PROCEEDINGS OF THE SYMPOSIUM

ON

LIVING RESOURCES *of* THE SEAS AROUND INDIA

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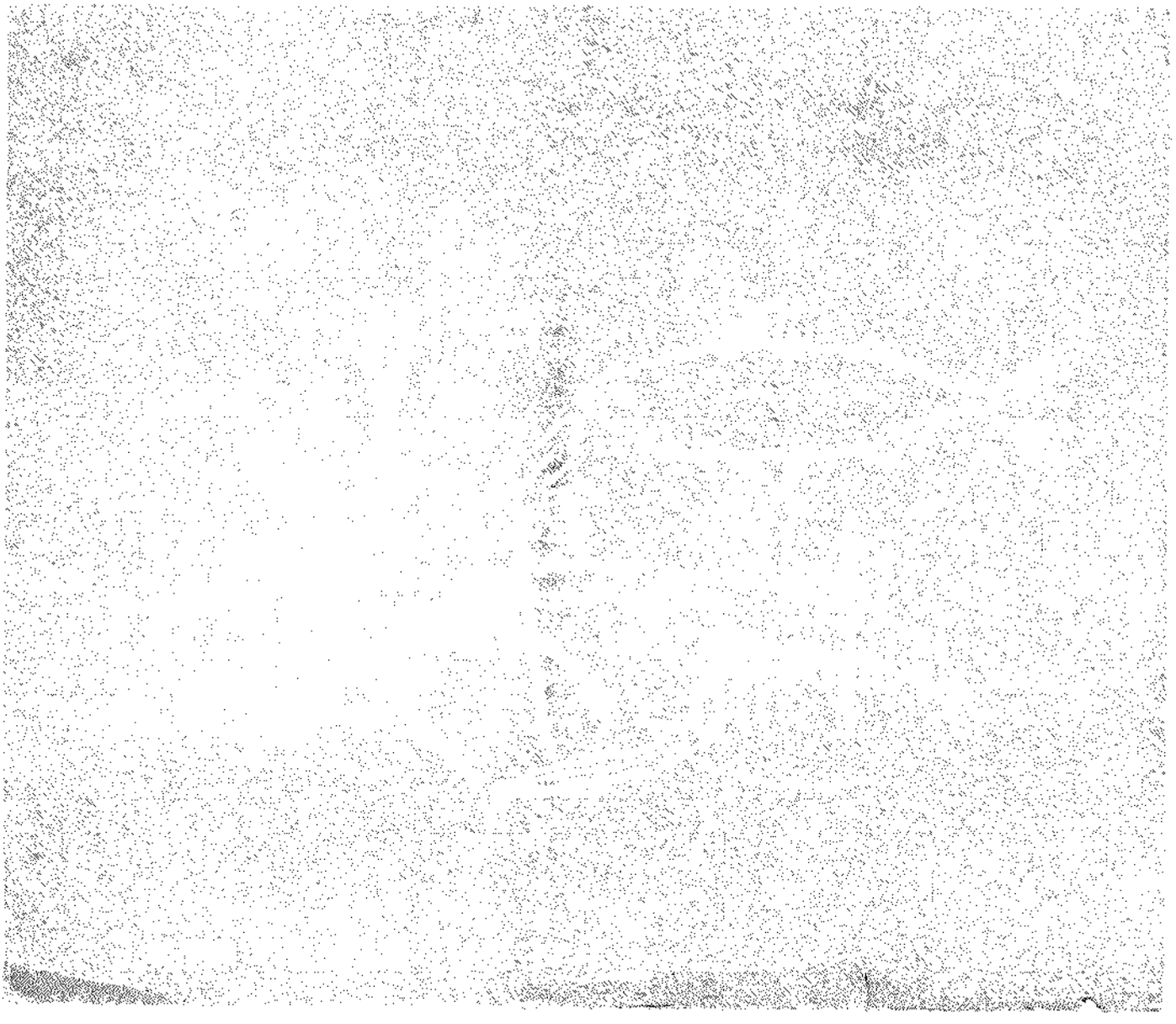

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APPLICATION OF TECHNOLOGY IN OPTIMUM UTILIZATION OF THE FISHERY RESOURCES OF INDIA

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ABSTRACT

The paper deals with some of the recent achievements made towards finding out ways and means of proper handling, transportation, preservation by different methods of processing, economic utilization of the byproducts and equitable distribution of our fishery products. Hygienic methods of handling fresh fish on board, proper icing procedures, improvements in existing containers and evolution of cheap and new ones including methods for long distance transportation, reported recently, have been briefly reviewed. Procedures for preservation of our important food fishes and shell fishes by freezing, canning and dehydration including curing have been summarised. Salient features of utilization of fish body and liver oils for industrial and pharmaceutical purposes, conversion of cheap varieties of trash fish into fish protein concentrate for human consumption, bacteriological peptones and speciality products like fish flakes, soup powder, fish pastes, etc., and economic usage of wastes from processing factories for fish meal and isolation of valuable chemical compounds, methods for which have been evolved recently, are reported.

