.05±2.92^{a}	665.67±76.47^{a}	3.1 x10^{3}±11.20^{a}
- 3 %	3.17±0.60^{bc}	11.42±0.96	80.56±0.79^{a}	9.20±2.87^{b}	395.40±68.02^{b}	3.9 x10^{3}±10.80^{a}
- 5 %	3.37±0.87^{ac}	10.93±0.72^{b}	80.36±0.86^{a}	7.10±2.88^{c}	360.86±69.92^{b}	3.1 x10^{3}±10.12^{a}
- 8 %	3.77±0.72^{a}	10.59±0.41^{b}	81.23±0.88^{a}	5.72±3.06^{d}	378.63±61.56^{b}	3.1 x10^{3}±11.16^{a}
Storage Time (Days)						
- 0	2.83±0.66^{a}	11.53±0.98^{a}	79.93±0.68^{a}	4.80±2.13^{a}	459.17±142.32^{a}	2.35x10^{3}±9.23
- 2	3.07±0.44^{ab}	11.01±0.88^{a}	81.35±1.18^{a}	6.30±1.75^{b}	412.61±106.30^{bc}	1.22x10± 9.21
- 15	3.28±0.59^{bc}	-	81.83±1.16^{a}	6.45±2.15^{b}	443.42±173.17^{ac}	-
- 28	3.50±0.78^{c}	-	79.76±0.39^{a}	8.75±3.47^{c}	450.92±158.72^{a}	-
- 42	3.30±0.61^{c}	-	80.00±0.97^{a}	10.31±3.63^{d}	440.28±152.27^{a}	-
- 60	4.19±0.82^{e}	-	79.92±0.66^{a}	10.36±3.42^{d}	476.53±120.38^{a}	-
- 75	3.39±0.57^{c}	11.00±0.94^{a}	79.28±0.67^{a}	10.82±2.83^{f}	468.22±139.26^{a}	6.6 x10^{3}±8.24

a, b, c, d, e, f: Means in the same variable with different superscripts are different (P≤0.05).

Table 2. Pooled mean sensory score against type and quantity of additional flours and storage time of frozen fish balls.

Treatment	Score								
	Outer Surface	Gel Strength	Hardness	Appearance	Succulence	Texture	Glossiness	Cut Surface	Flavour
Type of Flour									
- Tapioca flour	3.08±0.73^{a}	3.73±0.71^{a}	3.39±0.92^{a}	3.87±1.12^{a}	3.17±0.75^{a}	3.95±0.58^{a}	3.08±0.73^{a}	3.23±0.71^{a}	3.36±0.49^{a}
- Purity 4	3.10±0.73^{a}	3.73±0.71^{a}	3.28±0.83^{ac}	3.89±1.11^{a}	3.13±0.76^{a}	3.91±0.59^{a}	3.10±0.73^{a}	3.73±0.71^{a}	3.38±0.49^{a}
- National Frigex	3.15±0.73^{a}	3.77±0.72^{a}	3.20±0.78^{bc}	3.88±1.11^{a}	3.07±0.72^{a}	3.94±0.56^{a}	3.15±0.73^{a}	3.77±0.72^{a}	3.37±0.48^{a}
Quantity of flour									
- 0 %	2.82±0.66^{a}	8.13±1.17^{a}	2.90±0.89^{a}	3.75±1.10^{a}	2.89±0.65^{a}	3.86±0.61^{a}	2.82±0.66^{a}	3.68±0.77^{a}	3.23±0.48^{a}
- 3 %	3.19±0.70^{b}	7.84±0.96^{b}	3.56±0.84^{b}	3.89±1.11^{b}	3.20±0.73^{b}	3.92±0.54^{a}	3.19±0.70^{b}	3.75±0.72^{a}	3.42±0.49^{b}
- 5 %	3.21±0.77^{b}	7.79±1.07^{b}	3.50±0.76^{b}	3.94±1.11^{b}	3.27±0.80^{b}	3.98±0.57^{a}	3.21±0.77^{b}	3.77±0.69^{a}	3.41±0.48^{b}
- 8 %	3.21±0.71^{b}	7.84±1.17^{b}	3.21±0.74^{c}	3.94±1.12^{b}	3.14±0.77^{b}	3.98±0.58^{a}	3.21±0.71^{b}	3.79±0.66^{a}	3.42±0.99^{b}
Storage Time (Days)									
- 0	3.57±0.50^{a}	8.62±0.75^{a}	3.90±0.63^{b}	4.68±0.47^{a}	3.44±0.79^{acd}	4.53±0.46^{a}	3.57±0.80^{a}	4.49±0.50^{a}	3.60±0.40^{a}
- 2	3.69±0.49^{ac}	8.10±0.65^{c}	3.67±0.68^{c}	4.81±0.58^{ab}	3.58±0.50^{a}	4.28±0.56^{b}	3.69±0.49^{a}	3.89±0.55^{b}	3.64±0.48^{a}
- 15	3.17±0.58^{b}	8.20±0.94^{c}	3.46±0.78^{dc}	4.54±0.58^{ac}	3.30±0.60^{ce}	3.90±0.45^{ch}	3.17±0.58^{b}	3.97±0.60^{b}	3.31±0.46^{b}
- 28	3.17±0.58^{b}	8.29±0.94^{c}	3.46±0.78^{d}	4.54±0.58^{ac}	3.30±0.60^{de}	3.90±0.45^{dh}	3.17±0.58^{b}	3.97±0.60^{b}	3.31±0.46^{b}
- 42	2.91±0.81^{d}	8.21±1.06^{c}	3.08±0.79^{e}	3.79±0.61^{d}	2.88±0.72^{be}	3.82±0.39^{ehi}	2.91±0.82^{d}	3.56±0.54^{c}	3.32±0.51^{b}
- 60	2.78±0.71^{d}	6.90±0.91^{d}	3.17±0.80^{e}	2.51±0.42^{e}	2.83±0.82^{b}	3.72±0.45^{fi}	2.78±0.72^{e}	3.47±0.58^{c}	3.22±0.01^{b}
- 75	2.47±0.53^{e}	6.88±0.90^{d}	2.29±0.37^{f}	2.28±0.30^{f}	2.54±0.58^{f}	3.39±0.49^{g}	2.47±0.53^{f}	2.88±0.33^{d}	3.22±0.41^{b}

a, b, c, d, e, f, g, h, i: Means in the same variable with different superscripts are different ($P \leq 0.05$).

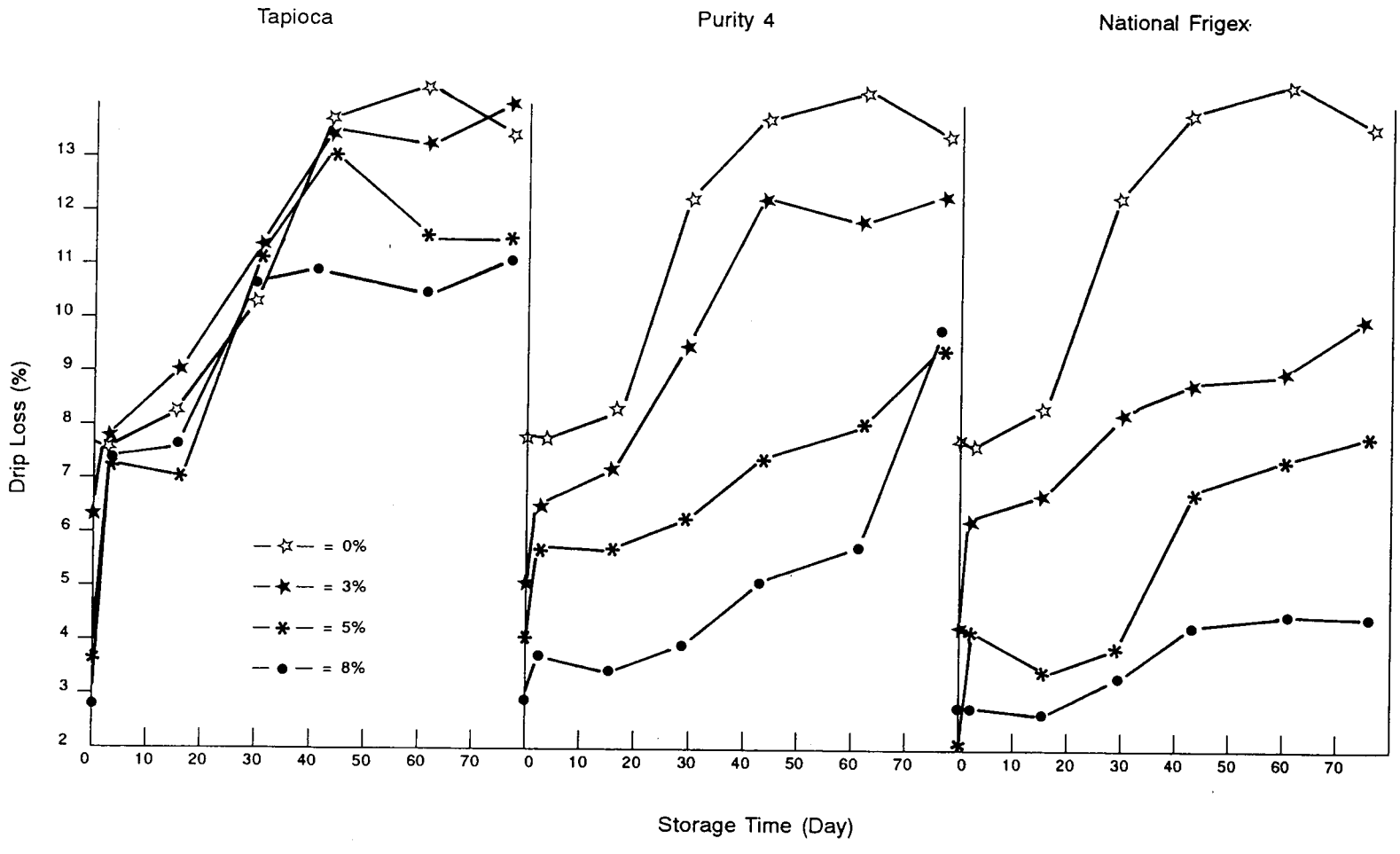

Fig. 1. Effect of type and quantity of flour on drip loss of fish balls during frozen storage.

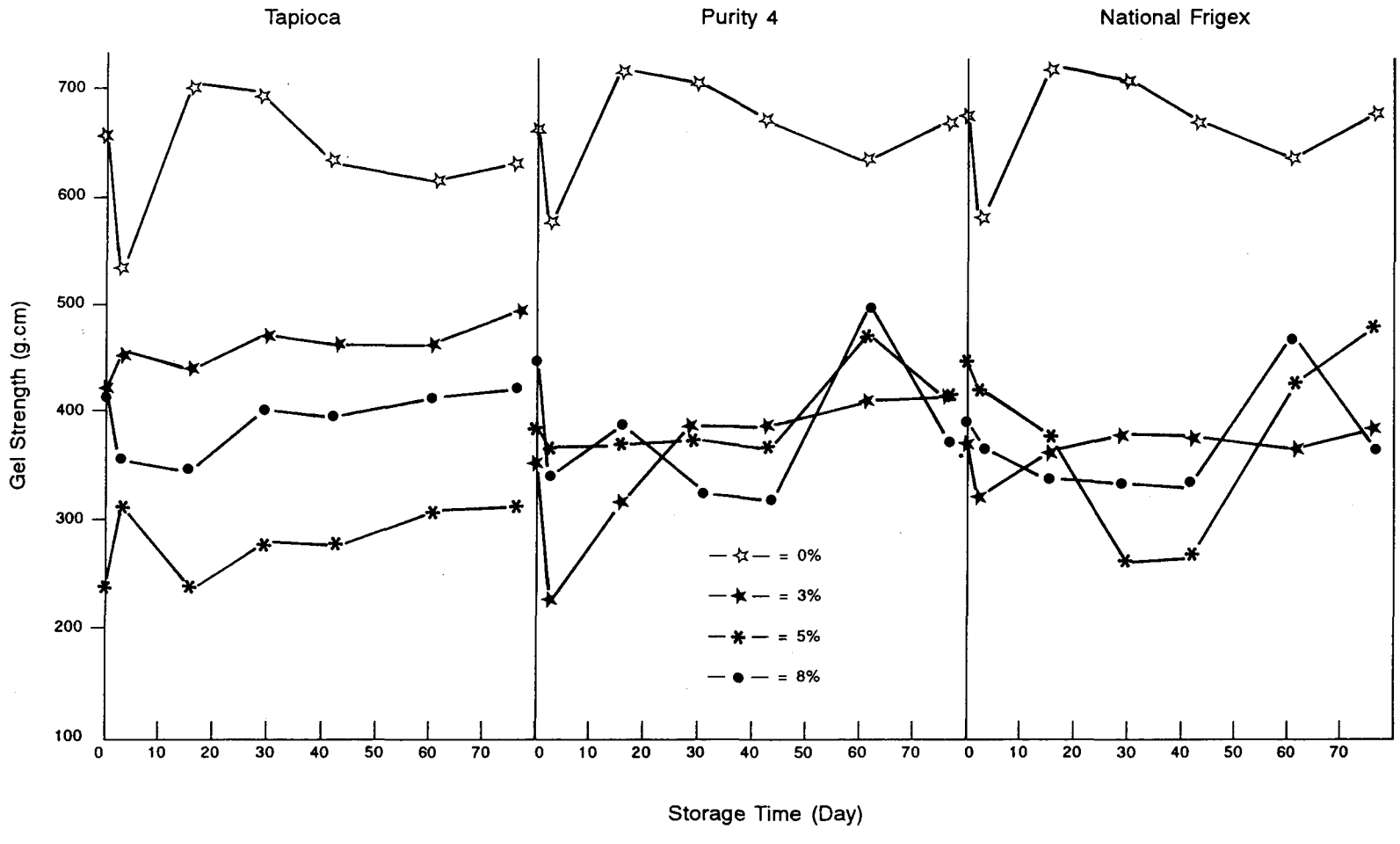

Fig. 2. Effect of type and quantity of flour on gel strength of fish balls during frozen storage (rheometer scores).

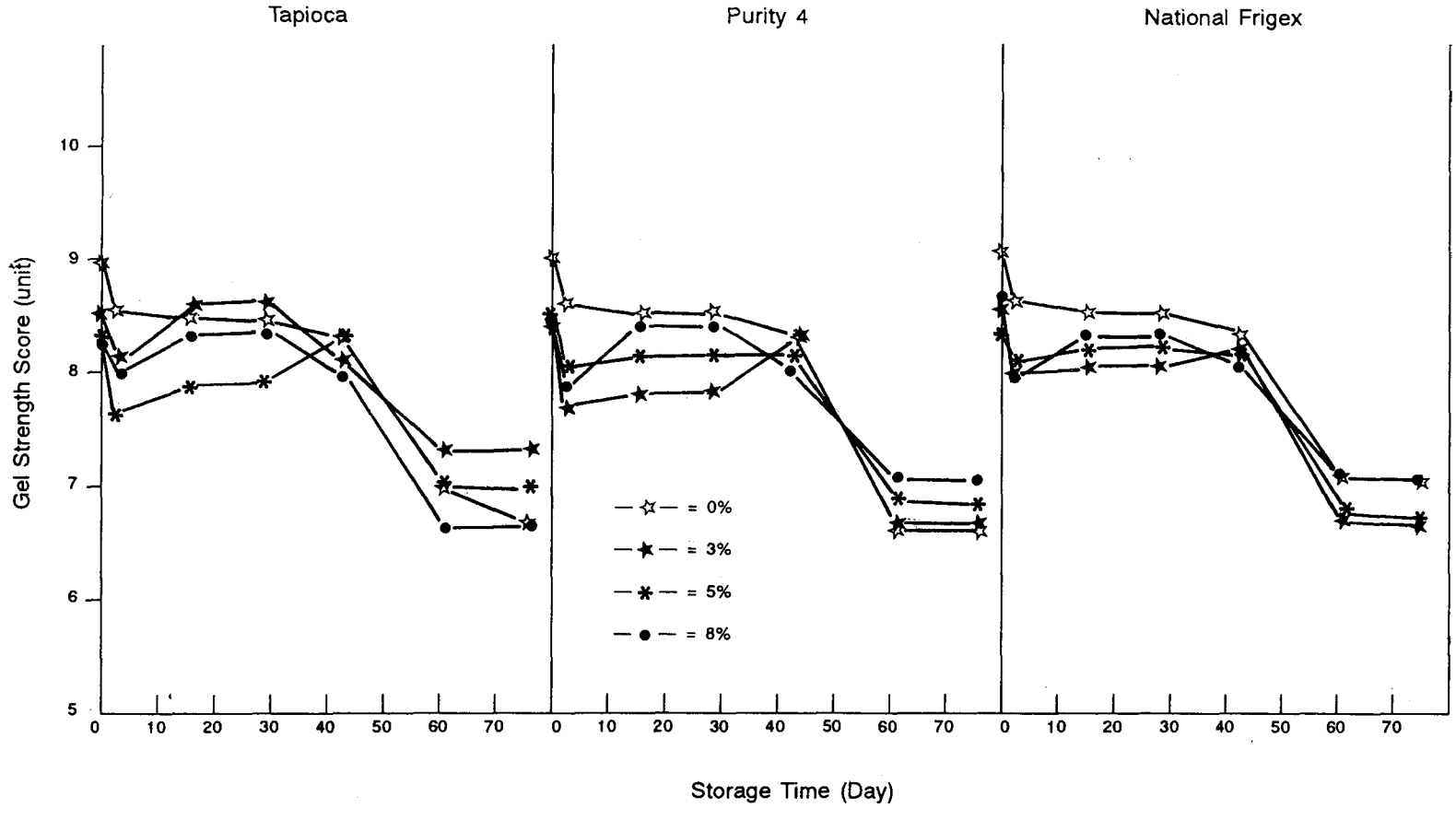

Fig. 3. Effect of type and quantity of flour on gel strength of fish balls during frozen storage (organoleptic scores).

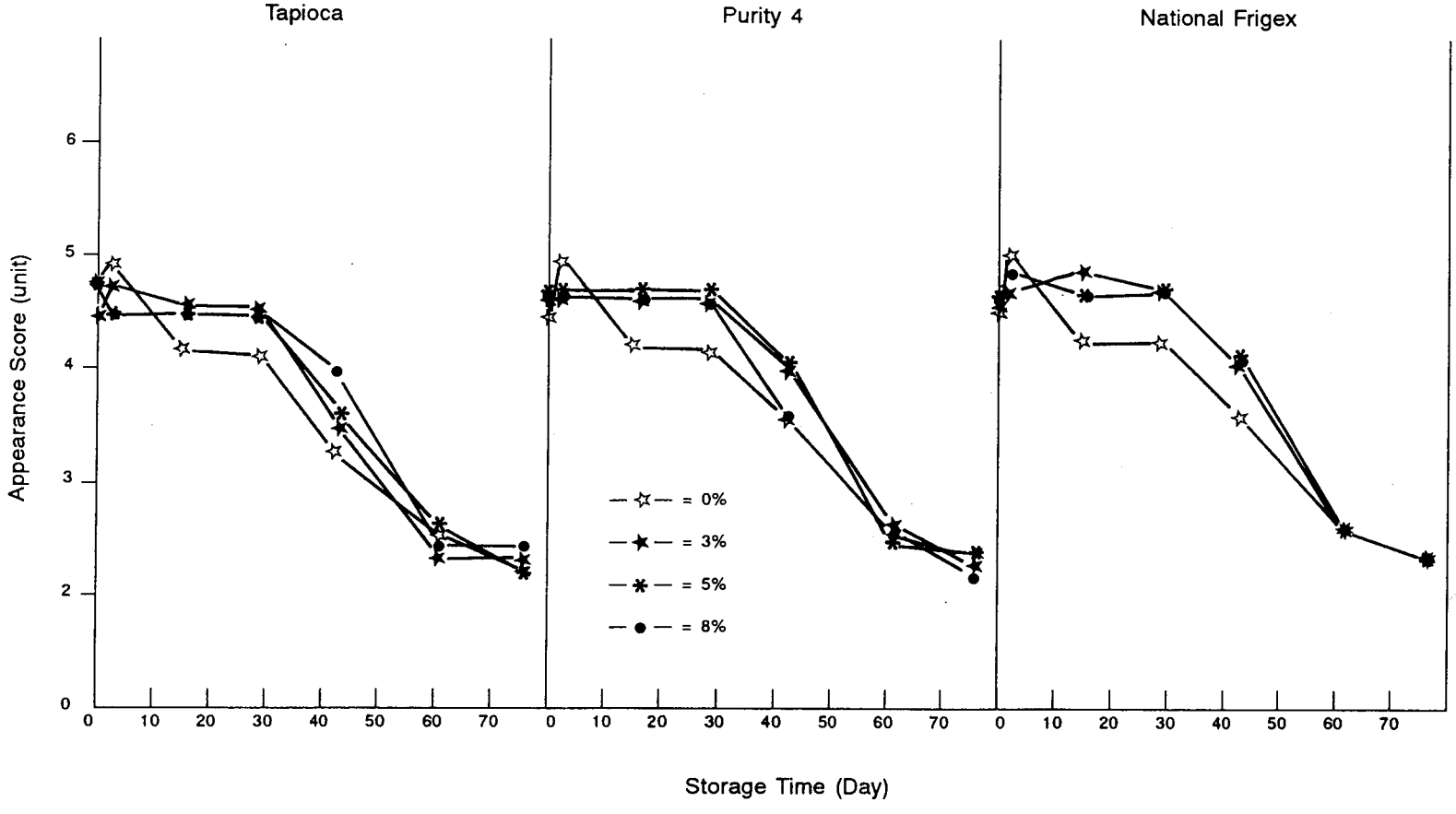

Fig. 4. Effect of type and quantity of flour on appearance of fish balls during frozen storage.

reduce drip loss during storage to a level lower than that experienced with the use of normal tapioca flour. The findings are consistent with Sorensen's (1976) study, in which he concluded that freezing would affect drip loss in minced fish during frozen storage.

Sensory assessment of the frozen fish balls showed that the samples before freezing and the samples kept for two days after freezing were not significantly different in general appearance, outer surface, glossiness and succulence. It was found that the scores awarded on outer surface, general appearance, succulence and glossiness by the panelists decreased as the storage time increased. Fig. 4 shows that the fish balls with additional tapioca flour, Purity 4 and National frigex of different levels during storage were awarded decreasing appearance scores as storage time proceeded and the scores were obviously low if stored for more than 42 days. The samples kept for 60 days were found to be dry, not glossy and unacceptable. The cut surface of the frozen fish balls was found to be rough and not shiny compared with samples that had not undergone freezing; however, the scores still fell into the acceptable range throughout the storage period. Storage time did not affect the flavour of the samples as shown by the acceptability scores. These were between 3.2 and 3.6 (judged acceptable) throughout the storage period (Table 2).

Conclusion

Quality values of frozen fish balls (eg, drip loss and texture damage) can be improved by the addition of appropriate modified starches with freeze-thaw stability. In this study, fish balls with additional 8% National Frigex, reduced drip loss up to 50% compared with the samples without additional flour. They also showed better results than samples with additional tapioca flour (unmodified starch). The type and quantity of the modified starches added did not significantly affect general appearance, outer surface, succulence, texture, glossiness and flavour of the frozen fish balls during storage, but the products with additional flours had smoother outer surfaces and superior glossiness and succulence to samples without additional flour. Frozen fish balls which were stored for more than 60 days showed outer-surface dryness and dullness and were judged unacceptable by the panelists.

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Discussion

A comment was made that samples to which no starch had been added had better gel strength, while samples with starches had lower gel strength but demonstrated reduced drip losses. A question was raised as to whether there was a balance between saving on the drip loss and loss of gel strength due to addition of starch. Mrs Yamprayoon said that the starch increases the hardness of the fish balls and that this was reflected in an increase in the gel strength by rheometer measurement. However, the panelists were able to judge the difference between springiness and hardness caused by the starch.

On the comment that commercial processors in Thailand are already producing frozen fish balls and when asked what type of starch was used in the industry and why tapioca flour was chosen for the study, Mrs Yamprayoon answered that only one processor is producing frozen fish ball in Thailand and that the type of flour used was not known; hence the need for this study. Tapioca flour is cheap and is available locally, and so was chosen for the study.

In response to a question on colour differences between frozen and thawed fish balls, it was stated that both samples had the same colour.

Optimum Processing Conditions And Shelf-life Of Smoked Striped Catfish(*Pangasius sutchi*)

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Abstract

Striped catfish (*Pangasius sutchi*) is a fatty fish which possesses a specific non-palatable flavour. Processing of this species into value-added smoked product so as to improve flavour and odour was therefore studied. The appropriate conditions for brining and dry curing were studied using 15, 20 and 26% brine for 10, 20 and 30 min, and salt to fish ratios of 1:3, 1:5 and 1:7 for 20, 30 and 40 min, respectively. Sample with the highest acceptability scores ($P \leq 0.05$) of each curing method was selected for further study on appropriate conditions of natural smoking using coconut hull. Smoking temperatures at 60, 70 and 80°C were studied for the smoking time of 2 and 3 hr at each temperature.

The proper conditions were found to be brining with 26% brine for 10 min, then smoking at 60°C for 3 hr or dry salting with salt to fish ratio of 1:7 for 20 min and smoking at 60°C for 2 hr.

Introduction

Smoked fish is a popular traditional product in Thailand, where it is known as *pla krob*. In general, it is made from freshwater fish such as butter catfish, sheat fish or minnow. *Pla krob* is crisp-dried to make it preservable at ambient temperature, whereas the Western style of hot-smoking fish produces a soft product with high moisture content, eg smoked salmon. Many species of freshwater and marine fish in Thailand have the potential to be used as raw material for hot smoking.

Striped catfish was one of the economical freshwater species suggested by the Department of Fisheries. In 1985, the total harvest of freshwater fish in Thailand was 75,254 mt of which 13,786 mt (18.3%) was striped catfish (Department of Fisheries, 1987). Because the supply for fresh consumption is much higher than the demand, the price of striped catfish is low. For this reason, it is necessary to process striped catfish in order to produce a ready-cooked item, such as smoked product, and thus add value to the raw material. Striped catfish is a fatty fish which possesses non-palatable flavour but it has bright yellow colour and soft flesh that should be suitable for hot smoking to improve its flavour and odour.

The objective of this study is to find the proper conditions for natural smoking of striped catfish with coconut hull.

Materials And Methods

Raw Material

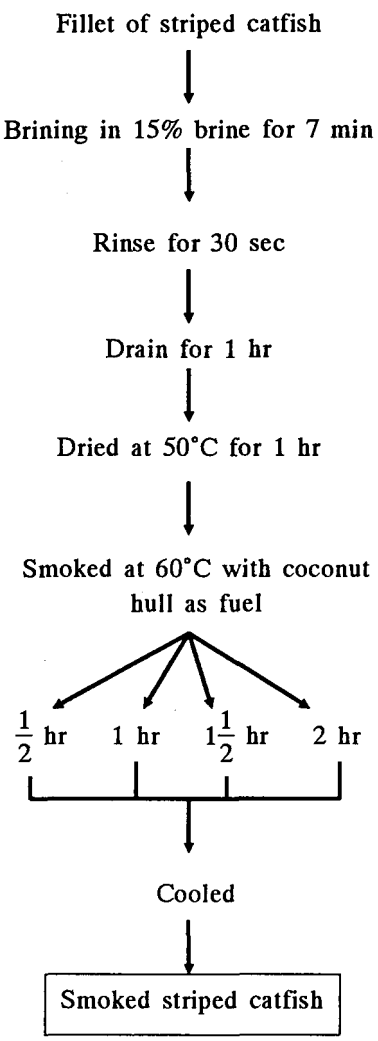
Striped catfish (*Pangasius sutchi*)

Methods

1. Quality Standard Of Acceptable Smoked Striped Catfish

At the present time, there is no quality standard for smoked fish; thus it is necessary to set up the acceptable quality to be used in further studies.

The preparation of smoked striped catfish was as follows:



Sensory evaluation of product was carried out by a panel of 12 persons familiar with the product. The panel judged the raw product for colour and appearance, and the cooked product for flavour, saltiness, texture and overall acceptability using a 9-point hedonic scale. The smoked fillet was trimmed to 1.6 cm^2 (0.5 in^2), skinned and microwave cooked for 1 min before serving to the judges. The result was statistically analyzed using completely randomized design (CRD). The moisture content was also determined (AOAC, 1980).

2. Preparation And Quality Analysis Of Raw Material

Striped catfish was sampled for quality analysis,ie freshness, K-value (Uchiyama, 1978), proximate composition (AOAC, 1980).

3. Appropriate Conditions Of Salting And Smoking

Two salting methods were used, wet and dry salting. The brine concentrations, ratio of fish to salt and salting time were varied to get a product with at least 3% water phase salt (WPS) which is enough in inhibit the germination and toxin production of *Clostridium botulinum* type E while the flavour of the product is still acceptable (Christiansen *et al*, 1968).

3.1. Proper Salting Condition

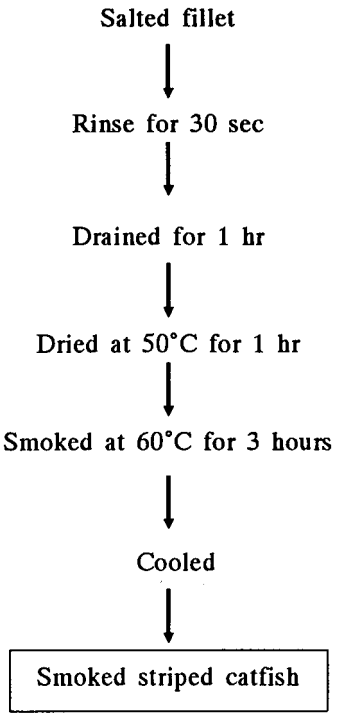
Striped catfish was headed, gutted, washed and filleted. Fat was trimmed off. The fillet was divided into 2 parts and salted as follows.

3.1.1. Brine Salting

The fish was soaked in brine at a fish to brine ratio of 1:1 (wt/wt). The brine concentrations were 15, 20 and 26%. The soaking times were 10, 20 and 30 min for each concentration.

3.1.2. Dry Salting.

The second stage consisted of dry salting with salt-to-fish ratio of 1:3, 1:5 and 1:7 (wt/wt) for 20, 30 and 40 min for each ratio. Both salted fillet from *3.1.1 and 3.1.2* were smoked as follows:



Smoked striped catfish were analyzed for WPS, using the following formula :

$$\text{WPS (\%)} = \frac{\text{\% NaCl}}{\text{\% NaCl + \% Moisture content}} \times 100$$

(Weckel and Wosje, 1966; Mill, n.d.). Moisture contents and sensory evaluation for colour, appearance, saltiness, flavour, texture and overall acceptability were also recorded.

The results were statistically analyzed by Symmetric Factorial Experiment 3 x 3 and Duncan's New Multiple Range Test.

3.2. Appropriate Conditions For Smoking

From *3.1.* we selected the best salting conditions. Smoking was carried out in a Torry Kiln using coconut hull as fuel. The temperatures studied were 60, 70 and 80°C for 2 and 3 hr.

Results

Acceptability Of Smoked Striped Catfish

See Table 1.

Preparation And Analysis Of Quality Of Raw Materials

The striped catfish used was very fresh with clear eyes, red gill, bright skin, fresh odour and elastic texture. Weight of the fillet ranged from 180 - 200 g, thickness ranged from 1.6 - 1.8 cm. The colour of the flesh was yellowish orange with layer of fat (Table 2).

3.2.1. Appropriate Conditions Of Salting

3.2.1.1. Wet Salting

It was found that brine concentration and salting time have no effect on colour and texture but that they significantly affected appearance ($P \leq 0.05$) and that there was interaction effect between brine concentration and salting time on saltiness, flavour and overall acceptability ($P \leq 0.01$) (Tables 3 and 4).

Statistical analysis of the average of WPS and moisture content showed that brine concentration and salting time had significant effects on WPS and moisture content respectively (Table 5).

Appropriate Condition Of Dry Salting

It appeared that fish : salt ratios and salting time had no effect on colour, appearance and texture of smoked product but significantly affect flavour ($P \leq 0.01$). Both salting time and fish to salt ratios had interacting effects on saltiness and overall acceptability (Table 6).

Statistical analysis of WPS and moisture content showed that fish : salt ratio and salting time had significant effects on WPS and moisture content.

Table 1. Sensory evaluation score and moisture content of smoked striped catfish at 60°C for 30, 60, 90 and 120 min.

Smoking Time (min)	Moisture Content (%)	Average Sensory Score ± SD			
		Colour[1]	Appearance[1]	Texture[1]	Overall[1] Acceptability
30	76.62 ± 0.75	3.00 ± 0.93	2.88 ± 0.83	3.50 ± 0.53	3.38 ± 0.52
60	74.62 ± 1.07	3.63 ± 1.41	4.00 ± 0.93	4.63 ± 0.92	4.25 ± 0.71
90	72.83 ± 0.60	4.75 ± 1.16	4.50 ± 1.07	5.25 ± 0.46	4.50 ± 0.53
120	71.28 ± 0.48	7.50 ± 0.53	7.88 ± 0.83	7.63 ± 0.74	7.75 ± 0.46

[1] Significantly different (P≤0.05)

Table 2. Proximate composition and freshness index of raw striped catfish.

	Average value[1] ± S.D.
K-value (%)	10.77 ± 1.61
Protein (%)	16.89 ± 0.79
Fat (%)	2.23 ± 0.47
Moisture content (%)	79.22 ± 1.05
Ash (%)	1.35 ± 0.05

[1] Average of 4 determinations.

Appropriate Smoking Condition

Appropriate Smoking Condition Of Striped Catfish Prepared By Wet Salting At 26% Brine For 10 Min

It appeared that smoking time did not affect all characters tested but smoking temperature significantly affected saltiness and texture (Table 9). Both smoking time and temperature had interacting effects on colour, appearance and overall acceptability (Table 10).

Statistical analysis of WPS and moisture content showed that smoking temperature and time had interacting effects on WPS and moisture content respectively.

Appropriate Smoking Condition Of Striped Catfish Dry Salting At Salt : Fish Ratio Of 1:7 For 20 Min

It appeared that smoking time had no effect on sensory evaluation scores but that smoking temperature affected colour, appearance, flavour, texture and overall acceptability of the product (P≤0.01). There was no interacting effect of smoking time and temperature on sensory score.

Statistical analysis of WPS and moisture content showed that smoking temperature affected WPS but that smoking time had no effect (P≤0.05). Interaction of smoking temperature and time significantly affected moisture content (P≤0.01).

Discussion

Quality Standard Quality Standard Of Acceptable Smoked Striped Catfish

Smoked striped catfish was prepared according to the procedure of the Fishery Technological Development Division. The smoked product was tested for colour, appearance, texture and overall acceptability as well as moisture content. As Table 1 indicates, the product smoked for two hours with a moisture content of 71.28% was the most preferred sample. Samples with moisture content between 76.62 - 72.83 % had a lower acceptability score (P≤0.05). The most acceptable product was

Table 3. Sensory evaluation score of smoked striped catfish prepared at different brine concentration and salting times of 10, 20 and 30 min.

Brine Concentration (%)	Average Values ± S.D.								
	Saltiness			Flavour			Overall Acceptability		
	10min	20min	30min	10min	20min	30min	10min	20min	30min
	aA	aA	aA	aA	aA	aA	aA	aA	aA
15	7.33±0.75	7.42±0.95	7.50±0.76	7.50±0.76	7.33±0.85	7.08±0.64	7.17±0.69	7.33±0.75	7.25±0.60
	aA	bA	cB	aA	aA	aB	aB	aA	bB
20	7.67±0.85	7.17±0.80	4.67±1.03	7.58±0.86	7.50±0.96	5.25±0.83	7.67±0.75	7.50±0.96	4.67±0.75
	aA	bB	cC	aA	bB	cC	aB	bB	cC
26	7.75±0.72	4.92±1.62	3.33±1.03	7.67±0.85	5.92±0.64	4.00±1.15	7.87±0.55	5.25±0.72	3.17±0.80

a,b,c values in the same line followed by different letter are significantly different ($P \leq 0.05$)

A,B,C values in the same columnn followed by different letter are significantly different ($P \leq 0.05$)

Table 4. Sensory evaluation score of appearance of striped catfish prepared at different brine concentration and salting time.

Brine concentration (%)	Average score ± S.D.
15	8.03^{a} ± 0.25
20	7.81^{ab} ± 0.13
26	7.72^{b} ± 0.05

a,b values followed by different letter in column are significantly different (P≤0.05).

Table 6. Sensory evaluation score of smoked striped catfish prepared at different ratio of fish : salt and salting time.

Salting time (min)	Average ± S.D.
20	7.83^{a} ± 0.09
30	6.53^{b} ± 0.50
40	6.31^{b} ± 0.13

a,b values followed by different letter are significantly different (P≤0.05).

Table 5. WPS and moisture content of smoked striped catfish prepared at different brine concentration and salting times of 10, 20 and 30 min.

