UNIVERSITI PUTRA MALAYSIA

AMOUNT OF FISH, TYPE OF STARCH AND STEAMING DURATION ON THE QUALITY OF FISH CRACKER ("KEROPOK")

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FSMB 1998 15

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1998

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BY

KYAW ZAY YA

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

July 1998

Dedicated to

my beloved parents

ACKNOWLEDGEMENTS

I would like to express my deepest appreciation and sincere gratitude to Chairman of my supervisory committee, Professor Dr. Yu Swee Yean, for her understanding, patience, invaluable guidance, suggestions, constructive criticisms and constant encouragement throughout the planning and execution of the research. My deep appreciation and gratitude go to Professor Dr. Yaakob Che Man and En. Dzulkifly Mat Hashim, members of supervisory committee, for guidance and suggestions.

I wish to thank the Dean, Prof. Dr. Gulam Rusul Rahmat Ali of the Faculty of Food Science and Biotechnology, UPM, for his support and assistance during the course of my study.

My sincere gratitude is also extended to Mr. Cheow Chong Seng for his invaluable suggestions and constant encouragement. Thanks are also due to the laboratory assistants who have helped me, especially, En Razali Othman, Encik Soib, Encik Amran, Encik Mustaffa, Mr. Chan Tin Wan, Puan Shahrul and Puan Siti Ziryani.

I am grateful to uncle U Tint Swe, aunty Daw Yi Yi Khaing and Ko Phyo Zaw Swe for their invaluable guidance, suggestion and support during my study.

Last but not least, I am greatly indebted to my beloved parents and family members for their understanding and encouragement throughout the course of this study.

I would like to thank all my friends who gave me encouragement to initiate and complete the study. To these and all others who have helped during this study, I wish to express deepest appreciation.

TABLE OF CONTENTS

		Page
ACKNOWLEDGEMENTS		iii
LIST OF TABLES		viii
LIST OF FIGURES		x
LIST OF PLATES		xii
LIST OF SYMBOLS AND ABBREVIATIONS		xiii
ABSTRACT		xiv
ABSTRAK		xvii
CHAPTER		
1	**GENERAL INTRODUCTION**	1
2	**LITERATURE REVIEW**	7
	"Keropok" Production in Peninsular Malaysia	8
	Traditional Method of "Keropok" Processing	8
	The Improved Method of "Keropok" Processing	9
	Factors Affecting "Keropok" Quality	13
	Functional Properties of Proteins in Food	15
	Fish Protein Functionality	16
	Starch	17
	Physical and Chemical Properties of Starch	18
	Starch Cooking Phenomena	20
	Factors Affecting Starch Gelatinisation	23
	Half-product Expanded Snacks	30
	Functionality of Starch in Expanded Snacks	31
	Indirectly-Puffed Snacks	33
	Directly-Puffed Snacks	34
	Rheological Behaviour of Starch Gels	35
	Rheological Properties of Fish Gels	37
	Viscoelastic Properties of Surimi	38
	Rheology of Wheat Flour Dough	39
3	**THE EFFECT OF STEAMING DURATION ON MICROSTRUCTURE AND LINEAR EXPANSION OF "KEROPOK"**	
	Introduction	43
	Materials and Methods	44
	Raw Materials	44
	Preparation of "Keropok"	45
	Proximate Analysis	46
	Amylose Determination	46

Heat Penetration in the "Keropok" Gel during Steaming.... 47
Degree of Gelatinisation.. 47
Scanning Electron Microscopy.................................. 48
Texture Analyses... 49
Linear Expansion of "Keropok".................................. 49
Statistical Analyses.. 50
Results and Discussion... 50
Heat Penetration of the "Keropok" gel During Steaming ... 50
Degree of Gelatinisation.. 52
Chemical Composition of Raw Materials and "Keropok".... 54
Scanning Electron Microscopy (SEM).......................... 55
Texture Analyses 66
Linear Expansion of "Keropok".................................. 69
Conclusion.. 71