INTRODUCTION

THE annual marine fish landings in India averaged 7,75,341 metric tons for the years 1961–67 and the target for the fourth five year plan is to increase it by another 50% by the end of the plan period. Considering the rapid pace at which mechanisation of fishing operations is progressing in our country, this target is easily attainable. However, increased landings of fish call for application of modern scientific methods of handling, preservation and distribution in order to derive the maximum advantage out of this natural resource of ours in assisting to solve the problems of our food shortage as well as improvement of the socio-economic condition of the lakhs of fishermen engaged in this profession. It was not in the distant past that we in Kerala were compelled, though occasionally, to bury sardine and mackerel as manure in coconut gardens in seasons of glut due to lack of quick means of transport and the technical know-how for proper handling and preservation. But of late, conditions have changed for the better and by the use of plenty of ice for preservation and quick methods of transportation like lorries, trucks, insulated vans, carrier launches and refrigerated rail wagons, fresh fish is rushed to distant and interior markets so that wastage is completely prevented. Application of modern methods of processing and preservation also has helped a lot in reducing wastage.

A very unhealthy tendency is observed at present in our mechanised fishing industry in that they confine their activities only to catching prawns which find a ready export market and the other fishes are completely ignored. It is a grim fact that some of our mechanised fishing boats operating on the west coast throw away all other fishes in order to make room for the foreign exchange earner. The reason put forth for such a trend is that mechanised fishing for fish other than prawns is not economical so that they are not able to meet even the cost of fuel by catching them. Another deplorable fact today is that a sizable fraction of the total installed capacity of our freezing and canning factories lies idle due to the keen competition that has sprung up in recent years for prawns which have failed to catch up with the speed with which such processing plants have grown up. These plants at present are not inclined even to utilize their idle capacity at least for preserving fish other than prawns, partly due to economic reasons and partly because the technical know-how

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for such processing were not available until very recently. In a country like ours subjected to constant threat of food shortage, it is absolutely important that we catch and preserve as much as possible of this nutritious food resource of ours and make them available to the protein-hungry millions of the country by a process of equitable distribution. The purpose of this paper is to review some of the recent achievements made towards finding out ways and means of proper handling, transportation, preservation by different methods of processing and equitable distribution of our fishery resources.

HANDLING

Table I gives the total fish landings in India for the years 1961–66 and their utilization by different methods (F.A.O. 1966). As is evident from the figures in the table, 48–71% of our total landings of fish is consumed as fresh. Hence it is absolutely important that efficient and hygienic handling practices are employed so as to ensure the fish reaching the consumer in the freshest and

TABLE I

Utilization of fish landings in India

Year	Total landings: Lakh M. tons	Marketing fresh: % of total	Curing: % of total	Freezing: % of total	Canning: % of total	Reduction: % of total	Miscellaneous: % of total
1961	9·6	47·9	43·7	..	..	8·3	..
1962	9·7	48·4	43·3	..	..	8·2	..
1963	10·4	67·3	26·9	0·38	0·10	4·8	..
1964	13·2	69·7	22·0	1·21	0·24	6·1	0·76
1965	13·3	68·4	25·5	1·35	0·38	3·8	0·30
1966	13·7	70·9	21·9	1·90	0·57	3·9	0·80

safest condition possible. Being the most perishable of human food materials, utmost care has to be taken in handling the fish right from the time of catch. The important points to be observed during this stage have been described by the author in a recent communication (Govindan, 1966). Boat decks, fish holds and wooden boxes used for storing the fish have been observed to build up bacterial loads of the order of 10^8, *E. coli* ranging from 0–259 and faecal *Streptococci* of the order of 10^5 per square inch in the course of one fishing operation. These organisms contaminate the fresh fish unless they are got rid of after each operation (Iyer *et al.*, 1966). It was found by practical field trials that these could be brought down to safe limits by a process of cleaning with some detergent followed by disinfection with a solution of bleaching powder containing 100 parts per million of available chlorine. Since the chain of spoilage reactions starts the moment the fish is taken out of water, they have to be kept under control for which the simplest means is to chill the fish with 1 : 1 proportion of crushed ice as early as possible after catch. It has been observed that in the case of larger mechanised boats which stay out fishing for several days continuously, it is preferable to eviscerate and remove the gills in the case of teleost fishes and remove the heads in the case of prawns before icing, since these processes eliminate a major portion of the agents which cause spoilage, *viz.*, bacteria and enzymes. Icing has to be done in alternate layers so as to ensure maximum contact of the ice with fish, taking care to see that the total depth of ice and fish in the container does not exceed the limit of crushing or bruising the bottom layers of fish.