Brine concentration (%)	Average ± SD					
	WPS (%)			Moisture Content (%)		
	10min	20min	30min	10min	20min	30min
	aA	bA	cA	aA	aA	bA
15	1.96±0.03	2.53±0.18	2.84±0.07	69.50±0.28	69.70±0.13	68.51±0.13
	aB	bB	cB	aA	aA	bB
20	2.21±0.13	2.85±0.09	3.85±0.09	69.37±0.34	69.18±0.14	67.23±0.23
	aC	bC	cC	aA	aB	bB
26	3.39±0.13	4.02±0.13	5.26±0.13	69.30±0.20	69.02±0.11	67.04±0.22

a,b,c values in the same line followed by different letter are significantly different (P≤0.05).

A,B,C values in the same column followed by different letter are significantly different (P≤0.05).

Table 7. Sensory evaluation score of saltiness and overall acceptability prepared at different fish : salt ratios and salting times of 20, 30 and 40 min.

Salt : Fish ratio	Average ± SD					
	Saltiness			Overall Acceptability		
	20min	30min	40min	20min	30min	40min
	aA	bA	bA	aA	bA	bA
1:3	7.33±0.94	3.75±1.23	3.26±1.14	7.75±0.43	3.75±0.92	3.33±1.03
	aA	bA	bB	aA	bB	bB
1:5	7.50±0.96	4.25±0.72	4.25±1.01	7.83±0.69	4.92±0.76	4.42±1.04
	aA	bB	cB	aA	bC	bC
1:7	7.67±0.75	6.58±0.95	5.00±0.82	8.00±0.71	6.67±1.05	6.00±0.71

a,b,c values in the same line followed by different letter are significantly different ($P \leq 0.05$).

A,B,C values in the same column followed by different letter are significantly different ($P \leq 0.05$).

Table 8. WPS and moisture content of smoked striped catfish prepared at different fish : salt ratios and salting times of 20, 30 and 40 min.

Salt : Fish Ratio	Average ± SD					
	WPS (%)			Moisture content (%)		
	20min	30min	40min	20min	30min	40min
	aA	bA	bA	aA	bA	cA
1:3	3.78±0.23	5.00±0.12	5.17±0.07	68.66±0.26	66.79±0.30	67.36±1.10
	aA	bB	cB	aB	aB	bB
1:5	3.72±0.30	4.25±0.15	4.79±0.12	68.28±0.08	68.45±0.01	66.99±0.24
	aA	bC	cB	aB	bC	aC
1:7	3.62±0.03	3.89±0.04	4.62±0.02	68.13±0.14	69.47±0.04	68.37±0.03

a,b,c values in the same line followed by different letter are significantly different ($P \leq 0.05$).

A,B,C values in the same column followed by different letter are significantly different ($P \leq 0.05$).

Table 9. Sensory evaluation score of saltiness, flavour and texture of smoked striped catfish prepared by wet salting and smoked at different smoking time and temperature.

Smoking Temperature (°C)	Average ± SD		
	Saltiness	Flavour	Texture
60	$7.92^{a} \pm 0.12$	$8.09^{a} \pm 0.12$	$8.19^{a} \pm 0.33$
70	$7.50^{b} \pm 0.10$	$7.54^{b} \pm 0.06$	$7.13^{b} \pm 0.59$
80	$7.65^{ab} \pm 0.09$	$7.29^{b} \pm 0.06$	$5.94^{c} \pm 0.21$

a, b, c values in the same column followed by different letter are significantly different ($P \leq 0.05$).

Table 10. Sensory evaluation score of colour, appearance and overall acceptability of smoked striped catfish prepared by wet salting at different temperatures and times of 2 and 3 hr.

Smoking Temperature (°C)	Average ± SD					
	Colour		Appearance		Overall	
	2hr	3hr	2hr	3hr	2hr	3hr
	aA	bA	aA	bA	aA	bA
60	7.58±0.49	8.33±0.62	7.63±0.46	8.33±0.62	8.08±0.49	8.50±0.50
	aA	bB	aA	bB	aB	bB
70	7.67±1.03	6.21±0.75	7.42±0.64	6.17±0.80	7.46±0.63	6.67±0.94
	aB	aC	aB	aC	aC	bC
80	4.83±0.69	4.92±0.76	4.54±0.95	4.50±0.87	5.67±0.85	5.17±0.99

a,b,c values in the same line followed by different letter are significantly different ($P \leq 0.05$).

A,B,C values in the same column followed by different letter are significantly different ($P \leq 0.05$).

Table 11. WPS and moisture content of smoked striped catfish prepared by wet salting and smoked at different temperatures and times of 2 and 3 hr.

Smoking Temperature (°C)	Average ± SD			
	WPS (%)		Moisture Content (%)	
	2hr	3hr	2hr	3hr
	aA	bA	aA	bA
60	3.33±0.49	3.62±0.04	71.70±0.18	69.61±0.11
	aA	bA	aB	bB
70	3.27±0.09	3.58±0.03	69.91±0.01	68.14±0.11
	aB	aA	aC	bC
80	3.58±0.06	3.55±0.06	67.07±0.10	66.15±0.23

a,b,c values in the same line followed by different letter are significantly different (P≤0.05).

A,B,C values in the same column followed by different letter are significantly different (P≤0.05).

Table 12. Sensory evaluation score of colour, appearance, flavour, texture and overall acceptability of smoked striped catfish prepared by dry salting and smoked at different temperature and time.

Smoking Temperature (°C)	Average ± SD				
	Colour	Appearance	Flavour	Texture	Overall Acceptability
60	7.75^{a} ± 0.47	7.83^{a} ± 0.35	7.87^{a} ± 0.23	8.08^{a} ± 0.42	7.83^{a} ± 0.42
70	6.25^{b} ± 0.24	5.96^{b} ± 0.06	7.52^{b} ± 0.03	6.58^{b} ± 0.06	6.62^{b} ± 0.12
80	5.50^{c} ± 0.00	5.12^{c} ± 0.06	7.44^{b} ± 0.03	5.91^{c} ± 0.12	6.21^{c} ± 0.06

a, b, c values in the same column followed by different letter are significantly different (P ≤0.05).

Table 13. WPS of smoked striped catfish prepared by dry salting and smoked at different smoking times and temperatures.

Smoking Temperature (°C)	WPS (%) ± S.D.
60	3.54^{a} ± 0.03
70	3.13^{b} ± 0.13
80	3.49^{a} ± 0.17

a, b values followed by different letter are significantly different (P≤0.05).

yellowish-brown or golden-brown, smooth and soft in glossy texture. Other samples with higher moisture content had lighter colour and soggy texture. It could be concluded that the product smoked for two hours was the most acceptable. It was similar to smoked chubs with 61.19 - 72.65% moisture content (Graham, Hamilton and Pierson, 1986). Thus, moisture content around 71% or lower was selected as a standard for using in further studies.

Preparation And Quality Analysis Of Raw Material

The striped catfish used in the experiment was alive so its K-value was very low (10.77%). In general, fish with K-value lower than 20% was judged very fresh and can be eaten raw since its protein were not denatured (Uchiyama, 1978).

The proximate composition showed that striped catfish had more than 2% fat content (Cole and Greenwood-Barton, 1965). This fish with inter-muscular fat is suitable for smoking because the finished product will have soft texture.

Appropriate Conditions Of Salting And Smoking

Appropriate Salting Condition

1. Wet Salting

The appropriate brine concentration and brining time were 26% for 10 min, respectively with WPS higher than 3% required for inhibition of toxin production of *Clostridium botulinum* (Christiansen *et al*, 1968). As seen in Table 4, the highest appearance score (8.03) was obtained at 15% brine,

Table 14. Moisture content of smoked striped catfish prepared by salting and smoked at different temperatures and times of 2 and 3 hr.

Smoking Temperature (°C)	Average Moisture Content ± S.D.	
	2hr	3hr
60	70.26^{aA} ± 0.03	69.50^{bA} ± 0.06
70	69.19^{aB} ± 0.03	67.28^{bB} ± 0.13
80	68.54^{aC} ± 0.01	65.48^{bc} ± 0.01

a,b,c values in the same line followed by different letter are significantly different (P≤0.05).

A,B,C values in the same column followed by different letter are significantly different (P≤0.05).

but at 15% brine salting time had no effect on saltiness (Table 3). At 20 and 26% brine concentration, the fish salted for 20 and 30 min had a lower saltiness score than the fish salted for 10 min ($P \leq 0.05$). Thus 10 min was selected as an appropriate salting time. Brine concentration, together with brining time, affected the moisture content of the finished product. At a higher salt content the moisture content tended to be lower. This may be due to the fact that high salt denatured protein and decreased the water-holding capacity of the muscle protein (Dell Valle and Ganzalez Inigo, 1968).

2. Dry Salting

From Table 7 we see that salting time between 20 and 30 min and ratio of salt : fish affected saltiness of the product significantly. The smoked product salted for 20 min, had the highest acceptable score for flavour and WPS was also higher than 3%. Fish : salt ratios had shown antagonism effects with salting time on moisture content of the product.

At a salt to fish ratio of 1:3, moisture content was decreased, when salted for 20-30 min - more than that of the sample salted at salt : fish ratio of 1:5, and salted for 40 min.

At salt : fish ratio of 1 : 7 moisture content was slightly changed. Moisture content of samples salted at salt : fish ratio of 1 : 5 and 1 : 7 were not significantly different and were lower than the set standard of 71%.

From sensory evaluation scores, WPS and moisture content, dry salting at a salt fish ratio of 1:7 for 20 min was selected as the best condition. Shorter processing time is required because it will provide a better control of contamination (Ragulin, 1985).

Appropriate Smoking Condition

1. Fish Prepared By Wet Salting At 26% Brine For 10 Min.

It appeared that smoking at 60°C yielded a product with higher sensory score for saltiness, flavour, and texture than those smoked at 70 and 80°C. Smoking at 80°C yielded a product which was too dry, probably due to the denaturation of skinned fillet by heating and moisture loss (Suryanarayama Rao and Khabada, 1968; Deng, Toledo and Lillard, 1974).

Smoking time at 80°C had no effect on colour and appearance but both had sensory scores lower than 5, which was the borderline, and could have been due to the melting of intramuscular fat between skin and flesh and denaturation of the tissue which connect skin and muscle protein (Suzuki, 1981). High temperature will catalyse the Maillard reaction at the skin of the product which will darken the colour of the product (Ruiter, 1979). Statistical analysis of WPS and moisture content (Table 11) showed that at 70°C for 2 hr and 60°C for 3 hr the latter had higher WPS with 69.61% moisture content which was acceptable. This sample also had highest sensory evaluation score. Thus smoking at 60°C for 3 hr was selected.

2. Appropriate Smoking Condition Of The Fish Prepared By Dry Salting With Salt : Fish Ratio Of 1:7 For 20 Min.

Smoking time had no effect on all sensory evaluation scores, but smoking temperature did affect the sensory scores. Smoking at 60°C for 2 hr appeared to produce the highest score for acceptable samples which also have acceptable WPS and moisture content.

Thus smoking at 60°C for 2 hr was selected for striped catfish dry-salting at salt to fish ratio of 1:7 for 20 min.

Conclusion

1. Acceptable smoked striped catfish should have not more than 71% moisture content, 3-4% WPS.
2. The appropriate conditions of natural smoking using coconut hull were:
   - 2.1 Wet salting at 26% brine for 10 min and smoking at 60°C for 3 hr.
   - 2.2 Dry salting at salt to fish ratio of 1:7 for 20 min and smoking at 60°C for 2 hr.

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Discussion

Since smoked fish is a semi-dried product and susceptible to mould growth, a particpant asked why analysis for mould was not included in the study. Miss Kiatkungwalkrai said this has not been a storage study but one aimed at developing a processing technique. In any case, the product has about 69% moisture and must be kept chilled.

Clarifying the price breakdown in producing this product, Miss Kiatkungwankrai replied that fresh catfish costs ฿ 8-10/kg, while the yield was of the final product is 26%. This works out to be between ฿ 30 to ฿ 40/kg cost price.

Asked whether there was any commercial production of smoked striped catfish in Thailand, she replied that there is no commercial production at the moment. On the subject of product quality, she noted that while traditional smoked products from other kinds of catfish were dry and quite hard, this new type of product is moist and soft.

Regarding the storage life of the product, she replied under 5-7°C, two months storage was possible. If kept frozen, the period was six months.

Utilization Of Low Value Fish In The Development Of Convenience Foods

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Abstract

Formulation studies on different fishery products like fish noodles, fishballs and fish sausage were conducted to develop, from low market value marine species and excess catch, convenience foods that are protein-rich, palatable and acceptable. These products will generate technology into home-based industries for the fishermen's family.

The study shows that consumer-type fish products can be developed from mixtures of fishes of low commercial value.

Results of chemical, microbial, sensory, costs and return analysis and storage stability of the processed products are presented.

Introduction

Optimum utilization of low-value fish catch to reduce wastage is needed to maximize financial returns to fishermen. Low and non-commercial value fish species which are normally discarded can command higher market value if transformed into raw materials for further processing.

With the introduction of mechanical deboning machines, low-value fishes can be processed rapidly by removing flesh from the bones, thus producing minced fish meat. The common non-commercial species of fish are as follows :

English Name	Scientific Name	Local Name
Ribbon-finned nemipterid	*Nemipterus tolu*	*Bisugo*
Common lizard fish	*Saurida tumbil*	*Kalaso*
Common whiting	*Sillago* sp.	*Asohos*
Yellow-stripped goatfish	*Upeneus* sp.	*Saramuleyete*
Common slipmouth	*Leiognathus* sp.	*Sapsap*
Indian anchovy	*Stolephorus indicus*	*Tuakang*
Hairtail	*Trichurius* sp.	*Balila*
Flying fish	*Capselorius* sp.	*Bolador*
Indian flat head	*Athernia* sp.	*Sunog*
Big-eyed scad	*Selar crumenopthelmus*	*Matambaka*
Fimbriated herring	*Sardinella fimbriata*	*Tunsoy*
Moonfish	*Mene maculata*	*Chabita*

Note: This paper was presented at the Seminar by Ms Borja.

Minced fish meat is the raw material for the production of surimi, which is subsequently used in the development of surimi-based products.

There is potential market for convenience food and other new products from fish. So, as its name implies, convenience items meet the demands of a busy lifestyle and changing consumer demands. They can also augment the income of fishermen's families when the technology is applied in home-based industries.

It is hoped that the development of these convenience foods and other fishery products will contribute to the advancement of the fish processing industry, boost the fishing industry, increase food supply and expand the market.

The objectives of this study are to :

- Formulate new products as convenience foods from low-value fish.
- Standardize and to test their general acceptability.
- Study the shelf-life of the finished products.
- Look into the costing and feasibility of developing home-based industries from the generated technologies.

Literature Review

In the Philippines, there are many species of fish categorized as non-commercial, with low market value. These are utilized as fish meal or processed into fish sauce or fish paste.

During the sixties, intensive efforts were made to develop and introduce powdered fish products with a very high protein content, and suitable for mass feeding to the malnourished population of the developing world. In the early seventies, technologists paid relatively little attention to the problem of producing protein concentrates. In recent years, however, there has been a renewed interest related to the growing desire to improve the utilization of marine resources.

Steinberg (1974), stated that one of the primary concerns of fishery product technology is to make the maximum use of our stocks of fish consistent with maintenance of the resources.

There are many species of fish that could provide high quality protein but are underutilized for various reasons. These include small-sized fish and fish with dark meat, high fat content, strong flavour, high bone content, unacceptable properties and other factors. Inspite of these disadvantages, utilization of such fish would be desirable, because fish protein is well balanced in essential amino acid composition and easily digestible.

Low and non-commercial value fish species which are normally discarded can command higher prices if transformed into raw materials for processing. It is estimated that around 60% of the available resources are harvested. One possibility for the fish industry is to increase the production of minced fish. Mince fish is the raw material for surimi production which subsequently can be used in the formulation of products due to its unique texture forming properties. The under-utilized fish protein resources can be tapped and high quality protein snack foods can be developed whereby original identity and functional shortcomings of these fish can be masked. Gonzales (1981) found that acceptable sausages and cakes can be prepared from groupages. Studies conducted on the development of fish product from commercial fish species like caesio, surgeon fish, and skipjack showed that such convenience items are highly acceptable as substitutes for meat products (Guevara, *et al*, 1978).

Jacobs (1944) defines noodle products as the "class of product prepared from dough containing one or more semolina, drum flour, farina flour, and not less than 5.5% of the solid of egg yolk, or with or without one or more onions, celery, garlic, bayleaf, and salt."

Local noodles or "mike" are made from hard wheat flour, water and salt mixed to form a very stiff dough, sheeted and then cut into ribbons or strips approximately 0.20 to 0.25cm in cross section. These are then cooked by boiling and named as "mike" or "mami".

Gibbs, Agcaoli & Shilling (1912) gave the following procedures for making mike : the dough is made in the saline water to which a small quan-

tity of alkaline is added principally for the purpose of making the product yellow.

Fish balls in the Philippines are a favourite convenience food and are sold in public places like markets, parks, and the like where they are fried in deep fat. In the past few years, there has been a shortage of raw materials for fishball making. As a result, utilization of low-valued fish was emphasized, especially in the development of convenience items. Improvement in quality of the fish and the product was undertaken through generated technology. New processing methods (MFRD, 1987) were studied and recommended to private entrepreneurs.

One development in the recovery and utilization of fish flesh for human foods has been the invention of the meat and bone separator which has enabled, at relatively little cost, up to 10% extra flesh from fish frames (King, 1972).

An important objective of this research therefore, particularly along the line of producing convenience foods, is to maximize the utilization of low-value fish. To quote Steinberg (1974), " it is unwise not to use a renewable resource if its use can contribute to the satisfaction of human needs".

Materials And Methods

Raw Material

Samples used were juvenile and adult fish of different species of good quality and low value. The length of fish ranged from 3 to 9 cm. The fish were purchased from Malabon fishlanding and transported in ice to the laboratory.

Methods

The experiment was divided into four parts, as follows:

1. Sensory evaluation and quality assessment of raw material.
2. Preparation of minced fish.
3. Product formulation.
4. Effect of storage temperatures on the shelf-life of minced fish products.

1. Sensory evaluation and quality assessment of raw material.

Upon arrival at the laboratory, the fish were washed, sized and sampled at random for quality analysis.

1.1 *Degree of freshness*

Sensory evaluation were performed by well trained panelists of seven using a 9-point Hedonic test to determine the quality of the raw material. When the quality was found to be acceptable the raw materials were then accepted for the investigation, and the following tests are further conducted:

- Total volatile bases (TVB) and Trimethlyamine (TMA) were determined using micro-diffusion method
- Thiobarbituric acid (TBA) determination
- pH determination
- Proximate chemical composition (AOAC, 1975)

2. Preparation of minced fish

The fish were cleaned, gutted and washed in ice water and passed through the meat and bone separator using a 3 mm perforation drum. The resulting minced meat was treated by washing it twice with four times its volume of ice water and 0.2% and 0.3% of salt respectively. When the meat has settled, water was removed, drained and pressed. These were used for formulation of convenience items such as fish noodles, fish balls and fish sausage (Fig. 1).

3. Product formulation

Formulation of different convenience food items was undertaken using traditional methods of cooking. These consisted of mixing the mince with flour, egg, spices, salt and pepper and shaping it into balls, sausages and noodles.

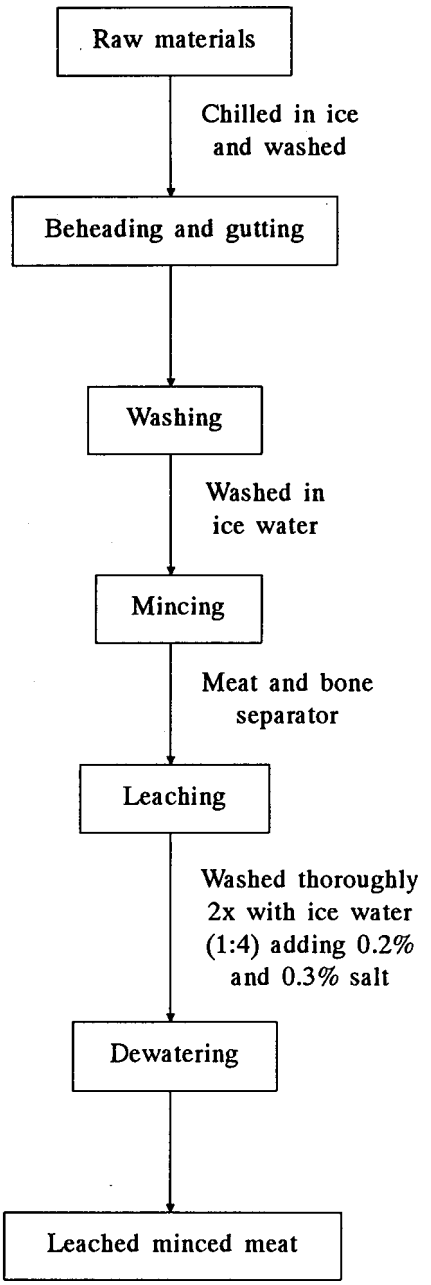

Fig. 1. Preparation of minced meat.

4. Effect of storage temperatures on the shelf-life of minced fish noodles, fishballs, and fish sausages.

Minced fish were divided into three parts : One part was utilized for fish noodles, one part for fishball and the other part for fish sausage. Fish noodles were kept at room temperature only. Both fishballs and fish sausages were stored at ambient, chilling and freezing temperatures. These food items were randomly sampled before storage and after one week of storage for sensory evaluation using a 9-point Hedonic scale, chemical analysis as described in the AOAC (1975), and microbiological examination using American Public Health Procedure for total plate count and mould count.

Results And Discussion

Freshness Evaluation Of Raw Material

Several species of fish sampled at random were evaluated for their physical appearance. The criteria were brightness of colour, brightness of eyes, redness of gills, fresh seaweedy smell, adherent scales and clean viscera.

Chemical parameters

Samples were evaluated for their freshness and proximate composition. Degree of freshness were measured using total volatile base (TVB), trimethylamine (TMA), thiobarbituric acid (TBA) and pH determination. Analyses of proximate composition (total protein, fat, ash and moisture) were carried out as described in the AOAC (1975). All samples were analyzed in duplicate as shown in Table 1.

Chemical analyses made for freshness test showed values for TVB, TMA and TBA to be within specified limit for fresh marine species. Hence, the fish samples used in the experiment were fresh and of good quality. The proximate composition showed significantly high protein content for fish samples.

Table 1. Quality assessment on the fish sample.

Quality Tests	Sample I	Sample II	Average analysis %
pH	6.3	6.7	6.5
Protein	16.4	15.5	16.0
Moisture	77.0	76.9	77.0
Fat	1.6	1.6	1.6
Ash	1.3	1.4	1.3
TVB (mg N/100g)	9.3	9.5	9.4
TMA (mg N/100g)	4.6	4.4	4.5
TBA (mg malonaldehyde/kg)	1.6	1.7	1.6

Preparation Of Minced Fish

The yield of mince obtained from headed and gutted was around 35% - 50%, probably because of small size and bony structure of some fish specie used. The mince fish contained an average moisture of 77.0%, 16.0% total protein, 1.5% fat, and 1.35% ash and is classified as low oil - high protein (Stansbyl, 1961).

Product Formulation

Fish noodles

The preparation of fish noodles is described in Fig. 2. The egg noodle preparation is similar to fish noodle except that minced fish is not incorporated in the formulation. In Table 2, the percentage of ingredients for both products are given.

Fish balls

The production of fishball is described in Fig. 3. In fishball processing two formulations were made, the first formulation consisted of minced fish from various species and the second formulation utilizing *Caesio* sp. Both samples were kept at 3 storage temperatures : ambient temperature (28° ± 2°C), chilling temperature (10° ± 2°C) and freezing temperature (-5° ± 2°C). Table 3 shows the percentage of ingredients in the preparation of fishball using minced fish and *Caesio* sp.

Table 2. Formulation used in the preparation of fish noodle and egg noodle.

Ingredients	Fish Noodle (%)	Egg Noodle (%)
Minced Fish	37.0	-
Flour	57.5	76.0
Egg	-	8.0
Lye	1.0	1.0
Salt	3.0	3.0
Water	1.5	12.0

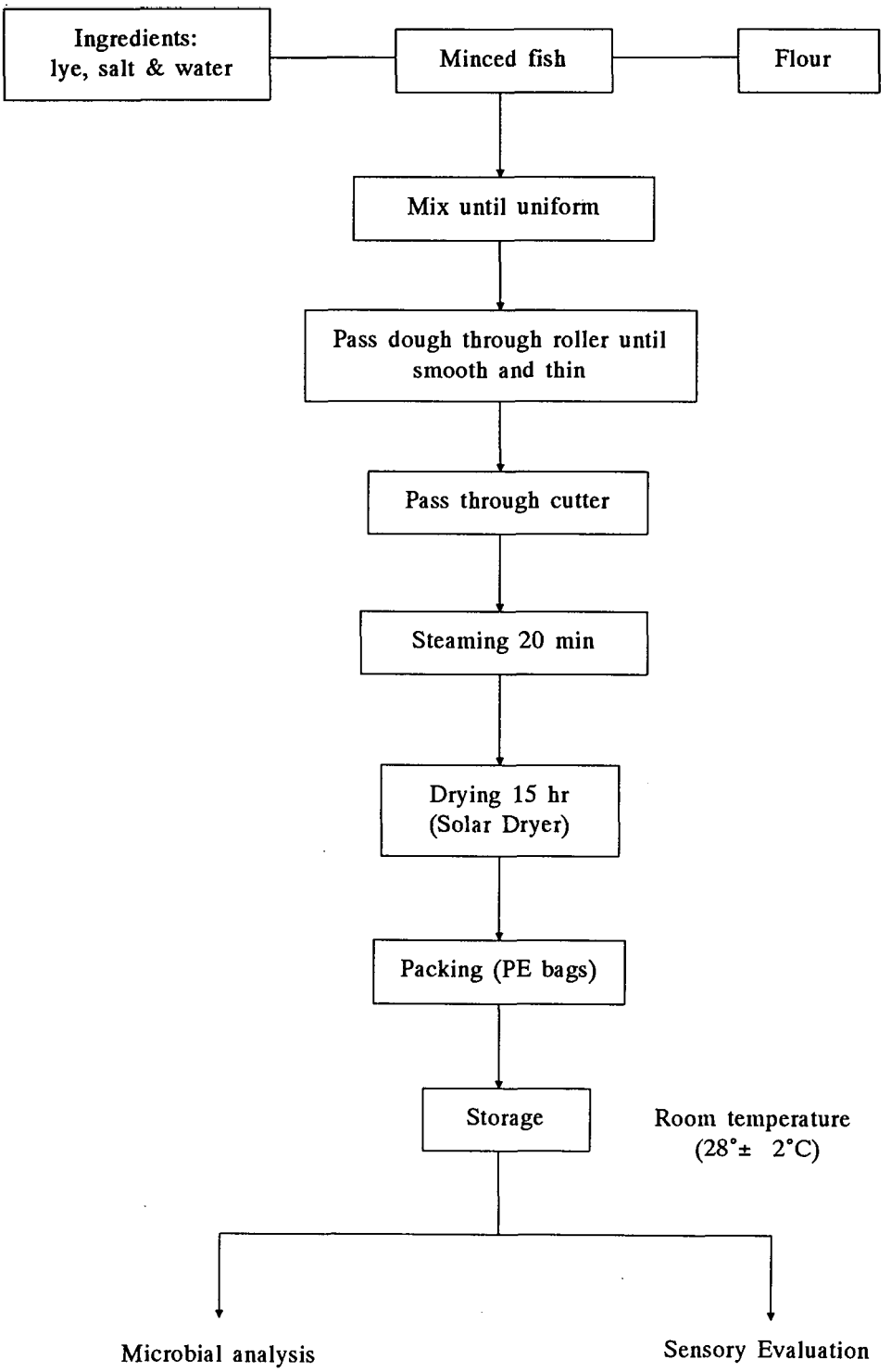

Fig. 2. Fish noodle preparation.

Table 3. Formulation in the production of fishball using mixed fish and *Caesio* sp.

Ingredients	Mixed fish (%)	*Caesio* sp. (%)
Fish meat	94.0	94.0
Cornstarch	3.0	3.0
Baking powder	1.0	1.0
Salt	2.0	2.0
MSG	0.5	0.5

Fish sausages

The fish sausage preparation was formulated using the standardized recipe of the Post Harvest Technology Division of BFAR (Fig. 4). The raw materials used were blue-lined surgeon fish (*Acabthurus blekerii*) and mixed fish using different species. The only difference in the production of fish sausage using the blue-lined surgeon is the scraping of the meat to separate it from skin and bones of the fish. Table 4 shows two formulations of fish sausage.

Effect Of Storage Temperature On The Shelf-life Of Minced Fish Noodles, Fishballs, And Fish Sausage

Fish noodles and dried egg noodles

a) Proximate composition

The proximate analysis of fish noodle and egg noodle are presented in Table 5.

The results obtained showed that the protein content of fish noodle has a mean value of 13.6%.

Table 4. Formulation in the production of fish sausage using mixed fish and surgeon fish.

Ingredients	Mixed Fish (%)	Surgeon Fish (%)
Fish meat	80.0	80.0
Salt	2.4	2.4
Pork fat	2.2	2.2
Cornstarch	9.0	9.0
MSG	0.1	0.1
Brown sugar	1.6	1.6
White pepper	0.3	0.3
Onion powder	0.1	0.1
Garlic powder	0.1	0.1
Allspice	0.1	0.1
Nutmeg	0.1	0.1
Food colouring	4.0	4.0

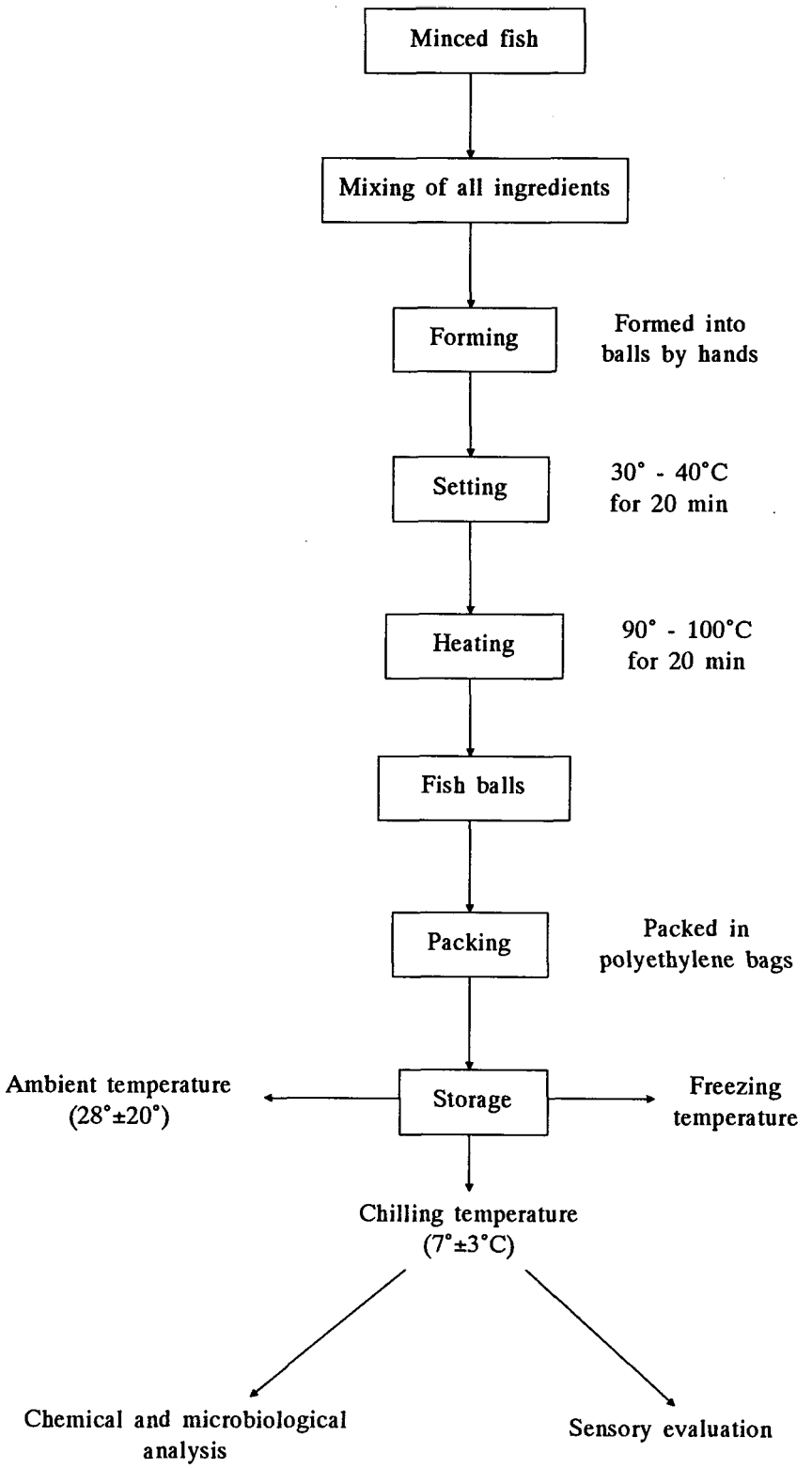

Fig. 3. Fish ball production.

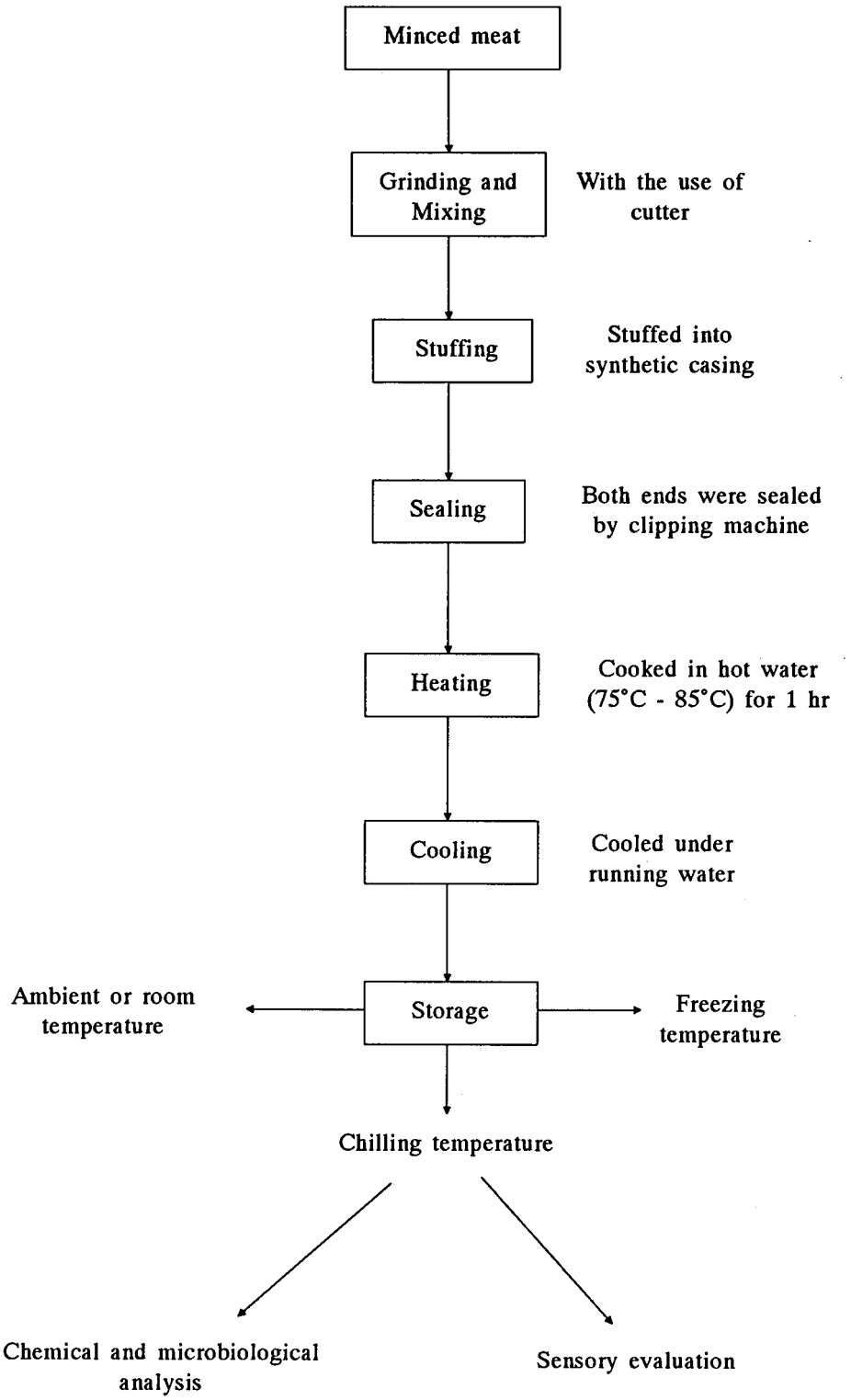

Fig. 4. Preparation of fish sausage from mixed fish.