4 PHYSICOCHEMICAL PROPERTIES OF STARCHES ON LINEAR EXPANSION OF "KEROPOK"
Introduction.. 72
Materials and Methods.. 75
Materials... 75
"Keropok" Processing 75
Chemical Analysis.. 76
Solubility, Amylose and Amylopectin Leaching................ 76
Swelling Power... 77
Pasting Characteristics.. 77
Statistical Analyses.. 78
Results and Discussion.. 78
Chemical Composition of Raw Materials and "Keropok".... 78
Swelling Power and Solubility 82
Amylose and Amylopectin Leaching............................ 85
Pasting Characteristic 88
Relationship between Physicochemical Properties of Starch and Linear Expansion 92
Conclusion... 97

5 IDENTIFICATION OF THE UNGELATINISED CORE IN "KEROPOK" WITH LOW FISH CONTENT
Introduction.. 98
Materials and Methods.. 99
Materials... 99
Sample Preparation of Fish-Starch Dough 100
Determination of Protein.. 100
Water Holding Capacity (WHC)................................. 101
Rheological Measurements...................................... 101
Moisture Profile Analyses 102

Degree of Gelatanisation.. 102
Scanning Electron Microscopy (SEM)........................ 102
Statistical Analyses.. 103
Results and Discussion... 103
Water Holding Capacity (WHC)................................ 103
Dynamic Rheological Properties of “Keropok” Dough 105
Moisture Profile Analyses of “Keropok” Gels................ 113
Scanning Electron Microscopy (SEM)......................... 114
Relationship between Physicochemical Properties of Dough and Degree of Gelatinisation of “Keropok” Gel..... 125
Conclusion.. 129

6 **GENERAL CONCLUSION AND RECOMMENDATION**
Conclusion.. 130
Recommendations.. 131

REFERENCES.. 132

APPENDIX... 148

BIOGRAPHICAL SKETCH.. 154

LIST OF TABLES

Table		Page
1	Effect of Protein Content of Flour on the Linear Expansion of "Keropok"…………………………………………….	14
2	Effect of Protein Concentration and Denaturation on Consistency of Gelatinized Starch………………………………	27
3	Effect of Salt Concentrations on the Gelatinization Endotherm of Wheat Starch…………………………………….	29
4	Amylose and Amylopectin Contents (% dry basic) of Starches……………………………………………………………..	33
5	Chemical Composition of Raw Materials………………………	54
6	Chemical Composition of Dried "Keropok" Made with Different Type of Starches and Flours…………………………	55
7	Effect of Steaming Duration on Compressive Force and Penetration Force of "Keropok" Gels……………………………	67
8	Chemical Composition of Starches, Flours and Fish (*Johnius sp*)………………………………………………………	80
9	Chemical Composition of Dried "Keropok" Made with Different Type of Starches and Flours………………………..	81
10	Physicochemical Properties of Starches and Flours…………	86
11	Pasting Characteristics of Starches and Flours……………..…	91
12	Linear Expansion of "Keropok" Made from Different Types of Starch/Flour……………………………………	93
13	Physicochemical Properties of "Keropok" Doughs with Different Fish to Starch Ratios…………………………………	112
14	Moisture Profiles of Periphery and Centre of "Keropok" Gels with Different Fish to Starch Ratios………………………	114
15	Effect of Fish to Starch Ratios on Degree of Gelatinization of Starch in "Keropok"…………………………………………………	127

16 Effect of Steaming Times on Percentage Linear Expansion of 'Keropok'.. 153

LIST OF FIGURES

Figure		Page
1	Flow Chart of Improved Method for "Keropok" Processing	11
2	Mechanism of Cooking and Retrogradation of Starch	19
3	Enthalpy of Gelatinization of Rice Starch as a Function of Time at Various Heating Temperature................................	24
4	Schematic Representation of Dough Structure	40
5	Heat Penetration to Periphery and Centre of "Keropok" Gels...	50
6	Effect of Steaming Time on Degree of Gelatinization of Starches in "Keropok"...	53
7	Effect of Steaming Times on Percentage Linear Expansion of "Keropok" on Frying....................................	70
8	Swelling Power of Starches and Flours...............................	84
9	Solubility of Starches and Flours......................................	84
10	Amylose Leaching of Starches and Flours..........................	87
11	Amylopectin Leaching of Starches and Flours......................	88
12	Brabender Viscograms of Starches and Flours....................	90
13	The Effect of Swelling Power of Starches on Linear Expansion of "Keropok"..	94
14	The Effect of Solubility of Starches on Linear Expansion of "Keropok"..	95
15	The Effect of Amylose Leaching of Starches on Linear Expansion of "Keropok"..	96
16	The Effect of Amylopectin Leaching of Starches on Linear Expansion of "Keropok"..	96
17	Water Holding Capacity of "Keropok" Doughs as Influenced by Fish Content..	104