Quality of Ice

Unless the ice used for preservation of fish is prepared from potable water and handled and transported under strictly hygienic conditions, it can act as a major source of contamination of the fresh fish (Iyer and Choudhury, 1966). Use of unclean water for making ice, storing of ice along with fish in chill rooms, dragging of ice blocks over unclean surfaces like factory floors covering of ice with unclean gunny and saw dust and crushing of ice blocks on factory floors all contribute to the bacterial load of ice, which has to be strictly avoided.

Quality of water.—The water used for making ice as well as at all stages of processing and preservation of fish must be of potable quality containing not more than 100 micro-organisms per ml and no coliforms in 100 ml of the sample. Other requirements for such water are described in I.S.I. Standards (I.S.: 3957, 1966).

Use of antibiotics.—Velankar and Kamasastri (1958) have observed that use of ice prepared from water to which 5 ppm of chlorotetracycline (CTC) have been added improved the storage life of perch (*Lethrinus* sp.), horse mackerel (*Caranx* sp.), *Lactarius*, mackerel, milk fish (*Chanos* sp.) and morral (*Hemiramphus* sp.) both as regards bacteriological as well as organoleptic quality. Prawns dipped in a solution of 50 ppm CTC for 10 minutes followed by storage in 5 ppm CTC ice were the best preserved microbially and organoleptically after different periods of storage compared to those given dip treatment in the antibiotic solution and then stored in ordinary ice and those preserved straightaway in antibiotic ice (Anon., 1967 *h*). Both antibiotic dip treatment and antibiotic incorporated ice appear to be promising under our conditions in so far as they suppress the bacterial loads on the fish.

Transportation

As seen from the figures in Table I, there is a phenomenal increase in the consumption of fish in the fresh condition in our country since 1962. This has been made possible by employing better handling practices and quicker means of transport mentioned earlier. One of the most important requirements for successful long distance transport of fresh fish is cheap and efficient containers. The traditional container used in our country for this purpose is the bamboo basket. By providing an inner lining to these baskets with kraft paper or double layer of gunny and a layer of 300 guage polythene above, the storage life of fish mixed with 1 : 1 proportion of ice in them could be almost doubled from the usual 11–12 hours in the control in plain baskets both under stationary state and actual transportation by train (Rao and Perigrien, 1964). A very efficient insulated container has been reported recently which can hold fish mixed with 1 : 1 ice in prime condition for 60 hours at ambient temperatures (Anon., 1965 *e*). It consists of a second hand tea-chest insulated inside with 2 cm thick thermocole sheet sealed in 150 guage polythene bag on all the six sides, the lid of which is nailed on after filling the fish and ice and the whole container wrapped in gunny and stitched. Fresh whole fish Vacked in this way reached distant destinations like Delhi and Calcutta in excellent condition from peraval, the meltage of ice being reduced to 20%. The cost of insulating a box 48 cm × 48 cm × 62 cm worked out to Rs. 6·50 and the box could be used over and over again. Fillets of shark prepared by brining the flesh in 10% brine for 30 minutes and packing in polythene bags and transported from Veraval in the above container with ice in ordinary rail wagons reached interior markets like Ahmedabad and Delhi in fine condition and were very well accepted by the consumers (Anon., 1965 *b*). Fish frozen individually and in blocks to −17 to −20° C and packed in the above container could be transported in good condition involving a journey of 4 days at ambient temperatures, the fish reaching the destination in a partially thawed state which could be sold as fresh fish immediately or stored in good acceptable condition in ice for a further period of 2–3 days (Anon., 1967 *d*). A container of size 38 cm × 38 cm × 38 cm could hold 20 kg of individually frozen and 25 kg of block frozen fish and the cost of freezing, container, freight, etc., for transporting fish from Cochin to Calcutta worked out from 90 paise to one rupee per kg. An important requisite for insulated containers and vehicles for transportation of fish as well as for

frozen storage and chill rooms for fish is efficient insulation boards. A method of preparing such boards from coconut pith so abundantly available in Kerala has been reported recently (Anon., 1963 *a*). The method consisted in mixing the pith with rubber latex diluted with ammoniacal water, taking the mixture in wooden moulds of required size, adding the required amount of acetic acid for coagulating the rubber, pressing in a screw press and drying at 50° C for 6 hours to a moisture level below 10%. The board had an equilibrium moisture content of 11·3% at 85% R.H., thermal conductivity of 0·27–0·32 B.T.U./hour/sq. ft/° F., density of maximum 10·7 lb/c.ft and operational range upto 80° C.

