
UNIVERSITI PUTRA MALAYSIA

# EFFECTS OF INGREDIENT SUBSTITUTION ON PROCESSED CHEESE

KARIMAH AHMAD

# EFFECTS OF INGREDIENT SUBSTITUTION ON PROCESSED CHEESE

By

KARIMAH AHMAD

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

January 1996

**ACKNOWLEDGEMENTS**

All praise due to God, the Most Gracious and Merciful, for giving me the strength, health and determination to complete my research studies.

My utmost gratitute to my chairman, Dr. Mohd Yazid bin Abd. Manap for his sincere and frank advice, guidance, constructive criticism and patience throughout the study and during the preparation of this thesis.

I am indebted and really thankful to the Palm Oil Research Institute of Malaysia who had given me the time and financial support to pursue my studies.

I am very grateful to the other members of my supervisory committee Dr. Mohd Suria Affandi and Dr. Yaakob Che Man for their kind cooperation and assistance throughout my research studies.

Finally, I wish to convey my thanks to my family, relatives, friends and all staff from the Palm Oil Research Institute of Malaysia and the Faculty of Food Science and Biotechnology, Uni-

versiti Pertanian Malaysia who had contributed in one way or the other towards the success of this study. May God bless you all always.

**TABLE OF CONTENTS**

## LIST OF TABLES

## LIST OF FIGURES

## LIST OF PLATES

## LIST OF ABBREVIATIONS

| | |
|---|---|
| AMF | Anhydrous Milkfat |
| BF | Butterfat |
| CNO | Coconut Oil |
| CSO | Cotton Seed Oil |
| FAC | Fatty Acid Composition |
| HDL | High Density Lipoprotein |
| IE | Interesterification |
| IV | Iodine Value |
| LDL | Low Density Lipoprotein |
| NMR | Nuclear Magnetic Resonance |
| PC | Plastic Casein |
| PKO | Palm Kernel Oil |
| $PKO_O$ | Palm Kernel Olein |
| PO | Palm Oil |
| $PO_O$ | Palm Olein |
| PORIM | Palm Oil Research Institute of Malaysia |
| PUFA | Polyunsaturated Fatty Acid |
| RSO | Rapeseed Oil |
| SBO | Soyabean Oil |
| SFC | Solid Fat Content |
| SFO | Sunflower Oil |
| SMP | Slip Melting Point |
| WHP | Whole Milk Powder |

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

**EFFECTS OF INGREDIENT SUBSTITUTION ON PROCESSED CHEESE**

By

**KARIMAH AHMAD**

**JANUARY 1996**

Chairman : Dr. Mohd Yazid Abdul Manap

Faculty : Food Science and Biotechnology

The availability of a wide range of quality palm products ranging from crude to fully refined, its flexibility and reliability of supply had enabled the substitution of palm blend for milkfat. Furthermore, milkfat contains saturated fatty a
high cholesterol content is considered to be a health liability.

The fatty acid composition(FAC) of commercial processed cheese and matured cheddar cheese, confirmed that milkfat was the sole fat source in both samples. Commercial processed cheese was used as an external

control and matured cheddar cheese as an ingredient in the processed cheese formulation.

The solid fat content (SFC), FAC and slip melting point (SMP) of different palm fractions were studied. The blending of different palm fractions were conducted and one with the closest SFC profile compared to milkfat was selected to partially replace milkfat in the experimental processed cheese formulation. Palm blend comprising 30% palm oil and 70% palm kernel olein was found to be most compatible to milkfat. The SFC of the blend was further improved by random interesterification(IE).

Plastic casein was manufactured to replace the young and medium cheese in natural processed cheese. The percentage of fat in plastic casein was 0.3% thus enhancing the substitution of IE palm blend.

Four different blends of experimental processed cheese were made from matured cheddar cheese, plastic casein, IE palm blend and emulsifying salt. The main differences between them were the proportions of matured cheddar cheese and plastic casein used i.e. 40:60, 50:50, 60:40 and 70:30 respectively. The experimental processed cheese were compared with control samples.

Experimental processed cheese was stored at 7-8$^{o}$C for one month and variables such as moisture, yield value, total nitrogen and pH were evaluated. Statistical analysis revealed that the yield value of blends 1, 2, 4 and the internal control sample were similar. For pH, only blend 4 was closely related to the internal control sample. Blends 2 and 4 also had a moisture profile similar to the control sample. The total nitrogen content of the experimental samples were higher than the control samples. From this study, it could be deduced that blends 2 and 4 were most promising and exhibited characteristics similar to the control samples.