18 Effect of Fish Contents on G' and G'' of "Keropok" Doughs...... 106

19 Effect of Fish Contents on η^* of "Keropok" Doughs 107

20 Frequency Dependence of Storage Modulus (G') and Loss Modulus (G'') of 'Keropok' Dough with Different Fish to Starch Ratio. 108

21 Effect of Fish Contents on Gradient (n) of G' of "Keropok" Doughs 110

22 Effect of Fish Contents on Tan δ of "Keropok" Doughs........... 111

23 Standard Curve for Amylose Determination........................ 149

24 Diagram of "Keropok" Gel and Thermocouple Probe............. 150

25 Standard Curve for Solubility.. 151

26 The Estimation Method for Gelatinization Temperature of Starch Suspension Using Brabender Viscograph................. 152

LIST OF PLATES

Plate		Page
1	SEM Photomicrograph of Tapioca “Keropok” Gel	57
2	SEM photomicrograph of Sago “Keropok” Gel	60
3	SEM Photomicrograph of Wheat “Keropok” Gel	63
4	Scanning Electron Microphotograph of “Keropok” Dough without Fish	117
5	Scanning Electron Microphotograph of “ “Keropok” Dough with 10% Fish	118
6	Scanning Electron Microphotograph of “Keropok” Dough with 15% Fish	119
7	Scanning Electron Microphotograph of “Keropok” Dough with 50% Fish	120
8	Scanning Electron Microphotograph of “Keropok” Gel with 15% Fish	121
9	Scanning Electron Microphotograph of “Keropok” Gel with 50% Fish	122
10	Scanning Electron Microphotograph of Periphery of “Keropok” Gel	123
11	Scanning Electron Microphotograph of Centre of “Keropok” Gel	124
12	Dried “Keropok”	128

LIST OF SYMBOLS AND ABBREVIATIONS

Symbols

G'	Storage modulus
G"	Loss modulus
ΔH	Enthalpy of gelatinization
T_c	Conclusion temperature
T_o	Onset temperature
T_p	Peak tempearture
η^*	Complex viscosity
ω	Frequency

Abbreviations

AM	Amylose
AML	Amylose leaching
AMPL	Amylopectin leachings
AOAC	Association of Official Analytical Chemists
AP	Amylopectin
BU	Brabender Unit
MSG	Monosodium glutamate
SEM	Scanning Electron Microscopy
SAS	Statistical Analysis System
WHC	Water Holding Capacity

Abstract of Thesis Submitted to the Senate of Universiti Putra Malaysia in Fulfilment of the Requirements for the Degree of Master of Science.

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BY

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July 1998

Chairman : **Professor Yu Swee Yean, Ph.D.**

Faculty : **Food Science and Biotechnology**

The effect of steaming duration on the linear expansion of "keropok" in relation to microstructure of starch in "keropok" gel was investigated. Tapioca starch *(Manihot esculentus),* sago starch (*Metroxylon sagu*) and wheat starch (*Triticum aestivum*) were used. Linear expansion of "keropok" was best when the starch granules were fully gelatinized and expanded to their largest sizes. It was found that 20 to 30 minutes steaming was sufficient to cook the gel (40 mm diameter). When starch granules swell, water is absorbed. The entrapped water molecules contribute to higher linear expansion, due to the steam released from water in the starch granules during frying in oil. "Keropok" made from tapioca starch gave the

best expansion at 20-30 minutes steaming, and prolonged steaming led to reduced expansion due to fragmentation of the starch granules.

The protein contents of native starches and flours were negatively correlated to swelling power of starches and linear expansion of “keropok”. Among the six varieties of starches and flours, swelling power and solubility of tapioca starch and flour and sago starch were relatively higher than that of cereal starches (wheat starch, wheat flour and rice flour), and gave better linear expansions. There was positive correlation between amylose/amylopectin leaching and linear expansion of “keropok”. The ratio of amylose and amylopectin did not contribute to expansion.