Freezing

Prawns.—At present we have got in India thirty-five freezing factories with an installed capacity of 227 metric tons per day. In the year 1967, India exported 11,856 metric tons of frozen prawns earning foreign exchange worth Rs. 12·1 crores. The technical details of freezing of prawns are well known to those engaged in the industry and consist in removing the heads alone of prawns (raw headless), peeling and deveining (P & D) or cooking the peeled prawns (Peeled Cooked) in brine as the case may be, arranging weighed quantities (generally five pounds) in metallic trays, filling the inter spaces with ice-water (glazing), freezing to —40° C, reglazing and packing in waxed cartons with a polythene wrapping inside, followed by sealing in thick cardboard master cartons. Dehydration during frozen storage is a common defect occurring in frozen prawns which could be completely prevented by reglazing the frozen blocks with 2·5% solution of sodium alginate (Pillai, 1964). Another serious defect which causes a loss of 100 tons of prawns per year to our country is the thaw drip loss which amounts to 10% in P & D, 5% in headless and 3% in cooked frozen variety (Anon., 1968 *d*). This could be successfully prevented by dipping the prawns in a solution of 12% sodium tripolyphosphate and 8·6% sodium dihydrogen phosphate for one minute before freezing.

As has been indicated earlier, our freezing factories at present confine themselves to prawns and some quantities of lobster tails and froglegs which find ready export markets, the rest of the installed capacity lying idle. It is high time that at least this idle capacity is utilized for freezing and preserving other fish which can help to solve our food problem to some extent. The technical know-how for freezing preservation of some of our important teleost fishes has been worked out recently and is briefly summarised below.

Sardine.—Fresh oil sardines washed clean, arranged in metallic trays, glazed with ice-water, quick frozen and stored at —18° C remained in good edible condition for 2–5 months depending upon the fat content of the fish to which the shelf life bore an inverse relation (Mathen *et al.*, 1966). In the case of individually quick frozen sardines which were: (1) dipped in 0·05 to 0·5% hydroquinone prior to freezing and (2) glazed with 1·0% agar agar after freezing, the storage lives were enhanced to 7 and 8 months respectively compared to 3 months in the control, by preventing rancidity and yellowing.

A serious defect occurring during frozen as well as iced storage of oil sardines is the bursting of belly walls and exuding of the viscera which reduces the consumer acceptability of the fish. This phenomenon could be successfully controlled by giving a dip treatment to fresh oil sardines in 15% brine for 30 minutes prior to freezing or storage in ice (Anon., 1968 *f*).

Pomfrets.—Fresh pomfrets washed clean, individually quick frozen in blast freezers, glazed by dipping in a solution of 1·0% ascorbic acid or a mixture of 2·0% ascorbic acid and 0·2% citric acid packed in polythene lined gunny bags and stored at —10 to —15° F with reglazing at five weeks interval kept in fine condition for one year without any dehydration or discolouration (Anon., 1965 *c*).

Other small and medium sized table fishes like mackerel, *Lactarius*, Bombay duck, Caranx and perches can be well preserved by freezing following either of the methods described above. Bigger size fihes like seer, tunnies, elasmobranchs, hilsa, catfishes and eels can preferably be frozen in the form of fillets or round slices and preserved for distribution in lean seasons.

Canning

Prawns.—The total installed capacity of our canning factories at present is 5·25 lakh cans per day, distributed over 40 plants. In the year 1967, India exported canned prawns worth Rs. 3·5 crores. The technical know-how of the process is well known to the industry. It consists in peeling and deveining the prawns, blanching in boiling 10% brine for 4–8 minutes, cooling under fan, filling weighed quantities in cans followed by hot 2% brine containing 0·1% citric acid, exhausting, seaming, sterilising at 0·7 kg/cm^2 steam pressure for 18 minutes, cooling, wiping dry and labelling. However, strict adherence to the processing conditions is absolutely essential for turning out a standard quality product and the precautions to be taken for achieving this have been reported by the author earlier (Govindan, 1966, *loc. cit.*).