Table 5. Composition of dried fish noodle and dried egg noodle.

Samples	Composition			
	% Protein	% Moisture	% Ash	% NaCl
Dried fish noodle	13.6	6.9	2.6	1.7
Dried egg noodle	11.8	6.1	2.7	2.4

Fish protein also has a superior biological value compared to egg noodle, since fish protein contains essential amino acids such as lysine and methionine.

The moisture content obtained after 15 hours solar drying for fish noodle is 6.9% whereas egg noodle is 6.1%.

b) Sensory evaluation

Table 6 shows the changes in sensory quality on a Hedonic scale during 0 to 28 days of storage at ambient temperature. Overall acceptability of both samples showed no significant difference. However, after the 56th day of storage, a slight deterioration of quality occurred, with general scores of acceptability of 5.7 for fish noodle and 5.9 for egg noodle. At this stage, appearance of moulds in both samples of noodles were observed. Furthermore, there was a change in the colour of the noodle from yellow to brown. Therefore both samples of noodles were rejected by the panelists on day-56.

c) Microbiological analysis

Total bacterial count (TBC) changes during storage period is shown in Table 7. Total bacterial count fluctuated and tended to increase during storage. The average log bacterial count for fish noodle was 3.36 while egg noodle was 2.62. Moulds were absent in both samples from 0 to 28th day of storage. However, mould growth was observed on the 56th day of storage.

Table 6. General acceptability scores of dried fish noodle and dried egg noodle stored at ambient temperature (28° ± 2°C).

Storage (days)	Flavour		Texture		Colour		Odour		General Acceptability	
	A*	B**	A	B	A	B	A	B	A	B
0	7.5	7.6	7.0	7.1	7.4	7.5	7.2	7.4	7.2	7.4
7	7.0	7.2	6.8	7.0	6.9	7.1	6.9	7.1	6.9	7.1
14	6.9	7.1	6.6	6.8	6.6	6.8	6.7	6.9	6.7	6.9
21	7.0	7.2	6.8	6.9	6.9	7.1	6.9	7.0	6.9	7.0
28	6.6	7.0	6.5	6.6	6.7	6.9	6.6	6.9	6.6	6.8
56	-	-	6.3	6.4	5.5	5.7	5.5	5.7	5.7	5.9

A* - Dried Fish Noodle

B** - Dried Egg Noodle

Table 7. Microbial analysis of dried fish noodle and egg noodle during storage.

Storage (Days)	Dried Egg Noodle		Dried Fish Noodle	
	log TBC	Mould Growth	log TBC	Mould Growth
0	2.25	Negative	3.60	Negative
7	2.30	Negative	3.49	Negative
14	3.38	Negative	3.25	Negative
21	2.17	Negative	2.62	Negative
28	2.17	Negative	2.39	Negative
56	3.47	2.18	4.80	1.40
84	Spoiled	Terminated	Spoiled	Terminated

Mixed fish and caesio fishball

a) Proximate chemical analysis

Results of proximate analysis are given in Table 8 below. The values obtained from the analysis showed no significant difference between the samples on the initial sampling in terms of moisture, protein, fat and ash content. However, during prolonged storage at chilling and freezing temperatures, moisture content decreased. This is attributed to the dehydration process that proceeded rapidly during storage at freezing temperatures. Protein content of fishball slightly increased up to the end of storage as a consequence.

b) Sensory evaluation

The general acceptability scores showed preference of panelists in relation to both samples of fishballs. Table 9 shows that mixed fishball has a general acceptability of 7.5 and caesio fishball rated 7.6 on the initial sampling which corresponds between "like very much" and "like moderately". There is an insignificant difference between both samples in all sensory attributes like colour, odour, taste, and texture evaluated.

Table 8. Quality changes of mixed fish and caesio fishball.

Quality Factor	Initial		Final					
			Mixed Fishball			Caesio Fishball		
	Mixed Fishball	Caesio Fishball	Ambient	Chilling	Freezing	Ambient	Chilling	Freezing
%Protein	12.1	13.7	13.5	14.0	14.5	13.8	14.0	14.4
%Fat	1.1	0.7	0.8	0.8	1.5	0.8	0.9	1.2
%Ash	1.9	3.2	2.0	2.3	2.1	2.3	2.4	2.0
%Moisture	77.6	82.2	75.0	73.4	68.8	75.2	73.8	70.1

Table 9. General acceptability scores of mixed fish and caesio fishball stored at various conditions.

Storage Period (days)	Storage condition					
	Ambient		Chilling		Freezing	
	C*	D**	C	D	C	D
0	7.5	7.6	7.5	7.6	7.5	7.6
1	6.9	7.1	7.3	7.4	7.3	7.4
2	6.4	6.6	7.2	7.2	7.0	7.1
3	SPOILED		6.5	6.9	7.2	7.2
5			6.4	6.8	6.9	6.9
7			6.3	6.4	7.2	6.8
9			SPOILED		6.7	6.9
11					6.5	6.6
84					5.6	5.7

* C - mixed fishball

**D - caesio fishball

However, during storage at chilling temperature, the flavour or taste scores were rejected by the panelist on day-9 while the other sensory properties including appearance, odour, and texture were still acceptable. On the other hand, fishballs stored at freezing temperature was rejected by the panelist on the 84th day which correspond to a rating of 5.6 for mixed and 5.7 for caesio. Both samples had tough texture and bland flavour.

c) Microbiological analysis

It was found that freezing slowed down the growth of microorganism. Table 10 shows samples kept at freezing temperature (-5°±2°C) have very good stability and its shelf-life is longer (up to 84 days) than that of samples stored at chilling and ambient temperatures. Fishball stored at chilling temperature showed the first visual sign of spoilage by the presence of typical fruity odour on the 9th day of storage, whereas samples stored at ambient temperature (28°±2°C) showed formation of slime on the surface after 2 days of storage.

Fish sausage

a) Proximate chemical analysis

Proximate analysis for fish sausage and blueline surgeon fish sausage is presented in Table 11. From the results obtained both samples showed an insignificant difference on its chemical component. However, this comparison shows that protein content in both samples tend to increase slightly during storage. After the 56th day of storage there were significant changes in the moisture and protein component of the samples stored at chilling and freezing temperatures. This was probably caused by dehydration of the samples during prolonged storage.

Table 10. Log bacterial count of mixed fish and caesio fishball stored at various conditions.

Storage Period (days)	Storage condition					
	Ambient		Chilling		Freezing	
	E*	F**	E	F	E	F
0	3.55	3.62	3.55	3.62	3.55	3.62
1	3.90	4.11	3.50	3.55	3.50	3.41
2	4.05	4.95	3.40	3.20	3.40	3.38
3	SPOILED		3.25	3.54	3.25	3.30
5			4.09	4.11	2.80	2.60
7			4.41	4.39	2.60	2.54
9			SPOILED		2.50	2.97
11					2.45	2.62
84					1.09	1.20

* E - mixed fishball

**F - caesio fishball

Table 11. Quality changes of mixed fish and surgeon fish sausages.

Quality Factor	Initial		Final					
	Mixed Sausage	Surgeon Sausage	Mixed sausage			Surgeon Sausage		
			Ambient	Chilling	Freezing	Ambient	Chilling	Freezing
%Protein	10.1	10.5	10.1	10.9	11.8	10.5	10.6	11.2
%Fat	2.7	1.4	2.7	2.7	3.0	2.7	2.8	2.9
%Ash	1.5	2.4	1.5	1.6	2.0	2.4	2.6	2.7
%Moisture	77.6	75.6	76.8	76.3	70.8	74.9	72.9	68.5

b) Sensory evaluation

The resulting products were found to change in sensory quality during prolonged storage as shown in Table 12. At the initial stage of sensory evaluation, mixed fish and blue-lined surgeon fish sausage, exhibited ratings of 6.9 and 7.0 respectively. Other sensory attributes such as odour, taste and texture yielded a very close result and showed no significant difference. However, at ambient temperature, both samples were unacceptable after one day of storage. Likewise, both samples were sensorily not well acceptable as microbial spoilage became evident on the ninth day of storage at chilling temperature. The samples stored at freezing temperature remained stable up to 56th day of storage and were rated on the "borderline of acceptability".

c) Microbiological analysis

Table 13 shows that the storage temperature had an effect on the total bacterial count (TBC) and sensory scores. Fish sausage kept at ambient temperature (28°±2°C) showed rapid deterioration after 1 day of storage. In contrast there was hardly any increase in TBC from 0 day to 5th day of storage in the other treatments. On the other hand, fish sausage kept at freezing temperature (-5°±2°C) showed a decreasing trend on the total bacterial load. There was a decrease in number up to the 84th day of storage.

Cost Of Production

Appendices A, B and C show the cost analysis of home-based operations for producing mince meat, fish noodle and fish balls.

Table 12. General acceptability scores of mixed fish and surgeon fish sausage stored at various conditions.

Storage Period (days)	Storage condition					
	Ambient		Chilling		Freezing	
	G*	H**	G	H	G	H
0	6.9	7.0	6.9	7.0	6.9	7.0
1	5.6	7.0	6.5	6.8	6.8	7.0
2	SPOILED		6.5	6.7	6.7	6.9
3			6.7	6.2	6.5	6.8
5			5.9	6.0	6.1	6.8
7			5.8	6.0	6.2	6.0
9			SPOILED		6.4	6.5
28					6.0	6.3
56					5.5	5.7
84					5.4	5.5

* G - mixed fish sausage

**H - surgeon fish sausage

Table 13. Log bacterial count of mixed fish and surgeon fish sausage stored at various conditions.

Storage Period (days)	Storage condition					
	Ambient		Chilling		Freezing	
	G*	H**	G	H	G	H
0	4.11	4.80	4.11	4.80	4.11	4.80
1	4.93	5.00	4.30	4.50	3.35	3.38
2	5.93	5.80	3.26	3.20	2.90	2.80
3	SPOILED		3.14	3.10	2.81	2.60
5			2.64	3.90	2.68	2.50
7			3.78	4.00	2.79	2.40
9			SPOILED		2.60	2.20
11					2.39	2.15
84					1.21	1.20

* G - mixed fish sausage

**H - surgeon fish sausage

Conclusion

The minced fish used in this study possess good characteristics for commercial purposes because of good sensory quality and acceptability, shelf-life and storage stability.

Judging from the overall acceptability score, frozen storage (-5°±2°C) could extend the shelf-life of fish balls and fish sausages up to 84 days and 56 days respectively, whereas at chilling temperature (10°±2°C) mixed fish balls and fish sausages can be stored up to seven days. However, both products can be kept only at ambient temperature up to one or two days. Likewise, fish noodles can be kept at ambient temperature (28°±2°C) and are generally acceptable up to 56 days.

Appendix A

COST AND RETURN ANALYSIS FOR A MONTHLY OPERATION OF A HOME-BASED MINCED FISH INDUSTRY

CAPACITY : 90 kg of minced fish

I. FIXED ₱31,391.00

A. Equipment	Qty (unit)	Life Service (years)	Estimated cost (₱)
Basin	3	5	105.00
Colander	1	5	50.00
Knife	2	5	90.00
Chopping board	4	5	100.00
Pail	2	5	70.00
Weighing scale	1	5	250.00
Aluminium tray	2	5	110.00
Teaspoon	6	5	15.00
Refrigerator	1	10	10,000.00
Deboning machine	1	20	20,601.00

II. VARIABLE COST (per day)

A.	Raw materials	3,208.00
	300 kg "trash" fish at ₱ 10.00/kg	3,000.00
	20 bags ice cubes at ₱ 6.05/bag	120.00
	400 plastic bags at ₱ 22.00/100 pcs	88.00
B.	Labour	409.00
	1 Supervisor	180.00
	1 Skilled labourer	89.00
	2 Unskilled labourer	140.00
C.	Manufacturing overhead	582.33
	Light, water, etc	200.00
	Transportation	200.00
	Depreciation	182.33
	TOTAL DAILY WORKING CAPITAL	₱ 4,199.33

III. TOTAL MONTHLY COST AND SALES REVENUE

A.	Sales revenue (GS)			₱90,000.00
	a.	Daily production of minced fish	300 kg	
	b.	Total yield (30%); 90 kgs (20 days/month)	1800 kg	
	c.	Sales at ₱50.00/kg pack		
B.	Production cost (TPC)			₱85,666.33
	a.	Raw materials		64,160.00
	b.	Labour		8,180.00
	c.	Manufacturing overhead		11,646.60
	d.	Contingencies (2% of a, b & c)		1,679.73
C.	Profit before tax			
	Total sales revenue			₱90,000.00
	Total monthly production cost			85,666.33
	Income (GS-TPC)			4,333.67
D.	Return per peso invested (Income ÷ TPC)			₱0.05

Appendix B

COST AND RETURN ANALYSIS FOR A MONTHLY OPERATION OF A HOME-BASED FISH NOODLE INDUSTRY

CAPACITY : 110 kg of fish noodle

I. FIXED ₱2,220.00

A. Equipment	Qty (unit)	Life Service (years)	Estimated cost (₱)
Noodle machine	1	10	690.00
Knife	2	5	90.00
Mixing bowl	2	5	100.00
Tray	2	5	100.00
Strainer	1	5	25.00
Measuring cup	1	5	35.00
Measuring spoon	1	5	20.00
Rolling pin	3	5	60.00
Weighing scale	1	5	350.00
Steamer	1	5	750.00

II. VARIABLE COST (per day)

A.	Raw materials	₱2,791.20
	40 kg minced fish at ₱50.00/kg	2,000.00
	64 kg flour	768.00
	1 kg salt	5.20
	3 bottles lye	18.00
B.	Labour	320.00
	1 Supervisor	180.00
	2 Unskilled labourer	140.00
C.	Manufacturing overhead	280.67
	Light, water, etc	150.00
	Transportation	100.00
	Depreciation	30.67
	TOTAL DAILY WORKING CAPITAL	₱3,391.87

III. TOTAL MONTHLY COST AND SALES REVENUE

A.	Sales revenue (GS)			₱77,000.00
	a.	Daily production of fish noodle	110 kg	
	b.	Total yield (110 kg x 20)	2,200 kg	
	c.	Sales at ₱35.00/kg		
B.	Production cost (TPC)			₱69,194.15
	a.	Raw materials		55,824.00
	b.	Labour		6,400.00
	c.	Manufacturing overhead		5,613.40
	d.	Contingencies (2% of a, b & c)		1,356.75
C.	Profit before tax			
	Total sales revenue			₱77,000.00
	Total monthly production cost			69,194.15
	Income (GS-TPC)			7,805.85
D.	Return per peso invested (Income ÷ TPC)			₱0.11

Appendix C

COST AND RETURN ANALYSIS FOR A MONTHLY OPERATION OF A HOME-BASED FISH BALL INDUSTRY

CAPACITY : 22,000 pieces of fishball

I.	FIXED				₱17,775.00
	A. Equipment		Qty (unit)	Life Service (years)	Estimated cost (₱)
		Mixing bowl	1	5	135.00
		Casserole	2	5	120.00
		Colander	2	5	100.00
		Measuring cup	1	5	35.00
		Measuring spoon	1	5	20.00
		Weighing scale	1	5	350.00
		Teaspoon	6	5	15.00
		Freezer	1	10	17,000.00
II.	VARIABLE COST (per day)				
	A.	Raw material at ₱50/kg			₱4,822.20
		90 kg minced fish at ₱50.00/kg			4,500.00
		6 kg cornstarch			75.00
		2 kg baking powder			171.00
		6 kg salt			31.20
		Plastic bags			45.00
	B.	Labour			320.00
		1 Supervisor			180.00
		2 Unskilled labourers			140.00
	C.	Manufacturing overhead			404.59
		Light, water, etc			150.00
		Transportation			100.00
		Depreciation			154.59
	TOTAL DAILY WORKING CAPITAL				₱5,546.79

III. TOTAL MONTHLY COST AND SALES REVENUE

A.	Sales Revenue (GS)			₱ 158,400.00
	a.	Daily production	22,000 pcs	
	b.	Total yield		
		880 packs (25pcs/pk) x 20 days	17,600 packs	
	c.	Sales at ₱ 9.00/pk		
B.	Production Cost (TPC)			₱ 113,154.52
	a.	Raw materials		96,444.00
	b.	Labor		6,400.00
	c.	Manufacturing overhead		8,091.80
	d.	Contingencies (2% of a, b & c)		2,218.72
C.	Profit Before Tax			
	Total sales revenue			₱ 158,400.00
	Total monthly production cost			113,154.52
	Income (GS-TPC)			45,245.48
D.	Profit Per Peso Invested (Income ÷ TPC)			₱ 0.40

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Discussion

The meeting noted that 12 different species of fish were listed in the paper, and Miss Borja was asked whether in the study, species composition variations were taken into consideration. Miss Borja said that there was no control of the species composition and that the actual composition was random.

It was noted that most of the research work on surimi and fish jelly products were based on physical parameters, and that there were no reports on the biological evaluation of surimi products, such as digestibility of these gels. Researchers were therefore encouraged to consider working this aspect.

In making fish sausage products, careful temperature control is necessary to eliminate the possibility of *Clostridium botulinum* growth. The present processing technique is inadequate to remove this danger and a participant commented that it may be premature to introduce this technique to small-scale producers.

Liquid Smoking Of Some Fishery Products

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Abstract

Natural and liquid smoking of striped catfish (*Pangasius sutchi*), chub mackerel (*Rastrelliger brachysonus*), squid (*Loligo edulis*) and green mussel (*Mytilus viridis*) were compared to evaluate the feasibility of liquid smoking of these products.

The appropriate brine concentration and brining time as well as liquid smoke concentration and soaking time for each product were determined. The acceptability of these smoked products was tested by sensory evaluation using a nine-point hedonic scale. The characteristics of the products judged were colour, flavour, odour, texture and overall acceptability. A panel of 14 judges was drawn from the faculty members and students of the Department of Fishery Products, Faculty of Fisheries. The results were statistically analyzed using Student's t-test.

The appropriate brine concentration and brining time for striped catfish, chub mackerel, squid and green mussel were 15% for 7 min; 20% for 30 min; 15% for 10 min and 5% for 4 min, respectively.

The suitable liquid smoke concentration and soaking time for striped catfish and chub mackerel were 10% for 15 min; for squid and green mussel the appropriate concentration and soaking time were 6% for 15 min and 1% for 2 min respectively.

The sensory evaluation scores of both natural and liquid smoked products were comparable. The scores for colour, flavour, odour, texture and overall acceptability of striped catfish, chub mackerel and green mussel were not significantly different. However, the score for odour of liquid smoked squid was significantly lower than that of natural smoked squid ($P \leq 0.05$) but all other characteristic scores were not significantly different.

Introduction

Smoking provides desirable colour, flavour and texture to food products but there are evidences that smoking may generate carcinogenic compounds such as polycyclic aromatic hydrocarbon (PAH). Many PAH, especially benzo(a)pyrene which is regarded as an indicator of carcinogenicity, have been found in smoked meat and fish (Sikorski, 1988). According to data compiled by Tilgner and Daun (1969), the amount of PAH in smoked products varies from 0.7-60 ng/g wet weight. The influence of smoking temperature and time on the formation of PAH was observed. Nieto and Orejana (1984) suggested a method for reducing PAH by separating the smoking chamber from the firebox. Reducing the combustion temperature, using smoke filter and controlling flow rate of inlet air will reduce 3,4 benzo(a)pyrene in smoked fish (Chandrasekhar and Kaveriappa, 1985). Studies have shown that PAH are removed in the particulate phase of smoke. Analyses of several liquid smoke preparation have shown that they do not contain PAH especially benzo(a)pyrene (Kramlich, Pearson and Tauber,1973). It was also reported that liquid smoke still retained antioxidant and bacteriostatic properties (Hollenbeck, 1979). The other advantages of liquid smoking are as follows:

Note: This paper was presented at the Seminar by Dr Nongnuch.

- it does not require installation of smoke generator
- the process is more repeatable as the composition of liquid smoke is more constant.

Although smoked and dried fish is very popular in Thailand, there is no report on liquid smoking of fishery products. The overall objective of this study is to study the feasibility of liquid smoking of some fishery products. The appropriate brine concentration, brining time, liquid smoke concentration and soaking time of each product are also investigated.

Materials And Methods

Materials

1. Striped catfish (*Pangasius sutchi*)
2. Chub mackerel (*Rastrelliger brachysonus*)
3. Squid (*Loligo edulis*)
4. Green mussel (*Mytilus viridis*)
5. Liquid smoke (Griffith Laboratories (Thailand) Ltd.)
6. Coconut hull for natural smoking
7. Smoking chamber
8. Hot air oven (Thelco, Model 28)

Methods

The methods used to prepare the product are as follows:

1. Striped Catfish

The fish was headed, gutted, washed, filleted and cut into pieces of about 4 x 5 cm. Fat was trimmed off as much as possible. The pieces of fish were soaked in 15% brine for 7 min, according to the suggested method of the Fishery Technological Development Division, Department of Fisheries. The ratio of fish to brine was 1 : 2 (wt/vol). The brined fish was divided into 2 parts.

One part was dried and cooked at 60°C for 1 hr, then smoked in the traditional kiln for 1 hr. The fish was turned and smoked for another half an hour. The second part was soaked in 3, 6 and 10% liquid smoke solution for 4, 7 and 15 min. The ratio of fish to liquid smoke solution was 1 : 1. The fish was drained and cooked at 60°C for 1 hr then at 80°C for another 2 hr.

The flow diagram of the preparation of smoked striped catfish is shown in Fig.1

2. Chub Mackerel

The fish was gutted, washed, soaked in 15 and 20% brine for 15 and 30 min. The ratio of fish to brine was 1:2 (wt/vol). The brined fish was divided into 2 parts. One part was dried and cooked at 60°C for 1 hr and natural smoked as for striped catfish. The second part was soaked in 6 and 10% liquid smoke solution for 10 and 15 min. The ratio of fish : liquid smoke solution was 1:1. The fish was drained and cooked for the same time and temperature as for striped catfish.

The flow diagram of the preparation method of smoked chub mackerel is shown in Fig. 2.

3. Squid

The squid was headed, gutted, skinned, washed, blanched in boiling water for 1 min and drained. The blanched squid was soaked in 10 and 15% brine for 10, 15 and 20 min. The ratio of squid to brine was 1 : 2. The brined squid was divided into 2 parts. One part was natural smoked for 1 hr. The second part was soaked in 3 and 6% liquid smoke solution for 8 and 15 min. The ratio of squid to liquid smoke solution was 1 : 1. The squid was drained and cooked at 60°C for 1 hr and at 80°C for another $1\frac{1}{2}$ hr.

4. Green Mussel

The mussel was shucked, removed byssus, washed and blanched at 80°C for 1 min. The blanched mussel was soaked in 5 and 10% brine for 2 and 4 min. The ratio of mussel to brine was 1 : 2. The brined mussel was divided into 2 parts. One part was dried and cooked at 60°C for 1 hr and smoked for 1 hr. The second part was soaked in 0.5, 1 and 5% liquid smoke solution for 2 and 4 min. The ratio of mussel to liquid smoke solution

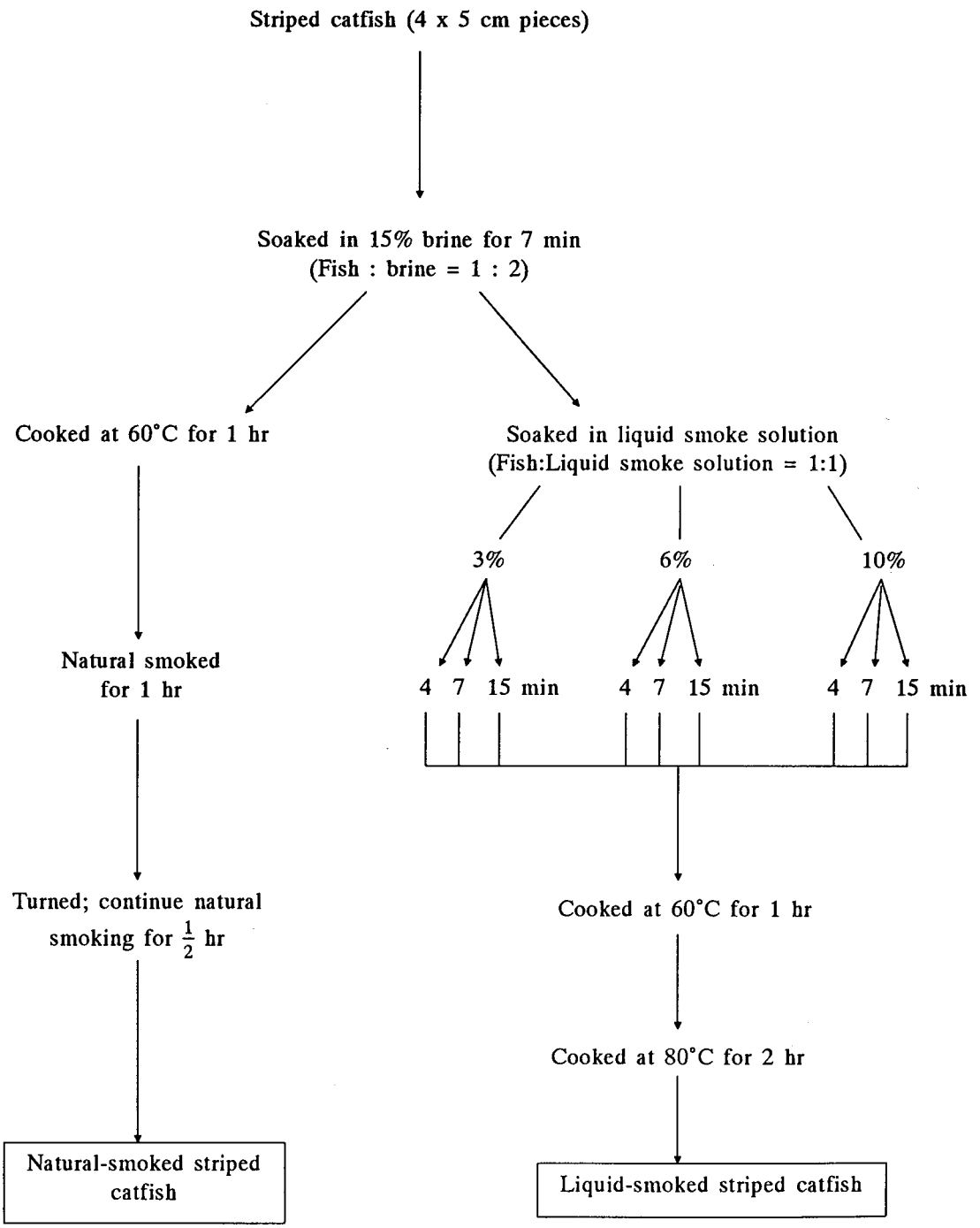

Fig. 1. Flow diagram of preparation method of smoked striped catfish.

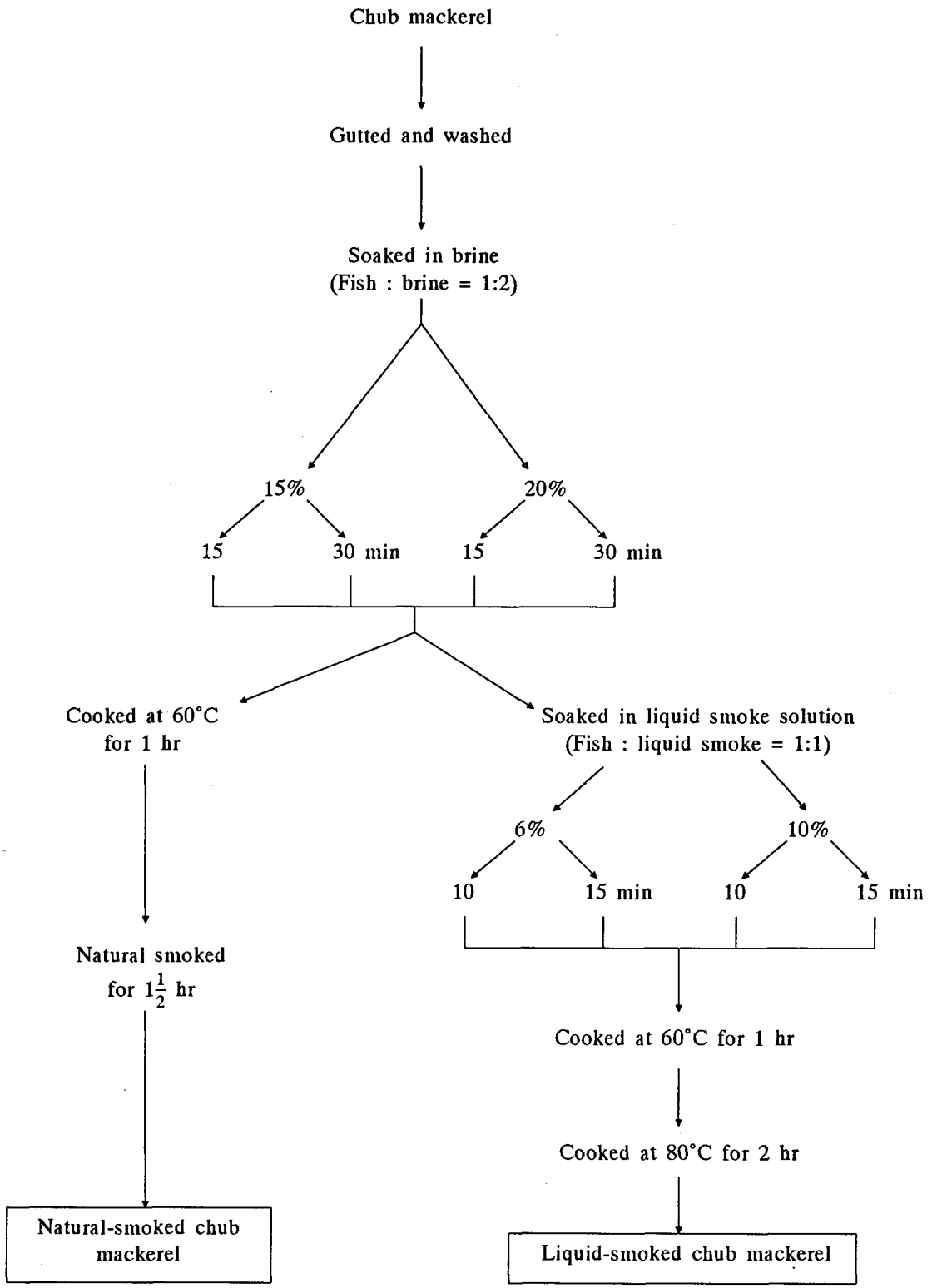

Fig. 2. Flow diagram of preparation method for smoked chub mackerel.

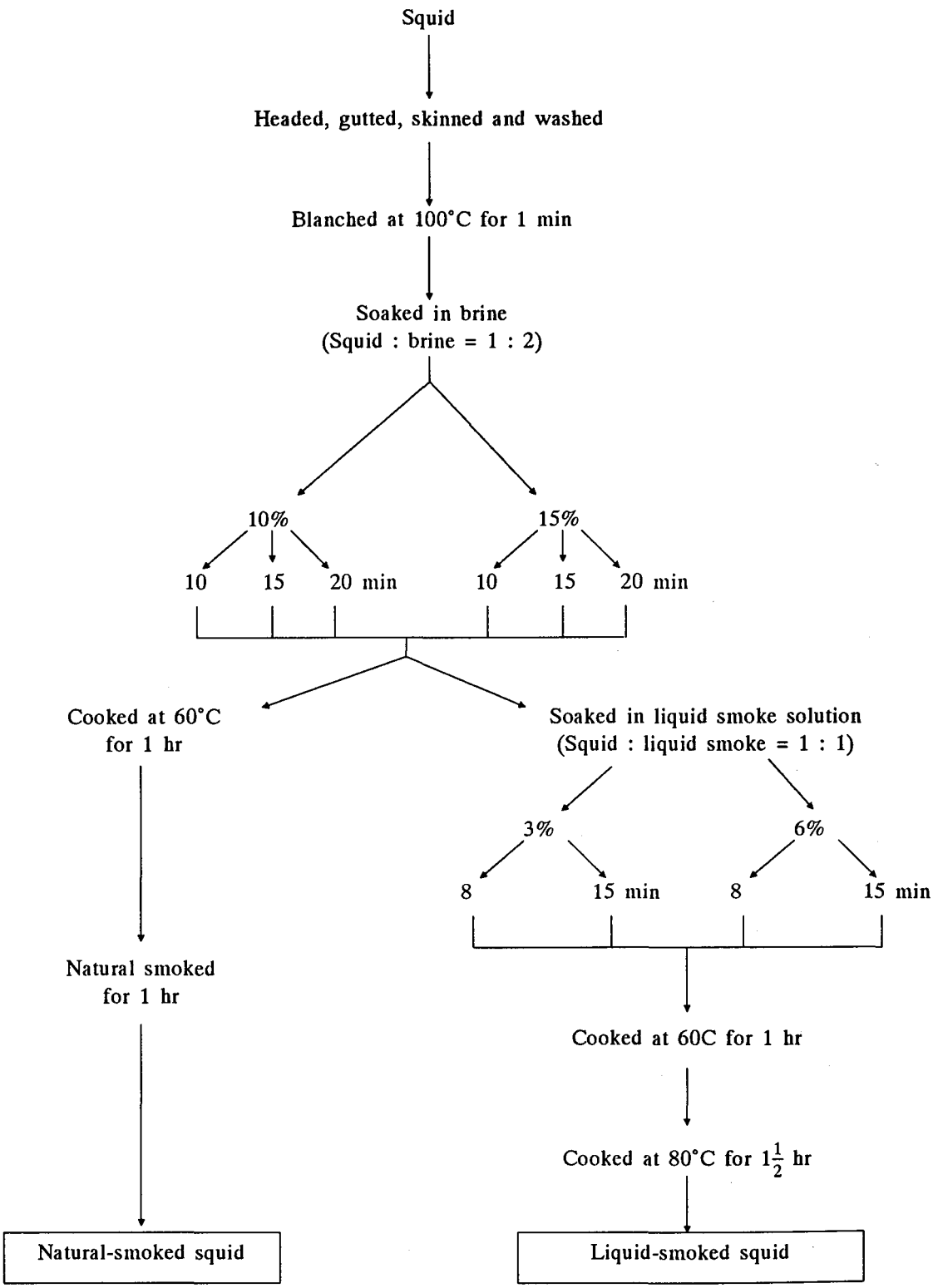

Fig. 3. Flow diagram of preparation method of smoked squid.

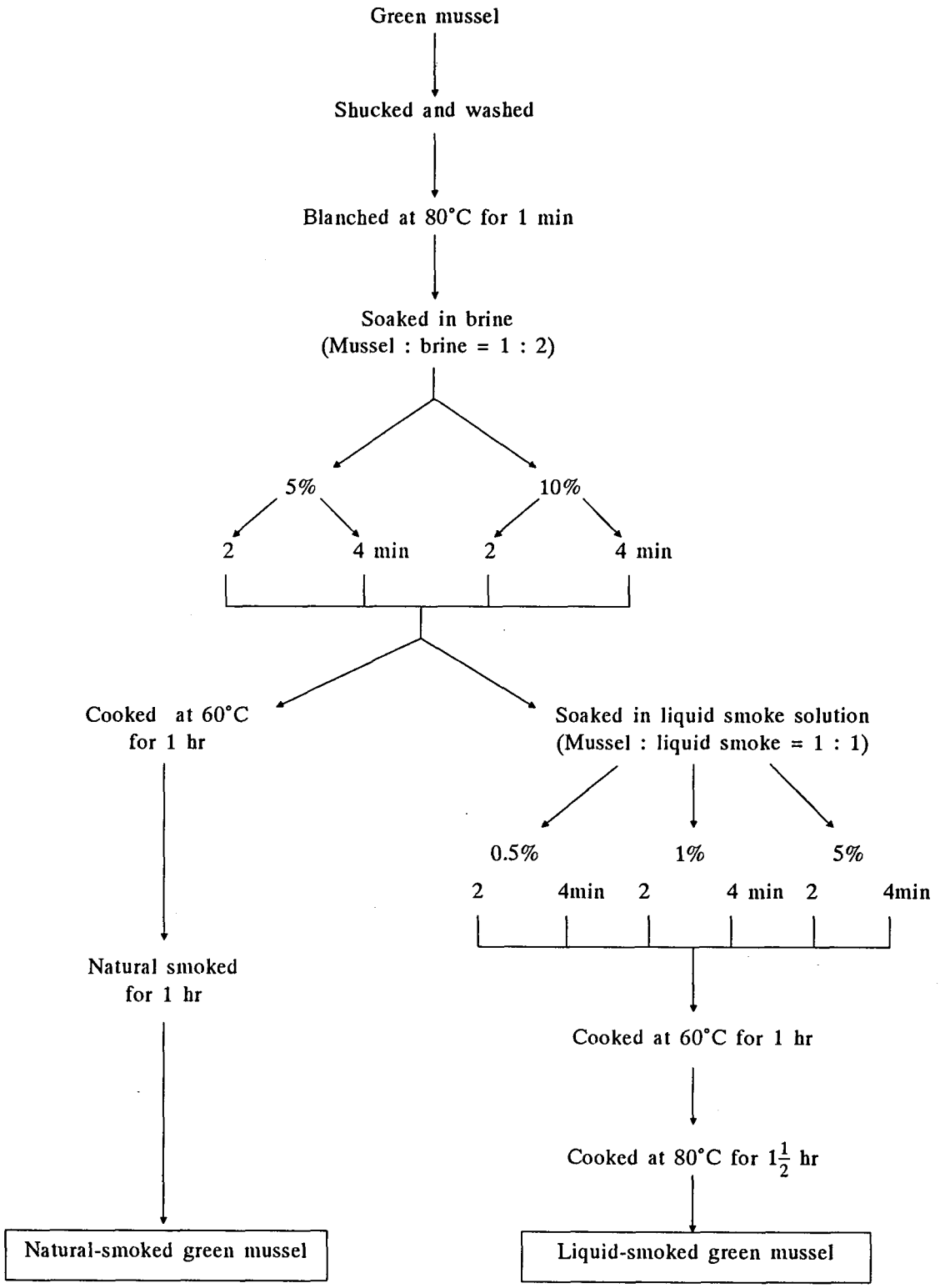

Fig. 4. Flow diagram of preparation method of smoked green mussel.

was 1 : 1 (wt/vol). The mussel was drained and cooked at 60°C for 1 hr and at 80°C for $1\frac{1}{2}$ hr.

