UNIVERSITI PUTRA MALAYSIA

EFFECT OF FISH PROTEINS, SALT, SUGAR AND MONOSODIUM GLUTAMATE ON THE MICROSTRUCTURAL, RHEOLOGICAL AND PHYSICO-CHEMICAL PROPERTIES OF FISH CRACKER ('KEROPOK')

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By

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Dissertation Sumitted in Fulfilment of the Requirements for the Degree of Doctor of Philosophy in the Faculty of Food Science and Biotechnology, Universiti Putra Malaysia

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF ABBREVIATIONS AND SYMBOLS

δ	delta
G'	storage modulus
G"	loss modulus
G*	complex shear modulus
η^*	complex viscosity
ω	frequency, radian/s
n	slope of log-log plot of G' versus frequency
T_o	onset gelatinization temperature
T_p	peak gelatinization temperature
T_c	conclusion gelatinization temperature
ϑ_S	starch fraction of mixed gel of cassava starch and whey protein isolate
Hz	cycle/second
kPa	kiloPascal, kN/m^2
rev/min	revolution per minute
AR	Analytical Reagent
BSA	bovine serum albumin
DSC	Differential Scanning Calorimetry
ESP	egg white powder
LM	Light Microscopy

MSG	monosodium glutamate
m c	moisture content
SEM	Scanning Electron Microscopy
SPI	soya protein isolate
TEM	Transmission Electron Microscopy
w/v	weight/volume basis
w/w	weight/weight basis
YPC	yeast protein concentrate

Abstract of the Dissertation presented to the Senate of Universiti Putra Malaysia in fulfilment of the Requirements for the Degree of Doctor of Philosophy.

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CHEOW CHONG SENG

July 1998

Chairman : Professor Yu Swee Yean, Ph. D.

Faculty : Food Science and Biotechnology

Fish cracker or more commonly known as 'keropok' in Malaysia is a popular snack food among countries in the ASEAN region. This work examines factors affecting 'keropok' quality such as the effect of fish proteins, salt. sugar, monosodium glutamate (MSG) on the gelatinisation of tapioca and sago starches. Microstructural studies of 'keropok' during different stages of processing were also observed and correlated to rheological behaviour.

Results from differential scanning calorimetry (DSC) showed that with increasing fish content the conclusion gelatinisation temperature (T_c) of the mixture remained relatively constant while the range of gelatinisation temperature decreased. There were hardly any effect due to the addition of 1% sugar and 0.4% MSG. on the onset (T_o) and peak(T_p) gelatinisation temperatures of sago and tapioca starches. The addition of 2% salt had the greatest effect on gelatinisation temperature of

'keropok' mixture, linear expansion of fried 'keropok', and small and large deformations of 'keropok' gel. The technology of producing a good expanded 'k

that fresh fish, sufficient amount of salt (2% of the total weight of wet fish and starch), proper sequence of mixing of the 'keropok' mixture to form evenly-distributed fi

expansion, full gelatinisation of fish-starch gel, and elastic fish-starch gel formation. At high fish contents (60-70%) the formation of fish protein network in the matrix caused a drop in expansion. There was, however, a sharp increase in the compressive strength of the 'keropok' gel. This result is complemented by the higher storage modulus (G') and lower loss tangent (tan δ) values obtained. indicative of the existence of a strong elastic network. Such conditions were observed when the microstructure of the fish muscle fibres appeared to be well crosslinked.

The findings in this study revealed that in order to produce better expanded 'keropok' and a more elastic and fully gelatinised 'keropok' gel, superior in terms of appearance, shape and linear expansion, several important factors that ensure even distribution of fish proteins in the fish-starch gel must be taken into account. In conclusion, fresh fish, sufficient amount of salt (2% of the weight of wet fish and starch) and the proper sequence of adding ingredients in mixing are recommended to produce high quality 'keropok'.

Abstrak disertasi yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah.

