UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT OF FISHBURGERS FROM Selaroides leptolepis, Aristichthys nobilis AND Alutera monoceros

SIAH WATT MOEY

DEVELOPMENT OF FISHBURGERS FROM *Selaroides leptolepis*, *Aristichthys nobilis* AND *Alutera monoceros*

SIAH WATT MOEY

MASTER OF SCIENCE
UNIVERSITI PUTRA MALAYSIA

1997

DEVELOPMENT OF FISHBURGERS FROM *Selaroides leptolepis*, *Aristichthys nobilis* AND *Alutera monoceros*

BY
SIAH WATT MOEY

Thesis Submitted in Fulfilment of the Requirements
for the Degree of Master of Science
in the Faculty of Food Science and Biotechnology
Universiti Putra Malaysia

1997

ACKNOWLEDGEMENTS

The author wishes to extend her deepest appreciation and gratitude to the following persons who have help to make this thesis possible :

Prof. Dr Yu Swee Yean, Chairman of my supervisory committee who has constantly offered her guidance, advice, patience and understanding during the course of this project.

Members of my supervisory committee Dr Russly Abd Rahman and Encik Dzulkifly Mat Hashim for their invaluable suggestions, guidance and constructive comments towards the preparation of this thesis.

The author's husband, Mr Ong Yong Yiu, and family for their continous moral support throughout the entire project.

I would also like to thank the laboratory assistants who have unconditionally and patiently helped me, especially Encik Razali Othman, Mr Chan Tin Wah, Encik Amran, Puan Shahrul, Puan Siti Ziryani, Cik Siti Rosmah, Encik Mustaffa and Encik Zulkifli.