One serious defect that has occurred recently in our canned prawns resulting in rejection of several thousand cases in foreign markets involving a substantial loss to the industry was the blackening of the interior of the can and contents. A detailed study of the problem showed that the defect originated from the particular factory not adding citric acid to the filling brine and was completely under control when this was remedied (Anon., 1968 *a*). Blackening is caused by contamination of the material with traces of copper (even as low as 1·58 mg/100 g) and iron from utensils and other surfaces with which it comes into contact in the processing factory. Blackening due to iron is completely controlled by the acid in the filling brine (pH to be 6·4 to 6·6) while that due to copper is independent of the pH. The latter could be avoided only by strict care not to allow the material to come into contact with any copper or copper alloy surfaces.

Other fishes.—Unlike in the freezing industry, our canning factories process a sizable quantity of sardine, mackerel and tuna which have got a good demand from the Army Purchase Organisation. A very small portion of these products is exported to other countries and a similar amount sold in the internal markets. Besides these, fishes like *Lactarius*, dara, *Tilapia* and seer lend themselves well to canning preservation, methods for which have been developed recently. In the case of medium and small size fish, *viz.*, sardine, mackerel, *Lactarius*, dara and *Tilapia*, they are dressed by removing heads, viscera, tails, fins and scales, washed clean, brined and pre-cooked. Larger fishes like tuna and seer are eviscerated, cleaned, cut into chunks of convenient sizes for pressure cooking in autoclave, cooked, flesh separated and brined. They are then filled in cans, followed by hot refined oil, exhausted as usual, seamed, sterilised, cooled, labelled and packed. The conditions of processing at the different stages are given in Table II.

Research work on evolving methods of canning of a large number of other fishes like eel, *Synagris*, *Otolithes*, *Serranus*, etc., are well under way and soon we may be in possession of the technical details for these processes. Smoking of sardine and mackerel prior to canning gave products with very appealing flavour (unpublished work) which are likely to be well accepted. Since freezing and canning retain the original qualities of the material (organoleptic as well as nutritive) more than the other methods, we have to lay more emphasis on these methods. As the American we have to make our motto " Eat what we can and can what we can't".

Curing

As seen from Table I, the method by which maximum amount of fish is preserved in our country is curing. Even though the figure has fallen from 43% to the level of 22% of the total landings since 1962 due to the increase in consumption in the fresh condition, being the cheapest

TABLE II

Canning conditions for some common marine food fishes

Name of fish	Brining		Pre-cooking		Sterilisation		Reference
	% of brine	Time: Mts.	Pressure: kg/sq. cm	Time: Mts.	Pressure: kg/sq. cm	Time: Mts.	
Sardine	15	15	0·35	35 to 40	0·84	70 to 75	Anon., 1964 *c*
Mackerel.	15	26	0·35	45 to 50	0·91	60	Anon., 1964 *d*
Lactarius	26, with 1% HAc.	15	0·35	20	0·84	90	Anon., 1965 *f*
Dara	20	30	0·70	15	1·05	45	Anon., 1968 *g*
Tilapia	26, with 0·3 to 0·5% HAc.	15	0·35	40	1·05	60	Anon., 1968 *b*
Tuna	15, with 0·075% $NaHCO_3$	22	0·84	90 to 120	0·84	60	Anon., 1964 *a*
Seer	15, with 0·05% $NaHCO_3$	24	0·70	60	0·91	75	Anon., 1965 *a*

method, curing is bound to stay as the largest single method of fish preservation not only in India but in all the developing countries. However, this industry has not received even a fraction of the attention and development which the canning and freezing industries have been able to command in recent years. It is still being carried on in the hereditary way without any improvement whatsoever. The main reason for this is the lack of attractive foreign markets for these products which again is attributable to their unsatisfactory quality. Methods by which this industry could be modernised on scientific lines to produce best quality product for internal consumption and export have been described by the author in an earlier communication (Govindan, 1967). The most important defects met with in our commercially cured fish samples, *viz.*, fungus and red halophilic bacterial attack have been completely brought under control by giving a pre-dip treatment of the dressed fish in 4% propionic acid bath for 5 minutes followed by the usual processes of salting and drying (Valsan *et al.*, 1961, Rao and Valsan, 1962). A further simplification of this treatment in which absorption of the chemical by the fish tissue was almost completely prevented consisted in smearing the fish cured and dried by the usual commercial method with a dusting mixture containing 3% sodium propionate in powdery refined salt in the ratio of one part of preservative mixture to 10 parts of cured fish prior to packing, yielding the same results as the dip treatment (Anon., 1967 *b*). The packing of these products also require a complete change over from the present methods, the best packing materials being polythene lined dealwood boxes or gunny bags for bulk packing and attractive sealed polythene bags for consumer packs (private communication).