The flow diagram of the preparation of smoked green mussel is shown in Fig. 4.

Sensory Evaluation

Natural and liquid-smoked products were evaluated for preference of colour, flavour, odour, texture and overall acceptability by a panel of 14 faculty members and students of the Department of Fishery Products, Faculty of Fisheries, using a nine point hedonic scale as described by Larmond (1977).

The results were analyzed for statistical significance using Student's t-test.

Results And Discussion

The appropriate brine concentration, brining time, liquid smoke concentration and soaking time of each product with highest preference score are summarized in Table 1.

The sensory evaluation scores of each product are summarized in Table 2.

It was found that the appropriate concentration and the soaking time of liquid-smoked striped catfish was 10% for 15 min. The product was the most similar to a natural smoked one. The lower concentration or shorter soaking time resulted in a very light colour with lower preference score. The comparison of the natural and liquid smoked products showed no significant difference ($P \leq 0.05$).

For chub mackerel, the salt penetration rate for round fish was lower, thus longer brining time was required. It was found that 20% brine for 30

Table 1. Appropriate brine concentration and brining time, liquid smoke concentration and soaking time, smoking and cooking time for each product.

Product	Brine		Liquid Smoke		Cooking Time (min)		Natural Smoking Time (min)
	Conc. (%)	Time (min)	Conc. (%)	Time (min)	60°C	80°C	
Striped catfish							
Natural smoked	15	7	-	-	60	-	90
Liquid smoked	15	7	10	15	60	120	-
Chub mackerel							
Natural smoked	20	30	-	-	60	-	90
Liquid smoked	20	30	10	15	60	120	-
Squid							
Natural smoked	15	10	-	-	60	-	60
Liquid smoked	15	10	6	15	60	90	-
Green mussel							
Natural smoked	5	4	-	-	60	-	60
Liquid smoked	5	4	1	2	60	90	-

Table 2. Sensory evaluation score of natural and smoked products.

Product	Sensory evaluation score[1]				
	Colour	Flavour	Odour	Texture	Overall Acceptability
Striped catfish					
Natural smoked	7.24	7.27	7.14	7.28	7.18
Liquid smoked	7.33	6.33	6.67	7.17	6.97
Chub mackerel					
Natural smoked	6.64	6.57	6.96	6.93	6.86
Liquid smoked	7.00	6.71	6.71	6.14	6.73
Squid					
Natural smoked	7.50	5.93	6.64a[2]	6.46	6.50
Liquid smoked	6.57	5.93	5.78b	6.43	6.14
Green mussel					
Natural smoked	6.78	6.57	6.36	6.14	6.28
Liquid smoked	6.85	6.62	6.62	6.92	6.85

[1] Hedonic scale 1 = extremely dislike, 9 = extremely like

[2] Values in the same column followed by different letter are significantly different ($P \leq 0.05$)

min was suitable. The colour of liquid-smoked striped catfish was darker than smoked chub mackerel when the same liquid smoke concentration and soaking time (10% for 15 min) were used. It appeared that liquid smoke was better bound to flesh than to skin. Statistical analysis of preference scores showed no significant difference between natural and liquid smoked chub mackerel.

Liquid smoked squid was not different from natural smoked squid in colour, flavour, texture and overall acceptability but was significantly lower in odour ($P \leq 0.05$). The appropriate brine concentration and brining time and liquid smoke concentration and soaking time were 15% for 10 min and 6% for 15 min, respectively.

The appropriate brine concentration, brining time and liquid smoke concentration and soaking time for green mussel were 5% for 4 min and 1% for 2 min, respectively. The colour of green mussel is darker than other raw materials, thus did not require high liquid smoke concentration.

Conclusion

It can be concluded that it is possible to liquid-smoke some fishery products. Apart from reduction of PAH, liquid-smoked products were reported to contain lower nitrosamine (Theiler, Sato, Aspelund and Miller, 1984). Further study should be carried out to compare the cost of production using liquid smoke and natural smoke, determine PAH and nitrosamine content in both products and to investigate shelf-life of each product at different storage temperatures.

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Discussion

Asked whether the composition of liquid smoke is known, Dr Nongnuch replied that it is a commercial product and that the composition is not known.

Bacterial Contamination Of The Blood Cockle (*Anadara granosa*)

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Abstract

The contamination of cockles by bacteria of faecal origin was monitored during harvesting, at landing sites, and finally at the retail market. The study was carried out in the three major cockle-producing states of Penang, Perak and Selangor. Cockles from the retail markets were found to be the most contaminated with an average FC-MPN/g count of 177 compared with figures of 62 for harvested cockles and 89 for 'washed'cockles. The state of Penang showed the worst contamination having an average FC-MPN/g count of 242 compared with 119 for Perak and 60 for Selangor. Data from harvesting and landing sites for Penang and Perak showed high contamination levels of FC-MPN/g counts of 318 & 153 and 41 & 118 respectively. However, data from Selangor showed corresponding average FC-MPN/g counts of 17 & 13, figures below the Singapore standard. Basically, results of this study emphasised the need to improve the post-harvest handling of cockles and to depurate them prior to marketing.

Introduction

The cockle industry is a major component of Malaysian aquaculture, contributing about 4% of the total fisheries production in 1989 (Malaysian Fisheries Statistics, 1989). However, this is a decrease from the 11% registered in 1980. In terms of volume, from a peak production of 121,269 mt in 1980, the annual production has decreased to a low of 38,530 mt in 1983 and 39,346 mt in 1989 (Malaysian Fisheries Statistics). The decline in production seems to be correlated to the deteriorating spatfalls in the natural beds over the years (Devakie, 1986). But another reason could be fear of contracting diseases such as gastro-enteritis and hepatitis A which had purportedly been linked to consumption of contaminated cockles (ASEAN Food Handling Bureau, 1984). Such fears had affected export of cockles to neighbouring countries and depressed local demand for the commodity.

The Government of Malaysia immediately retained the services of an expert on depuration of molluscs, through the ASEAN-Australia Programme. The expert helped to set up a pilot-scale depuration plant based on a stack-nesting recirculating seawater system, sterilised by ultra-violet irradiation.

Research and development studies were carried out to determine the feasability of such a system. The results and recommendations following the study have been reported elsewhere (Ismail, 1988).

While R & D were being carried out on depuration of the cockles, a national programme was launched in July 1986 to determine the status of cockle contamination at various points from harvest to washing at landing sites to retail markets. The program continued to June 1987.

Materials And Methods

Cockle Collection

Cockle samples (at least 15 per sample) were collected at weekly intervals from nine sampling stations immediately after they were harvested, eight sampling stations after washing at landing sites and 12 sampling stations from major retail

Table 1. Station codes for various states.

Station code		Station	Code type
PULAU PINANG (P)			
	P1C	Chowrasta Market	C
	P2C	Jelutong Market	C
	P3C	Bukit Mertajam Market	C
	P4A	Kuala Juru	A
	P4B	Kuala Juru	B
PERAK (A)			
	A2C	Ipoh	C
	A2C	Sungei Siput	C
	A3C	Taiping	C
	A4C	Kuala Kangsar	C
	A5A	Kuala Gula	A
	A5B	Kuala Gula	B
	A6A	Kuala Larut	A
	A7A	Bagan Panchor	A
	A7B	Bagan Panchor	B
	A8A	Sungei Kerang	A
	A8B	Sungei Kerang	B
SELANGOR (B)			
	B1C	Kelang	C
	B2C	Pelabunan Kelang	C
	B3C	Selayang, K.L.	C
	B4C	Petaling Jaya	C
	B5A	Sungei Besar	A
	B5B	Sungei Besar	B
	B6A	Kuala Selangor	A
	B6B	Kuala Selangor	B
	B7A	Sungei Burong	A
	B7B	Sungei Burong	B
	B8A	Parit Baru	A
	B8B	Parit Baru	B
	B9C	Banting	C

A = before washing, B = after washing, C = market sample,

markets in the states of Penang, Perak and Selangor, which are the major cockle producing areas (Table 1). The cockles were labelled, transported in ice-coolers and examined within six hours of harvesting at three Fisheries Department Laboratories located within each state.

Bacteriological Techniques

A modification of the ASEAN-Australia technique (Ayres, 1990) was employed. Modified minerals glutamate broth was used in a 5-tube MPN technique with direct incubation into an air oven set at 44 ± 1°C for up to 24 hours. Positive tubes for faecal coliforms were those that changed colour from purple to yellow accompanied with gas production.

Results

Freshly-harvested cockles from Penang showed the highest contamination at a mean of 318 FC-MPN/g compared with 41 and 17 FC-MPN/g for Perak and Selangor, respectively. Cockles 'washed' prior to bagging from Penang again showed the highest level of contamination at 153 compared with 118 and 13 FC-MPN/g for Perak and Selangor, respectively. The contamination at the retail market level was also highest in Penang, being 254 compared with 185 and 109 FC-MPN/g for Perak and Selangor, respectively (Table 2 and Fig. 1). However, data from Penang and Selangor showed a decreasing trend in the contamination levels of cockles which were washed after harvest, having mean FC-MPN/g counts of 153 and 13, down from 318 and 17, respectively. The corresponding FC-MPN/g count for Perak was 118, as compared with 41 for prewashed cockles.

In general, cockles from the retail markets showed the highest contamination at a mean count of 177 FC-MPN/g, followed by 'washed' cockles and 'prewashed' cockles at mean counts of 89 and 62 FC-MPN/g, respectively (Table 2 and Fig. 2).

When the combined data were analysed on a monthly basis, an increasing trend in the mean monthly count was observed for the months of November through to March for the states of Penang and Perak (but not for Selangor), which coincided with the rainy season (Fig. 2).

Table 2. Mean annual counts by station, state and national (FC-MPN/g).

PULAU PINANG		PERAK	
Pa	318 (28)	Aa	41 (139)
Pb	153 (42)	Ab	118 (156)
Pc	254 (130)	Ac	185 (169)
Pav.	242 (200)	Aav	119 (464)
SELANGOR		**NATIONAL**	
Ba	17 (93)	Na	62 (260)
Bb	13 (95)	Nb	89 (293)
Bc	109 (167)	Nc	177 (466)
Bav.	60 (355)	Nav.	122 (1019)

( ) = number of samples
a = before washing
b = after washing
c = market samples
av = average

Discussion And Conclusions

On the whole, cockles from Penang seemed to be the most contaminated, with those from Selangor being the least contaminated. However, except for washed cockles from Selangor, at a mean FC-MPN/g count of 13, the rest of the data indicated that all the samples, whether prewashed, washed or retail market, would not meet the importing standard of Singapore which sets an *Escherichia coli* MPN/g count of 20 (Cheong, 1982), not to mention the more stringent standard of Japan at an FC-MPN/g count of 2.3. The higher level of contamination as shown by the annual mean counts for washed cockles in Perak could be attributed to washing of landed cockles with contaminated seawater. This practice was observed and recorded in places like Kuala Sepetang in Perak where most of Perak cockles were landed

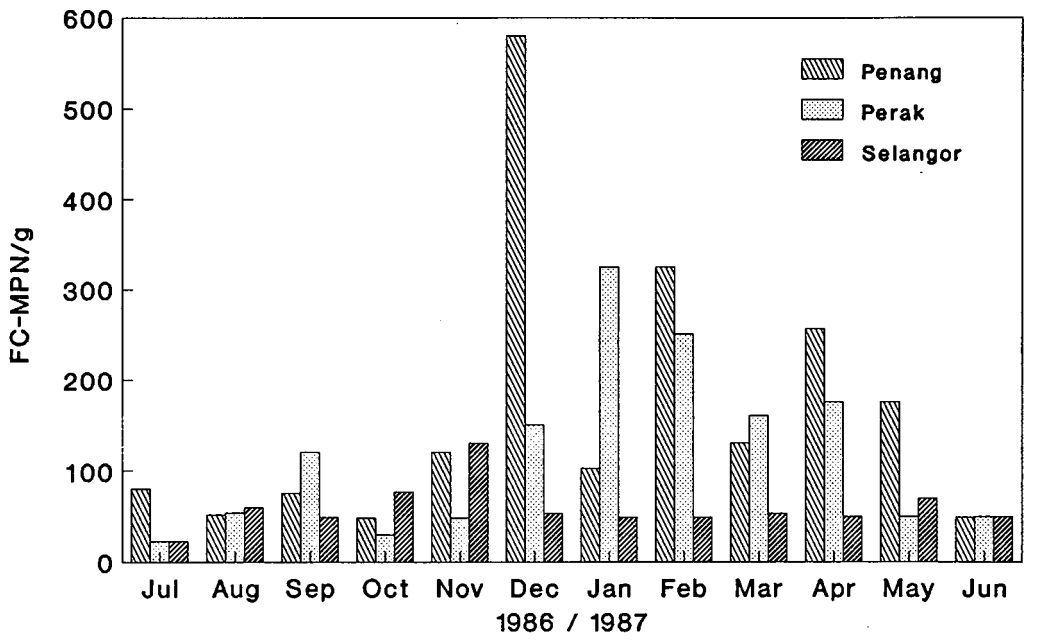

Fig. 1. Bacterial contamination profile of Malaysian cockles - mean monthly FC-MPN/g counts.

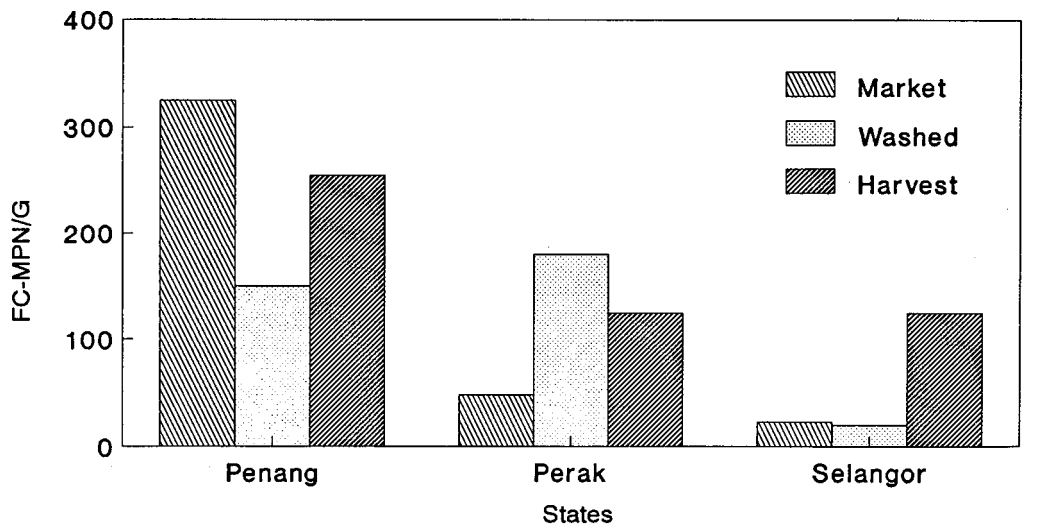

Fig. 2. Bacterial contamination profile of Malaysian cockles - mean FC-MPN/g counts by states and sources.

(see Ayres, 1986). Although this elevated contamination was not observed in Penang and Selangor, detailed analysis on the weekly data showed that there were occurrences of elevated contamination following washing of cockles. That the situation was not reflected on an annual scale might be attributed to factors such as washing possibly having been carried out during periods of high waters. Also, contamination from andropogenic sources were not to the same scale as for Kuala Sepetang. Another possible reason could be that washing was carried out at harvest sites which are commonly contamination-free (Ayres,1986) as is a common practice in Selangor.

Several explanations are possible for the proliferation of faecal coliforms at the market level. It is common for cockles to be bagged in used and sometimes uncleaned fertiliser and bonemeal bags. The cockles are also 'washed' in contaminated seawater before bagging and this might also exacerbate the problem. Proliferation could have taken place during the transportation of the cockles, due to elevated temperatures in the unrefrigerated lorries. Similar proliferation had been reported for mussels transported by lorries in Canada (Blogoslawski & Stewart, 1983).

It has to be pointed out that cockles from the retail markets in the different states did not necessarily come from culture sites from that particular state. There was and still is a considerable movement of cockles from one state to another.

Nonetheless, cockles are shown to harbour quantities of faecal organisms which might pose possible health hazards when consumed raw or semi-cooked - the traditional way of consumption amongst the local Chinese. To satisfy consumer preference, and to protect what is regarded as an important industry, it is envisaged that all cockles regardless of origin would have to be depurated before being marketed.

Acknowledgements

I would like to thank the Director of Research, Fisheries Research Institute, Department of Fisheries Malaysia, for reading the draft manuscript and making useful suggestions. I would also like to thank the Director-General of Fisheries Malaysia for allowing me to attend this seminar.

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Discussion

In reply to a query about the FC-MPN of washing water, Mr Ismail said that the faecal coliform count was very variable and appears to be influenced by the tides.

Asked whether there was a cheap way to depurate cockles, Mr Ismail replied that depuration is an expensive process and that the present depuration system has not been adopted by the industry because of the low wholesale price of cockles. The Government of Malaysia has initiated the establishment of a pilot depuration plant with a 1 mt/day capacity to further promote depuration.

Asked why faecal coliform count was high in December and January, Mr Ismail replied that no study has been conducted to determine the reason. His personal view was that the rainy season could be a factor.

Mr Bremner commented that some studies had shown that mud at the bottom of estuaries tends to absorb bacteria when the salinity is high. During the rainy season, salinity is decreased and bacteria are released.

Mr Santoso commented that in a study of this nature, *Vibrio parahaemolyticus* would also be a meaningful indicator. Mr Ismail replied that at the time this study was conducted, they did not have the facilities to investigate *V. parahaemolyticus*.

Some Factors Influencing The Gel Strength Of Tropical Sardine (*Sardinella gibbosa*)

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Abstract

Initial investigations into the use of *Sardinella gibbosa* for making surimi showed that gel strength (G.S.) of around 400 g cm was achievable under normal surimi processing conditions. Adjusting the pH during the leaching process, by means of $NaHCO_3$ and by means of $Na_4O_7P_2$ with vacuum, did not improve the G.S. The fat content of local sardine was low and did not interfere with the surimi processing. The optimum conditions for setting the gel of paste were subjected to between 40 to 50°C for 20 min, followed by 20 min at 90°C. The surimi underwent *modori** when subjected to 60°C for 20 min. Sugar was necessary as a cryoprotective agent for frozen surimi.

It was found that crude aqueous extract of unfrozen *S. gibbosa* kidney tissues had G.S. enhancing effect. Kidney extract made from frozen sardine which were then frozen again, lost this G.S. enhancing effect.

Kidney extract made from unfrozen *Caesio erythrogaster* also had this G.S. enhancing effect. The kidney extract was heat stable, and retained the G.S. enhancing effect after exposure to 80°C for 10 min. However, the kidney extract did not prevent *modori* when the gel was exposed to 60°C for 20 min.

Introduction

In Southeast Asia, sardine is an abundant resource. However, sardines and other pelagic fish species are reputed to be difficult to use for surimi processing on account of their high oil content, rapidly deteriorating meat, and dark colour. Many researchers in Europe and in Japan have studied the temperate sardine species, and have proposed numerous ways to utilise the sardines.

Sardine as a raw material for the production of surimi have been investigated by Japanese researchers for many years. The main difficulties encountered in utilising sardine appear to be its low meat pH, high fat content , strong fish odour, dark meat colour, and its rapid spoiling characteristics. All these factors may contribute to the generally lower G.S. of the resulting surimi. Efforts to improve the G.S. were centered on the effects of meat pH, and consequently different alkaline leaching conditions were investigated. Some recent developments by Nishioka *et al* (1990) provided a different perspective on sardine surimi, and proposed a promising solution to some of the problems associated with sardine surimi production.

Note: This paper was presented at the Seminar by Ms Ng Mui Chng.

* the breakdown and loss of elasticity in the surimi gel attributed to unsuitable temperature and/or proteolytic enzyme activity.

Review And Re-Interpretation Of Some Past Results

The Marine Fisheries Research Department (MFRD) conducted a short study on the use of *Sardinella gibbosa* for making surimi (MFRD, 1984). It was found that chilled sardine of average freshness (K value = 50%) could be made into surimi with G. S. of around 400 g.cm. It was found that setting the paste at 40°C for 20 min, followed by 20 min at 90°C gave good gel strength. The meat pH of *S. gibbosa* was found to be from 6.7 to 7.0. The total lipid of *S. gibbosa* did not exceed 2.5%, and fat was therefore not a problem in the processing of surimi.

In an experiment, alkaline leaching was achieved by first dispersing the mince meat in four times its volume of water containing 0.2% NaCl (c.a.5°C). After stirring, the pH was adjusted by using $NaHCO_3$, to 6.5, 7.0 and 7.5 respectively for the three treatments. After standing for 15 min, the supernatant was decanted, and the meat slurry was washed three times with cold water. The meat was leached a second time with 0.3% NaCl. The control sample was leached in succession with 0.2% and 0.3% NaCl respectively without adjusting the pH. The results showed that alkaline leaching did not produce any improvement in the G.S., compared with normal leaching (Fig. 1).

The effects of freezing on the differently treated surimi were examined. The experiment was set up as shown in Fig. 2, and the results are presented in Table 1. Treatments 1, 3 and 5 were samples without sugar and polyphosphates. Treatments 2, 4 and 6 each contained 3% sugar and 0.2% polyphosphate. The samples were then contact frozen and stored at -20°C, monitoring intervals were 0, 2, 4 and 8 weeks. In all cases, after freezing, surimi with sugar and polyphosphate showed better G.S. than those without.

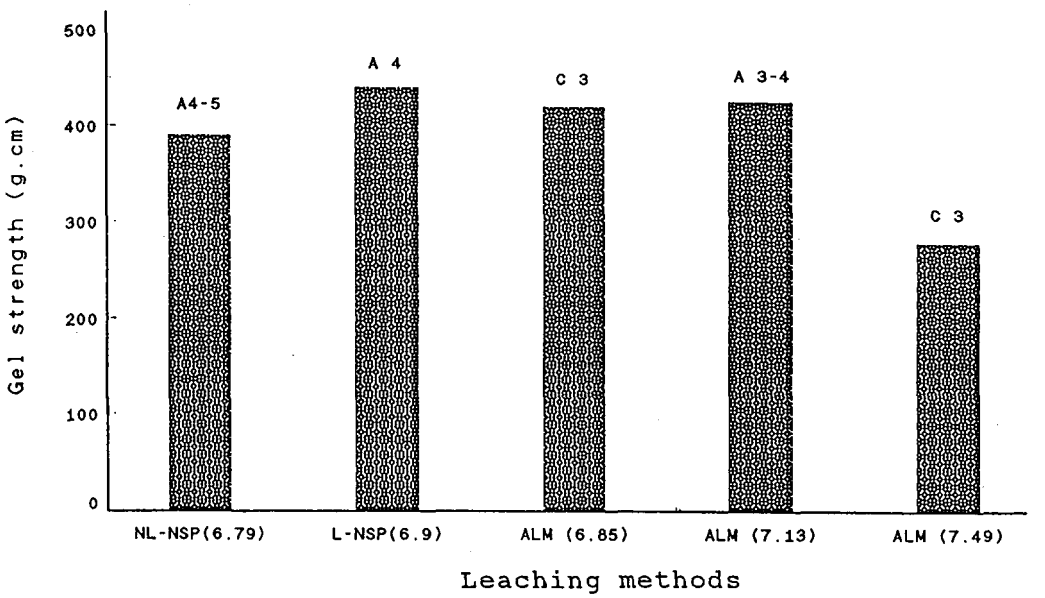


Fig. 1. Comparison of different leaching methods on gel strength.

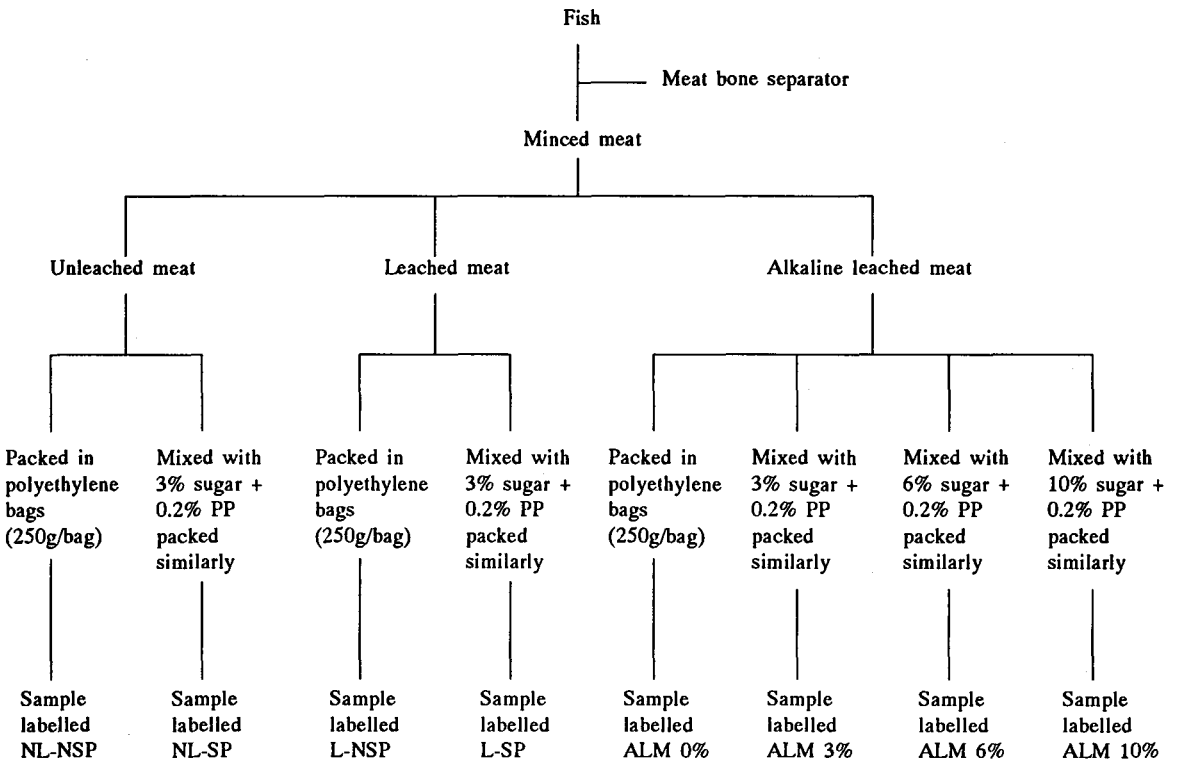


Fig. 2. Diagram of the experimental set-up for studying the effects of freezing and storage on the gel strength of surimi.

The optimum sugar concentration for cryoprotection of the surimi during frozen storage was investigated (Treatments 5, 6, 7 and 8). The G.S. of unfrozen surimi of Treatment 5 was much higher than those of Treatments 6, 7 and 8. This could be due to the higher percentage of protein in Treatment 5 compared with the other treatments, which had, respectively 3%, 6% and 10% less fish meat. However, after freezing, the G.S. of Treatment 5 was the lowest, showing the cryoprotective effects of sugar on freezing of surimi.

During frozen storage of the surimi, the G.S. dropped from about 400 to 300 g.cm. The G.S. was maintained at around 300 g.cm during the 8 weeks of frozen storage. The effect of freezing caused a decrease in G.S.

From Table 1 it was observed that the normal leached surimi (Treatments 3 and 4) had the highest G.S. It appears that alkaline leaching as defined here was not effective in increasing the G.S. of sardine surimi.

Report On Our Recent Findings

At a recent scientific meeting (IIR, 1990), Hamann provided a summary of the round table discussion on surimi/*kamaboko*. On the topic of *modori*, the latest postulate is that it is due to a group of serum proteinases called *modori*-inducing proteinases (MIPs). It was also mentioned that proteolytic activities were involved in *modori*, and that inhibition of proteolytic activity was commonly practiced in the USA, by mixing wide-spectrum inhibitors such as α-macroglobulin from bovine plasma. For example, it was essential to use α-macroglobulin when processing Pacific whiting (hake) and menhaden or when kidney tissue was present.

Table 1. The effect of freezing on the gel strength (G.S.) of different sardine surimi. (n = 5).

Treatment	Before freezing	After freezing	% drop G. S.
1 (NL - NSP)	306	114	62.7
2 (NL - SP)	268	224	16.4
3 (L - NSP)	631	142	77.5
4 (L - SP)	645	279	56.7
5 (ALM-0% S)	570	134	76.5
6 (ALM-3% S)	340	302	11.2
7 (ALM-6% S)	246	280	(13.8)
8 (ALM-10% S)	292	237	20.2

L = Leached
NL = Non leached
ALM = Alkaline leached meat
SP = Sugar + Polyphosphate
NSP = No sugar and no polyphosphate
S = Sugar

The action mechanism of α-macroglobulin however is still not clear.

In the local context, sardines that are landed are often inadequately iced, and autolytic degradation is assumed to be significant. The following studies were designed to understand the local sardine surimi better.

Experiment 1

Aim : (i) To determine the influence of different temperatures on the gel strength of the sardine surimi.
(ii) To determine the influence of kidney tissue extract on the G.S.

Procedure:

Surimi preparation: A batch of *S. gibbosa* (K value = 20%; meat pH 6.5) was used. The fish were beheaded and degutted, and made into surimi. A batch of unfrozen surimi, and a batch of surimi that was blast frozen to -30°C and stored at -20°C for a week were used for the experiment.

Kidney tissue extract: The fish frames were trimmed to remove all other tissues except the kidney tissues which were encased by the backbone. These materials were kept cold and were pounded with a mortar. A ratio of 1:2 fish material to water (w/w) was prepared, centrifuged and the supernatant used as the crude kidney tissue extract.

Experimental samples: The unfrozen and frozen surimi for Treatments A, B and C, were individually ground with salt. The paste were filled into sausage casing using a manual sausage filler. Fifteen sausages (25mm D; 140mm L) were prepared from each of the batches of surimi. In the case of Treatment D, the unfrozen surimi was ground with the kidney extract instead of water. The paste was filled into three sausage tubes. For all the paste, the final moisture was adjusted to 85%. The samples made from unfrozen and frozen surimi were subjected to the following conditions:

Treatment A:
Setting at 50°C x 20 min.

Treatment B:
Setting at 50°C x 20 min, then at 90°C x 20 min.

Treatment C:
Setting at 90°C x 20 min.

Treatment D:
Setting at 50°C x 20 min, then 90°C x 20 min.

After setting, the sample temperature was equilibrated in running tap water before the G.S. was measured. Four cylindical samples, each measuring 25 mm in height, were prepared from each sausage, and the G.S. readings were taken with a rheometer (Fudoh Model NRM 2002J).

Result:

The data (Tables 2a & 2b) were subjected to Analysis of Variance (ANOVA) test. It was found that in the unfrozen surimi, the G.S. of the 3 treatments were not significantly different whereas the results were significantly different for the frozen surimi. The G.S. of Treatment D was found to be significantly higher than that of Treatment B (Student's t-test, $p \leq 0.01$).

Discussion:

The result for the unfrozen surimi showed that the samples were not subjected to setting temperature conditions where *modori* was significant. The differences found in the frozen surimi were attributed to the effects of freezing rather than to the setting temperature.

Table 2a. The gel strength (G.S.) obtained from unfrozen surimi paste incubated at different temperatures.

Treatment A		Treatment B		Treatment C		Treatment D	
190	260	357	359	220	216	374	248
371	366	390	174	280	227	290	409
304	304	228	334	223	279	334	
317	262	327	358	271	183	417	
161	158	245	185	189	196	437	
240	191	271	243	221	274	307	
274	301	189	231	143	320	310	
272	214	142	280	198	248	464	
233	322	175	250	236	298	321	
173	316	238	290	300	288	273	
$n = 20$		$n = 20$		$n = 20$		$n = 12$	
$\bar{x} = 262$		$\bar{x} = 263$		$\bar{x} = 241$		$\bar{x} = 349$	
$s_{n-1} = 65.0$		$s_{n-1} = 72.2$		$s_{n-1} = 46.9$		$s_{n-1} = 69.8$	
TC = 5		TC = 5 to 6		TC = 5		TC = 6 to 7	
FT = AA		FT = AA		FT = AA		FT = AA	

Treatment A: Setting at 50°C x 20 min.
Treatment B: Setting at 50°C x 20 min, then at 90°C x 20 min.
Treatment C: Setting at 90°C x 20 min.
Treatment D: Setting at 50°C x 20 min, then 90°C x 20 min.
TC = Teeth cutting test
FT = Folding test

Table 2b. The gel strength (G.S.) obtained from frozen surimi paste incubated at different temperatures.

Treatment A		Treatment B		Treatment C	
189	202	263	318	163	164
311	262	197	327	124	144
231	232	335	175	191	182
201	205	272	394	198	162
193	122	406	257	223	210
157	180	222	268	172	150
238	267	303	356	198	207
205	243	221	237	144	138
208	283	303	238	102	254
307	----	290	179	195	141
$n = 20$		$n = 20$		$n = 20$	
$\bar{x} = 223$		$\bar{x} = 278$		$\bar{x} = 173$	
$s_{n-1} = 48.8$		$s_{n-1} = 65.7$		$s_{n-1} = 36.9$	
TC = 5		TC = 6		TC = 5	
FT = AA		FT = AA		FT = AA	

Treatment A: Setting at 50°C x 20 min.
Treatment B: Setting at 50°C x 20 min, then at 90°C x 20 min.
Treatment C: Setting at 90°C x 20 min.
TC = Teeth cutting test
FT = Folding test

The result from Treatment D was unexpected, and it appears that something in the kidney extract had G.S.-enhancing effect. The mode of action needs to be investigated further.

Experiment 2

Aim: To determine the influence of the kidney tissue extract on the G.S. of sardine surimi.

Procedure:

S. gibbosa (K value = 17%; meat pH 6.2) was purchased from Punggol Fishing Port. A batch of surimi was made from the usual beheaded and degutted fish, which had kidney tissues embedded

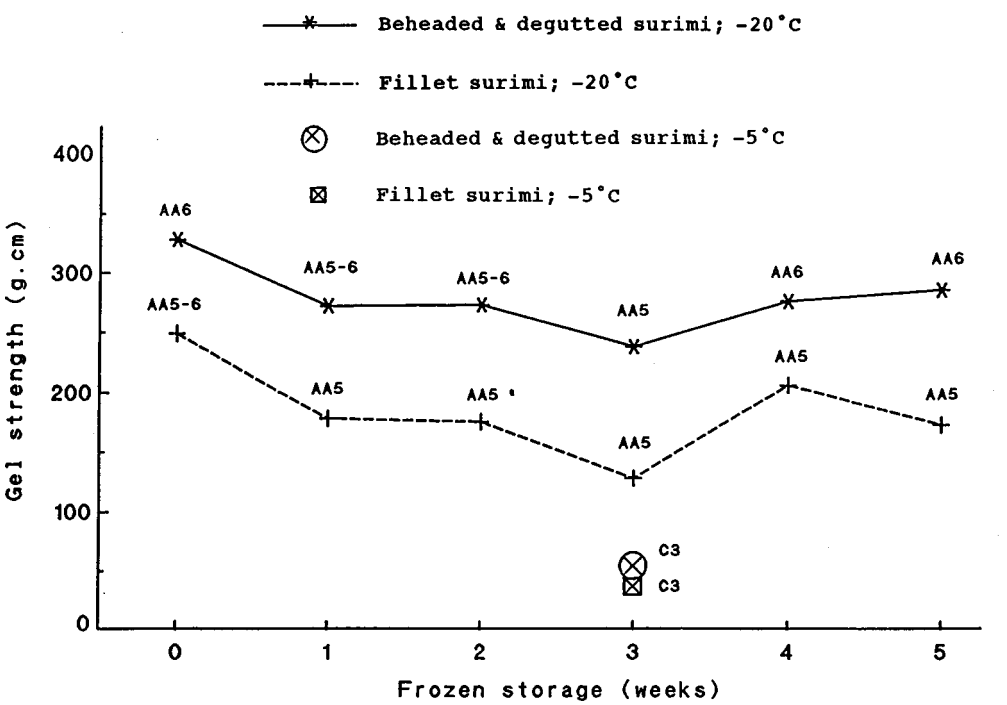
in the backbone (Treatment A). A second batch of surimi was made from fillets, excluding any kidney tissues (Treatment B). The G.S. from these 2 types of surimi were compared before freezing, and after frozen storage at -20°C for up to 6 weeks. A single batch of surimi from each of the treatments was kept at -5°C for 3 weeks , and the G.S. was compared with similar surimi kept at -20°C for the corresponding period. In the weekly monitoring, surimi from each treatment was ground separately. The paste was made into a single long sausage. Ten to 12 sample pieces were prepared from each sausage for G.S. measurement.