TABLE OF CONTENTS

Page

ACKNOWLEDGEMENTS iii

LIST OF TABLES ix

LIST OF FIGURES xi

LIST OF PLATES xiii

ABSTRACT xiv

ABSTRAK xvi

CHAPTER

1 **GENERAL INTRODUCTION** 1

2 **LITERATURE REVIEW**

Introduction 5

Definition of Surimi and Surimi-based Products 7

Preparation of Surimi 9

Preparation of Products from Surimi 12

Products of Surimi 13

Traditional Products 13

Shellfish Analogues 13

Factors Affecting the Quality of Surimi 14

Freshness 14

Seasonality 15

Use of Fillet or Headed and Gutted Fish..... 15

Mincing..... 15

Leaching..... 16

Denaturation of Myofibrillar 23

Properties of Fish Myofib 25

Effect of Ingredients on Gel Texture 26

Chemical Ingredients Related to Protein Extraction 27

Chemical Ingredients Affecting Network Formation 29

Gelling Substances 30

Fish Used for Surimi Production 31

Value-added Products from Fish 35

Storage Stability of Fish Products 38

Packaging 39

3 **PRODUCT DEVELOPMENT**

Introduction 43

Aims, Objective and Constraints 45

New Product Idea Generation 47

Product Screening 48

Product Concept and Specification 53

Formulation Development 56

Process Development 73

Final Consumer Testing 76

Conclusion..... 83

4 **EFFECT OF PACKAGING ON THE STORAGE STABILITY OF FISHBURGERS**

Introduction 84

Materials and Methods 85

Materials 85

Methods 86

Sample Preparation 86

Physical-chemical Analyses 87

Microbiological Test 87

Sensory Evaluation 88

Statistical Analysis 88

Proximate Analyses 88

Determination of Amino Acid Composition 89

Results and Discussion 90

Thiobarbituric Acid No. 90

Trimethylamine 92

Total Volatile Basic Nitrogen 94

Salt Soluble Protein 95

pH 96

Moisture Content 98

Microbiological Test 101

Sensory Characteristics during Storage 102

Proximate Analyses and Amino Acid Profile of Fishburgers 109

Conclusion 110

5 EFFECT OF WASHING ON THE STORAGE STABILITY OF *S.leptolepis* AND *A.nobilis* SURIMI

Introduction 111

Materials and Methods 112

Materials 112

Methods 112

Sample Preparation 113

Recovery Studies 114

Proximate Analyses 114

Amino Acid Profile 115

Physical Analyses 115

Chemical Analyses 118

Statistical Analyses 119

Results and discussion 119

Recovery Studies 119

Proximate Compositions of Fish Mince and Surimi 120

Amino Acid Profile 122

Texture Profile Analyses 123

Folding Test 134

pH 136

Moisture Content 138

Expressible Moisture 141

Colour : Whiteness 143

Thiobarbituric Acid No. 148

Total Volatile Basic Nitrogen 152

Trimethylamine 154

Salt Soluble Protein 156

Conclusion..... 159

6 **GENERAL CONCLUSION AND RECOMMENDATIONS**

Conclusion 160

Recommendations 161

BIBLIOGRAPHY 162

PUBLICATION 175

APPENDICES..... 179

BIOGRAPHICAL SKETCH 196

LIST OF TABLES

Table		Page
1	Some Value-added Products Developed from Low-Cost Fish.....	36
2	Sequential Screening of Product Idea.....	49
3	Range of Score from Check List Screening.....	52
4	Proposed Ingredients List for Fishburgers.....	55
5	Preliminary Formulation for Fishburgers.....	57
6	Formulation of Fishburgers with Different Levels of Starches.....	58
7	Sensory Evaluation of Fishburgers Made with Potato Starch.....	59
8	Sensory Evaluation of Fishburgers Made with Tapioca Starch.....	60
9	Sensory Evaluation of Fishburgers Made with Wheat Starch.....	61
10	Results from Sensory Evaluation.....	62
11	Formulation for Fishburgers with 3% Soya Isolate and Different Levels of Potato Starch.....	63
12	Sensory Evaluation of Fishburgers with Soya Isolate.....	64
13	Formulation for Fishburgers Containing Carrageenan.....	65
14	Sensory Evaluation of Fishburgers Containing Carrageenan.....	66
15	Formulation of Fishburgers Containing Vegetable Mixtures.....	67
16	Sensory Evaluation of Fishburgers Containing Vegetable Mixtures....	68
17	Fishburgers Formulation with *S.leptolepis*, *A.nobilis* and *A.monoceros* Surimi.....	70
18	Sensory Evaluation of Fishburgers Made from *S.leptolepis* and *A.nobilis* Surimi.....	72

19	Sensory Evaluation of Fishburgers Made from *S.leptolepis* and *A.monoceros* Surimi	73
20	Thiobarbituric Acid No. (TBA), Trimethylamine (TMA), Total Volatile Basic Nitrogen (TVBN) ans Salt Soluble Protein (SSP) of Fishburgers during Storage at -20 °C	91
21	pH, Moisture Content and Microbial Counts of Fishburgers during Storage at -20 °C	99
22	Sensory Characteristic of Fishburgers during Storage at -20 °C	103
23	Proximate Compositions of Raw Fishburgers	109
24	Amino Acid Profile *S.leptolepis* and *A.nobilis*	110
25	Recovery of Fish Mince from *S.leptolepis*, *A.nobilis* and *A.monoceros*	120
26	Proximate Composition of Fish Mince and Surimi	121
27	Amino Acid Composition of *S.leptolepis*, *A.nobilis*, *A.monoceros* and Beef	122
28	Texture Profile: Hardness, Springiness and Cohesiveness of Surimi Gels during Storage at -20 °C	124
29	Texture Profile: Gumminess, Chewiness and Elasticity of Surimi Gels during Storage at -20 °C	126
30	pH, moisture Content and Expressible Moisture of Surimi gels during Storage at -20 °C	139
31	Whiteness and Thiobarbituric Acid No. (TBA) of Surimi during Storage at -20 °C	144
32	Total Volatile Basic Nitrogen (TVBN), Trimethylamine (TMA) and Salt Soluble Protein (SSP) of Surimi during Storage at -20 °C	149
33	Initial Factors for Check List Screening	181
34	Check List Screening Technique Factors	182
35	Check List Screening	185