Under the present conditions, our fish curing industry has to depend entirely on the vagaries of the weather for drying their products. A tunnel dryer for artificial drying of fish under controlled and hygienic conditions has been reported recently (Prabhu *et al.*, 1963). By a judicious adjustment of the temperature and relative humidity inside the tunnel in a phased manner, the drying process could be accelerated and salted fishes like mackerel, *Lactarius*, jew fish and *Synagris* could be dried to 30% moisture level in 12 hours (Anon., 1968 *e*). The elasmobranch fish, *viz.*, sharks, rays, etc., contain 5·8–7·5% DWB urea which renders them unpalatable on curing and drying. A simple method has been reported recently for removing the urea almost completely by a process of heavy salting of the fillets followed by desalting in 5% brine (Kandoran *et al.*, 1965).

Colombo curing.—This is an indigenous pickling method of preservation used mainly for mackerel, in which small pieces of the dried pods of the fruits of *Garcinea cambogea* are placed in the stomach cavity of the split and salted fish which are then stacked in wooden barrels and covered with saturated brine. The shelf life of this product could be doubled by giving a dip treatment to the dressed fish in 4% propionic acid for 10 minutes prior to salting and storing under saturated brine or covering the salted fish with saturated brine containing 1% propionic acid (Rao and Valsan, 1962).

Smoke curing.—Even though smoke curing was widely employed in India during World War II, it has been discontinued thereafter. Smoking salted mackerel, sardine, silver belly, etc., before drying imparts a very agreeable flavour to the products and they are likely to be very well accepted in our internal markets. Details of this process have been reported recently (Anon., 1962 *c*, 1966 *c*). Another important smoked product which finds a ready export market to Ceylon, Burma, etc., is " mass min " produced in Laccadive and Minicoy Islands from tuna by an indigenous process of cooking the fillets in dilute seawater followed by alternate smoking and sun-drying until the product becomes hard enough. Standardisation of the process on scientific lines has been carried out recently (Anon., 1963 *b*).

Sun-drying.—Small fish like silver belly and sprats are mostly sun-dried without any pretreatment. When large quantities of these fishes are landed, they are generally dried on the sandy beaches when they take up sand to the extent of 15–20%. An equipment has been fabricated recently which can reduce the sand content to 3–4% (Anon., 1966 *d*).

Dry prawns.—Dry prawn pulp was our most important export commodity prior to the birth of the freezing and canning industries. Even though this product has since lost its importance, almost the entire quantity of the smallest variety of prawns are being used by this industry which is still being carried on in the traditional way and leaves much to be desired towards improving the product. Some of the important points to be borne in mind to achieve this end have been reported (Anon., 1962 *a*). An entirely new process in which fresh headless prawns can be converted into high quality prawn pulp under very hygienic conditions consisted in charging the prawns into a steam jacketed mild steel drum rotated by an electric motor and increasing the speed of rotation gradually from 10 to 30 rpm, when the prawns got cooked, dehydrated and deshelled in a single process in about 3 hours (Balachandran and Bose, 1963).

Freeze drying.—Though comparatively a costly process, freeze drying offers an ideal method of preservation for many varieties of fish and shell fish of our country in so far as such products are light to handle and transport, easy to reconstitute and prepare for the table and are only next in quality to frozen products, but at the same time not requiring refrigerated transportation and distribution lines. Lean fishes like prawns, shark, tuna and serranus, both in the fresh and cooked forms, lend themselves well to freeze drying, while too much fat in the fish (*e.g.*, sardine, mackerel, mullet and seer) not only retarded the rate of removal of water but also interfered with reabsorption of water during reconstitution. High calorie, pre-cooked, ready-to-serve foods like fish salads which are very important from our defence point of view could well be preserved by freeze drying (Anon., 1967 *i*).

Fish Oils

Both fish body and liver oils are extracted in India. Among the body oils, sardine oil occupies the most important position, possessing promising industrial potentialities. The method employed for its extraction at present is the primitive one yielding a very poor quality oil with dark colour and foul smell unfit for any industrial purpose other than painting of country boats for which it is widely used. Scientific lines of extraction of the oil using aluminium vessels instead of iron for cooking the sardines and salting out the oil from the press liquor, yielding a golden yellow oil, which can be directly put to many industrial uses, have been worked out recently (Anon., 1966 *b*).

Treating preheated sardine oil (iodine value: 80–100) with 20% elemental sulphur at 180° C and adding 10% sardine oil during the final stages of reaction yielded a product comparable to commercial practice from vegetable oil which is widely used as a filler in rubber industry (Kaimal and Madhavan, 1967).

Stearine separated sardine oil heat-bodied at 200° C for 2 hours in the presence of 1% cobalt oxide followed by polymerisation with 40% rosin at 250° C for 8 hours and incorporation of pigment, dryer and thinner yielded ready mixed paints conforming in quality to I.S.I. Standards (Kaimal *et al.*, 1968).