The centre of the “keropok” gel containing 0-10% fish did not gelatinize after steaming for 2 hr. This may be due to the effect of water movement during steaming. The water-holding capacity (WHC) of “keropok” dough increased with increasing fish content. WHC of the dough with 15% fish was significantly ($P<0.05$) higher than that of the dough with 10% fish. Consequently, water movement may be limited by the fish protein-starch network in the “keropok” dough with high fish content. This was supported by moisture profile analyses. Scanning electron microscopy results showed that the fish-protein network started to build up at a fish : starch ratio of 15:85. Rheological properties changed markedly with different fish : starch ratios. The value of storage modulus (G'), loss modulus (G") and complex viscosity (η*) in the doughs containing 15% fish and above were noticeably higher than that containing 10% fish due to the fish protein network formation.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains.

AMAUN IKAN, JENIS KANJI DAN TEMPOH MASA PENGUKUSAN TERHADAP MUTU KEROPOK IKAN

Oleh

KYAW ZAY YA

Julai 1998

Pengerusi: **Profesor Yu Swee Yean, Ph.D.**

Fakulti: **Sains Makanan dan Bioteknologi**

Kesan masa pengukusan terhadap pengembangan linear keropok dan mikrostruktur kanji gel keropok telah dikaji. Kanji ubi kayu (*Manihot esculentus*), kanji sagu (*Metroxylon sagu*) dan kanji gandum (*Triticum aestivum*) digunakan. Pengembangan linear keropok terbaik dicapai apabila granul-granul kanji digelatinisasikan sepenuhnya dan mengembang pada saiz maksimum. Kajian mendapati bahawa masa pengukusan di antara 20 hingga 30 minit adalah mencukupi untuk mengukus gel yang bergarispusat 40 mm. Apabila granul kanji mengembang, air akan terjerap. Molekul-molekul air yang terperangkap menyumbang kepada bengembangan linear yang lebih tinggi disebabkan oleh pembebasan stim oleh air dalam granul-granul kanji semasa digoreng. Keropok yang dibuat menggunakan kanji ubi kayu memberikan pengembangan terbaik semasa dikukus selama 20 hingga 30 minit, tetapi jika dikukus lebih lama lagi, pengembangan akan

berkurangan. Ini disebabkan oleh pemecahan yang berlaku pada granul kanji.

Kandungan protein kanji-kanji asli dan tepung berkorelasi negatif dengan keupayaan kanji untuk mengembang dan pengembangan linear keropok. Di antara enam jenis kanji dan tepung yang dikaji daya pengembangan dan kebolehlarutan, kanji dari tepung ubi kayu dan kanji sagu adalah lebih tinggi jika dibandingkan dengan kanji bijirin (kanji gandum, tepung gandum dan tepung beras) dan ini menghasilkan pengembangan linear yang lebih baik. Terdapat hubung-kait positif antara larut lesap amilosa/ amilopektin dengan pengembangan linear keropok. Nisbah amilosa dan amilopektin pada granul asal kanji tidak meberikan kesan terhadap pengembangan keropok.

Kanji pada bahagian tengah gel keropok yang mengandungi 0-10% ikan tidak digelatinisasikan selepas dikukus selama 2 jam. Ini mungkin disebabkan oleh kesan pergerakan air semasa pengukusan. Keupayaan pegangan air (water holding capacity atau WHC) adunan keropok meningkat dengan penambahan kandungan ikan. WHC adunan yang mengandungi 15% ikan adalah secara bererti lebih tinggi ($P<0.05$) daripada adunan yang mengandungi 10% ikan. Ini adalah mungkin kerana pergerakan air yang terbatas kandungan ikan. Keputusan ini disokong oleh keputusan analisis profil lembapan. Keputusan Scanning Electron

Microscopy (SEM) menunjukkan protein ikan mula terbentuk pada nisbah ikan:kanji = 15:85. Nilai storage modulus (G'), loss modulus (G") dan kelikatan kompleks (η*) adunan yang mengandungi 15% atau lebih ikan adalah jelas lebih tinggi daripada adunan yang mengandungi 10% ikan kerana rangkaian protein-ikan adalah lebih terbentuk.

CHAPTER 1

GENERAL INTRODUCTION

Fish crackers known as "keropok" in Malaysia are popular snack foods in Malaysia and the ASEAN countries. Generally, "keropok" would be classified as a puffed snack product (Akzo, 1973), expanded snack product (Cumminford and Beck, 1972) half products or intermediates (Lachmann, 1969). Half products are defined as low moisture, shelf-stable intermediate products in the forms of pellets (Wang, 1997).