LIST OF FIGURES

Figure		Page
1	Preparation of Surimi and Surimi-based Products.....	8
2	Effect of Agitation Time on the Extraction of Proteins of Varying Meat-to-Water Ratios.....	19
3	Effect of Washing Cycles on Changes in Myofibrillar and Sarcoplasmic Proteins and Gel-Forming Ability of Red Hake Surimi Washed at a 1:3 Ratio of Meat-to-Water.....	19
4	Effect of Wash Water Temperature and Time on the Draining Efficiency of Red Hake Mince.....	22
5	Processing of Fishburgers.....	74
6	Market Trial of *S.leptolepis* and *A.nobilis* Fishburgers : Taste.....	78
7	Market Trial of *S.leptolepis* and *A.nobilis* Fishburgers : Texture.....	79
8	Market Trial of *S.leptolepis* and *A.nobilis* Fishburgers : Juiceness...	80
9	Market Trial of *S.leptolepis* and *A.nobilis* Fishburgers : Colour.....	81
10	Market Trial of *S.leptolepis* and *A.nobilis* Fishburgers : Overall Acceptability.....	82
11	Changes in Thiobarbituric Acid No. (TBA) of Fishburgers during Storage at -20 °C.....	92
12	Changes in Trimethylamine (TMA) of Fishburgers during Storage at -20 °C.....	93
13	Changes in Total Volatile Basic Nitrogen (TVBN) of Fishburgers during Storage at -20 °C.....	94
14	Changes in Salt Soluble Protein (SSP) of Fishburgers during Storage at -20 °C.....	96
15	Changes in pH of Fishburgers during Storage at -20 °C.....	97
16	Changes in Moisture Content of Fishburgers during Storage at -20 °C.....	100

17	Microbial Count of Fishburgers during Storage at -20 °.....	101
18	Changes in Taste Score of Fishburgers during Storage at -20 °C....	104
19	Changes in Texture Score of Fishburgers during Storage at -20 °....	105
20	Changes in Colour of Fishburgers during Storage at -20 °C.....	106
21	Changes in Juiceness of Fishburgers during Storage at -20 °C.....	107
22	Changes in Overall Acceptability of Fishburgers during Storage at -20 °C.....	108
23	Typical Shape of a TPA Curve Obtained by the Instron Universal Testing Machine.....	116
24	Changes in Hardness of Surimi Gels during Storage at -20 °C.....	129
25	Changes in Springiness of Surimi Gels during Storage at -20 °C.....	130
26	Changes in Cohesiveness of Surimi Gels during Storage at -20 °C...	131
27	Changes in Gumminess of Surimi Gels during Storage at -20 °C.....	132
28	Changes in Chewiness of Surimi Gels during Storage at -20 °C.....	133
29	Changes in Elasticity of Surimi Gels during Storage at -20 °C.....	135
30	Changes in pH of Surimi Gels during Storage at -20 °C.....	137
31	Changes in Expressible Moisture of Surimi Gels during Storage at -20 °C.....	142
32	Changes in Colour of Surimi Gels during Storage at -20 °C.....	147
33	Changes in Thiobarbituric Acid No. (TBA) of Surimi during Storage at -20 °C.....	151
34	Changes in Total Volatile Basic Nitrogen (TVBN) of Surimi during Storage at -20 °C.....	153
35	Changes in Trimethylamine (TMA) of Surimi during Storage at -20 °C.....	156
36	Changes in Salt Soluble Protein (SSP) of Surimi during Storage at -20 °C.....	158

LIST OF PLATES

Plate		Page
1	*Selaroides leptolepis*.....	192
2	*Aristichthys nobilis*.....	193
3	*Alutera monoceros*.....	193
4	Fishburgers in LDPE Bag.....	194
5	Fishburgers in PP Semi Rigid Container.....	194
6	Fishburgers in PS + LDPE Cling Flim.....	195
7	Fishburgers Before and After Frying.....	195

Abstract of thesis submitted to the Senate of Universiti Pertanian Malaysia in fulfilment of the requirements for the degreee of Master of Science.