Result :

The data is presented in Fig. 3. The average G.S. (n=10) from each weekly monitoring for the treatments were subjected to the Student's t-test (paired comparison). The G.S. of Treatment A was significantly higher than that of Treatment B ($P \leq 0.01$). In the single sample comparison of both treatments at -5°C, both exhibited very low G.S., with Treatment A having a higher G.S.

Discussion:

The presence of some factors in the kidney tissue in Treatment A enhanced the G.S. significantly. Based on the single sample comparison, this active fraction was not stable and was lost during storage at -5°C.



AA5-6 and C3 = AA : Folding test, 3,5 and 6 : Teeth-cutting test

Fig. 3. Changes in gel strength of frozen surimi made from beheaded and degutted sardine and sardine fillets.

Experiment 3

Aim: To study the effects of kidney extract made from frozen sardine on the G.S. of frozen sardine surimi.

Procedure:

Kidney tissue was obtained from frozen sardines (5 weeks storage at -20°C) and the extract made as described previously. The kidney extract was frozen and stored for 2 weeks at -20°C. Frozen sardine surimi prepared from beheaded and degutted fish, and stored for 5 weeks at -20°C was used for the experiment. The following treatments were made:

Treatment A:
Frozen surimi ground with water.
Set at 50°C x 20 min, then at 90°C x 20 min.

Treatment B:
Frozen surimi ground with water.
Set at 60°C x 30 min, then at 90°C x 20 min.

Treatment C:
Frozen surimi ground with kidney extract.
Set at 50°C x 20 min, then at 90°C x 20 min.

Treatment D:
Frozen surimi ground with kidney extract.
Set at 60°C x 30 min, then at 90°C x 20 min.

Data were collected by measuring the G.S. of 5 sample pieces per sausage, and for each treatment, six sausages were sampled. Within each treatment, the mean G.S. values of the individual sausage were grouped (Table 3). These means were subjected to the Student's t-test.

Table 3. The effect of setting temperature and kidney extract on the gel strength (G.S.) of frozen sardine surimi.

Mean G.S. from individual sausage (n = 6)			
Treatment A	Treatment B	Treatment C	Treatment D
246	100	202	61
241	90	226	124
192	93	235	61
194	84	226	95
240	76	226	41
214	156	248	47
$\bar{X}_x$ = 221	$\bar{X}_x$ = 99.8	$\bar{X}_x$ = 227.2	$\bar{X}_x$ = 71.5
S.E. = 24.5	S.E. = 28.6	S.E. = 15.1	S.E. = 31.8

Treatment A: Frozen surimi ground with water. Set at 50°C x 20 min, then at 90°C x 20 min.
Treatment B: Frozen surimi ground with water. Set at 60°C x 30 min, then at 90°C x 20 min.
Treatment C: Frozen surimi ground with kidney extract. Set at 50°C x 20 min, then at 90°C x 20 min.
Treatment D: Frozen surimi ground with kidney extract. Set at 60°C x 30 min, then at 90°C x 20 min.

Result:

Comparisons of Treatment A and Treatment C showed no significant difference between the two treatments. This meant that the frozen kidney extract made from frozen sardine had lost its G.S.-enhancing effect.

In comparing Treatment A and B, and Treatment C and D respectively, significant differences were found between the two temperature-treatment pairs. The paste made from frozen sardine surimi underwent *modori* at 60°C irrespective of whether the kidney extract was present or not.

Discussion:

In this experiment, since the G.S.-enhancing effect was lost due to freezing, it was not possible to conclude the influence of the kidney tissue extract on the *modori* phenomenon.

Experiment 4

Aim: To determine if kidney extract from *Caesio erythrogaster* exhibits gel-enhancing properties.

Procedure:

Chilled fish frames of *C. erythrogaster* (body length about 12 cm) were obtained from a factory and the kidney extract (c.a. 7.5 mg protein per ml) was made as before. A portion of the kidney tissue extract was heated to 80°C for 10 min in a water bath. The extract was centrifuged to remove the preciptated proteins, and the clear supernatant was cooled before use. Commercial surimi was used in this experiment. The following conditions were investigated:

Treatment A:
Surimi ground with kidney extract.
Set at 40°C x 20 min, then at 90°C x 20 min.

Treatment B:
Surimi ground with heat treated kidney extract.
Set at 40°C x 20 min, then at 90°C x 20 min.

Treatment C:
Surimi ground with water (Control sample).
Set at 40°C x 20 min then at 90°C x 20 min.

Ten sausages were sampled per treatment. Five sample pieces per sausage were used for measuring the G.S. Within each treatment, the mean G.S. value of all the samples from each individual sausage were grouped. These mean values were subjected to the Student's t-test (Table 4).

Result:

The G.S. from Treatment A was significantly higher than that from Treatment C (Student's t-test $P \leq 0.01$). The kidney tissue extract from *C. erythrogaster* had a G.S.-enhancing effect.

The G.S. from Treatment B was signficantly higher than that of Treatment C (Student's t-test $P \leq 0.01$). The heating process up to 80°C for 10 min did not destroy the G.S.-enhancing effect.

The G.S. of Treatment B was significantly higher than that of Treatment A (Student's t-test $P \leq 0.01$). This implied that the kidney extract may have more than one factor influencing the G.S. Heating the kidney extract to 80°C may have destroyed some of the proteolytic enzymes reportedly present in kidney tissues which had negative effects on the G.S.

Experiment 5

Aim: To determine whether kidney extract from *C. erythrogaster* can prevent *modori*.

Procedure:

Kidney extract from *C. erythrogaster* was prepared as described before. Commercial surimi was used in this experiment. The following treatments were prepared:

Treatment A:
Surimi paste with kidney extract.
Setting at 60°C x 20 min, then 90°C x 20 min.

Table 4. The effect of kidney extract from *C. erythrogaster* on the gel strength (G.S.) of commercial surimi.

Mean G.S. from individual sausage (n = 10)		
Treatment A	Treatment B	Treatment C
73	69	52
62	58	45
53	87	48
57	74	41
62	68	66
54	75	54
52	65	47
56	68	44
47	70	50
62	78	51
$\overline{X}_x$ = 57.8	$\overline{X}_x$ = 71.2	$\overline{X}_x$ = 49.8
S.E. = 7.3	S.E. = 7.9	S.E. = 6.9

Treatment A: Surimi ground with kidney extract. Set at 50°C x 20 min, then at 90°C x 20 min.
Treatment B: Surimi ground with heat treated kidney extract. Set at 60°C x 30 min, then at 90°C x 20 min.
Treatment C: Surimi ground with water. Set at 50°C x 20 min, then at 90°C x 20 min.

Treatment B:
Surimi paste with kidney extract.
Setting at 40°C x 20 min, then 90°C x 20 min.

Treatment C:
Surimi paste with water.
Setting at 40°C x 20 min, then 90°C x 20 min.

Ten sausages were prepared for each treatment, and five sample pieces per sausage were used to measure the G.S. The mean G.S. from sausages within each treatment was used in analysis.

Result:

The data is shown in Table 5. There were significant differences between Treatments A and B (Student's-test $p \leq 0.01$). The kidney extract did not prevent *modori*. There were significant differences between Treatments B and C, confirming that the kidney tissue extract had a G.S.-enhancing effect.

Discussion:

Paiboon *et al* (1988) repeated the earlier work done by MFRD (1984, unpublished) on alkaline

Table 5. The effect of kidney extract of *C. erythrogaster* on the *modori* phenomenon.

Mean G.S. from individual sausage (n = 10)		
Treatment A	Treatment B	Treatment C
62	211	206
72	232	224
65	235	228
62	214	185
71	208	228
73	225	175
71	224	156
70	217	191
85	220	186
71	185	204
$\overline{X}_x$ = 70	$\overline{X}_x$ = 217	$\overline{X}_x$ = 198
S.E. = 6.6	S.E. = 14.2	S.E. = 24.1

Treatment A: Surimi ground with kidney extract. Set at 60°C x 20 min, then at 90°C x 20 min.
Treatment B: Surimi ground with kidney extract. Set at 40°C x 20 min, then at 90°C x 20 min.
Treatment C: Surimi ground with water. Set at 40°C x 20 min, then at 90°C x 20 min.

leaching with *S. gibbosa* and *S. fimbriata*. In addition, leaching with sodium pyrophosphate ($Na_4O_7P_2$) under vacuum was also studied. The results showed conclusively that both types of alkaline leaching were not effective in improving the G.S. The raw sardine meat had pH of 6.7 to 7.0, and did not warrant alkaline leaching. It was noted that the final product after pyrophosphate leaching had a smoother and more elastic texture. This was attributed to the homogenisation process where the fish meat was finely minced and the added pyrophosphate. Whereas normal water-leached surimi, actomyosin is recognised as the main component in forming gel. In pyrophosphate leaching, the actomyosin was believed to be broken into actin and myosin. The resulting gel was due to the myosin instead of the actomyosin. This difference in network formation could account for the different gel characteristics observed.

Recently Nishioka *et al* (1990) reported a surimi-processing technique incorporating leaching with $Na_4O_7P_2$ to moderate the meat pH, and vacuum leaching to remove the excessive fat in pelagic fishes. They also postulated a new hypothesis on the mechanism of *kamaboko* formation (gel formation). Briefly, they proposed that (a) myosin plays the most important role in forming gel due to its strong water-holding capacity; (b) the

increase in gel-strength resulting from leaching the meat is brought about by the relaxation of the firm bond between actin and myosin that occurs after death; (c) the weaker the binding between myosin and actin, the stronger the gel- strength.

In reviewing our data, we found that the local sardine species has only about 3% total lipid, and this did not interfere with the surimi production. Vacuum leaching for fat removal as proposed by Nishioka is not required. Moreover, in the case of chilled tropical sardines, leaching with $Na_4O_7P_2$ did not produce any increase in G.S. However, as Nishioka's group have reported the best results so far for making surimi from frozen sardine, more work should be done along similar lines with the local species, especially frozen sardine.

Paiboon, *et al* (1988) also studied the relationship between fish freshness (K value) and gel-forming ability (Fig. 4). The G.S. of *S. fimbriata* was high at zero day, dropped after three days in ice, then showed an increase after five days in ice. The G.S. of *S. gibbosa* showed a decreasing trend during storage. Paiboon concluded that the K value showed no relationship to the G.S. for *S. fimbriata*. However, the present authors feel that the K value at which the dip in G.S. occurred was indicative of the gel forming potential. Based on Fig. 4, the cut-off point for fish freshness suitable for surimi was about K value 50% . This was further substantiated by the earlier work where sardine of 50% K value were successfully made into surimi with good G.S.

The peculiar upturn in the G. S. of *S. fimbriata* meat during ice storage was not explained by Paiboon. Recently, Kinoshita *et al* (1990) studied the *modori* phenomenon in relation to the meat pH of freshly killed *Tilapia* (Fig. 5). They observed a similar decrease in G.S. from the time of death till about nine hours. At about 12 hrs after death, the G.S. increased and peaked at about 24 hours before decreasing again after 48 hours of storage. During the first 12 hours, the meat pH decreased from about 6.8 to 6.3, and thereafter remained stable despite the increase and sub-

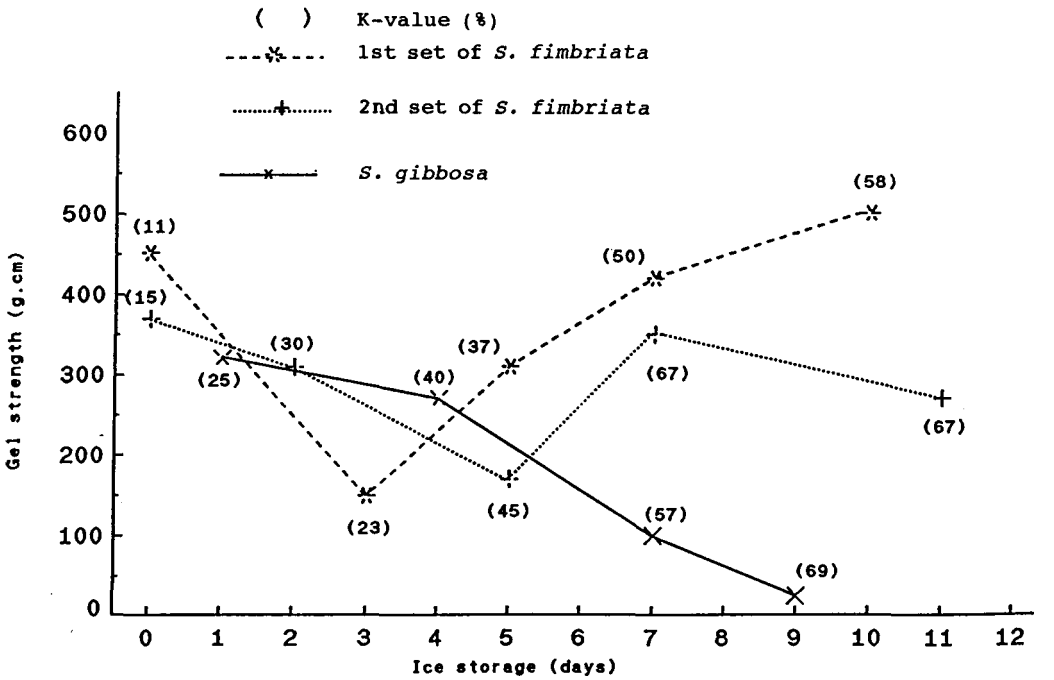


Fig. 4. Relationship between fish freshness K value (%) and gel strength in Sardinella fimbriata *and* S. gibbosa.

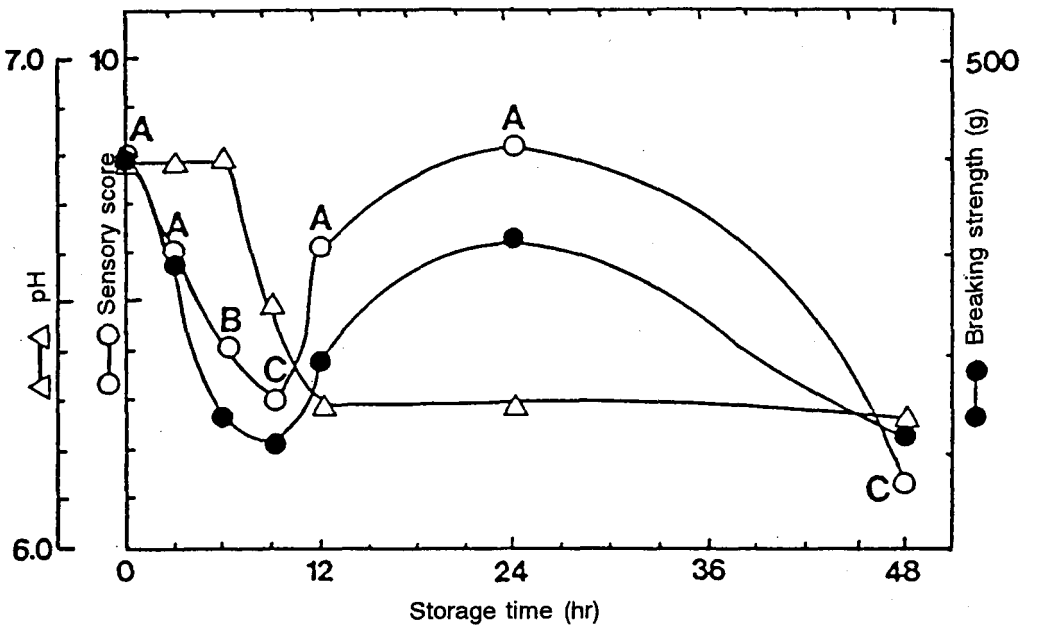


Fig. 5. Change of degree of modori *during storage period. Letters in the figure denote the score values in the folding test. (Figure from a paper presented at IIR Commission Meeting on 'Chilling and Freezing of New Fish Products', Aberdeen, 1990, p.65. Series-Refrigeration Science and Technology).*

sequent decrease in the G.S. Kinoshita did not relate the changes in G.S. to fish freshness. Instead, he postulated that the newly described *modori* inducing proteinases (MIPs) may play a role in this observed phenomenon.

In the recent study, it was found that adding kidney tissue extract during the grinding of the surimi paste gave an enhanced G.S. This was contrary to the popular belief that enzymes in the kidney contributed to the decrease in G.S. through proteolytic activities. The exact nature of the fraction in the kidney tissue extract that was responsible for this observation is not known.

Kimura (1989) reported that, during setting, the myosin heavy chain decreased and cross-linked myosin with large molecular sizes (dimers, trimers etc) was formed in the *suwari* gel. He also reported that a protein factor in the water-soluble fraction of surimi catalysed this cross-linking reaction. This protein factor was identified as a transglutaminase. In our experiments, the factor responsible for enhanced G.S. effect was fairly heat stable, and is not likely to be similar to what Kimura reported.

Autio and Mietsch (1990) reported that addition of blood globins and plasma changed the thermal gelation of myofibrils. Both these were present in the kidney tissue extract. However, the amount of kidney extract used in the study was small in comparison with the amount of surimi, and so the contribution of the blood globins and plasma to G.S. was unlikely to be significant.

Conclusion

Tropical sardine species are generally low in fat content, and the meat pH is fairly neutral. It was possible to produce surimi with good gel strength from chilled tropical sardines of average freshness.

Alkaline leaching and vacuum alkaline leaching did not improve the G.S. There were no additional steps required for processing the surimi. Frozen tropical sardine could not give good G.S. under the present processing method.

There was a fraction in the kidney extracts from *S. gibbosa* and *C. erythrogaster*, which, when added to the surimi during grinding, enhanced the G.S. The extract did not prevent the *modori* phenomenon . This crude fraction, with about 7.5 mg protein per ml, was fairly heat stable. It retained the G.S.-enhancing effect even after exposure to 80°C for 10 min. However, freezing seemed to destroy this characteristic. Further work to concentrate and purify the kidney extract is in progress.

Autio, K. and Mietsch, F. 1990. Heat induced gelation of myofibrilla proteins and sausages: effect of blood plasma and globin. Journal of Food Science 55 (6): 1494 - 1496.

Hamann, D. D. 1990. Summary report on round-table discussion on "*Surimi-kamaboko*" in International Institute of Refrigeration Conference "Chilling and Freezing of New Fish Products": 131 - 132. Aberdeen, Sep 18 - 20, 1990.

Kimura, I. 1989. Setting phenomenon (*suwari*) of fish meat paste. Paper presented at "The 1989 International Chemical Congress of Pacific Basin Societies" Agrochemistry Paper No. 351, Honolulu, Dec 17 - 22.

Kinoshita, M., H. Toyohara, and Y. Shimizu. 1990. Proteolytic of fish gel (*modori*-phenomenon) during heating process in International Institute of Refrigeration Conference "Chilling and Freezing of New Fish Products": 61 - 67. Aberdeen Sep 18 - 20, 1990.

MFRD, 1984. Preliminary studies of utilization of sardine (*Sardinella gibbosa*) for production of surimi. MFRD Fellowship Report (unpublished).

Nishioka, F., T. Tokunaga, T. Fujiwara and S. Yoshioka. 1990. Development of new leaching technology and a system to manufacture high quality frozen surimi. *In* International Institute of Refrigeration Conference "Chilling and Freezing of New Fish Products": 123 - 130. Aberdeen Sep 18 - 20, 1990.

Paiboon, T., H.K. Lee, S. Loo, M.C. Ng, and N. Tsukuda. 1988. A preliminary study on the gel forming ability of two kinds of sardine meat during ice-storage. Songkanakarin Journal of Science and Technology 3: 339 - 347.

Discussion

A comment was made that in the present study, only the effects of proteinases and gel promoting factors were considered. The sardine is a very special fish species because sardine meat contains enzymes which affect the gelation process, and there is also a non-enzymatic *modori* phenomenon reaction present. Therefore, future studies should take into consideration both the enzymatic and non-enzymatic reactions on the *modori* phenomenon.

Also in the present study, only the gel strength was measured for estimating the occurrence of the *modori* phenomenon. It was suggested that a complementary study on the breakdown of the myosin heavy chain by the SDS-PAGE electrophoresis be conducted to better understand the conditions.

The K Value As A Freshness Index For Tropical Food Fish And Its Application As A Quality Control Tool During Fish Storage And Distribution

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Abstract

The K value, expressed as

$$\text{K value } \% = \frac{\text{HxR + Hx}}{\text{ATP + ADP + AMP + IMP + HxR + Hx}} \times 100$$

is a good index for estimating the enzymatic freshness of fish.

The changes in K value of various species of tropical food fishes during ice-storage had been studied. It was found that these warm water fishes deteriorate slowly under ice-storage preservation. A study was made on the K value changes of three species of fish (*Polynemus* sp., *Rastrelliger kanagurta* and *Pampus argenteus*) in a supermarket distribution chain. Most sets of data showed changes of quality; from the point of supply until the morning after an overnight stay on display shelves. The results support a conclusion that the shelflife limit of fresh tropical food fish, based on sensory evaluation, was, when handled well, between 12 to 28 days ice-storage depending on species, with the K value ranging from 24 - 37%.

Introduction

When a fish dies, the adenosine triphosphate (ATP) is broken down by enzymes into other compounds as follows:

$$\text{ATP} \xrightarrow{\text{Tpase}} \text{ADP} \xrightarrow{\text{myokinase}} \text{AMP} \xrightarrow{\text{deaminase}} \text{IMP} \xrightarrow[\text{phosphatase}]{\text{alkaline}} \text{HxR}$$

$$\xrightarrow[\text{phospharylase}]{\text{nucleoside}} \text{Hx} \xrightarrow[\text{oxidase}]{\text{xanthine}} \text{UA}$$

where ATP = adenosine triphosphate
ADP = adenosine diphosphate
AMP = adenosine monophosphate
IMP = inosine monophosphate
HxR = inosine
Hx = hypoxanthine
UA = uric acid

Presently, two K value determination methods are adopted by our laboratory, viz the anion exchange chromatography method and the oxygen-electrode method using the Freshness Meter (Model KV 101, Oriental Co.) (Low *et al*, 1989).

The objective of this study was to examine the endogenous changes of tropical food fishes during ice-storage as well as during distribution. As the freshness of fish changes enzymatically before significant bacterial activity begins, the K value was considered a suitable index for quality changes.

Twelve tropical food fish species - *Lates calcarifer* (seabass), *Epinephalus tauvina* (greasy grouper), *E. bleekeri* (Bleeker's grouper), *Lutjanus*

Note: This paper was presented at the Seminar by Mrs Tan.

johnni (golden snapper), *L. argentimaculatus* (mangrove snapper), and *Pampus chinensis* (Chinese pomfret) purchased live from aquaculture farms and *Scomberomorus commerson* (Spanish mackerel), *Thunnus tonggol* (tonggol), *Saurida tumbil* (lizardfish), *Rastrelliger kanagurta* (Indian mackerel), *P. chinensis* (Chinese pomfret) and *P. argenteus* (silver pomfret) purchased fresh from wholesale/retail markets were studied under ice-storage.

The K value changes of fish in a commercial retail cold-chain distribution system was monitored.

Changes In The K Value Of Tropical Food Fish Under Ice-Storage

Method And Materials

Six species of fish were purchased live from aquaculture farms for study of K value changes under ice-storage. Upon arrival, they were immediately killed by immersion in ice-cold water. They were ice-stored with proportion of fish to ice of 2:1. Regular physical examinations for changes were made on days of sampling. For each species, three fishes were sampled for K value per storage day. An interval of three to four days was allowed for each lot of sampling. Monitoring of K value continued until gills emitted a strong putrid odour and to the point at which body muscle turned soft and non-resilient. Overall acceptability was based on organoleptic assessment of steamed samples.

The K values of fresh fishes purchased from wholesale/retail markets were also studied under similar ice-storage conditions.

The K values were determined by the anion exchange chromatography method (Hasegawa, 1987).

Results And Discussion

In all the fish species studied, a gradual increase in K value during ice storage (Figs. 1 and 2) was observed.

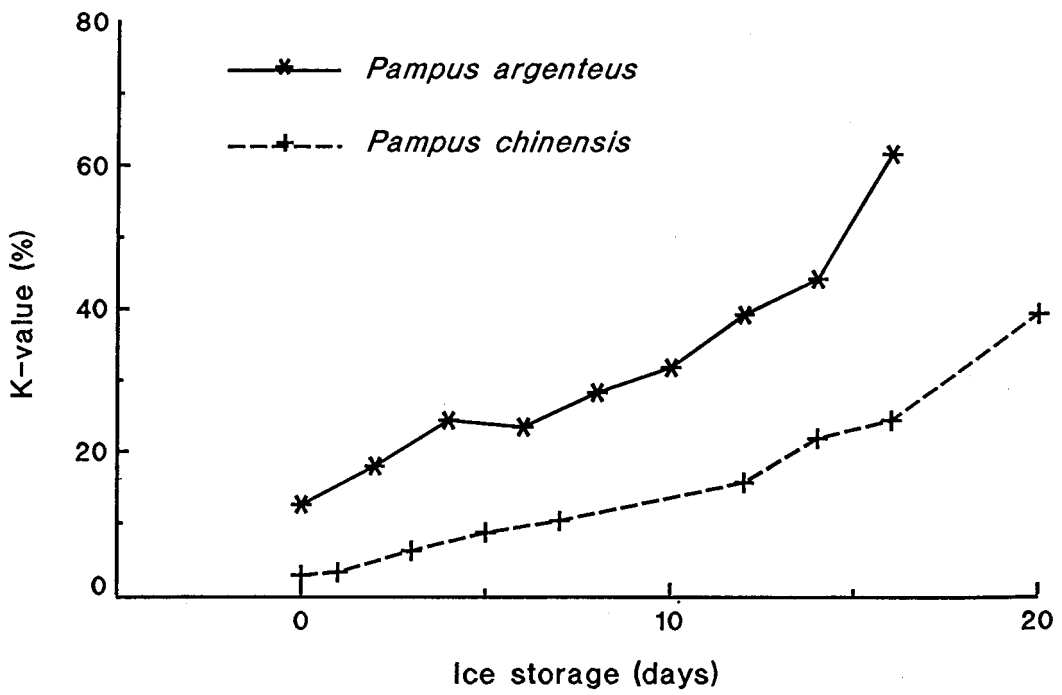

Fig. 1. Changes in freshness (K value) of promfrets during ice storage.

The muscle proteins stability as well as the late initiation of bacterial propagation contributed greatly to maintaining the freshness of the fish during ice-storage.

Referring to Tables 1 and 2, it was found that sensory evaluation acceptability of fishes varied according to species from 12 to 28 days ice-storage with the K value range of 24% to 37% respectively.

Most of the fishes from the wholesale/retail markets had K values between 12 to 25% on arrival. The lizardfish, being of better initial quality (12.9%), could be ice-stored for 6 days before reaching 20% K value.

Case Study : Monitoring Changes In K Value Of Fishes During Retail Distribution

Method

A local supermarket chain was selected for this study. The company operated a central processing plant where the fish were prepared and packed for distribution to the retail stores. Three retail outlets were selected for inclusion in this study.

Generally, fishes were delivered to the central processing plant in the morning (8.00am). These were re-chilled, washed, processed and packed into styrofoam trays for subsequent distribution in the afternoon (1.00pm) by refrigerated trucks. The pre-packed fish were placed on the display shelves at the retail outlets (-4 to 8°C) for sale.

In this study, the temperature of the fish was measured at the central processing plant, and at various points in the distribution outlets. Fish samples were taken for K value determination at the central processing plant, upon arrival at outlets and after one day at the display shelves.

Fig. 3 shows the operational flowchart of the distribution, and the data collection points.

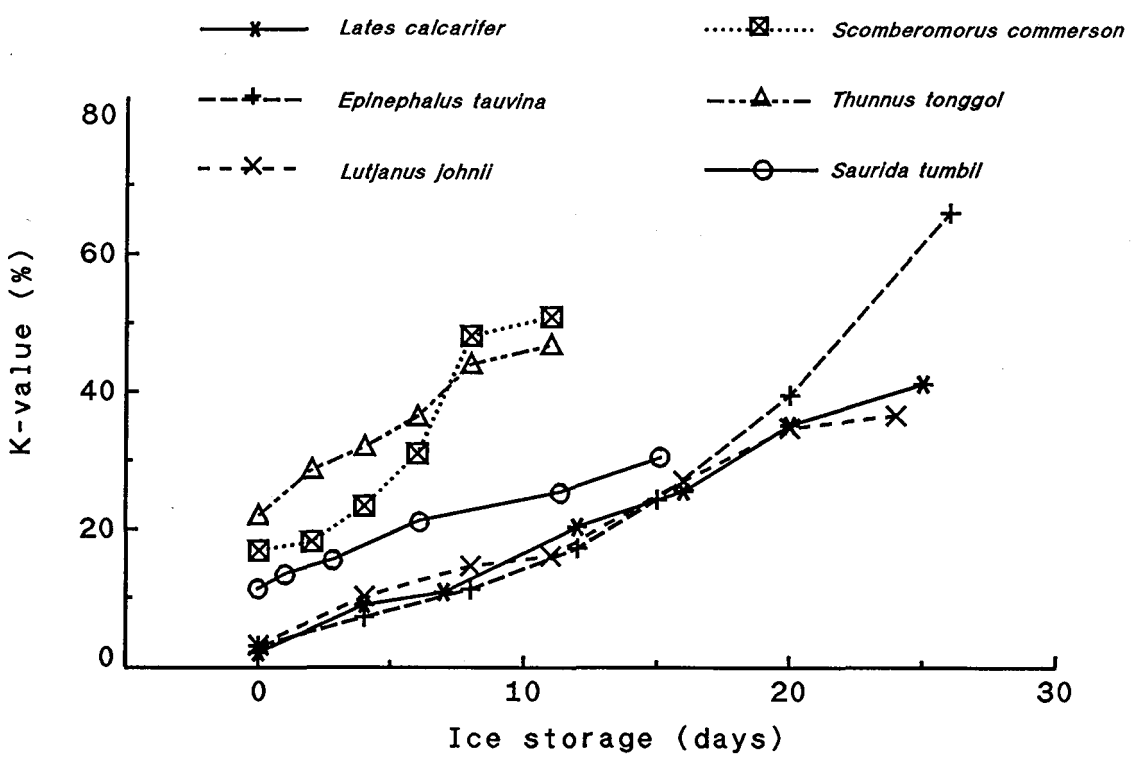

Fig. 2. Changes in freshness (K value) of tropical fishes during ice storage.

Table 1. Changes in K value, VB-N, TMA and sensoric properties of grouper (body length : 34.5 cm, bodyweight : 1 kg) during storage.

Days of Storage	K Value (%)	VB-N (mgN/100g)	TMA-N (mgN/100g)	Eye	Gill	Appearance	Flesh (raw)
0	4.4	8.2	ND	transparent, not sunken.	red, no slime, no smell (seaweedy).	dark brown, no smell, no slime.	white colour (normal), no smell, rubbery texture.
3	5.9	13.2	0.3	milky white, not sunken.	pale red, slightly slimy, smells but not bad smell.	(rigor mortis), no smell, no slime.	slightly yellowish, slightly softer, no smell.
7	12.0	11.6	0.2	-do-	dark red, sticky mucus, very slightly fishy smell.	(post rigor) no smell, no slime.	white with yellowish tint, no smell, very soft texture. Skin: no smell.
11	18.1	17.3	0.3	-do-	dark red, sticky mucus, strong fishy (bad) smell.	very slight smell, slimy.	slightly reddish tint, no smell, very soft. Skin: no smell.
15	26.7	11.8	0.5	cloudy/milky white, sunken.	dark red, very slimy.	normal colour, slightly fishy smell, slightly slimy.	yellowish tint, no/very slight fishy smell, soft. Skin: no/very slight fishy smell.
18	37.1	12.1	2.6	milky-white with reddish colour, sunken.	dark red; very slimy, spoiled smell.	normal colour, fishy smell, slime.	greyish tint, very slight fishy smell, soft and sticky. Skin: slight fishy smell.
21	34.0	16.9	4.4	-do-	reddish brown colour, slimy, spoiled smell.	normal colour, spoiled smell, slime.	white with yellowish tint, moderate fishy smell (very slightly), very soft, sticky structure. Skin: fishy smell but not rancid.
24	42.3	18.3	6.5	-do-	-do-	-do-	white with yellowish tint, slight fishy smell, very soft texture. Skin: surface: spoiled smell, not rancid; meat: slightly fishy smell.

Table 2. Iced storage characteristics of various fishes.

Fish type	Scientific name	Acceptability limit (days)	K value (%)
Indian mackerel	*Rastrelliger kanagurta*	5	28.7
White pomfret	*Pampus argenteus*	12	29.9
Chinese pomfret	*Pampus chinensis*	16	24.4
Seabass	*Lates calcarifer*	14	27.9
Grouper	*Epinephelus bleekeri*	24	37.4
Grouper	*Epinephelus tauvina*	28	28.2

The oxygen-electrode based Freshness Meter was used during this study.

Results And Discussion

On the whole, all fishes arrived between 10 min of each other around 8.00 am. The smaller fishes were generally well-iced whereas the larger fishes such as *Polynemus* sp. were moderately iced. Body temperatures of smaller fishes monitored were well below 10°C whereas that of the larger fishes were around 15°C . The preparation room's temperature was kept low at around 16°C.

All fishes, after saline washing, were around 2°C and 7 to 9°C after sampling for K value measurements. The time lapse for samples left in the chiller room (2°C) before distribution was 2 hr, when sampling was also completed.

Time taken from Center to Outlet 1 was 28 min, to Outlet 2 was 56 min and Outlet 3 was 86 min on the average.

Referring to Table 3, there was negligible differences in K value amongst most samples.

The prompt handling of fishes between the warehouse and the outlets had helped maintain their quality at their best. The quality of fish delivered to the supermarket, however, was not always the best. Other than the threadfin which showed constant excellence of quality, a mixed supply of good and lower quality small fishes was noted. In particular, though initial physical appearance of silver pomfrets may appear good for the majority, yet K value had been found to be high on the average.

Freshness Breakdown Trend In Tropical Food Fish

Ng *et al* (1983) found that in grouper and white pomfret, most muscular proteins, particularly myofibrillar and sarcoplasmic proteins, were of very stable condition throughout ice-storage. This further supports the observations of Uchiyama *et al* (1978) that tropical fish has muscular protein stability. That is, most tropical food fishes degrade in freshness very gradually when well-iced and handled. VB-N data remains reasonably stable in most fish studied whereas the TMA-N remains low for about 14 days before it starts showing signs of increase. As the degradation of fish freshness is a biochemical reaction influenced by body temperature changes; a fish subjected to a larger temperature fall is more likely to retain better freshness than one which experiences a smaller change in temperature.

Conclusion

The K value is a suitable freshness indicator for tropical food fishes.

The long shelflife of tropical food fish could be attributed to the stability of its muscular proteins, the larger fall in temperature during ice-storage and the low bacterial activity present.