The two essential ingredients in "keropok" making are starch or flour and water. Fish, prawns or other food ingredients are usually added for flavour (Yu, 1992). Certain types of fish such as ikan parang (*Chirocentrus dorab*), ikan tamban beluru (*Clupea leiogaster*) and ikan selayang (*Decapterus russellii*) are preferred although other fishes are also used (Wan Daud, 1978). Tapioca or sago starch is used but sago starch is said to give the best product (Sidaway, 1971).

Basically, “keropok” is 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 (Siaw et al., 1985). Traditional “keropok” production methods result in products of poor quality, with uneven expansion characteristics, dark objectionable colours and varying shapes, sizes and thicknesses as well as low hygiene (Yu, 1986). Siaw and Idrus (1979) have attempted to upgrade product quality. They have introduced mechanization and standardization into “keropok” making. Their process is less time-consuming and gives a better-quality product compared to the traditionally-produced “keropok”.

Besides developing improved technology in “keropok” production, several attempts have been conducted on the effect of type of fish and starch on the quality of “keropok”. The effect of various flours used on the linear expansion of “keropok” was conducted by Yu (1991, 1993) and Norrakiah (1987). Siaw et al. (1979) made an evaluation on Malaysian fish crackers using six combinations of two types of fish and three types of flour. They found that “keropok” made from tapioca flour and highly-flavoured fish, were preferred by taste panelists. Crispiness was found to be the most important factor governing product acceptability.

Okraku-Offei (1974) stated that in Ghana, “keropok” doughs were steamed at 100°C for 4 hr. However, they are steamed 60 to 90 min in “keropok” production industries in Malaysia. More than 65% of the total production cost is attributed to the steaming process used to cook the dough for 60-90 min. High energy costs are involved in producing the volumes of steam needed (Yu and Low, 1992). Somchai (1994) stated that the dough was found to be completely gelatinized after 20 min of steaming in making ‘khao kriap waue’ (KKW) (Thai rice-based snack). A puffed KKW from 20 min or more of steaming showed better linear expansion than the KKW that had been steamed for a shorter period. However, no research have been conducted on the effect of steaming time on linear expansion of “keropok”.

Starch plays a very important role in the expansion of “keropok”. The quality of expanded foods is judged by their crispiness, which in turn is determined by their expanded volume (Chinnaswamy and Hanna, 1988). The type of starch/flour used was the controlling factor in the expansion of “keropok” and type of fish used did not contribute to it (Yu, 1991). Starch structure and type are important factors in understanding starch function in snackfood (Wang, 1997).

The expanded volumes of cereals and starches extrudate decreased with increasing amount of proteins or lipids in the raw material, but increased with increasing starch content (Linko et al., 1981). Further, it has been reported that among different types of starches some expanded better than others. Thus, it appears that starch quality (amylose and amylopectin content) most significantly affect expansion. Starches with low (waxy) and high amylose contents expanded the best at 135°C and 225°C, respectively (Mercier and Feillet, 1975). Different native corn starches have different optimum temperatures for expansion, i.e., 130°C for 0% amylose, 140°C for 25% amylose, 150°C for 50% amylose, and 160°C for 70% amylose starch (Chinnaswamy and Hanna, 1988). This shows that higher temperatures are needed for high-amylose content starches in order to obtain better expansion.

Chandrasekhar and Chattopadhyay (1990) stated that the high pressure due to steam formed inside the starch granules forced the cooked starch to expand during the puffing of rice. In extrusion technology, puffing occurs on flash evaporation of water due to exposure to high temperature and /or sudden drop in pressure (Guraya and Toledo, 1994). For starchy half-products, the most important change during such processing is starch gelatinization (Gomez and Aguilera, 1984) which is time, temperature and moisture-dependent (Lund, 1984). Expansion during extrusion is directly related to degree of gelatinization of starch (Guraya and Toledo, 1994).

Food is a complex and heterogeneous system containing many different chemical components. In a product consisting of proteins, lipids, carbohydrates and electrolytes, interactions among various constituents need to be well balanced so that a stable system evolves (Samant et al., 1993). Protein and starches are present in many foods and they contribute to their structural and textural characteristics through their aggregation and