DEVELOPMENT OF FISHBURGER FROM *Selaroides leptolepis*, *Aristichthys nobilis* AND *Alutera monoceros*

by

SIAH WATT MOEY

1997

Chairman : Prof. Dr Yu Swee Yean

Faculty : Food Science and Biotechnology

Selaroides leptolepis, *Aristichthys nobilis* and *Alutera monoceros* were used to develop frozen fish product aimed at fastfood outlets and households. At the idea generation stage, 24 product ideas were generated. The 24 product ideas were reduced to three using a series of scoring techniques for screening. Fishburgers were chosen for furthur development. The formulation for fishburger was established using a sensory panel. A final consumer testing of the product was carried out in a nearby housing area. A sample size of 60 households was used. Results showed that the market potential for this product is expected to be very good as 75% of the respondents are willing to buy this product if it is in the market. The acceptable price range is RM 5.50 to RM 6.50. Fishburgers packed in LDPE bags, PP semi rigid containers and PS tray overwrapped with LDPE cling flim were acceptable after 18

weeks of storage at -20 °C. The storage quality in terms of thiobarbituric acid no (TBA), trimethylamine (TMA) and total volatile basic nitrogen (TVBN) showed significant ($P<0.05$) increases. There were decreases in salt soluble protein, pH, moisture content and microbial counts. Fishburgers in PP semi rigid containers had the best stability followed by samples in LDPE bags and PS + LDPE. The effects of washing and storage on the quality of *S.leptolepis* and *A.nobilis* surimi kept at -20 °C for 24 weeks were studied. Surimi was prepared from unwashed, once-washed and twice-washed minces. The storage quality in terms of texture, colour, elasticity, moisture content, pH and SSP values for all samples showed significant ($P<0.05$) decreases during storage. There were increases in expressible moisture, TMA, TVBN and TBA. Results also showed that twice-washed mince of both species were generally more stable than once-washed and unwashed minces.

Abstrak tesis yang dikemukakan kepada Senat Universiti Pertanian Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains.

PENGEMBANGAN BURGER IKAN DARI *Selaroides leptolepis*, *Aristichthys nobilis* DAN *Alutera monoceros*

oleh

SIAH WATT MOEY

1997

Pengerusi : Prof. Dr Yu Swee Yean

Fakulti : Sains Makanan dan Bioteknologi

Selaroides leptolepis, *Aristichthys nobilis* dan *Alutera monoceros* digunakan untuk pengeluaran hasilan dari ikan bersasaran pada restoran makanan segera dan keluarga dengan menggunakan proses pengembangan hasil. 24 idea produk telah dihasilkan. Dengan menggunakan teknik saringan, 24 idea produk telah dikurangkan sehingga 3 idea produk. Burger ikan telah dipilih untuk pengembangan yang seterusnya. Formulasi burger ikan telah ditentukan melalui sesi-sesi penilaian deria. Penilaian pasaran secara umum dijalankan disekitar kawasan perumahan berhampiran. Seramai 60 panel digunakan. Hasil dari kajian menunjukkan potensi burger ikan yang dihasilkan adalah baik memandangkan 75% daripada mereka ingin membeli hasilan tersebut jika ia dipasarkan. Harga yang sanggup ditawarkan adalah pada julat RM 5.50 dan RM 6.50. Burger ikan yang dibungkus dalam beg LDPE , kotak PP dan trey PS dibalut dengan filem LDPE boleh diterima selepas disimpan selama 18

minggu pada -20 °C. Kualiti penyimpanan dari segi nilai tiobarbiturik asid (TBA), trimetilamin (TMA) dan 'total volatile basic nitrogen' (TVBN) menunjukkan peningkatan yang bererti ($P<0.05$). Terdapat penurunan yang bererti ($P<0.05$) pada nilai protein larut garam (SSP), pH, kandungan lembapan dan bilangan microorganisma. Burger ikan dalm kotak PP mempunyai kestabilan penyimpanan yang paling baik diikuti oleh sampel dalam beg LDPE dan trey PS + LDPE. Kesan bilangan cucian dan penyimpanan selama 24 minggu pada suhu -20 °C keatas kualiti surimi dari *S.leptolepis* dan *A.nobilis* juga dijalankan. Surimi disediakan dari isi ikan tanpa dicuci, dicuci sekali dan dicuci sebanyak dua kali. Kualiti penyimpanan dari segi tekstur, warna, kekenyalan, kandungan lembapan, pH dan nilai protein larut garam mengalami penurunan yang bererti ($P<0.05$). Manakala terdapat peningkatan yang bererti ($P<0.05$) bagi nilai 'expressible moisture', TMA, TVBN dan TBA. Keputusan juga menunjukkan bahawa kualiti penyimpanan surimi hasil dari dua kali cucian isi ikan dari kedua-dua spesis ikan adalah lebih baik berbanding dengan yang dicuci sekali dan tanpa dicuci.