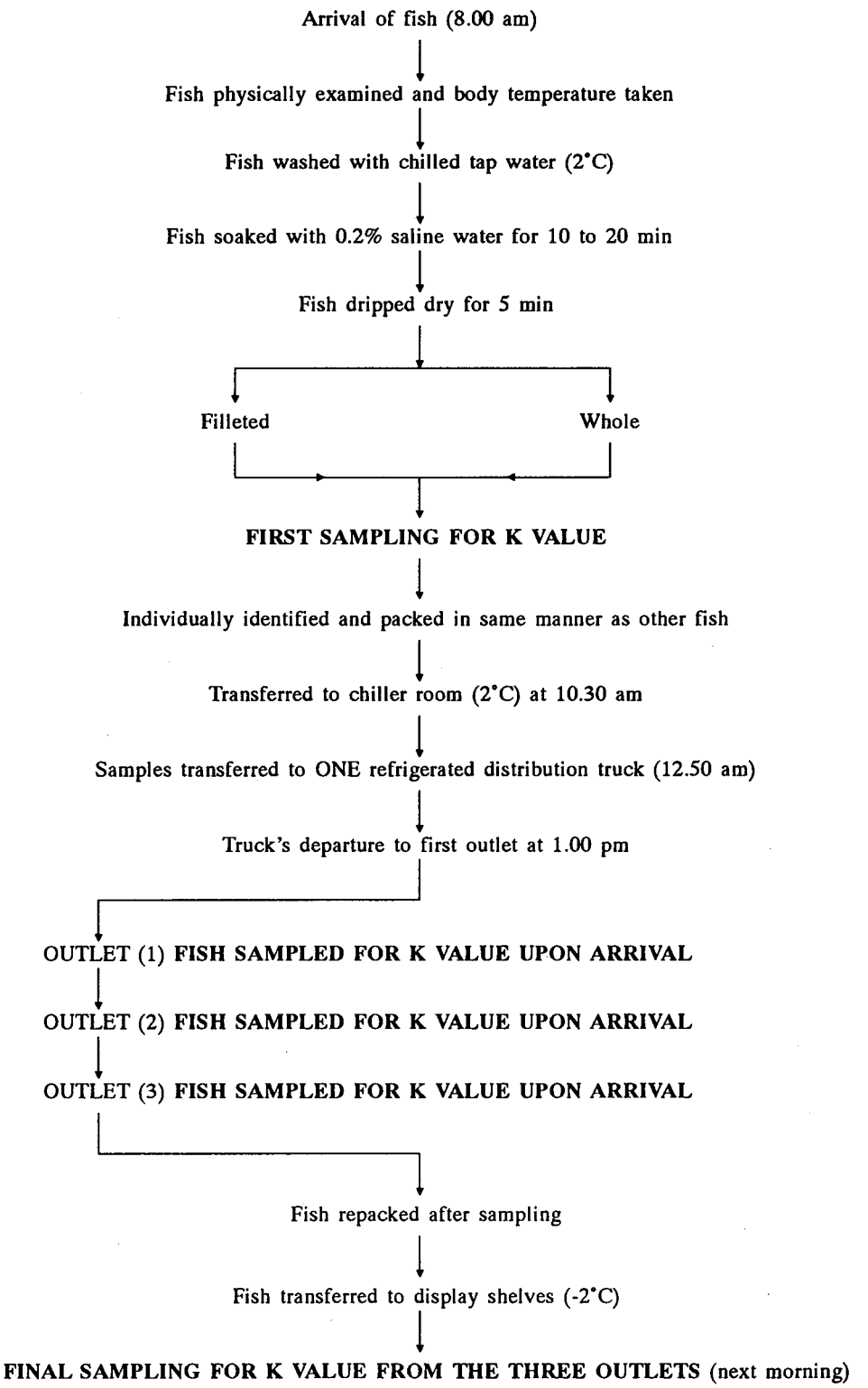

Fig. 3. Fish quality monitoring in a retail distributor and its outlets.

Table 3. Changes in K value (%) of fish in a major distribution chain and its outlets.

OUTLET	THREADFIN			INDIAN MACKEREL			SILVER POMFRET		
	A	B	C	A	B	C	A	B	C
1	9.2	13.7	15.2	12.3	14.8	14.4	52.8	50.5	48.3
	9.0	12.1	12.0	5.6	9.4	11.7	68.2	68.3	62.8
	9.8	14.0	10.8	14.6	15.5	21.1	57.7	54.0	54.1
	12.6	13.6	12.1	13.2	15.7	17.9	32.0	30.0	33.6
2	14.8	17.1	13.8	7.1	9.8	14.7	30.7	26.6	24.4
	13.2	14.9	12.6	20.1	20.7	25.4	45.9	37.5	33.7
	12.3	14.4	13.3	12.7	14.0	21.3	39.7	33.1	40.2
	11.8	14.4	12.8	7.1	10.0	17.7	51.6	49.4	48.2
3	13.5	14.9	17.4	6.5	11.6	13.6	38.8	35.4	40.8
	12.4	11.2	12.7	10.7	14.6	15.2	62.3	64.0	60.6
	13.1	13.2	14.1	19.8	22.3	22.8	51.5	47.8	49.1
	14.0	15.0	15.2	16.9	19.7	19.9	50.6	49.5	52.2

A - all samples taken simultaneoulsy at main distribution center in the morning.
B - samples taken at three outlets, upon arrival in the afternoon.
C - overnight samples in display shelves, taken on next morning.

The K value increase in all ice-stored samples were gradual and varied according to species. Species such as the groupers were more hardy than others and were still acceptable as steamed samples when K value ranged from 28 to 37% (24 to 28 days ice-storage). Others, like the seabass, mangrove snappers, golden snappers and pomfrets, were organoptically acceptable till around 30% K value (18 days ice-storage).

Acknowledgement

The authors are grateful to Mr Hooi Kok Kuang, Chief of MFRD and Dr Katsutoshi Miwa, Deputy Chief of MFRD for permission to publish this paper as well as to Mr M Yamagata and Ms Low Lai Kim for their guidance and help.

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Discussion

Asked about the procedure used to determine the acceptability limit, Mrs Tan replied that it was based on a panel assessment of steamed samples.

It was noted that the study showed good correlation between the K value and TMA-N. Mrs Tan agreed that as TMA-N is related to bacteria activity, this may not be suitable for frozen fish since the K value will increase faster than TMA-N increase in the frozen state. It was further noted that in the western countries, the hypoxanthine was quantified instead of the K-value. A query was then raised as to whether data to compare these two parameters were available. Mrs Tan replied that as some fishes have high levels of hypoxanthine, it is more accurate to use K value instead of hypoxanthine.

Mrs Tan was asked whether the analysis of K value by ion exchange was feasible when large numbers of samples need to be analysed, and whether the commercial freshness meter was accurate. She replied that the freshness meter was the faster method, and that previous studies had shown that the K values obtained had high correlation coefficient with the data obtained by the ion-change method.

Studies On The Quality Indices And Preservation Methods For Boiled, Dried Anchovies (*Stolephorus* sp.)

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Abstract

Boiled, dried anchovies sold in Singapore are mainly imported from neighbouring countries. A survey was conducted to obtain an understanding of the quality of this product which is sold packed in polypropylene bags at supermarkets. The survey showed that the product had a high moisture content (≥25% dry wt) and hence should be categorised as an intermediate-moisture product rather than as a dried product. It also had a high percentage breakage, a considerable amount of foreign matter, high water activity from 0.663 to 0.700 and total lipid of 7.0 - 8.6%. The organoleptic quality of most samples was acceptable. This survey showed that the quality of this product at retail outlets could be improved.

The following are suitable quality indicators: percentage breakage, protein content, salt content, ash and acid insoluble ash, but they need not be monitored in storage studies. The suitable quality indices for quality changes of this product were identified as moisture content, water activity, total volatile basic nitrogen, total lipid, peroxide value, thiobarbituric acid number, colour and sensory evaluation. Trimethylamine nitrogen is, however not a suitable parameter.

The effect of storage at different conditions (refrigerated: 7±2°C, 80% RH; room temperature exposed to light and kept in the dark: 27±40°C, 73±16% RH) on the shelflife of the product was also investigated. The samples were again found to have a high moisture and hence mould growth was the main contributor to spoilage at room temperature. Refrigerated storage extended the shelflife beyond six weeks, yielding a fairly good quality product. However it caused the moisture and water activity to increase with storage. The shelflife of samples stored at room temperature exposed to light was 4 weeks and those in the dark was two weeks.

Drying and vacuum packing were done to study their effect on shelflife extension. The samples were further dried to a moisture of ≤25% (dry weight) using the oven and low temperature vacuum dryer, then vacuum packed and stored in an air-conditioned room. These were compared with two other samples that were not further dried; one lot was stored exposed at room temperature and the other was vacuum packed and stored in an air-conditioned room. The samples were monitored weekly for the first 6 weeks and thereafter monthly. The first 6 weeks of this experiment is reported here; these preliminary results showed that further drying and vacuum packaging effectively reduced the moisture and also retarded mould growth. Thus the product is still fairly good even after six weeks.

Note: This paper was presented at the Seminar by Ms Low.

Introduction

Anchovies found in the region are mainly *Stolephorus* sp. Of the 344,918 mt landed in 1988, Indonesia caught 33.5% (115,601 mt), Malaysia 9.3% (32,065 mt), Philippines 36.6% (126,373 mt), Singapore 0.02% (543 mt) and Thailand 20.1% (69,378 mt) (SEAFDEC, 1988). The total value of the anchovies caught in 1988 was US$108,213,000. Wholesale prices were US$0.64 in the Philippines, US$0.52 in Malaysia, and US$0.65 in Singapore (SEAFDEC, 1988).

The anchovies are usually processed by traditional methods into boiled, dried products. Boiled, dried anchovies are a popular food item in Southeast Asian countries. They are usually used as a flavouring condiment in soups and vegetable dishes or consumed fried with peanuts as a snack. Pulverised boiled, dried anchovies are also added to infant and young children's porridge as a supplementary source of calcium.

The current processing of boiled, dried anchovies is a low-technology operation resulting in a product of inconsistent quality and short shelflife. Freshly caught anchovies are usually processed on board after being caught by purse seine (as practised in West Malaysia) or on the *kelong* (as practised in Tanjong Pinang, Indonesia). They are first boiled in about 10% brine solution then removed from the brine solution and allowed to drain and cool. The cooked anchovies are then brought to shore where they are spread on straw mats on the ground and sun-dried. The drying process usually takes one fine day, or more under less sunny conditions. The dried products from Malaysia usually arrive in Singapore in large plastic bags, boxed in paper cartons, and those from Indonesia in large polyethylene-lined jute sacks. The retail price of boiled, dried anchovies in Singapore ranged from S$5.00 to S$8.00 per kg.

The quality of the final product is highly dependent on the processors' skills and the weather. In the hot and humid climate of this region, poor handling causes the quality of boiled, dried anchovies to deteriorate rapidly. As the anchovy catch in this region is large, and since boiled, dried anchovies are a popular food item, quality and preservation studies are important to upgrade the product and to extend shelflife.

This paper comprises three parts. Part I is a quality survey of boiled, dried anchovies sold in local supermarkets. Part II is a study of the quality deterioration and shelflife of the product under room temperature and refrigerated storage. Part III is a study of the effects of a moisture content level of 25% (dry weight) and of vacuum packing on the shelflife of the product.

Part I - Quality Survey Of Boiled, Dried Anchovies

Objective

A survey of boiled, dried anchovies was conducted to evaluate the present quality of this product and to identify areas for improvement.

Materials And Methods

Ten supermarkets were surveyed and 29 samples tested. The boiled, dried anchovies randomly sampled at these supermarkets were packed by four dried food packing companies which will be referred to as Suppliers SF, M, LKT, and UF. The boiled, dried anchovies are usually packed in polypropylene bags with net weights of either 75 or 100 g. Except for Supplier M, the companies usually seal the bags without vacuum. Supplier M also included oxygen-absorbent satchets in each package.

The packets of anchovies were brought to the laboratory and the following parameters were studied: total length (cm), total weight (g), percentage breakage (%), oxygen levels in the package (%), moisture content (%), water activity (Aw), salt (NaCl) content (%), trimethylamine-nitrogen (TMA-N, mg/100 g), total volatile basic nitrogen (VB-N, mg/100 g), total lipid content (TL, %), acid value (AV), peroxide value (PV, meq/kg) and thiobarbituric acid number (TBA). All analyses were carried out according to the methods in Hasegawa (1987).

Results And Discussion

The boiled, dried anchovies which originated from Malaysia had mean total lengths of 3.26 - 3.65 cm, and were categorised as small, based on the Malaysian Standard (SIRIM, 1984). According to the Japan Agricultural Standard (JAS, 1969), anchovies of body length between 3.0 and 7.5 cm are categorised as small. The mean total weight of individual fish was 0.19 g. The percentage breakage ranged from 17.9 to 35.6% and can be considered as Grade C by SIRIM. However if compared with JAS, then Suppliers UF had Grade A quality, Supplier LKT and M had Grade B quality and Supplier SF had Grade C quality.

Foreign matter was found in all samples, mainly in the form of small, dried shrimps, shells, jute fibres and other species of small fishes. The percentage of foreign matter based on the net weight of the products ranged from 0.6 to 2.0%. Only Supplier M vacuum-sealed the products - although not always - and with a mean oxygen level of 12.9%. The oxygen levels in the other samples ranged from 18.2 to 20.6%. Salt content of individual samples ranged from 5.4 to 12.0% (dry weight) indicating inconsistent quality and processing control.

The products were slightly moist to touch with moisture content ranging from 25 to 33.5% (dry weight). This is high compared to JAS standard of 20% (wet weight) or 25% (dry weight) for small boiled, dried sardines. The water activity (Aw) ranged from 0.663 to 0.700. As confirmed by subsequent observation, this moist product was susceptible to fungal and bacterial attack. The high moisture content of the boiled, dried anchovies qualifies this product to be categorised as an intermediate-moisture product rather than as a dried product.

The boiled, dried anchovies had lipid contents ranging from 7.0 to 8.6%. Even though the acid values ranged from 21.7 to 25.6, the peroxide values from 14.0 to 31.1 meq/kg and the TBA number from 16.9 to 21.4, no obvious rancid odour was observed. Most of the samples however had yellow bellies, an indication of fat oxidation.

The TMA-N levels ranged from 2.46 to 3.01 mg/100 g and VB-N was 22.03 to 23.25 mg/ 100 g showing that the samples were of average quality. The VB-N levels of most samples were not high enough to cause the anchovies to have ureal odour though one individual sample with VB-N of 35.5 mg/100 g had a distinct ureal odour.

Sensory evaluation of the samples showed that 86% had fresh odour, 10% mouldy odour and 3% were rejected because of stale and ureal odour. Moulds were present in 41% of the samples and 7% showed the presence of halophilic bacteria in the form of pink growth spots on the body. The samples ranged from yellow to brown-grey in body colour with grey eyes. The majority (93%) were of acceptable standard in terms of general appearance, 3% were of borderline quality and 3% were of reject quality. This unexpectedly high percentage of acceptance is due to the higher tolerance of local consumers to the presence of moulds on the products and lower expectation regarding product colour.

The survey gives a good understanding of the quality of boiled, dried anchovies in local supermarkets. The quality is considered to be superior to that usually found at wholesale and other retail outlets such as wet markets and provision shops.

Conclusion

The survey showed that although boiled, dried anchovies available in Singapore were generally of acceptable quality, there is much room for improvement. The main problems identified were inconsistent quality due to the lack of quality control in processing, quality deterioration due to overexposure to high temperatures and humid climate, and mould infestation due to high moisture content. Poor packing and handling conditions at the manufacturing, wholesale and retail levels also contribute to quality deterioration. The high moisture content of this product disqualifies it as a dried product. Thus the anchovies presently available in Singapore should be re-classified as an intermediate-moisture product.

To upgrade the product and extend its shelflife, the product should have a lower moisture

content. Care should be taken in packing to sort out and reduce the amount of foreign matter present and to lower the percentage of breakages. The product could be vacuum packed to reduce exposure to moisture and oxygen in order to slow down mould infestation and lipid oxidation.

Part II - Quality Deterioration And Shelflife Of Boiled, Dried Anchovies Under Room Temperature And Refrigerated Storage

Objective

The objective of this study is to identify suitable indices for quality changes of boiled, dried anchovies during storage; and to study changes of the product under different storage temperatures.

Materials And Methods

Freshly processed boiled, dried anchovies were purchased from Tanjong Pinang, Indonesia. On arrival at the laboratory, the moisture, salt, ash, lipid and protein content were determined. The anchovies were then packed in polyvinylidene chloride coated with biaxially oriented polypropylene vacuum bags (KOP/NEO), vacuumed and stored at -60°C for about a month.

For the present investigation the materials were thawed overnight at room temperature, packed into double-layered brown paper bags, and stored under different conditions as follows:

1) Refrigerated storage (7±2°C and 80% RH),
2) Room temperature, exposed to light (27±4°C and 73+16% RH), and
3) Room temperature, kept in the dark (27±4°C and 73+16% RH).

At weekly intervals, the samples were monitored for changes in the total lipid (TL), peroxide value (PV), thiobarbituric acid number (TBA), trimethylamine-nitrogen (TMA-N), total volatile basic nitrogen (VB-N), moisture, ash and salt (Hasegawa, 1987), and acid insoluble ash (using the Malaysian Standard, 1984). Water activity was determined using the Novasina Thermoconstanter and colour (CIE.Lab system) using Minolta Colour Meter Model R-200. Percentage breakage was determined based on the percentage of un-intact fish in 50 g samples. Sensory evaluation was carried out using a round table discussion panel of seven members and by a triangle-preference test with 10 panelists.

Results And Discussion

On arrival from Tanjong Pinang, the freshly processed boiled, dried anchovies had 43.26% moisture, 7.98% salt, 19.86% ash, 6.38% lipid and 76.86% protein based on dry weight.

The salt content, ash and acid insoluble ash did not change during storage under the various storage conditions. The salt content ranged from 7.19 to 8.10%. The stable ash content ranging from 19.19 to 20.92% dry weight under the different storage conditions and time indicate that the mineral content of the samples is independent of the storage condition and time. The acid-insoluble ash content of 0.13 to 0.44% showed that the level of impurities was low and unaffected by storage conditions and time. According to the Malaysian Standard, acid-insoluble ash should not exceed 1.5% by weight.

The product with a higher percentage of intact fish command a higher price. Hence, the percentage breakage should be low. The percentage breakage ranged from 30.6 to 60.3%. The values were generally high when compared with the Malaysian Standard which requires less than 5% percentage breakage for Grade A, 5 - 10% for Grade B and greater than 10% to be Grade C. Thus all samples in this study would then be Grade C. But if compared with the JAS the samples were either of Grade C (≥30% and ≤50%) or Grade D (≥50%).

The moisture content and water activity levels were high for a dried product. Refrigerated storage increased the moisture content and water activity with time from 43.26 to 57.51% and 0.768 to 0.848 respectively, after 6 weeks. The high

humidity (80% RH) in the refrigerator resulted in the moisture and water activity of the refrigerated samples to be higher than those held at room temperature. However, the lower temperature retarded the rate of mould growth in the samples. When mould growth was detected in the samples stored at room temperatures the Aw was 0.760 for samples exposed to light and 0.746 for those in the dark. At these Aw mouldy odours were also detected (Table 1).

No clear trend in the changes of TMA-N with storage was observed. The values fluctuated randomly and hence TMA-N is not a suitable quality index for boiled, dried anchovies. The VB-N of the samples stored at room temperatures increased significantly ($P<0.05$) with storage (Fig 1). When the values exceeded 111.6 mg/100 g (dry weight) a distinct ammoniacal/ureal odour was detected in the samples. However this was masked by the even stronger mouldy odour. The VB-N of the refrigerated samples however did not change with

Table 1. Sensory evaluation of boiled, dried anchovies (from Tanjong Pinang) during storage under room temperature and refrigerated storage conditions.

Storage Conditions	Storage Time (week)	Odour	Colour	Texture	Mould	Overall
Refrigerated (7 ± 2°C)	1	Fresh	Yellow	Slightly moist & soft	Not mouldy	Acceptable
	2	Fresh	Yellow	Very slightly moist & soft	Not mouldy	Acceptable
	3	Fresh	Yellow	Pliable, moist & soft	Not mouldy	Acceptable
	4	Fresh	Yellow	Slightly damp	Not mouldy	Acceptable
	5	Fresh	Yellow	Slightly damp	Not mouldy	Acceptable
	6	Fresh	Yellow	Slightly firm	Not mouldy	Acceptable
Room temperature/ light (27 ± 4°C)	1	Fresh	Yellow-brown	Dry, firm	Not mouldy	Acceptable
	2	Fresh	Brown	Dry, firm	Not mouldy	Acceptable
	3	Stale	Brown	Dry, firm	Not mouldy	Acceptable
	4	Off-odour	Brown	Firm	Slightly mouldy	Borderline
	5	Mouldy	Brown	Firm	Very mouldy	Unacceptable
	6	-	-	-	-	-
Room temperature/ dark (27 ± 4°C)	1	Fresh	Yellow-brown	Dry, firm	Not mouldy	Acceptable
	2	Slightly rancid	Yellow-brown	Dry, firm	Not mouldy	Acceptable
	3	Mouldy	Brown	Dry, firm	Mouldy	Unacceptable
	4	-	-	-	-	-
	5	-	-	-	-	-
	6	-	-	-	-	-

- means that the experiment was terminated.

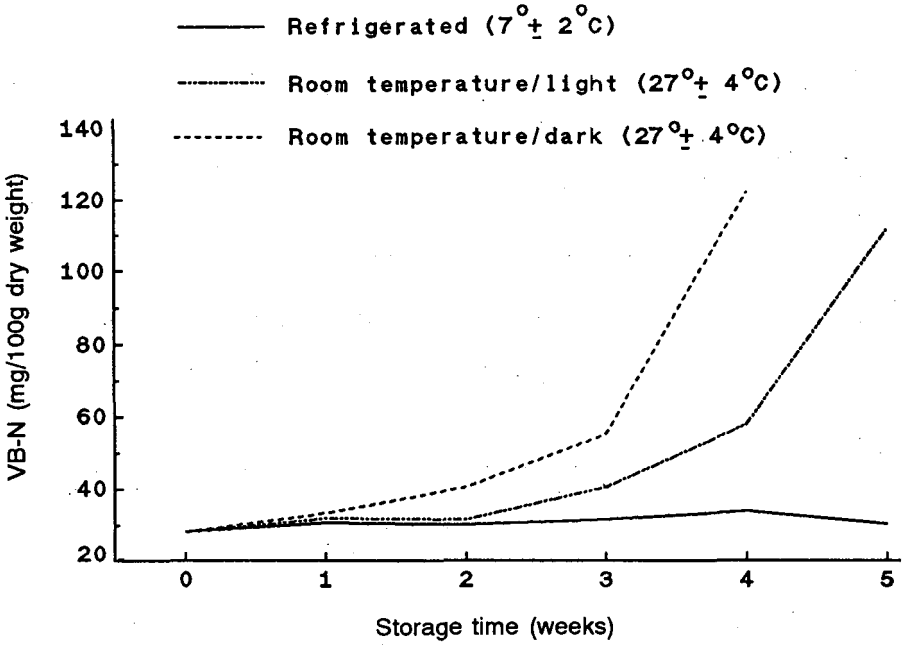

Fig. 1. Changes in total volatile basic nitrogen of boiled, dried anchovies during storage under various conditions.

storage time indicating that low temperature storage slows down the formation of volatile amines. When stale, off-flavour and mouldy odour were detected in the samples (Table 1), the VB-N values were 40.5 mg/100 g (dry weight basis).

The lipid deterioration of boiled, dried anchovies under various conditions during storage were determined by PV and TBA. The PV in general decreased with storage time likewise with the TBA. During the study, slight rancid odours were detected in samples stored in the dark at room temperature after 2 weeks of storage (Table 1). The high initial PV (39.1 meq/ kg) and TBA (81.0) values seem to indicate that the original samples are already fairly badly oxidised and the subsequent decreases in PV and TBA are actually indications of the degradation of peroxides and malonaldehydes to other breakdown products.

The samples stored at room temperatures developed deeper yellow colour with storage time (Fig 2). The low temperatures of refrigerated storage helped to slow down the yellowing process. When the samples were discarded, the b-values (yellowness) were +18.6 for samples kept at room temperature and exposed to light, and +17.2 for samples kept at room temperature in the dark.

Sensory evaluation (Table 1) showed that the refrigerated samples had fresh odour throughout storage and were of acceptable quality. No moulds were present throughout the storage period. The only disadvantage was that the samples were slightly moist and soft. Samples kept at room temperature in the dark had mould growth after three weeks, and had to be discarded. For those kept at room temperature exposed to light, stale odour developed on the third week, and after four weeks off-odour and the presence of moulds were detected. The samples which were badly infested by moulds at five weeks emitted a mouldy odour, and were discarded.

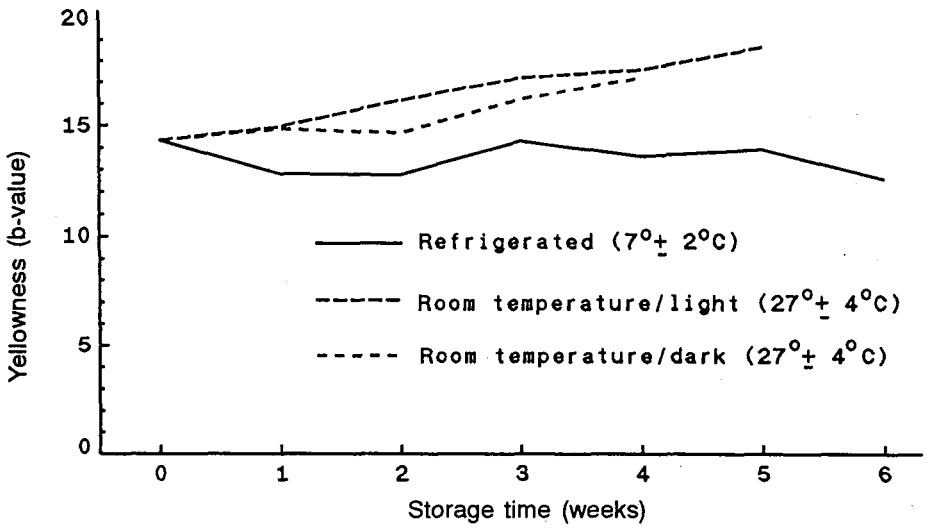

Fig. 2. Changes in the yellowness (b value) of boiled, dried anchovies during storage under various conditions.

Conclusion

From this set of data, the following were found to be suitable quality indices of boiled, dried anchovies, especially for storage studies: moisture content, water activity, total volatile basic nitrogen, total lipid, peroxide value, thiobarbituric acid number, and colour. It was recommended that acid value be included as one of the parameters for future studies. The following are good quality indices but are not necessary for continuous monitoring in a storage study: percentage breakage, protein content, salt content, ash and acid insoluble ash. Sensory evaluation is essential to complement and correctly interpret the chemical data.

The shelflife of boiled, dried anchovies stored at room temperature was four weeks when exposed to light and two weeks when kept in the dark. Refrigerated storage enabled the samples to be stored beyond six weeks.

As observed in the previous survey, the moisture of these products was also high and mould growth was also the main problem. Thus, the following study was conducted to study the effect of reduced moisture (25% dry weight) on shelflife.

Part III - Study Of The Effect Of Moisture Content Of 25% (Dry Weight) And Vacuum Packing On Shelflife

Objectives

The effect of reducing the moisture of boiled, dried anchovies to 25% (dry weight) and vacuum packing on shelflife was studied using different methods of reducing the moisture.

Materials And Methods

Good quality boiled, dried anchovies were purchased from Pasir Panjang Wholesale Market. They arrived from Malaysia 4 days before they were used for study. The moisture, water activity,

salt, ash, acid insoluble ash, protein content, total volatile basic nitrogen, total lipid, acid value, peroxide value and thiobarbituric acid number were determined for the O-day sample. Colour was determined using the Minolta CR-200 Colour Meter. Sensory evaluation was also done. For subsequent storage study salt, ash, acid insoluble ash and protein content were not monitored because, as observed in the previous study, they are not affected by the length of storage.

The samples were divided into four lots and subjected to four different treatments as follows:

Lot CI:

The boiled, dried anchovies were not further dried but simply stored in loose form in a box lined with plastic sheets on the inside to simulate the practice at the wholesale center. The box was covered with a fine wire mesh to keep out cockroaches, lizards, rats and cats. The box was left at room temperature (23 - 29°C, 57 - 91% RH) and three samples were taken from it weekly for monitoring.

Lot CII:

The boiled, dried anchovies were not further dried but were packed in KOP/NEO bags. Each vacuum sealed bag contained about 100 g of anchovies. They were stored in an airconditioned room (22 - 26°C, 56 - 71% RH). Three packets were used for each weekly monitoring.

Lot CIII (OVEN):

The boiled, dried anchovies were further dried in an oven at 35±1°C for 3 hr till the moisture of the anchovies was about 25% (dry weight). They were than packed into KOP/ NEO bags (100 g each), vacuum sealed and stored in an air-conditioned room (22 - 26°C, 56 - 71% RH). Three packets were used for each weekly monitoring.

Lot CIV (VACUUM):

The boiled, dried anchovies were further dried in a low temperature, vacuum dryer at 20±1°C (fish temperature) for $2\frac{1}{2}$ hr until the moisture of the anchovies was about 25% (dry weight). They were then packed in KOP/NEO bags (100 g each), vacuum sealed and stored in an air-conditioned room (22 - 26°C, 56 - 71% RH). Three packets were used for each weekly monitoring.

KOP/NEO bags are made of polyvinylidene chloride (PVDC) coated with biaxially oriented polypropylene (OPP) with excellent moisture proofing, water proofing, oil proofing, gas impermeability and transparency characteristics.

All the samples were monitored weekly for six weeks and treatments CII, OVEN and VACUUM were monitored monthly thereafter. As this study is still in progress, the results of the first six weeks of storage will be reported and discussed here.

Results And Discussion

On arrival, the boiled, dried anchovies had a moisture of 36.1% (dry weight), water activity of 0.702, salt content of 13.0% (dry weight), ash of 26.82% (dry weight), acid insoluble ash of 0.18% (dry weight) and protein content of 44.2% (dry weight). The total volatile basic nitrogen was 14.8 mgN/100 g (dry weight), total lipid content was 6.3% (dry weight), acid value was 21.3, peroxide value was 23.8 meq/kg and thiobarbituric acid was 38.4. Compared with those from Tanjong Pinang which were used in the previous study, these samples were of better initial quality.

The samples at O-day were white-yellow (Table 2a & b). During storage the yellowness increased significantly ($P<0.05$; Fig 3) for all 4 treatments (CI, CII, OVEN and VACUUM). Yellowing of the boiled, dried anchovies is due to rancidity and non-enzymatic browning reactions. After 1 week, all the treated samples were significantly yellower than the O-day sample. As storage progresses, all the other samples were significantly ($P<0.05$) yellower than the VACUUM.

Table 2a. Sensory evaluation of boiled, dried anchovies (from wholesale market) which were not further dried, and stored under different storage conditions.

Storage Conditions	Storage Time (weeks)	Odour	Colour	Texture	Mould	Bacterial Spots	Insect Infestation	Overall
	0	Fresh	White	Firm	Not mouldy	Absent	No	Acceptable
	1	Fresh	White-yellow	Firm	Not mouldy	Absent	Yes	Acceptable
CI: No further drying; loose form, room temperature	2	Fresh	Yellow	Firm	Not mouldy	Absent	Yes	Acceptable
	3	Fresh	Yellow	Slightly soft, moist	Mouldy	Absent	Yes	Acceptable
(23 - 29°C,	4	Fresh	Yellow-brown	Slightly soft, moist	Mouldy	Absent	Yes	Acceptable
57 - 91% RH)	5	Fresh	Brown	Soft, very moist	Mouldy	Present	Yes	Borderline
	6	Stale	Brown	Soft, very moist	Mouldy	Present	Yes	Borderline
	0	Fresh	White	Firm	Not mouldy	Absent	No	Acceptable
CII: No further drying; vacuum packed; air-conditioned temperature	1	Fresh	White-yellow	Firm	Not mouldy	Absent	No	Acceptable
	2	Fresh	Yellow	Firm	Not mouldy	Absent	No	Acceptable
	3	Fresh	Yellow	Firm	Not mouldy	Absent	No	Acceptable
	4	Fresh	Yellow	Firm	Not mouldy	Absent	No	Acceptable
(22 - 26°C,	5	Fresh	Yellow-Brown	Firm	Slightly mouldy	Absent	No	Acceptable
56 - 71% RH)	6	Fresh	Yellow-Brown	Firm	Mouldy	Absent	No	Acceptable

Percentage breakage is a good indicator of quality which does not significantly change during storage; the percentage breakage ranged from about 8 to 18%. These results showed that proper handling and packing of the samples reduced the extent of breakage when compared to the results of the previous study. The samples in this study could be categorised as Grade A according to JAS and Grades B and C according to the Malaysian Standard.

The moisture content of CI and CII samples was significantly higher ($P<0.05$) than the moisture content of the OVEN and VACUUM samples throughout the whole study (Fig 4). Further drying and vacuum packing enabled the samples to maintain a stable moisture of about 25±2% throughout the whole six weeks.

Water activity did not change significantly ($P<0.05$) with storage time for all treatments (Fig 5). However, for all weeks, the water activity of OVEN and VACUUM samples was significantly ($P<0.05$) lower than those of CI and CII samples. VACUUM samples had the lowest water activity. The Aw in general ranged from 0.647 to 0.704. The lower Aw as compared to samples from Tanjong Pinang resulted in the presence of mould only after five weeks of storage for CI samples (Table 2a).

Table 2b. Sensory evaluation of boiled, dried anchovies (from wholesale market) which were further dried, and stored under different storage conditions.

Storage Conditions	Storage Time (weeks)	Odour	Colour	Texture	Mould	Bacterial Spots	Insect Infestation	Overall
CIII (OVEN):	0	Fresh	White	Firm	Not mouldy	Absent	No	Acceptable
Dried in oven	1	Fresh	White-yellow	Firm	Not mouldy	Absent	No	Acceptable
at 35 ± 1°C								
for 3h; vacuum	2	Fresh	White-Yellow	Firm	Not mouldy	Absent	No	Acceptable
packed; air-								
conditioned	3	Fresh	Yellow	Firm	Not mouldy	Absent	No	Acceptable
temperature	4	Fresh	Yellow	Firm	Not mouldy	Absent	No	Acceptable
(22 - 26°C,	5	Fresh	Yellow-brown	Firm	Not mouldy	Absent	No	Acceptable
56 - 71% RH)								
	6	Stale	Yellow-brown	Firm	Not mouldy	Absent	No	Acceptable
CIV (VACUUM)	0	Fresh	White	Firm	Not mouldy	Absent	No	Acceptable
Dried in	1	Fresh	White-yellow	Firm	Not mouldy	Absent	No	Acceptable
vacuum dryer								
at 20 ± 1°C for	2	Fresh	Yellow	Firm	Not mouldy	Absent	No	Acceptable
2.5h; vacuum	3	Fresh	Yellow	Firm	Not mouldy	Absent	No	Acceptable
packed; air-	4	Fresh	Yellow	Firm	Not mouldy	Absent	No	Acceptable
conditioned	5	Fresh	Yellow	Firm	Not mouldy	Absent	No	Acceptable
temperature	6	Fresh	Yellow-Brown	Firm	Not mouldy	Absent	No	Acceptable
(22 - 26°C,								
56 - 71% RH)								

The total volatile basic nitrogen increased significantly ($P<0.05$) with storage time for all treatments (Fig. 6). The vacuum packed samples had significantly higher VB-N than the loose samples (CI) as the volatile vapours were trapped in the package. The values were low compared with those from Fig 1 and no off-odours were detected in these samples. The values obtained ranged from 14.8 to 22.2 mgN/100 g (dry weight).

The total lipid content did not vary significantly ($P<0.05$) with storage and range from 5.9 to 7.3% (dry weight). The acid value increased significantly ($P<0.05$) with storage time for CI, CII and VACUUM (Fig 7). Generally OVEN and VACUUM samples had the lowest acid values. Peroxide values increased and then decreased with storage time for all treatments (Table 3). CI and. OVEN samples peaked at week 2 and then declined. The VACUUM sample peaked at week 3. The VACUUM samples had lowest PV throughout. TBA decreased significantly ($P<0.05$) with storage (Fig 8).

Sensory evaluation (Tables 2a and 2b) showed that vacuum packaging was highly effective in maintaining the fresh odour and firm texture of the samples, and in delaying mould growth and

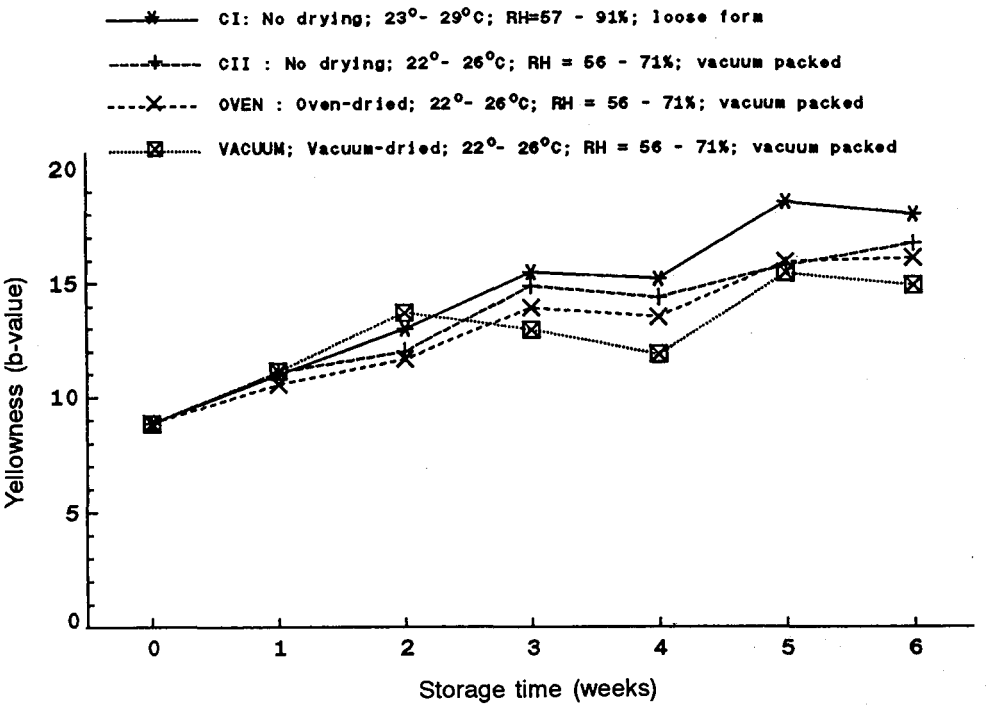

Fig. 3. Changes in the yellowness (b value) of boiled, dried anchovies with storage.