**Abstrak Tesis Yang Dikemukakan Kepada Senat Universiti Pertanian Malaysia Sebagai Memenuhi Syarat Keperluan Untuk Ijazah Master Sains**

# KESAN BAHAN PENGGANTI KEATAS KEJU TERPROSES

Oleh

**KARIMAH AHMAD**

**JANUARI 1996**

Pengerusi : Dr. Mohd Yazid Abdul Manap

Fakulti : Sains Makanan dan Bioteknologi

Kehadiran berbagai-bagai jenis hasilan minyak kelapa sawit yang bermutu tinggi daripada yang mentah hingga kepada yang ditulinkan sepenuhnya, mudahnya ia diubahsuai dan bekalan yang boleh dipercayai telah mendorong penggantian penggunaan lemak susu kepada campuran minyak sawit. Lagipun, lemak susu mengandungi asid lemak tepu 70% dan kandungan kolesterol yang tinggi dan ini dipercayai boleh menimbulkan penyakit.

Komposisi asid lemak keju terproses dan keju 'cheddar' matang apabila dibandingkan dengan lemak susu, menunjukkan bahawa hanya lemak susu telah digunakan didalam kedua-dua formulasi keju tersebut.

Keju terproses komersial telah digunakan sebagai kawalan dan keju 'cheddar' matang digunakan sebagai salah satu bahan di dalam formulasi keju terproses experimen.

Kajian keatas kandungan lemak pejal, kandungan asid lemak dan tahap lebur dilakukan ke atas beberapa jenis hasilan minyak kelapa sawit. Hasilan minyak kelapa sawit telah dicampurkan dan campuran yang mempunyai profil kandungan lemak pejal yang serupa dengan lemak susu dipilih untuk mengganti lemak susu didalam formulasi keju terproses experimen. Campuran sawit yang mengandungi 30% minyak kelapa sawit dan 70% olein isirong kelapa sawit didapati paling sesuai dan boleh mengganti lemak susu. Profil lemak pejal campuran kelapa sawit diperbaiki dengan interesterifikasi rawak.

Kasein plastik dibuat untuk mengganti keju 'cheddar' belum matang dan separuh matang di dalam formulasi keju terproses asli. Peratus lemak di dalam kasein plastik adalah sebanyak 3% dan ini lebih memudahkan penggantian minyak kelapa sawit.

Empat jenis keju terproses experimen telah dibuat menggunakan keju 'cheddar' matang, kasein plastik, campuran minyak kelapa sawit dan garam pengemulsi. Perbezaan besar di antara keempat-empat jenis campuran

ini adalah pada nisbah keju matang dan kasein plastik yang digunakan iaitu, 40:60, 50:50, 60:40 dan 70:30 masing-masingnya. Keju terproses experimen dibandingkan dengan keju terproses komersial sebagai kawalan dan kawalan dalaman.

Keju terproses experimen disimpan pada suhu 7-8$^{o}$C selama satu bulan dan perubahan-perubahan seperti kelembapan, kandungan nitrogan, pH dan kekerasan telah dikaji. Analisis statistik menunjukkan bahawa kekerasan campuran 1, 2, 4 dan kawalan dalaman adalah serupa. Bagi pH pula, hanya campuran 4 mempunyai ciri-ciri yang hampir dengan kawalan dalaman. Campuran 2 dan 4 mempunyai profil kelembapan yang serupa dengan sampel kawalan. Jumlah kandungan nitrogen bagi sampel-sampel cubaan adalah lebih tinggi daripada kawalan.

Daripada kajian ini adalah dirumuskan bahawa campuran 2 dan 4 mempunyai ciri-ciri yang hampir menyerupai dengan sampel kawalan.

# CHAPTER 1

## INTRODUCTION

Natural cheeses are widely used for the manufacture of processed cheese. The product is primarily made by blending natural cheeses (young, mature or different types) in the presence of water, colouring matter, emulsifying salts and other dairy ingredients. The concentrate then undergoes heating and agitation in order to produce a homogeneous emulsion.