When stearine separated sardine oil was heated alone at 200° C for 2 hours followed by addition of 40% rosin and 1% sulphur and further heating for 2 hours and the product obtained thus was mixed with pigment and other ingredients, it yielded a high quality printing ink which proved satisfactory in practical printing tests (Anon., 1967*f*).

Among fish liver oils extracted in our country, shark liver oil is the most important because of its high contents of vitamin A and consequent pharmaceutical use. However, the oil contents and vitamin potencies of the liver vary according to seasons (Kamdar *et al.*, 1967). Liver oils of skates and rays which do not contain any appreciable amount of vitamin A can be very well sulphonated and used in the leather industry (Anon., 1962*b*).

Fish Protein Concentrate

A method has been successfully worked out for preparing odourless and tasteless fish flour for human consumption which can be incorporated with bread or chapathis using cheap trash fish like *Synagris*, jew fish, etc., by cooking and pressing followed by extraction with an azeotropic mixture of hexane and alcohol (Ismail, 1968).

Bacteriological Peptone

The bacteriological peptone required for all laboratories in our country is being imported at present at exorbitant prices. Methods have been now worked out for preparing this product from trash fish like *Synagris* by a process of dressing, cooking, pressing, solvent extraction (to remove fat), hydrolysis with papain and drying in vacuum (Anon., 1967*g*).

Byproducts

For a fish processing factory to run on sound economic basis, it is absolutely essential that all its byproducts are fully utilized. Guano (the press cake from sardine oil industry) as well as small miscellaneous cheap fish which are not generally used for edible purposes can be converted into high quality fish meal which finds a ready export market and is in great demand inside the country as a good poultry and cattle feed. The chemical qualities of meals from different fishes have been reported (Anon., 1962*d*).

Prawn shells and heads which are discarded from processing factories in large quantities are nearly wasted at present, a small percentage being dried and powdered for manure or for incorporation in fish meal. Extraction of the dried waste with acetone to remove pigments and fat followed by decalcification with hydrochloric acid and treatment with sodium hydroxide to remove the proteins yielded chitin which on hydrolysis with concentrated hydrochloric acid gave glucosamine hydrochloride, a valuable pharmaceutical compound (Kamasastri and Prabhu, 1961). Cholesterol was isolated from the unsaponifiable portion of the fat extracted from prawn waste by the dibromide method (Kaimal and Rao, 1965).

Dried shark fins are exported from our country in large quantities to far eastern countries where they are used for making soups. The spinal and tail fins are cut from fresh sharks, adhering flesh removed, salted in the ratio 1 : 10 (salt to fins), allowed to stand 24 hours, washed and dried to 7 to 8% moisture (Anon., 1964 *b*). If the rays are extracted from the fins, they are likely to fetch better prices. Methods of extraction of the rays by treatment of the fins with dilute acid have been reported (Anon., 1967 *a*). Shark skin leather is another important product which finds varied uses. The skins are carefully flayed from large size sharks, cured with salt and tanned as usual when high quality leather is obtained (Anon., 1964 *f*). Large quantities of fish maws used for making soups and clarification of wine are exported from India. The air bladders from large fishes are separated, washed clean, dried in the sun and packed (Anon., 1964 *e*).

Fish offal thrown out of processing factories and cheap miscellaneous trash fish can be preserved as a liquid ensilage for cattle and poultry feed by mincing them and mixing with molasses followed by addition of a pure culture of *Lactobacillus plantarum* which produces lactic acid from the molasses, which acts as the preservative (James, 1966).

Speciality Products

Products in which fish is only one of the ingredients and require a greater amount of preparation than the usual canning process can be termed 'speciality products.' Products with special purposes like bread-spreads and those aimed at utilization of cheap varieties of trash fish have been reported recently.

Fish pastes.—Tuna paste prepared from cooked tuna meat, starch, fat and flavouring agents and prawn paste from homogenised fresh prawns (partially hydrolysed by papain), starch and flavouring agents, both packed in cans and sterilised, are good bread-spreads (Anon., 1965 *d*). A method for converting Bombay duck into a high quality paste which can be used as a bread-spread as well as for preparation of cutlets and soup has been evolved. It consisted in dressing the fish, cooking under pressure, blending, filling in cans and sterilising (Anon., 1967 *e*). The smallest size prawns called 'Jawala prawns' (*Acetes* sp.) which are generally sun-dried and powdered for export can be converted into a palatable product called shrimp extract which is in great demand in U.K., U.S.A., etc. The dried whole prawns were powdered, partially hydrolysed with papain in acid medium, concentrated, packed in cans and sterilised (Anon., 1965 *g*). Crab concentrate was prepared by cooking crabs, separating the meat, blending it with water, concentrating, packing in cans and sterilising (Anon., 1966 *e*).