CHAPTER 1

GENERAL INTRODUCTION

The trend in the consumption of animal protein sources has been and still is a switch from red meats toward white meats. At first it was a move from pork and beef to poultry, but now it is extended to fish. There are probably several reasons for this increase in consumption of fish but the major reason is most likely that health authorities and dieticians recommend that fish is a healthy food which has a good balance of protein, vitamins, minerals and a relatively low caloric content. In addition, certain species of seafood are excellent sources of Ω-3 polyunsaturated fatty acids which have therapeutic effects (Balasubramaniam et al., 1985; Kronhout et al., 1985; Kinsella, 1988).

Current world fish production is around 100 million tonnes (Poulter et al., 1988). However, there is a considerable waste through such practices as discarding the by-catch when harvesting more valuable species such as shrimp; spoilage of products due to inadequate storage or handling systems; and processing methods that do not efficiently preserve the protein content for human use. If fish are to make a greater contribution to the quantity of protein available to the world, by-catch and

other underutilised resources must be used. In addition, the yield or value of fully utilised species must be increased.

With the availability of the mechanical deboner, many underutilised fish species and the frames after filleting become potential sources of food proteins. The minced meat obtained after deboning is more unstable than intact fish muscle (Martin, 1976; Babbitt, 1986), therefore, it must be processed immediately. The most common way to preserve this minced flesh is by processing it into surimi. Surimi is mechanically deboned, washed and stabilised fish flesh widely used as an intermediate product for a variety of fabricated seafoods, including kamaboko, fish sausage, crab legs and immitation shrimp products(Lee, 1984).

Surimi is usually made from white-fleshed and low fat fish species. The versatility of surimi for production of a vast variety of minced fish analogues, coupled with the decline in the Alaskan pollack fishery, has prompted substantial efforts to study the suitability of other fish species for surimi production. In the United States, menhaden (*Brevoortia sp.*), a small, oily and dark blue to brown herring-like fish which represent 92% of the fish is used for reduction into fish meal and surimi processing (Bimbo, 1988). In the southern hemisphere, there is potential for production of surimi from hoki (*Macruronus novaezelandiae*) and blue whiting (*Micromesistius sp.*) particularly in New Zealand (MacDonald et al., 1990). Similar efforts are being carried out in Europe, the United Kingdom, Norway and other countries to explore the possibilities of using locally-available species for surimi processing (Putro, 1989). In developing tropical countries especially Southeast Asia,

species widely used for frozen surimi production include threadfin bream (*Nemipterus sp.*), bigeye snapper (*Priacanthus sp.*), barracuda (*Sphypaena sp.*) and croaker (*Pennahia sp.*). The development of surimi and minced fish production has been inspired by the continuous availability of cheap shrimp trawl by-catch and underutilised species, plus the growing popularity of fish jelly products complementing existing traditional cuisines. Various new products developed include fish balls, fish noodles, fish rolls, fish cakes and chikuwa (Venugopal et al., 1992). Surimi manufacturing will receive greater attention for further development in the coming years in line with the need for product diversification to meet the growing demand of different ethnic groups worldwide for surimi-based analogues. In addition, production is expected to play an important role in improving the nutritional status of people in the region through optimal utilisation of underutilised species for production of fish jelly products and surimi-based analogues. Recently, supermarkets have included various fish jelly products among their range of products. This trend signals the need for further studies related to product development, quality improvement, presentation and prolonging the shelflife of these products.

Of the many species of fish caught in the waters off the coast of Malaysia, a significant proportion constitutes commercially unimportant and hence underutilised species (29% of the total marine fish catch in 1994) (Kementerian Pertanian Malaysia, 1994). Currently, most of the underutilised species are processed by traditional methods such as curing, which do not involve high costs. However, such products do not enjoy high-market value (Yu and Siah, 1996). *Selaroides leptolepis* made up to 3% of the total marine fish catch of 1,065,585 mt in Malaysia, in 1994