Processed cheese can be classified into three different types commonly referred to as block variety, slices and cheese spread. The quality of processed cheese is governed by a multitude of factors, processing conditions (direct or indirect heating of the cheese blend), moisture content in the end product (processed cheese block or cheese spread), amount and type of emulsifying salts and finally the added flavour ingredients.

In the United States and Canada, the reliance on natural cheddar cheese for the production of

processed cheese is apparent. However, prolong storage of cheddar cheese is required to achieve the maturation process and this could be costly and time consuming. In the case of countries which have a limited supply of milk, the alternative is to produce a cheese base from skimmed milk powder for the manufacture of processed cheese. The cheese base is manufactured similar to the cheddar cheesemaking procedures.

The mounting health concerns of consumers are related to calorie intake, cholesterol and saturated fats. Milkfat, which is the major fat source in cheese, comprises 70% saturated fatty acids and a high cholesterol content. It tends to develop lipolytic flavours which are primarily associated with the short and medium chain fatty acids. These fatty acids have lower flavour threshold values than the long chain acids.

Although the pleasing flavour of milkfat is highly desired in many food products, its unique chemical and physical characteristics, especially crystallization and melting properties, do not make it suitable for a number of food applications. Therefore, a modified palm blend was used to partially replace milkfat and a cheese base was used to replace the young and medium cheddar cheese in the experimental processed cheese

formulation. The use of palm-based products will improve the nutritional value (no cholesterol, more unsaturated fatty acid), and will have better functionality and keeping quality.

The main objectives of the study were :

a) to identify a palm blend which simulates the physi cal properties of milkfat and to partially replace milkfat in the experimental processed cheese formu lation.

b) to produce plastic casein from reconstituted skimmed milk powder which acts as the cheese base.

c) to evaluate the quality of experimental processed cheese using different ratios of plastic casein, matured cheddar cheese and interesterified (IE) palm blend.

# CHAPTER 2

# LITERATURE REVIEW

## Processed Cheese

### History

Processed cheese was invented in the year 1912-1913. At the end of the last century and around the beginning of the 20th century, considerable efforts were being made, notably by the Germans and the Swiss, to export cheeses to tropical countries. The success of the Swiss inventor was due to the fact that they were able to change the relatively coarsely dispersed paracasein calcium of the raw cheese by means of heat and using sodium citrate as a peptisizing agent, into a homogeneous flowing condition (Meyer, 1973).

### Differences Between Cheese and Processed Cheese

Cheese is a product made from the curd obtained from milk by coagulating the protein with the help of rennet or similar enzymes in the presence of lactic acid produced by added or adventitious microorganisms. Part of the moisture

was removed by cutting and/or pressing and the cheese was then shaped in a mould and ripened by holding for sometime at suitable temperatures and humidity (Sukumar, 1980).

The protein matrix in cheese consists of large micelles, agglomerated micelles and thick strands of associated micelles. This association occurs due to the action of rennin on the k-casein and the resulting change in the surface properties of the micelles (Heertje et al., 1981).

Cheddar cheese is widely used to make processed cheese because it does not impose much problem during processing and its manufacture involves most of the stages required in all types of cheesemaking.

Processed cheese is made by blending natural cheeses (young, mature, or different types) in the presence of water, colouring matter, emulsifying salts and then heating and agitating to produce a homogeneous mixture (Kosikowski, 1982).

In processed cheese, a different situation exists. During the preparation of processed cheese, calcium ions which were originally present are removed from the casein micelles under the influence of the calcium

complexing action of the emulsifying salts. Calcium plays a decisive role in forming the casein micelle and in maintaining its integrity (Brule and Lenoir, 1986).

When calcium is removed from the micelles, disintegration into submicelles or possibly smaller units occurs and in this respect the situation is quite different from the normal cheese where casein micelles can be considered to be the building stones of the protein structure.

Processed cheese is considered as an oil in water suspensoid, protected and stabilized by an emulsoid solution of hydrated casein and emulsifying salt. Processed cheese also differs from cheese in solubility, melting properties and stability during storage (Thomas et al., 1970).

**Advantages of Processed Cheese**

Processed cheese keeps better than natural cheese for a number of reasons. The flavour and body do not alter during storage. It can be flavoured to suit different tastes. It reduces the need for refrigeration in storage and transit thus making it easier to export to countries with poor refrigeration facilities. It