KESAN PROTEIN IKAN, GARAM, GULA DAN MONOSODIUM GLUTAMAT TERHADAP SIFAT-SIFAT STRUKTUR MIKRO, REOLOGI, FIZIKO-KIMIA KEROPOK IKAN

Oleh

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Keropok merupakan makanan snek yang digemari ramai di kalangan negara-negara di rantau ASEAN. Kajian-kajian penyemperitan yang sering digunakan sebagai kajian perbandingan mungkin tidak menggambarkan sistem keropok yang sebenarnya. Ini menunjukkan betapa pentingnya penyelidikan ini yang melibatkan kajian terhadap faktor-faktor yang mempengaruhi kualiti keropok seperti protein ikan, garam, gula, monosodium glutamat (MSG) serta kesannya terhadap penggelatinan kanji ubi kayu dan sagu. Pemerhatian terhadap mikrostruktur keropok semasa pelbagai peringkat pemprosesan telah dilakukan dan dikaitkan dengan sifat reologinya.

Keputusan yang diperolehi menggunakan kalorimetri pengimbasan perbezaan (DSC) menunjukkan bahawa apabila kandungan protein ikan di dalam adunan meningkat, suhu akhir penggelatinan campuran tetap malar secara relatif manakala julat suhu penggelatinan menurun. Penambahan 1% gula dan 0.4% MSG tidak memberi kesan terhadap permulaan penggelatinan dan suhu puncak penggelatinan kanji sagu dan kanji ubi kayu. Penambahan 2% garam ke dalam adunan menghasilkan kesan yang paling ketara terhadap suhu penggelatinan, pengembangan linear apabila keropok digoreng serta perubahan bentuk kecil dan besar keropok. Teknologi penghasilan keropok kembang yang baik didapati sama dengan teknologi yang digunakan untuk surimi. Hasil keputusan mikroskop cahaya pula menunjukkan bahawa ikan yang segar, kandungan garam yang mencukupi (2% daripada jumlah berat ikan basah dan kanji) serta urutan pencampuran bahan adunan keropok yang betul akan membentuk jaringan serabut otot ikan yang seragam di dalam rangkaian gel kanji. Ini akan memastikan keropok yang dihasilkan akan kembang dengan baik, penggelatinan sepenuhnya gel kanji-ikan serta pembentukan gel kanji-ikan yang anjal. Pembentukan rangkaian protein ikan di dalam matriks kanji pada kandungan ikan yang tinggi (60-70%) menyebabkan keropok tidak berkembang dengan baik. Walaubagaimanapun kekuatan mampatan gel keropok meningkat. Keputusan ini disokong oleh data reologi nilai modulus storan (G′) yang lebih tinggi serta nilai tangen kehilangan (tan δ) yang lebih rendah, menunjukkan pembentukan

satu sistem jaringan yang anjal dan kuat di dalam adunan tersebut. Keadaan begini dapat dilihat bila serabut otot ikan membentuk jalinan yang kuat dan teratur.

Hasil penyelidikan ini menunjukkan bahawa untuk menghasilkan keropok yang lebih kembang, gel keropok yang lebih anjal dan digelatinasikan sepenuhnya serta mempunyai ciri-ciri yang baik dari segi rupa, bentuk dan pengembangan linear, beberapa faktor penting yang memastikan pembentukan protein ikan yang seragam di dalam sistem gel kanji-ikan harus diberi perhatian. Kesimpulannya, penggunaan ikan segar, amaun garam yang mencukupi (2% daripada jumlah berat ikan basah dan kanji) serta urutan pencampuran bahan adunan keropok yang betul adalah disarankan untuk menghasilkan keropok berkualiti tinggi.

CHAPTER 1

GENERAL INTRODUCTION

Fish cracker, more commonly known as 'keropok' in Malaysia, is a popular snack food among countries in the ASEAN region. In the West, it is classified as 'half-product', 'intermediates' or 'third generation snack'. Basically, 'keropok' is prepared by forming a dough from a mixture of tapioca and/or sago starches, comminuted fish, salt, sugar, monosodium glutamate and water. The dough is then shaped, boiled or steamed to gelatinise the starch and cut into thin slices prior to sun drying. When immersed in hot oil, the product expands resulting in a lo density, crispy snack food.

Fish 'keropok' is defined as the fish product made from fish and starch under the Malaysian Food Act 1983 and Food Regulation 1985 (Malaysia, 1985). Fish 'keropok' made of fresh fish, other than crustaceans and molluscs, shall contain not less than 20 per cent of protein, and the 'k
molluscs shall contain not less than 6.9% protein. It may contain permitted colouring substances and permitted flavour enhancers. The protein content of