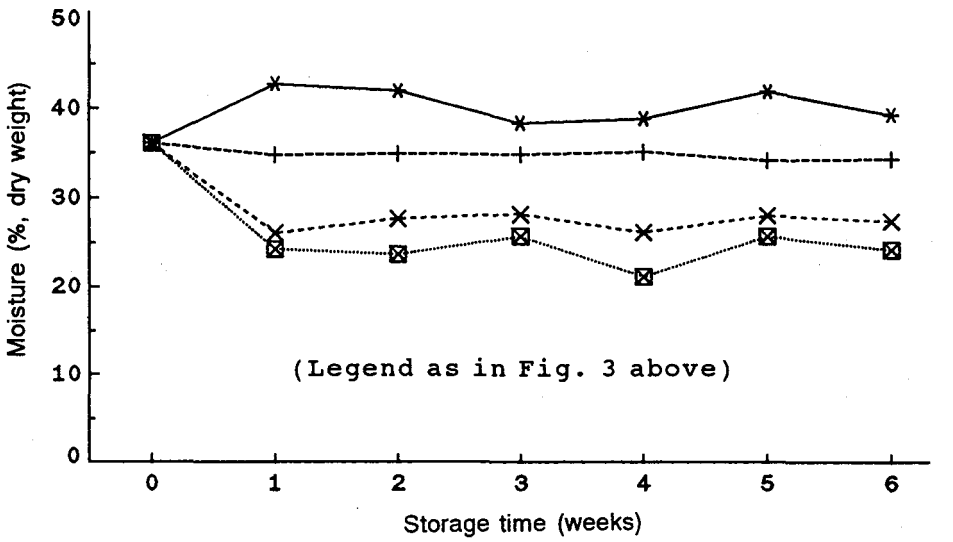

Fig. 4. Changes in the moisture content (%, dry weight) of boiled, dried anchovies under various conditions.

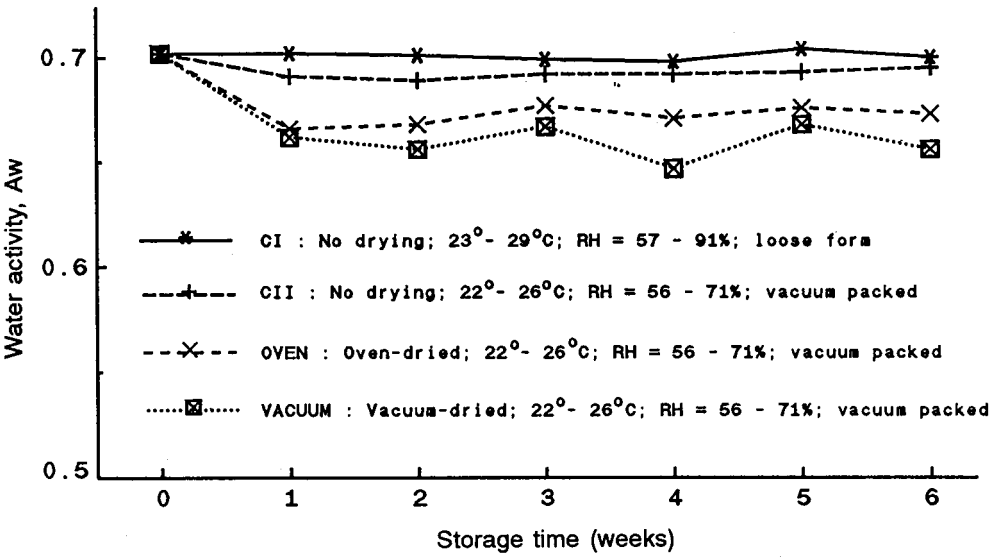

Fig. 5. Changes in water activity of boiled, dried anchovies under various conditions.

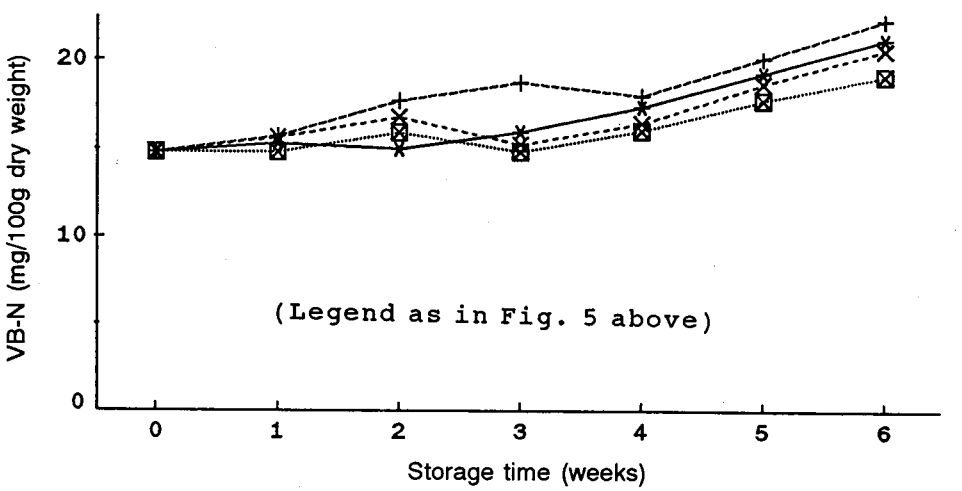

Fig. 6. Changes in the total volatile basic nitrogen (VBN) of boiled, dried anchovies under various conditions.

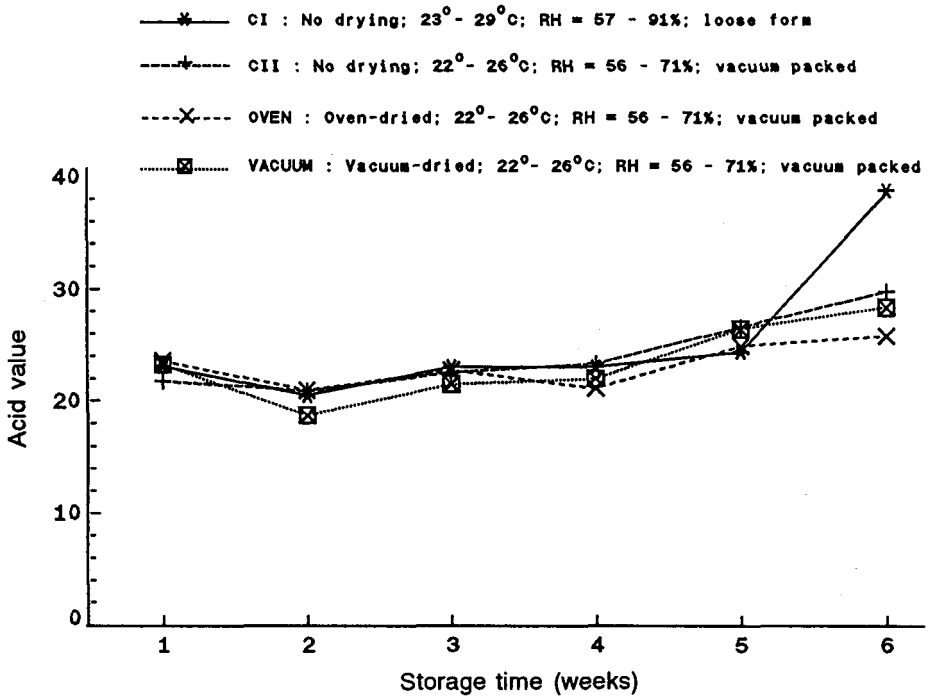

Fig. 7. Changes in acid value of boiled, dried anchovies with storage.

Table 3. Changes in peroxide value (PV) of boiled, dried anchovies under various storage conditions.

Treatment*	Storage time (weeks)					
	0	1	2	3	5	6
CI	23.76 ± 0.78	22.69 ± 4.45	36.15 ± 0.99	30.60 ± 3.64	32.60 ± 2.40	34.12 ± 1.26
CII	23.76 ± 0.78	36.06 ± 1.93	29.16 (n=1)	34.69 ± 2.22	18.68 ± 3.12	27.19 ± 0.72
OVEN	23.76 ± 0.78	39.15 ± 0.15	48.23 ± 3.42	20.95 (n=1)	21.98 ± 0.26	23.80 ± 0.94
VACUUM	23.76 ± 0.78	16.95 ± 0.91	25.90 ± 1.04	29.94 ± 1.57	17.62 ± 3.50	23.70 ± 0.79

* Legend as shown in Fig. 7 above

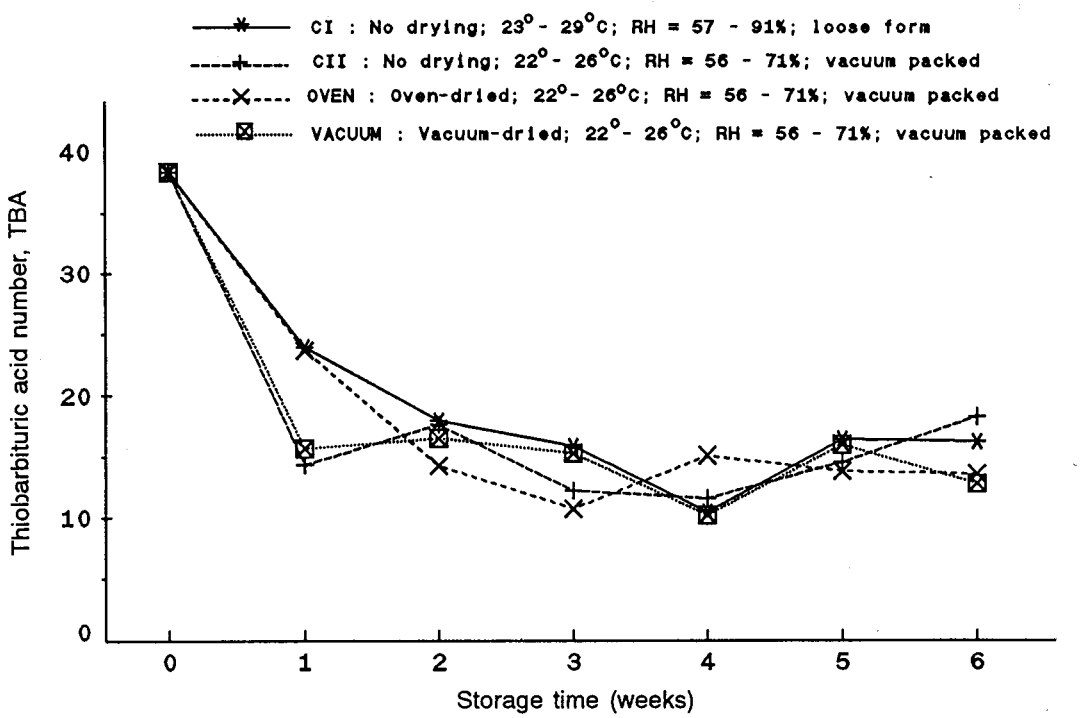

Fig. 8. Changes in thiobarbituric acid number (TBA) of boiled, dried anchovies under various conditions.

preventing insect infestation. Moulds managed to grow in CII samples because of the higher moisture content. CI samples were of borderline quality after five weeks of storage at room temperature. The better initial quality of the raw materials used in this study enabled the shelflife of this product under room temperature to be extended almost two-fold compared to those from Tanjong Pinang. The rest of the samples were still acceptable; as this study is still in progress, the shelflife limits for the various treatments will be reported later.

Conclusion

The results of this study showed that simple steps of further drying the boiled, dried anchovies and vacuum packing them were effective in maintaining its quality and extending shelflife. Samples that were vacuum dried under low temperatures yielded a better quality product.

In Singapore, boiled, dried anchovies are imported from our neighbours. Although, local packers have little influence on processing methods, however, further drying and vacuum packing are simple steps they can take in order to upgrade their products.

Since the South China Sea is an abundant anchovy resource and boiled, dried anchovy a popular food item of Southeast Asian countries, it is important to maximise anchovy utilization and reduce wastage due to spoilage as a result of poor processing and handling of the processed product. Results from this series of studies show that there can be much improvement in the processing methods and processing controls, re-processing and packaging of this commodity in this region.

The improved product does not only have the potential to fetch a higher price but is also a potential for export to Asian communities in America and Europe.

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Discussion

A query about the method used to analyse the presence of mould and how it was quantified was raised. In reply, Ms Low said that in the study, only organoleptic assessment and visual observations were conducted.

An explanation was sought as to why a decrease in the TMA-N after two weeks storage was not reflected in a corresponding decrease in the VB-N values. Ms Low replied that this fluctuation was also observed in other studies on the anchovy, and consequently she had recommended that the TMA-N is not a good quality index for the boiled-dried anchovy. There was no definite reason to explain this irregular fluctuation.

Asked why samples kept in the dark at room temperature deteriorated faster than those kept in the light. Ms Low replied that the samples kept in the dark trapped the VB-N within, and when assessed organoleptically, were of poorer odour and hence poorer organoleptic assessment grading. She added that the samples in the dark had more abundant mould growth.

Histamine Content Changes During Processing Of Canned Tuna By Indonesian Canning Factories

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Abstract

An assessment was carried out on histamine content of three canning factories. These factories are located in East Java (A), Bali (B) and North Sulawesi (C). Histamine contents were assessed along various stages of their processing.

Results showed that histamine contents changed during processing of canned tuna in both A and B factories and that they increased significantly especially after steaming. In contrast, decreasing histamine content was noted during processing of canned tuna at factory C. These results seem to stem from the fact that a lot of raw material was processed by factories A and B. Histamine was probably produced during delays along the processing line. This was in contrast to factory C in which a special tuna fish was processed for the study and only a small quantity of fish was going through at the time.

Introduction

Canned tuna production in Indonesia has increased during the last ten years and many factories are trying to increase their production. During the same period many factories have been established at many sites in Indonesia. Various parameters are used for determining the quality of canned tuna; but a specific parameter that reflects the hygienic condition at the canned tuna factory is histamine content. High histamine levels are found usually in spoiled tuna and other scombroid fish that have high levels of histidine in their muscle tissue. Studies by many researchers have showed that histamine formation from histidine is caused by histidine decarboxilase enzyme activity, which is present in many types of organisms especially *Proteus morganii*. The presence of histamine in canned tuna is considered to be an indicator of earlier microbial decomposition and reflects the hygienic level of the handling and processing stages.

In order to determine critical points for histamine formation in canned tuna processing, histamine content was assessed at each stage of processing in three tuna canning factories.

Materials And Methods

Samples Collection (Sampling)

Samples, including tuna flesh and canned products were collected from factory A which represented factories in east Java, factory B representing factories in Bali, and factory C representing two factories in North Sulawesi.

Samples included frozen tuna as raw materials, thawed tuna, steamed tuna and canned tuna (end products). Samples were taken randomly from A and B factories, with three replications.

Triplicate samples at the above stages of processing were collected from factory C.

Note: This paper was presented at the Seminar by Dr Sunarya.

Analysis Method

Histamine analysis was carried out at the National Center for Fishery Quality Control and Processing Technology Development (NCQC), Jakarta. The analysis used the spectrophotometry method of AOAC, 14th edition (1984).

Muscle tissues were weighed accurately at the factory's laboratory, put in sampling bottles which contained methanol, stored in a styrofoam box containing ice and transported to the NCQC, Jakarta. At the NCQC laboratory, samples in methanol medium were homogenized and analysed.

All histamine analyses for canned tuna samples were done in the NCQC laboratory using AOAC procedure.

Results And Discussion

Although muscle-tissue samples were analysed at Jakarta, the date of histamine content was considered to be the date of sampling because samples were stored in methanol. In this condition, micro-organisms were not able to grow and no changes in histamine content of fresh, thawed and steamed tuna took place during transportation to the laboratory (2 - 3 days). Also, the histamine content of canned tuna sample did not change during transportation to Jakarta because the canned products had been sterilized and packed under vacuum condition. The overall results of histamine content changes during processing of canned tuna produced by three factories are shown in Fig.1.

Fig.1 shows that histamine content seems to have increased during processing in A and B factories. Increase of histamine content, for A and B factories started from stage 1 to 2 in which, during thawing, micro-organisms probably started to grow. At the time of our visit to these two factories, large quantities of raw material were being processed. This delayed the processing of some raw material and during this stage, histamine was produced. Between stages 2 and 3, in which the fish was pre-cooked, the histamine content seemed to have increased. In these stages, theoretically, the amount of histamine would not change, but the increase of histamine content was probably due to a decrease in moisture content. During precooking of skipjack tuna at some canning factories, we found weight loss of approximately 20 to 24% by weight as a result of decreasing moisture content. Significant changes of histamine content took place in factories A and B between stages 3 and 4 in which the dark muscles were separated manually.

Because of the abundance of raw material in A and B factories, much time was taken up in processing. Contamination of micro-organisms from workers might occur, causing an increase in histamine content.

In contrast, the histamine content of canned tuna produced by factory C decreased along all stages of processing.

Decreases of histamine content occurred at stages 1 and 2. Raw materials (fresh fish) were gutted and washed. Decreases of histamine content in these stages were probably due to washing. The decreases of histamine content during processing in all stages at factory C, may have been a function of the small quantity of raw material being processed and the consequent lack of any delay. This resulted in almost no histamine changes at all stages, other than stages 1 and 2.

It can be seen from Fig.1, that histamine contents in tuna as raw materials in A and B factories were 0.73 mg % and 0.30 mg % respectively. These were much lower than that in C factory (3.6 mg %). This lower value in factories A and B seems to result from better handling applied on board and during transportation in East Java and Bali than in north Sulawesi, which supplied material to factory C.

On the basis of this assessment, we conclude that the histamine contents of canned tuna produced by these three factories were lower than 20 mg % - permitted level for canned tuna applied in the US market. All values found were also lower than 5 mg % which is the permitted level of histamine applied by buyers in western countries.

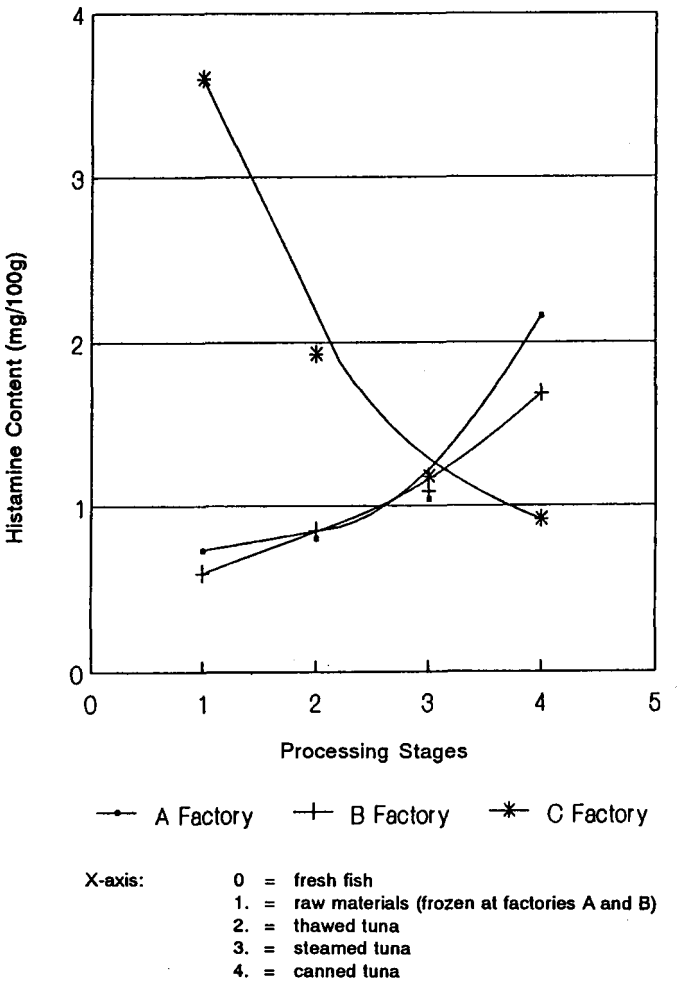

Fig. 1. Histamine content changes during processing of canned tuna.

Conclusions And Recommendation

This assessment concludes that the critical points of histamine formation during the processing of tuna in factories A and B were the thawing and dressing stages. This was due to the large quantity of raw material being processed. The histamine content of the raw material used in factories A, B and C varied, depending on the handling and transportation. However, they were lower than the permitted level mandated in some countries, in particular the USA and other western countries.

In order to maintain the lower histamine content during the processing of tuna in these canning factories, it is recommended that the efficiency of production be increased and that the risk of contamination be held to the lowest possible level.

Future studies, in particular HACCP, can be attempted in other factories, and parameters other than histamine can be used to control the quality of canned tuna.

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Primar, E and Santoso. 1990. Content of histamine in canned tuna production of MTI Company. Indonesia Journal of Post-Harvest Fisheries Technology and Quality Control 11(2) March.

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Discussion

Asked whether any microbiological work was done in relation to the histamine content in the tuna, Dr Sunarya replied that while no work of this nature was done on the tuna, previous work done on the *peda* (fermented fish) showed that many types of micro-organisms were capable of producing histamine.

Asked whether these micro-organisms were indigenous or due to contamination, Dr Sunarya said that he had no data on the subject.

Asked whether *Achromobacter* spp. were found in the samples, Dr Sunarya reiterated that in this tuna study, no microbiological work was done, but in an earlier study on the *peda*, both *Achromobacter* and *Escherichia* were present.

It was noted that tuna found in the USA had higher baseline value for histamine, and commented that the values reflected in this study indicated good quality. In response, Dr Sunarya said that while the results showed low histamine values, there were data to show that in some localities, the histamine level were very high, and that better control during processing was able to reduce this histamine level.

It was observed that delay during the processing of canned tuna may increase the histamine level and that the most significant effect of this delay would be deterioration of flavour and texture of the final product. As there is a standard for the time delay during processing, it was urged that this be given due consideration.

Determination of *Listeria Monocytogenes* In Fresh Shrimps Using New FDA *Listeria* Method

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Abstract

This paper describes a study to determine whether the new FDA *Listeria* method could detect *Listeria monocytogenes* in fresh shrimp (*Penaeus monodon*) grown in Java, Indonesia.

It was found to be applicable; selective medium MMA was however more sensitive than LPM agar.

Introduction

Outbreaks of *Listeria monocytogenes* infections caused by the consumption of contaminated cole slaw, pasteurized milk and cheese made with pasteurized milk have been reported (Lee and McClain, 1986). Until recently, there has been no report that in Indonesia, outbreaks of *L. monocytogenes* infection have been caused by the consumption of shrimps. Shrimps exported to the USA must be certified free of *L. monocytogenes*.

Indonesia's export of shrimps was slightly more than 60,000 mt in 1989 and has increased yearly. Most Indonesian shrimps are exported to Japan, with other shipments to USA and Europe. Shrimps exported to these countries are accompanied by a Certificate of Health from the Provincial Laboratories of Fishery Quality Control.

L. monocytogenes is a food-borne pathogen which can cause a variety of symptons, such as meningoencephalitis, flu - like low - grade *septimia in gravida*, septicemia in the prenatal period, pneumonia, endocarditis, urethritis and abortion (Gray and Killinger, 1966).

The aim of this work was to establish a standard method of *L. monocytogenes* analysis, which could then be adopted for use by the Provincial Laboratory of Fishery Quality Control in Indonesia, thus increasing confidence in the quality of the product.

Materials And Method

Fresh shrimps (*Penaeus monodon*) were collected from a shrimp factory in Jakarta, Indonesia. The cultured shrimps were from brackish-water ponds along the north Java coast.

Listeria monocytogenes were transported in an insulated box to the laboratory of the National Center for Fishery Quality Control and Processing Development. To maintain their freshness, crushed ice was added. In the laboratory, the shrimps were separated into two groups: Group I, which would undergo irradiation, and Group II with no irradiation. Each group contained two lots as replications. A 25 g sample of each lot was added to 225 cm^3 of *Listeria* enrichment broth (LEB). Each homogenate of group A was then inoculated with 10^3 *L. monocytogenes* and gently shaken.

The methodology for isolation and identification of these bacteria consisted of four basic steps:

Note: This paper was presented at the Seminar by Mr Santoso.

1. Enrichment

The initial step, in which the food sample was enriched in a non-selective nutrient medium.

2. Isolation

In this step selective media plates were used to restrict the growth of bacteria other than *L. monocytogenes*. Suspect colonies were examined using beamed white light powerful enough to illuminate the plate well, and to streak the plate bottom at a 45-degree angle. When examined in this oblique transmitted light from an eye positioned directly above the plate, *Listeria* colonies appear blue-grey to blue. Media used were Modified McBride agar (MMA) and lithium chloride phenylethanol mexalactam (LPM) agar. Typical colonies from these two media were picked and streaked onto trypticase soy agar with 0.6% yeast extract (TSA-YE).

3. Identification
   1. Examination of TSA-YE plates for typical colonies was performed using the oblique illumination system.
   2. Examination of typical colonies by wet mount, using 0.85% saline for suspending medium.
   3. Catalase test.
   4. Gram stain.
   5. Growth of typical colonies in trypticase soy broth with 0.6% yeast extract (TSB-YE) for biochemical tests.
   6. Haemolysis test using blood agar plate.
   7. Biochemical test:
      urease, nitrate, MR, VP, xylase, mannitol, esculine, maltose, glucose and motility of the bacteria in SIM medium; H_2S formation, acid/base on TSI (butt and slant).

4. Camp Test.

Results And Discussion

Results of determination of *L. monocytogenes* in shrimps (*P. monodon*) are shown on Tables 1, 2 and 3.

To interpret data collected, the new FDA *Listeria* Method was used. In this method, *L. monocytogenes* are characterized as gram positive, rods, positive catalase, hydrolize urea without producing H_2S, give an acid butt and acid slant on TSI medium, able to decompose rhamnose, esculine, maltose and glucose with acid production, but were not able to decompose mannitol and xylose. In MR-VP broth, these bacteria give +/+ reaction, but they are not able to reduce nitrate. In blood agar plates, they produce a slightly cleared zone around stab. On Camp Test, there is an interaction between *Staphylococcus aureus* and *L. monocytogenes* leading to production of clear haemolysis zone.

In the selection (isolation) step, both MMA and LPM produced typical colonies of *L. monocytogenes*. Colonies on LPM appeared to be sparkling blue, close to white, while colonies on MMA were blue grey. Trypticase soy agar, yeast extract plates (TSA-YE) were grown by typical colonies of *L. monocytogenes*.

All samples A,B,C and D on both selective media LPM and MMA contained typical colonies of these bacteria. Sample A on LPM did not contain a typical colony, but it did on MMA. On TSA-YE, only sample B was determined not to contain a typical colony. Biochemical and other tests confirmed that samples A and B did not contain *L.monocytogenes*, while samples C and D were confirmed to contain positive *L. monocytogenes*.

The second trial showed that sample B, on both LPM and MMA, did contain typical colony of *L. monocytogenes*, but sample A on the same media showed typical colonies and further isolation on TSA-YE gave positive results. On TSA-YE, samples C & D were found to contain typical colonies. Biochemical and further identification tests confirmed that colonies isolated from LPM & MMA representing sample C, and from MMA representing sample D, were *L. monocytogenes*. However, colonies isolated from LPM on sample D were confirmed not to contain these bacteria.

The third trial showed that *L. monocytogenes* were recovered from samples C & D. Although, typical colonies were found from MMA on sample

Table 1. Result of determination of *L. monocytogenes* on shrimp, first trial.

MEDIA		Code of sample							
		A		B		C		D	
1		2		3		4		5	
Selective agar		LPM	MMA	LPM	MMA	LPM	MMA	LPM	MMA
TSA-YE			+	+	-	+	+	+	+
TSB-YE	25		x	x		x	x	x	x
	35		+	+		+	+	+	+
Hemolysis Test	stab		o	+		o	+	+	+
	camp		-R/-S	-R/-S		-R/-S	+S	+S	+S
Gram stain			-	+		-	+	+	+
Catalase Test			-	+		+	+	+	+
Rhamnose			+	-		-	+	+	+
Xylose			+	+		-	-	-	-
Mannitol			-	-		+	-	-	-
Esculine			+	-		+	+	+	+
Maltose			+	+		+	+	+	+
Glucose			+	+		-	+	+	+
SIM			+	-		-	+	+	+
Urea			+	+		-	-	-	-
Nitrate			+	+		+	-	-	-
MR			-	-		+	+	+	+
VP			-	+		-	+	+	+
TSI	butt		a	a		k	a	a	a
	slant		k	k		k	a	a	a
	H_2S		+	+		-	-	-	-
	gas		+	+		+	-	-	-
Interpretation		neg.	neg.	neg.	neg.	neg.	pos.	pos.	pos.

Table 2. Result of determination of *L. monocytogenes* on shrimp, second trial.

MEDIA		Code of sample							
		A		B		C		D	
1		2		3		4		5	
Selective agar		LPM	MMA	LPM	MMA	LPM	MMA	LPM	MMA
TSA-YE		+	+			+	+	+	+
TSB-YE	25	x	x			x	x	x	x
	35	+	+			+	+	+	+
Hemolysis Test	stab	o	o			+	+	o	+
	camp	-R/-S	-R/-S			+S	+S	-R/S	+S
Gram stain		-	-			+	+	-	+
Catalase Test		+	-			+	+	-	+
Rhamnose		-	+			+	+	-	+
Xylose		-	-			-	-	-	-
Mannitol		+	-			-	-	+	-
Esculine		-	-			+	+	+	+
Maltose		+	+			+	+	-	+
Glucose		-	+			+	+	+	+
SIM		-	-			+	+	-	+
Urea		+	+			-	-	+	-
Nitrate		+	+			-	-	-	-
MR		-	-			+	+	-	+
VP		-	+			+	+	-	+
TSI	butt	a	k			a	a	a	a
	slant	k	k			a	a	k	a
	H_2S	+	+			-	-	+	-
	gas	-	+			-	-	+	-
Interpretation		neg.	neg.	neg.	neg.	neg.	pos.	pos.	pos.

Table 3. Result of determination of *L. monocytogenes* on shrimp, third trial.

MEDIA		Code of sample							
		A		B		C		D	
1		2		3		4		5	
Selective agar		LPM	MMA	LPM	MMA	LPM	MMA	LPM	MMA
TSA-YE			+			+	+	+	+
TSB-YE	25		x			x	x	x	x
	35		+			+	+	+	+
Hemolysis Test	stab		o			+	+	+	+
	camp		-R/-S			+S	+S	+S	+S
Gram stain			-			+	+	+	+
Catalase Test			+			+	+	+	+
Rhamnose			+			+	+	+	+
Xylose			-			-	-	-	-
Mannitol			-			-	-	-	-
Esculine			+			+	+	+	+
Maltose			+			+	+	+	+
Glucose			+			+	+	+	+
SIM			-			+	+	+	+
Urea			+			-	-	-	-
Nitrate			-			-	-	-	-
MR			-			+	+	+	+
VP			+			+	+	+	+
TSI	butt		a			a	a	a	a
	slant		k			a	a	a	a
	H_2S		+			-	-	-	-
	gas		+			-	-	-	-
Interpretation		neg.	neg.	neg.	neg.	neg.	pos.	pos.	pos.

Note (for Tables 1,2 and 3):

+	:	positive reaction
-	:	negative reaction
o	:	no hemolysis
+	:	positive hemolysis
+ R	:	positive interaction with *Rhodococcus*
+ S	:	positive interaction with *S. aureus*
-R/-S	:	no interaction with both *Rhodococcus* and *S. aureus*
a	:	acid
k	:	alkaline/base
x	:	no test
A	:	Sample was not contamintated with the bacteria
B	:	Sample was not contaminated with the bacteria
C	:	Sample was contaminated with the bacteria
D	:	Sample was contaminated with the bacteria

A, they were confirmed in further biochemical tests not to be *L. monocytogenes.*

Conclusion

1. The new FDA *Listeria* Method was able to determinate the presence of *L. monocytogenes* in shrimp.
2. Selective medium MMA was more sensitive than LPM agar.

Collins - Thompson, D.L. and P.J. Slade. 1987. Two stage enrichment procedures for isolation *Listeria monocytogenes* from raw milk. Journal of Food Protection, 50(11): 904-908

Food and Drug Administration. 1988. Bacterioloical analytical manual, Chapter 29 - *Listeria* isolation, revised method of analysis, Notice, Part II.

Gray, M.L. and A.H. Killinger. 1966. *Listeria monocytogenes* and listeric infections. Bacteriol. Rev., 30: 309-382.

Lee, W.H. and D. McClain. 1986. Improved *Listeria monocytogenes* selective agar. Applied and Environmental Microbiology, 52(5): 1215-1217.

McNab, W.B. and R.B. Truscott. 1988. Comparison cf media and procedures for the isolation of *Listeria monocytogenes* from ground beef. Journal of Food Protection, 51(8): 626-628, 638.

Discussion

A comment was made about the determination of *Listeria monocytogenes* in food and the fact that one of the biochemical tests conducted, an SIM test, gave good results. Mr Santoso emphasized the fact that before 1987, there was no internationally-recognised method to test for this bacteria.

Assessment Of Mercury Contents Of Tuna In East Indonesian Seas

SANTOSO, SUNARYA and EDDY P

National Center for Fishery Quality Control and Processing Development, Jakarta, Indonesia

Abstract

Samples of meat were taken from tuna landed at Ambon, Biak, Bitung and Denpasar between August 1989 and February 1990 at two month intervals. They were flown to Jakarta for assessment of their mercury content. It was found that the mercury content did not increase with size of tuna. The mercury content of tuna was generally well below 0.5 ppm, although samples from Ambon were higher than those from other three landing places.

Introduction

Tuna is an Indonesian export commodity that is exported in fresh and frozen forms. In 1987 tuna exports totalled 9,800 mt and the annual increase has been averaging 200%.

The maximum sustainable yield of tuna in Indonesian waters is 166,000 mt per year. Resources are mainly located in east Indonesia, including the waters off Makasar Strait, Arafura and other areas.

In most cases, tuna shipped for export should be accompanied by a certificate confirming that the fish does not contain mercury above the permitted level.

Most species of fish in oceanic waters contain 0.15 ppm mercury in muscle tissue. Much higher values are found in fish from contaminated water. Tuna (*Thunnus* spp.) and some other large fish normally contain high concentrations of mercury. It has been reported elsewhere that concentrations of 1 ppm in the muscle are common and may even reach 4.9 ppm (Clark, 1986).

Tunas are large carnivores at the end of food chains and their diets, therefore, contain high levels of mercury resulting from bioaccumulation and biomagnification. Much of this mercury is in the form of methyl mercury and because the fish cannot excrete it, its concentration in the tissues increases with the age of the fish (Clark, 1986).

The present assessment was performed between August 1989 and February 1990. Analysis of samples were done at National Centre for Fishery Quality Control and Processing Development, Jakarta (NCQC).

Materials And Methods

The samples consisted of flesh of fresh tuna landed at Denpasar (Bali), Biak (Irian Jaya), Ambon and Bitung (North Sulawesi). These samples were thought to originate in the waters off East Indonesia.

Based on the size, yellow fin tuna were grouped into three categories as follows:

1. Less than 5 kg in individual weight.
2. 5 - 20 kg in individual weight.
3. More than 20 kg in individual weight.

Preparation of tuna flesh was done at Provincial Laboratories of Fishery Quality Control. Frozen flesh was packed using styrofoam boxes. In the boxes, ice was added to maintain a low

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Note: This paper was presented at the Seminar by Dr Sunarya.

temperature. After boxing, samples were transported to NCQC by plane.

Sampling was carried out three times at intervals of two months. Mercury contents were determined using Atomic Absorption Spectrophotometer (Perkin Elmer, 2830 model) which was combined with Mercury Hydride System (MHS - 10, Perkin Elmer). For the method of analysis refer to AOAC 14th edition, 1984.

Results And Discussions

Results of the assessment of mercury content of tuna less than 5 kg in individual size is shown in Table 1.

Apparently the contents of mercury varied with the fishing period and the fishing grounds. It was difficult to conclude whether there were persistent differences between the periods of sampling. The lowest and the highest contents were found in tuna landed at Bitung - North Sulawesi (9.4 ppb) and Ambon (361 ppb) respectively.

Results of the assessment of the mercury content of tuna in the 5 to 20 kg range is shown in Table 2.

The mercury content of tuna with individual weights of 5 to 20 kg ranged from 45.7 (Bitung) to 467 ppb (Denpasar). The average mercury content in tuna of less than 5 kg was lower than those of 5 to 20 kg body weight.