(Kementerian Pertanian Malaysia, 1994). It is a relatively small pelagic fish and a substantial quantity is salted, or salted and dried. *Aristichthys nobilis*, or big head carp is a common species cultured in disused mining pools in Malaysia. Freshwater fishes are less acceptable to consumers compared to marine species mainly because of their soft texture and muddy flavour (Yu, 1991). There is no statistical data on the total landing of *A.monoceros* species or leather-jacket. In line with the goverment-backed policy of increasing the usage of freshwater fish and as well as better utilisation of trawl by-catch, it is the objectives of this study to :

1. Develop frozen fish jelly products from *S.leptolepis* , *A.nobilis* and *A. monoceros* surimi.
2. Evaluate the storage stability of frozen fish jelly product as affected by different forms of packaging.
3. Evaluate the storage stability of frozen *S.leptolepis* and *A.nobilis* surimi as affected by the number of washing.

CHAPTER 2

LITERATURE REVIEW

There is excellent scope for the use of fish mince in fabricated products which simulate the accepted texture, flavour and appearance characteristic of the popular high-value items like shrimp, crab legs, scallop, and lobster. The initial step in the development of such products is the conversion of the mince into an intermediate product known as surimi, a white protein material of excellent nutritional value (Venugopal et al., 1992).

`Surimi' is a Japanese term for mechanically deboned, water-washed fish flesh (Lee, 1984) . The surimi process serves to remove fat, blood, odourous substances, water-soluble proteins, and minerals from the myofibrillar proteins of the muscle and thereby serves to improve the gel strength, elasticity, appearance, and stability of minced fish flesh. The myofibrillar proteins of fish meat, notably myosin, are considered to be primarily responsible for gel formation in cooked products (Roussel and Cheftel, 1988).

Traditionally, the manufacture of fish gel products in Japan was one way of extending the shelf life of fish (Suzuki, 1981). It involved adding salt to washed fish

mince and heating the paste, usually by steaming to form heat set gel (Konstance, 1991). A wide range of products based on this process continue to be produced in Japan today. In the traditional process, surimi, because of its perishable nature, was processed directly into kamaboko products, but in today's industrial processes, it is invariably made into a frozen `intermediate' product which is manufactured into kamaboko or other gel products at a later date (Mackie, 1992).

Since the beginning of the 1980s, much interest in surimi has been generated throughout the seafood and food industries by the rapid growth in the popularity of surimi-based products, especially crab analogues in the United States and Europe. The characteristics of surimi paste as the raw material of processed foods may be summarized as follows (Kammuri and Fujita, 1990) :

1. Surimi paste becomes a gel if it is heated after kneading with an appropriate amount of salt. In this process, the surimi paste forms a white elastic gel.
2. Since surimi paste has little colour, taste, and odour, a wide variety of food can be manufactured by adding adequate amounts of seasonings, spices, flavours, coloring agents, etc.
3. Because surimi is a sol, it can be shaped into many forms by moulding.
4. Various kinds of gels, each having a different mouthfeel, can be manufactured by adding starch, egg white, soybean protein, wheat protein, or other materials to surimi paste. Fat can be blended into surimi and emulsified at a concentration up to about 20%. These products have a smooth mouthfeel. When a large amount of water is added, the product becomes a very elastic gel.

5. Shaped surimi can be heated by various methods such as broiling, steaming, boiling, and frying.
6. Since surimi paste has a binding ability, it is possible to make a surimi block containing various kinds of vegetables or pieces of meat.

Japan has been improving surimi technology for several hundred years. The development of the industry has been sustained by (Okada, 1992) :

1. The virtually unlimited resources of underutilized and less utilized species will ensure a sufficient production of surimi at reasonable cost to meet the need for these material for surimi-based products.
2. Frozen surimi has a long shelf life and is a highly functional protein ingredient.
3. Current technology permits mass production with consistent quality.

Definition of Surimi and Surimi-based Products

It is necessary to distinguish `surimi' from `minced fish' and `surimi-based products' as these terms are often confused in popular literature (Figure 1)(Okada, 1992). When fish flesh is separated from bones and skin (usually mechanically), it is called `minced fish', the starting material for surimi production and an ingredient for some processed fish products in its own right.

After the minced fish is water-washed to remove fat and water-soluble components, it becomes `raw surimi'. This raw surimi is a wet concentrate of the