Fish cakes and sticks.—Doma (*Otolithes* sp.) which is a cheap variety of trash fish can be converted into a wholesome product by blending its cooked meat with starch and flavouring agents, moulding into shape, coating with tapioca starch and deep freezing. The frozen product remained in fine condition for 25 to 30 days in frozen storage and yielded a delicious product on frying in oil (Anon., 1967 *c*). Frozen breaded fish sticks were prepared by sawing out uniform pieces from frozen fish like marlin, coating with batter and coarse bread powder and freezing. On frying in oil, it gave a very palatable product (Anon., 1966 *a*).

Other products.—Fish sauce which can be used as flavouring agents, etc., was produced from cheap varieties of fish like sardines and white baits by a process of salting for 6 to 18 months (Anon. 1961). A process for converting cheap fishes like *Synagris*, jew fish, etc., into flakes or crisps which can be fried in oil and eaten was reported recently. It consisted in cooking and deodourising the meat, blending it with starch, cooking in thin films, cutting out the films and drying (Venugopalan and Govindan, 1967). Another method of utilization of such fish was by converting them into soup powder. The cooked deodourised meat was blended with water, mixed with flavouring agents, etc., dried and powdered. It could be prepared for the table by boiling a 5% suspension of the powder for 2–3 minutes (Anon., 1968 *c*).

Summary

Hygienic methods of handling fresh fish on board fishing vessels, proper icing procedures to be followed, improvements in existing containers for storing and transporting fresh fish and evolution of cheap and efficient ones for long distance transportation of fresh fish have been briefly described. Technical details for the preservation of our important food fishes and shell fishes by the different processes of freezing, canning and dehydration, which have been worked out recently, are summarised. Suggestions are given for modernising the fish curing industry which still remains to be the largest single method of fish preservation employed in our country by scientific method of processing, using effective chemical preservatives and attractive and hygienic packing materials. Implementation of these improved methods ensures better utilisation of our fishery resources in the fresh and preserved forms by imparting longer shelf lives to them and effecting more even distribution of the products, besides earning valuable foreign exchange. Salient features of utilization of fish body oils like sardine oil and liver oils like shark liver oil for industrial and pharmaceutical purposes are discussed. Methods worked out recently for conversion of cheap varieties of trash fish into a colourless and odourless fish protein concentrate for human consumption by incorporation in bread, etc., and into bacteriological peptone by a process of enzyme hydrolysis under controlled conditions are briefly reviewed. Such fishes can also be converted into a variety of protein rich speciality products like fish flakes, fish soup powder, and fish pastes. Products with special purposes like frozen breaded shrimp and fish sticks and bread-spreads like prawn paste, shrimp extract, etc., are reported. Byproducts of the industry like shark fins, shark skin leather and fish maws find lucrative export markets. Waste materials from fish processing factories like offal and prawn shells and heads can be converted into fish meal or liquid fish ensilage for feeding livestock and also used for isolation of valuable chemical compounds, *e.g.*, cholesterol and glucosamine from prawn shell. All these methods can be advantageously employed for the maximum utilization of our fishery resources on scientific lines.

Conclusion

The foregoing is brief summary of some of the achievements made in recent years in research work aimed at maximum utilization of our exploited fishery resources, in the fresh and processed forms. What is required immediately is to increase our fish catches. This is possible only by extending our mechanised fishing activities to our pelagic fishes. As pointed out in the beginning of this article, at present no effort at all is being expended in applying mechanised fishing to these fishes. Now that we have got the technical know-how for utilizing these fishes in a variety of economic ways, there need not be any fear that they will go unutilized. The only point to be borne in mind is to select the most suitable method for preserving a particular type of fish. For example, lean fishes are more suitable for freezing and drying while fatty ones lend themselves better to the canning method of preservation. Again, small fish and shell fish which cannot be economically filletted or peeled and deveined, etc., have to be preserved by simple methods not requiring such preparations. To sum up I may quote a passage from a recent F.A.O. publication (F.A.O., 1968) which appears to apply appropriately to our country also: " In this connection, it is necessary to point out that, for some time to come, private enterprise will not find it attractive to supply inexpensive products to the mal-nourished poor of the developing regions. If fish is to fulfil its potential role in the fight against hunger, public policy will have to be oriented toward giving developing countries an opportunity to participate in increasing measure in the harvesting and domestic utilization of fishery resources."

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