The mercury content in tuna more than 20 kg body weight ranged from 34.6 ppb (Denpasar) to 544 ppb (Ambon) (Table 3).

Average content of mercury in tuna of more than 20 kg weight landed at Biak, Bitung and Denpasar were lower than those in tuna with 5 - 20 kg weight at the same places, while the contents in tuna landed at Ambon were higher.

According to data collected and depicted in Tables 1,2 and 3, we concluded that mercury contents on tuna varied with sampling periods and between the three landing places, and that the mercury content did not depend on the size of the tuna, but rather on individuals. To obtain better information regarding the mercury content of tuna, more frequent monitoring should be done.

Table 1. Mercury content of tuna less than 5 kg of individual weight.

Sampling period	Mercury content (ppb)			
	Tuna landed at			
	Biak	Bitung	Ambon	Denpasar
I	41.6	163.5	-	340.6
II	70.1	9.4	41.9	-
III	188.8	59.5	361.0	-

Table 2. Mercury content on tuna of 5 - 20 kg individual weight.

Sampling period	Mercury content (ppb)			
	Tuna landed at			
	Biak	Bitung	Ambon	Denpasar
I	161.8	171.3	103.5	467.0
II	122.9	45.7	249.7	-
III	307.9	388.0	458.0	-

Table 3. Mercury content of tuna over 20 kg of individual weight.

Sampling period	Mercury content (ppb)			
	Tuna landed at			
	Biak	Bitung	Ambon	Denpasar
I	199.0	175.9	130.1	377.0
II	181.0	63.5	442.6	34.6
III	43.0	348.0	544.0	337.0

In general, mercury content of tuna landed from the three landing places was less than 0.5 ppm, which is the maximum level mandated by Indonesian government. This means that in terms of mercury content, tuna caught from East Indonesian seas were safe for consumption.

Conclusion

The mercury content of tuna landed at Denpasar, Bitung and Biak was still below 0.5 ppm (maximum level permitted). The contents varied among the period of sampling and the size of tuna. This indicates that the mercury content depended on individual weight. We recommend more frequent monitoring of mercury on tuna landed in East Indonesian seas.

AOAC, 1984. Official methods of analysis of the Association of Official Analytical Chemists. 14th Ed. AOAC Inc. Virginia, USA.

Clark, R.B. 1986. Marine pollution. Oxford. Clarendon Press. 215pp.

Uktolseja, J.C.B. 1988. Potential resources of tuna in Indonesian seas. *Ikatan Sarjana Perikanan Indonesia*. Jakarta, Indonesia.

Discussion

A comment was made that in the paper, some tuna contained high concentration of mercury at 4.9 ppm. Asked whether the Indonesia government put a control on this as the USA mercury level guideline is only 0.5 ppm, the meeting was informed that this data was acquired not from Indonesian fish but from literature. However the Indonesian standard for mercury levels in tuna is 0.5 ppm.

Asked whether the mercury data reflected in the paper is for methyl mercury or total mercury, and whether data on methyl mercury were available, Mr Sunarya replied that the data related to total mercury and that there were no data for methyl mercury.

A comment was raised that less than 20 kg tuna may contain 0.5 ppm mercury, that 80-100 kg tuna may contain 1.0 - 1.5 ppm mercury, and that the USA has adopted a level of 1.0 ppm methyl mercury content for tuna. Mr Sunarya appreciated this informatin provided by Dr Watanabe.

It was suggested that regional surveys be conducted in order to better understand the distribution of mercury in tuna. Dr Sunarya reiterated that tuna stock migrates over great distances and sampling by region may not necessarily reflect the mercury level in each region. He agreed however, that such studies may contribute to greater understanding.

RECOMMENDATIONS

RECOMMENDATIONS

After reviewing the status and problems related to the development of post-harvest technology in the region, it was recommended that the following (not arranged in order of priority) receive adequate attention:

General Areas

- Improvement of the quality of fresh fish
- Improvement of the countries' existing fish products, and development of new products
- Evaluation and improvement of traditional processes and products
- More systematic and more specific collection of data to make cross-referencing of data possible
- Greater use of underutilized fish species, and processing of by-products such as wastes from tuna processing factories
- Increased cooperation among countries in the region, and strengthening of cooperation on existing projects
- Continued research, development, and training in fish processing and quality control
- Continuous monitoring of the dynamic changes in the fishing industry
- Greater emphasis on:
  - The needs of small-scale industries in terms of technology and expertise, and
  - Improvements to the many important fish products in the region.

Specific Areas

Surimi and surimi-based products

- Increased utilization of under-utilized species for surimi production
- Investigations into the use of food reductants to improve the gel quality of surimi
- Reduction of the influence of pH on lowering the gel strength of surimi
- Biological evaluation of surimi products, eg, evaluating the digestibility of the gels
- Continued investigation the shelf-life of surimi products at different storage temperatures
- Further studies of both enzymatic and non-enzymatic reactions on the setting and *modori* phenomena of sardine surimi
- Studies of the breakdown of myofibrillar proteins of sardines by SDS-PAGE electrophoresis
- Investigation into the reasons for the heat stability of kidney extract, and for the lack of low temperature tolerance.

Frozen fish balls

- Studies of starches for production of frozen fish balls
- Determination of the cost of producing frozen fish balls using different freezing methods.

Fish sausage

- Further studies in the preparation of fish sausage, in anticipation of introducing the technique to small-scale producers.

Fish crackers

- Continued study of steaming vs boiling in production of *keropok*
- Continued comparative study of starches in the formulation and production of *keropok*
- Formulation of a standardized measure of crispiness and linear expansion.

Dried salted fish

- Research into the use of vacuum packaging for dried salted fish to be stored at ambient temperature.

Smoking

- Analysis of smoked fish to determine mould content and $NaNO_2$ content
- Continued research in liquid smoking
- Comparison of the production costs of liquid smoking *vs* natural smoking
- Determination of the polycyclic aromatic hydrocarbon in natural and liquid smoking.

Depuration

- Depuration of cockles prior to marketing
- Continued study of the occurrence of *Vibrio parahaemolyticus* in cockle samples.

Histamine in tuna

- Encouragement of the practice of HACCP in the industry as a means of controlling the formation of histamine
- Investigation into the relationship between delays during processing of canned tuna and the flavour and texture in the final product.

Others

- Continued investigations into the utilization of shrimp shell in the production of chitin and chitosan
- The implications of the use of antibiotics in shrimp culture, and consideration of a safe withdrawl period
- The carrying out of a study into energy loss in the fish processing industry; and
- Formulation of standards for traditional products.

The meeting noted that recommendations that related to specific countries in the region will be taken up by them individually or collectively.

THE AMANO AWARD

On the recommendation of the 20th Anniversary Seminar on Development of Fish Products in Southeast Asia held in Singapore in 1987, the SEAFDEC Council at its Twentieth Meeting in Manila in 1987, agreed to institute The Amano Award for the best paper presented during future seminars organized by MFRD. The Amano Award is in recognition of the contributions of Dr. Keishi Amano to the development of the fishery post-harvest technology in Southeast Asia.

In the 1991 seminar, an Amano Award Committee was organized to serve as judges for the 1991 Amano Award. Dr. Keishi Amano served as Chief Judge.

The Committee felt that the criteria for the evaluation of the country reports should be different from those used for research papers. It was therefore recommended that for 1991, an MFRD Award also be given for the best country report presented at this and future Seminars.

Based on the recommendations of the judges, the 1991 Amano Award was awarded to the research paper on Technology for Fish Cracker (*Keropok*) Production by Dr Yu Swee Yean, and the 1991 MFRD Award to the country report of Thailand by Miss Sirilak Suwanrangsi.

In appreciation of the high standard of the papers presented, Dr. Keishi Amano and the SEAFDEC Secretary-General awarded Letters of Appreciation to all the presentors of the research papers and country reports.

WORKSHOP ON FISH PRODUCTS IN SOUTHEAST ASIA

Workshop On Fish Products In Southeast Asia

Introduction

The Workshop on the Fish Products in Southeast Asia was convened by the Marine Fisheries Research Department of SEAFDEC in Singapore on 7 May 1991.

Participants included representatives from Member Countries Japan, Malaysia, Philippines, Singapore, and Thailand; representatives from non-member countries Australia, Canada, Indonesia, and Norway; and officials and staff of SEAFDEC Secretariat and the Marine Fisheries Research Department (MFRD). The Workshop was chaired by the Deputy Secretary-General of SEAFDEC, Mr Kazuo Inoue.

Two papers, Fish Products Data Collection in the Philippines: A Personal Experience by Gloria Guevara, and Inventory of Fish Products in Southeast Asia by Ng Mui Chng, were presented in the Workshop. The text of these papers is reproduced in this publication.

During the discussion following the presentation of the above-mentioned papers, the following recommendations were made concerning ways to improve future inventories:

(1) The inventory should be updated periodically, at three-five-year intervals.

(2) In close collaboration with coordinators from participating countries, the contents of the inventory should be reviewed and updated regularly.

(3) Coordinators from participating countries should meet with MFRD to help design and compile the questionnaire, and to standardise data collection procedures.

(4) Updating of data in the inventory should be carried out in such a way as to ensure continuity. The Fishery Statistical Bulletin for South China Sea Area should include relevant data on fish products which could be used as a source of secondary data for the inventory.

(5) The inventory should reflect technical developments and changes in production technology for each product.

(6) Technical publications cited as references in the inventory should be provided to the MFRD Library so that these could be made available to other countries and used as secondary sources of data.

Fish Products Data Collection In The Philippines: A Personal Experience

GLORIA GUEVARA

Formerly Head of Post-Harvest Technology Division, Bureau of Fisheries and Aquatic Resources, Philippines

Introduction

The Southeast Asian Fish Products (1987 and 1991) provides comprehensive and convenient reference material for anyone who wants information on the different fish products produced and consumed in Southeast Asia. The publication describes the different technologies and techniques involved in the production of fish products. It provides the most important information that one may need to know about the fish products in Southeast Asia and of new products developed by each country. It also shows that some improvements are necessary to further upgrade the quality of the fish products especially if the technology has a potential for adoption in other ASEAN countries.

The Philippines, through the Bureau of Fisheries and Aquatic Resources (BEAR), the implementing fisheries agency of the country, conducted a survey of its fish processing industry in 1982 by Lagua and Payofelin (1982). The survey was designed to:

i) identify the processed products in the Provinces of Luzon, Visayas, and Mindanao;
ii) assess the existing technologies/techniques involved in the production of fish products;
iii) gather statistical data needed for policy formulation purposes, eg, import-export of fish products;
iv) identify the problems and constraints that affect the industry, particularly on the different processing methods; and
v) to introduce new fish processing technologies to areas where they are not utilized.

The results of this survey proved useful in determining the overall status of the fish processing industry in the three major islands of the Philippines (Luzon, Visayas and Mindanao).

The survey focussed on the number of fish processors, plant sizes, processing methods, raw material requirements, production systems and statistics, marketing systems and problems and weaknesses. Such information is needed to assess the needs of the fish processing industry. It is also required as basis for food policy formulation and for planning, evaluating and executing national improvement programs aimed at better utilization of fishery resources and improvement of nutritional standards.

In succeeding years, the Fisheries Utilization Division of the Bureau of Fisheries and Aquatic Resources conducted other surveys on fish processing to gather information on the amount and makeup of the total production that goes into drying, smoking and canning. This was done to improve understanding of the problems confronting the industry and to update information on the status of the Philippines fish processing industry. In 1985, another survey was undertaken in connection with the implementation of fisheries credit programmes designed to improve the viability of small and medium scale fishing activities. This provided secondary data in the compilation of fish products.

Data Gathering

Collection and compilation of fish products data in the Philippines was done by the Bureau of Fisheries and Aquatic Resources in the course of its updating of statistical data and information on fishery post-harvest technologies. This was done to determine what products are available and produced, the technologies of production, the capacities of processing plant, the number of fish processing establishments and problems encountered by fish processors which affect the development of the industry.

In gathering the data, three methods were employed:

Use Of Survey Questionnaire

A survey questionnaire was developed. Copies were sent to the 12 Regional Offices of the BFAR and were distributed to the fish processors/respondents by extension officers in the region. A deadline for retrieval of duly accomplished forms was set. About 85% responses was attained. The survey questionnaire used is shown in Annex I.

Plant Visit And Personal Interview With Guide Questionnaire

The technologists interviewed the respondents personally to verify some information and to obtain a personal overview of the actual fish processing activities.

In all areas visited, traditional methods of fish processing predominate, eg, salting, fermentation, fish sauce and fish paste. Other methods observed included drying and smoking, canning, freezing, filleting, salting, drying and the manufacture of squid flakes, shrimp and fish noodles, fish chips and many other fish-based snack foods.

Only selected provinces were visited. These included Palawan, Iloilo, Camarines Sur and Cebu and vicinity. Similar results were obtained as reported by Lagua and Payofelin (1982).

Secondary Data

Secondary data was gathered to supplement information from the survey. These included published reports, manuals and results of other surveys.

Observations/Findings

During the early part of the survey, it was observed that most processing activities focused on traditional methods of fish processing. Only fish that are left unsold in the wet markets go to the fish processing industry. Consequently, the finished products were poor in quality and were destined for local markets, rather than for export. However, fish products are now slowly finding their way into the export markets.

It was also further observed that certain types of products are known in some areas but not in others. For example, the fish paste and fish sauce locally known as *bagoong* and *patis* used to be known only in Navotas, Rizal, a province very close to Manila. In the latter part of the 70's they were introduced to the Bicol area, southern Luzon and later to northern Luzon. As a result of the surveys, the products have become popular and are now considered indispensable in every Filipino home..

Another product is boiled fish based on small tuna and tuna-like species, locally known as *sinaing na tulingan*. This product is indigenous to Batangas, a province in southern Luzon from where it has been introduced to the Visayas and Mindanao. This indicates that technology transfer activities have helped to increase the sale and promote the distribution of these products.

It was also observed that, generally, these traditional products need further improvement in terms of sanitation and product quality.

The Fish Processing Industry Profile, by Lagua and Payofelin (1982) projected a clear picture of the structure, capacity, and organization of the fish processing industry of each province and of the whole region.

For the purpose of analysis, fish processors were classified into three size-groups according to the annual volume of production as follows:

Small processors : less than 5 mt
Medium processors : 5 to 20 mt
Large processors : more than 20 mt

In most cases it was noted that small-scale processors are more willing to give data as they feel that the technologists may be able to help them improve their business. Medium and large scale processors, by contrast, are hesitant to give details on their production.

Data/information on production capacities and volume of production were seemingly inaccurate. Processing techniques are also not discussed by respondents.

Some medium and large-scale processors are willing to show their plant operations but are less willing to give information and prohibited the taking of pictures inside the plants. Video tapes are available in some large-scale industries.

In the regions visited, the types of equipment and facilities used for processing were simple and crude. For drying, bamboo slats were used as trays and fish drying was done only under the sun. On the other hand, some types of solar dryers and dehydrators are now in use indicating that some progress is being made.

The mode of processing of a particular type of product does not vary from operator to operator. Small-scale processing is usually done in the fishing village with the assistance of relatives and family members.

Product presentation in terms of packaging needs to be improved. Even today, some cured products are displayed without packaging and sold using old newspapers as wrappers.

Since production of fish products is labour-intensive, it generates employment and improves the economic condition of the locality.

Problems Encountered During The Survey

1. Slow retrieval of questionnaires from the regions which delayed the compilation process.
2. Reluctance of some respondents to give accurate information needed in the compilation.
3. Due to geographical location and dispersal through many scattered islands, transportation and communication posed some problems in data gathering.
4. Due to lack of funds, problems were encountered in data gathering especially in remote areas inaccessible to land transportation.
5. Lack of facilities and manpower to facilitate gathering of data (ie, computers and extension officers).
6. The reorganization programme of the government during the survey slowed down the gathering of data.
7. Peace and order situation.

Expectations In The Next Surveys

From my experiences in the surveys I feel that certain measures can be taken to advance and improve fish processing in the Philippines and other Southeast Asian countries; I am positive as a private individual that the following are the desired directions:

1. Improvement to traditional methods, following standard processes with emphasis on hygiene, sanitation and quality control for the development of standard fish processing guidelines for Southeast Asia.
2. Expansion of research studies for the development of new products.
3. Utilization of indigenous fishery resources and underutilized species of fish.
4. Expansion of markets for export of products.
5. Increased opportunities for exchange of technology and expertise among the ASEAN countries.
6. Studies on improvement of packaging.

7. Concerning the problems of the fish processing industry, more research studies must be undertaken not only of the technological and nutritional aspects of these problems but also of their socio-economic aspects.

Recommendations And Conclusion

1) Considering the usefulness of the Southeast Asian Fish Products (1987 and 1991) to researchers, food manufacturers and to the industry of the region, it is recommended that the compilation be made a continuing activity in the Southeast Asian countries in the future.
2) Since this compilation is a useful information tool for all Southeast Asian countries, it is hoped that the survey also serves as a medium for the exchange of ideas among the peoples in Southeast Asia and for the promotion of cooperation and economic ties.
3) Referring to the two surveys conducted in 1980 and 1985 in the Philippines, it is recommended that funds be made available specifically for the survey, and that consideration be given to extension officers and technologists involved in the project.

I like also to suggest the following related items:

4) With the problems in marketing and quality control presented for each product, research studies must be conducted in order to minimize if not totally solve the problems in the fish processing industry. New products may be developed and improvements to existing ones may be made.
5) Improvements are particularly desirable in sanitation and hygiene, implementation of standard procedures and good manufacturing practices, and in prolonging the shelf life of products.
6) The organization of cooperatives should be encouraged, to facilitate the marketing of fish products and to assist the fishing industry.

Lagua, N.M. and P. Payofelin. 1982. Fish Processing Industry Profile. Regions 4,5. Fisheries Newsletter Vol. XI No. 2: 28-57.

Lagua, N.M. and P. Payofelin. 1982. Fish Processing Industry Profile. Regions 7. Fisheries Newsletter Vol. XI No. 3: 23-37.

Lagua, N.M. and P. Payofelin. 1982. Fish Processing Industry Profile. Regions 11. Fisheries Newsletter Vol. XI No. 4: 41-66.

Marine Fisheries Research Department/SEAFDEC. 1987 and 1991 (2nd ed). Southeast Asian Fish Products. MFRD/SEAFDEC, Singapore. 86 pp.

Annex 1. Survey Questionaire Form Used In The Survey On Fish Products In The Philippines

Republic of the Philippines
DEPARTMENT OF AGRICULTURE
BUREAU OF FISHERIES AND AQUATIC RESOURCES
880 Marcelo Bldg., Quezon Avenue, Quezon City

SURVEY OF THE AVAILABILITY OF FISH AND FISHERY PRODUCTS

Respondent's Name : _____ Address : _____

1. RAW MATERIALS :

Species Of Fish Used	Amount/volume Procured	Source/s Of Raw Materials	Technology Used (Include New Techniques)	Peak Months Of Production	Lean Months Of Production

2. PRODUCTION :
Total Production : _____ Cost Of Production : _____
Process Involved (Brief Statement Of Procedure : _____

3. FINISHED PRODUCTS:

Products	Selling Price	Packaging Methods & Materials Used	Market Outlets	Average Shelf-life

4. LOSSES IN PRODUCTION :

A. Causes Of Losses :
- ( ) poor handling methods
- ( ) mode of transport
- ( ) processing methods
- ( ) packaging
- ( ) storage
- ( ) others (specify) _____

B. Estimated Percentage Loss By Product Type
- ( ) smoked
- ( ) salted
- ( ) dried
- ( ) others (pls. specify) _____

C. Selling Price Of Dried Fish Intended For Fish Meal _____

5. What alternative measure do you do to save your product?
- ( ) selling at low price
- ( ) cold store
- ( ) use insecticide (what brand? _____)
- ( ) keep fish in brine
- ( ) produce semi-dried product
- ( ) sell immediately
- ( ) others (specify) _____

6. What do you think is the most immediate solution to your problem?

7. What is the extent of brine solution used in the product? _____
a. source of salt _____ b. cost per pack _____

8. Quality control measures : _____

9. Other available species (underutilized fish and shellfishes) : _____

10. Technology used (if any) : _____

11. Hygiene and sanitation : _____

12. Comments/suggestions :

Thank You! Interviewed by _____ Date _____

Inventory Of Fish Products In Southeast Asia

NG MUI CHNG, HOOI KOK KUANG and KATSUTOSHI MIWA

Marine Fisheries Research Department
Southeast Asian Fisheries Development Center
Singapore

Introduction

At the 17th Meeting of the Council of the Southeast Asian Fisheries Development Center in 1984, the Council Director for the Philippines stressed the need for an inventory of fish products in Southeast Asia.

The Council then called on the Marine Fisheries Research Department to compile an inventory of fish products in Southeast Asia. The objective was to list the fish products available in the ASEAN countries and the technical problems and constraints in marketing.

The ASEAN countries participating in the survey were:

1. Brunei Darussalam
2. Indonesia
3. Malaysia
4. Philippines
5. Singapore, and
6. Thailand

A wide variety of fish products are consumed in the ASEAN countries. Based on a literature search, the fish products have been broadly classified as (alphabetical):

a) Boiled
b) Canned
c) Comminuted
d) Cured
e) Dried
f) Fermented
g) Fish meal
h) Frozen
i) Powdered/flaked
j) Smoked
k) Others

A questionnaire was sent to participating countries in 1984. The first inventory was subsequently published in September 1987. Encouraging feedback and remarks have been received regarding the first inventory and resulted in a reprint in August 1988. The findings were also presented at the 20th SEAFDEC Anniversary Seminar on Development of Fish Products in Southeast Asia held in October 1987 in Singapore.

Participants at that Seminar welcomed the publication and recommended periodic updating of information for use by researchers, food scientists, fish technologists, administrators, fish traders and others in the private sector.

Heeding this recommendation, a second survey was conducted in August 1989 and published in April 1991. The questionnaire incorporated suggestions from users of the first inventory and included comprehensive background information on fish products.

Achievements Of First And Second Inventories

The important fish products of Southeast Asia are identified in the two inventories. They also record the current status of a large variety of interesting products, and outline areas for improvement. The 1987 publication listed traditional fish products which needed urgent improvement, especially dried, fermented and smoked products. These traditional products are consumed widely in the ASEAN countries. Some traditional products presently produced for the local market are perceived to have export potential. Upgrading these products will benefit both the local and overseas markets.

Note: This paper was presented at the Workshop by Ms Ng.

The 1989 survey recorded additional fish products not listed in the first survey. These include canned, comminuted, frozen and other products. A list of the fish products consumed in Southeast Asia is shown in Table 1.

The publications also recorded other details of the fish products. These inlcuded the English and local names of the products, a description of the products and how they are consumed in the country. The materials, including type of fish, ingredients and the cost and processing methods associated with the products were recorded. The conditions of the final products, together with their packaging conditions, shelf life, storage methods/temperatures and retail prices were documented. Efforts were also made to obtain the production volume of the products from 1984 to 1987. It was noted that these data are normally not available or are difficult to collect. To ease this problem, SEAFDEC's Fishery Statistical Bulletin of the South China Sea Area (at the 6th Regional Workshop on Fishery Statistics in Southeast Asia, Bangkok, 1-4 Jul 86) adopted the same classification of products (except powdered product, which is consumed in small quantities) as used in the inventory. Therefore the production/export volume of the fish products will be reflected in the future issues of the Bulletin.

The publications also list the problems faced in the production and marketing of the fish products. The main problems faced are short storage life, the need to improve packaging to extend shelf life, processing methods and quality of raw materials. These problems are inter-related and affect the quality of the final products. The problems are summarised in Table 2.

Additional Achievements Of Second Inventory

The second inventory was designed as a follow-up to the first edition, with more information on the products, and improved features. Photographs have been included to aid users unfamiliar with the products. The format of the inventory is also more user-friendly. For example, it is possible to compare details of the same products amongst the ASEAN countries using the summary tables.

Readers of the inventory have expressed appreciation of the first edition. The compilers feel that the second edition will provide even better service to scientists and food technologists concerned with research and development of fish products in Southeast Asia. It should also benefit other readers, for example, processors from the private sector, in providing them with understanding of the products they are handling.

Problems Encounted In Compiling The Inventory

Some problems were encountered during compilation of the survey. It is hoped that these problems can be overcome in this Workshop, thus facilitating future compilation.

We would like to share two problems:

1. Questionnaire forms

The questionnaire forms (Annex 1) were designed so as to be easy to fill up. However, unfilled or incompleted forms continue to be a major problem. The compilers have suggested in the beginning that fish products, not produced in the country, should be indicated "NA" in the category of products. This is to avoid confusion where products are available but are not being recorded. In practice, incomplete returns are sent back to co-ordinators for completion and verification. A minimum period of one month is allowed for this verification process. Sometimes, questionnaires must be returned several times in order to complete the forms.

2. Information received

It is very important that information received be accurate, as in the case of production/export data. The production volume is for local and export consumption. Sometimes export volume are reported to exceed the production volume.

References listed in the inventory should be easily available. The MFRD believes that the ref-

Table 1. Table of fish products listed in survey.

PRODUCT	BRUNEI DARUSSALAM	INDONESIA	MALAYSIA	PHILIPPINES	SINGAPORE	THAILAND
Boiled	NA	Boiled fish	Boiled fish	NA	Cooked fish	Steamed fish
Canned	NA	Canned mackerel Canned tuna Canned sardine	NA	Milkfish in tomato sauce Milkfish, Salmon style Milkfish in oil Tuna in oil Sardine in tomato sauce Mackerel in tomato sauce	NA	Canned shrimp, babyclam, crab meat, fish in tomato sauce, tuna
Comminuted	Fishball Fishcake	Fishball	Fishball Fishcake Scallop flavoured fishcake Fish sausage Prawn sausage Cuttle fish sausage Prawn dumpling Prawn burger Fish burger *Otak-otak*	Fishball Native sausage Fish burger	Fishball Fishcake Cuttlefish ball Imitation crab meat	Fishball Fish noodle Surimi Imitation crab meat
Cured	NA	NA	NA	Cured fish	NA	NA
Dried	Salted fish Dried prawn Chilled sour salted fish Dried fish	Dried salted fish	Dried anchovy Dried/salted fish Dried prawn Dried cockle Dried cuttlefish Dried shellfish Dried jellyfish	Dried anchovy Dried shrimp Dried squid Dried fishes: anchovy, milkfish, lizardfish, hairtail, mackerel, scad, nemiptarid, barracuda, cravalle, slipmouth, herring, sardine, shark fin, abalone, sea cucumber	Dried sea cucumber Dried shark fin	Dried salted fish Dried shrimp Dried squid Dried shellfish Dried salted freshwater fish Dried jelly fish

Table 1. Table of fish products listed in survey (*contd.*).

PRODUCT	BRUNEI DARUSSALAM	INDONESIA	MALAYSIA	PHILIPPINES	SINGAPORE	THAILAND
Fermented	Fermented fish Fermented fish stomach Fermented mussel Shrimp paste Pickled shrimp	Fermented fish paste Fermented fish Fish sauce	Prawn paste Shrimp paste Fermented anchovy Pickled prawn	Shrimp paste Fish sauce Fish paste	NA	Fermented fish Fermented fish sauce Shrimp paste
Fish meal	NA	Animal feed	Animal feed Fish manure	Animal feed	Animal feed	Animal feed
Frozen	NA	Frozen product: fish shrimp, squid	Frozen cuttlefish Frozen prawn Frozen fish	Frozen product: milkfish, shrimp, prawn, tuna	Fish including fillet, steak, loin Prawn/shrimp Cuttlefish, squid	Fish Raw shrimp Cooked shrimp Cuttlefish Squid Octopus Shellfish
Powdered	NA	NA	Prawn dust	NA	NA	Fish floss
Smoked	Smoked semi-dried fish Smoked dried fish	Smoked fish	Smoked tuna	Smoked boneless milkfish Smoked sardine, roundscad, herring, milkfish	NA	Dried smoked fish
Others	Prawn cracker Squid cracker Fish cracker	Cracker	Fish cracker Prawn cracker Barbecued fish	Shrimp *kropeck* Seaweed	Prawn cracker Prepared cuttlefish	Shrimp/fish cracker Fish satay

Table 2. Summary table of technical problems raised in survey.

PRODUCTS	BRUNEI DARUSSALAM	INDONESIA	MALAYSIA	PHILIPPINES	SINGAPORE	THAILAND
Boiled	NA	Nil	Nil	NA	NA	To improve processing method and short storage life.
Canned	NA	NA	NA	Low fish supply and high cost of tin cans	NA	Nil
Comminuted	Short storage life. To improve packaging.	Nil	Nil	Nil	Nil	Short storage life.
Cured	NA	NA	NA	Problem on handling and sanitation causes reddening, souring, salt burn and slimy product.	NA	NA
Dried	To improve packaging and storage life.	Low hygiene requirement due to traditional processing method.	Lack of quality control of dried anchovy. Turnover is based on dryness of product.	Problem on packaging, hygiene/sanitation.	Nil	To improve processing method.
Fermented	To improve storage and package of product.	Nil	Fermented anchovy. Irregular supply of raw material. Poor sanitation of processing products.	Long fermentation period, rust on bottle caps.	NA	Fermented fish *(plara)* - spoilage caused by mould growth & insect/fly infestation during fermentation process and marketing. Fermented fish sause *(nam pla)*, fish sause *(budu)*, & shrimp paste-blackening of fish sauce which made the product unattractive. Good quality fish sauce must have clear red-brownish liquid. A good quality shrimp paste must have a purple brown colour, smooth texture and salty krill flavour.

Table 2. Summary table of technical problems raised in survey (*contd.*).

PRODUCTS	BRUNEI DARUSSALAM	INDONESIA	MALAYSIA	PHILIPPINES	SINGAPORE	THAILAND
Fish meal	NA	Nil	Shortage of raw material & competition from imported fish meal.	Nil	Nil	Problem on price and freshness of raw material.
Frozen	NA	Nil	Nil	Nil	Nil	Nil
Powdered	NA	NA	Nil	NA	NA	To improve packaging of product. Mould growth during storage.
Smoked	To improve handling & packaging of product and prevent mould growth during storage.	Nil	Nil	Mould & bacterial spoilage during storage.	NA	Problem on packaging.
Others	To improve packaging of crackers.	Nil	Shortage of raw material.	Nil	Nil	Problem on quality control during processing

NA : Product not available

Nil : No problem indicated

erences quoted could be useful and would therefore like to collect them in our library for the reference of all member countries of SEAFDEC. However attempts by MFRD to collect the references from participating countries have been unsuccessful.

The colour photographs/slides received have helped to make the inventory more interesting. The compilers have tried to include all the photographs received except those which are not clear or did not highlight the contents of the survey.

Solutions To Problems Encounted And Improvements Of Co-ordination

To overcome the above problems, the compilers hope that the coordinators will check the information returned by their respondents. Any changes should be carried out before the forms are returned to the compilers. This would make cooperation between the compilers and coordinators easier and faster. The receipt of more photographs and slides would be appreciated for inclusion in the inventory, in particular photographs of products popular in the country. It will be helpful to have the types of products or activities shown in the photographs indicated clearly to the compilers.

Deadlines Of Correspondences

Respondents should keep to the time schedule as closely as possible. Arrangements should be made to avoid delays caused, for example by the absence of the coordinator on training or leave.

Concluding Remarks

The first inventory was completed in 1987. This was followed by the second improved inventory in 1991. We hope that future compilations will continue to have additional improvements.

Annex 1. Questionnaire form.

INVENTORY OF FISH PRODUCTS IN SOUTHEAST ASIA

Please answer all items. If information is not available, please indicate by 'N.A.'.

General statements may be given if estimated figures are not available; please indicate this by abbreviation 'Gen.'

When exact statistical figures are not available, estimated figures may be used; please indicate by abbreviation 'Est.' if figures are estimated.

PART I: COUNTRY CONTACTS

a) **Name/address of co-ordinator:** _____

_____

_____

Telephone: Cable: Telex: Fax:

b) **Name/address of respondents [please indicate section(s) involved]**

(1) _____

_____

Telephone: Cable: Telex:

(2) _____

_____

Telephone: Cable: Telex:

(3) _____

_____

Telephone: Cable: Telex:

PART II: DETAILS OF PRODUCTS

Name of Product		Description of product	References	Materials Used			Outline of processing methods
English name	Local name			Main materials	Cost per kg	Sub-ingredients	

List of machines used	Final Product				
	Packaging conditions	Storage Conditions (state method/temp.)	Shelf life	Ways of consumption	Retail price per kg

Production volume (mt)								Countries of destination (export)	Remarks on present/current problems in marketing & quality control
Production				Export					
1984	1985	1986	1987	1984	1985	1986	1987		

APPENDICES

SEMINAR PROGRAMME

7 MAY

7.30 - 9.30 p.m.
Opening Ceremony

8 MAY

9.15 - 9.40 a.m.
Keynote Lecture

9.40 - 10.40 a.m.
Special Paper - Japan I

11.00 -11.35 a.m.
Special Paper - MFRD I

11.35 a.m. - 12.10 p.m.
Special Paper - Canada

1.30 -2.30 p.m.
Special Paper - Japan II

2.30 - 3.05 p.m.
Special Paper - MFRD II

3.25 - 4.00 p.m.
Special Paper - MFRD III

4.00 - 4.35 p.m.
Special Paper - Norway

4.35 - 5.10 p.m.
Special Paper - Australia

5.10 - 5.45 p.m.
Discussion

9 MAY

9.00 - 9.35 a.m.
Country Report - Indonesia

9.35 - 10.10 a.m.
Country Report - Malaysia

10.30 - 11.05 a.m.
Country Report - Philippines

11.05 - 11.40 a.m.
Country Report - Singapore

11.40 a.m. - 12.15 p.m.
Country Report - Thailand

1.30 - 2.00 p.m.
Research Paper - Malaysia I

2.00 - 2.30 p.m.
Research Paper - Thailand I

2.30 - 3.00 p.m.
Research Paper - Thailand II

3.20 - 3.50 p.m.
Research Paper - Thailand III

3.50 - 4.20 p.m.
Research Paper - Thailand IV

4.20 - 4.50 p.m.
Research Paper - Philippines

4.50 - 5.20 p.m.
Research Paper - Thailand V

5.20 -5.50 p.m.
Research Paper - Malaysia II

10 MAY

9.00 - 9.30 a.m.
Research Paper - MFRD I

9.30 - 10.00 a.m.
Research Paper - MFRD II

10.30 - 11.00 a.m.
Research Paper - MFRD III

11.00 - 11.30 a.m.
Research Paper - Indonesia I

11.30 a.m. - 12.00 p.m.
Research Paper - Indonesia II

12.00 - 12.30 p.m.
Research Paper - Indonesia III

2.00 - 3.30 p.m.
Discussion and Recommendations

3.30 - 3.50 p.m.
The Amano Award/MFRD Award Presentations

3.50 - 5.00 p.m.
Adoption of Report and Closing Address

11 MAY

Study Tour

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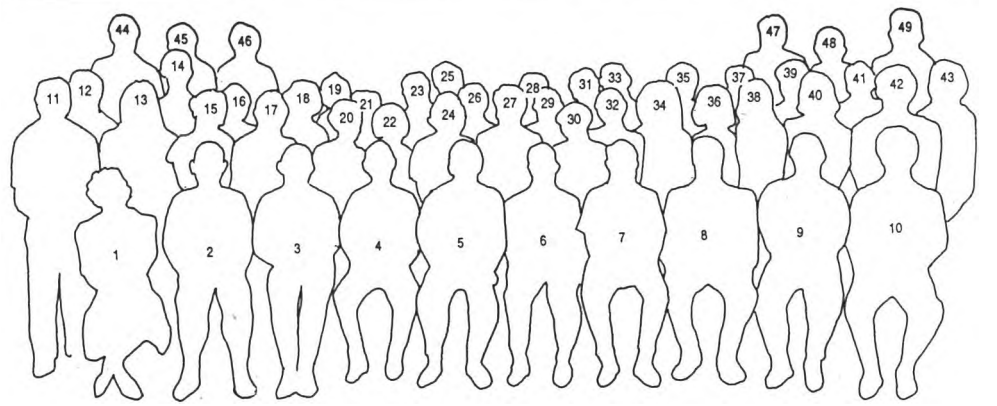

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As a sequel to the Southeast Asian Fisheries Development Center's (SEAFDEC) 20th Anniversary Seminar on Development of Fish Products in Southeast Asia in 1987, the Marine Fisheries Research Department of SEAFDEC organised a second Seminar to update information on the status of the fish processing industry in the region with particular attention to developments that had occurred since the first Seminar in 1987. A workshop to discuss the SEAFDEC's 1990 compilation of fish products in Southeast Asia was also held in conjunction with the Seminar.

The meeting was attended by researchers from Australia, Indonesia, Japan, Malaysia, Norway, Philippines, Singapore and Thailand, and by participants from the Canadian International Development Agency and SEAFDEC.

This volume reviews the advances made in the field of fishery post-harvest technology and presents edited papers, discussions and recommendations that emerged from the meeting.

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