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THE EVALUATION OF MILK EXTENDERS IN UNRIPENED SOFT CHEESE

A thesis presented in partial fulfilment
of the requirements for the degree of
Master in Technology in Food Technology
at Massey University

Lucila L. Cruz

1989

ABSTRACT

Mixtures of soybean milk, coconut cream and reconstituted skimmilk were utilized in the manufacture of unripened soft-type cheese for the purpose of extending the milk supply. Different treatment combinations had been formulated replacing part of the reconstituted skimmilk used as milk base. The product formulation selected on the basis of product quality, stability and production costs analysis was that having low levels of soybean milk (10% w/w), coconut cream (20% w/w) and mixed starter culture (1% w/v) for acid development.

The sensory qualities of the resulting soft cheese were satisfactory although inferior to control cheese (fresh cow's milk). Compositional analysis showed that the experimental soft cheese is equally nutritious relative to soft cheese produced from cow's milk.

It was observed that the presence of soybean milk particularly at high level (20% w/w) resulted in high fat and protein losses, increased water-holding capacity and decreased firmness. The experimental soft cheese had the tendency to soften further and to develop an unacceptable acid taste during prolonged storage in cheese with a starter culture. Experi - mental soft cheese without starter culture had organoleptically good acceptance and good storage life at 5°C.

From the technological and nutritional standpoint, the use of milk extenders in combination for soft cheese manufacture is feasible and suitable for cottage industry. A major advantage is year-round availability regardless of fresh milk supply.

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TABLE OF CONTENTS

Page

Page

Page

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Soft cheeses can be made easily and profitably in small farms since less labour and capital investment is needed, besides being ripened quickly. Although this type of cheese cannot be kept longer due to its high moisture content, however, its high protein and the minerals present made it excel as a good source of nutrients for the human diet (FAO, 1970). As proteins have acquired special significance in the discipline of nutrition, they are essential food ingredients needed daily to promote growth and replace worn out tissues in the body. Fresh milk is the best source of these nutrients but it is not available to many particularly in developing, underdeveloped or non-dairy countries (Abou El-Ella, 1980).

With the increasing concern for improving protein quality and increasing protein content of many existing foods coupled with the rising prices of conventional protein-containing foods, an interest in relatively low cost, high protein products are given attention to simulate existing foods. Dairy products especially cheeses are very expensive in countries with seasonal, insufficient or non-existent local dairy industry. Fresh milk as the main raw material and considered the most complete and nutritious food is not available to many, hence the use of milk extenders or even substitutes may be worthwhile to bridge the protein gap thereby combating the world's perennial problem - malnutrition.

In the Philippines, buffalo's milk or carabao's milk is the chief ingredient in making soft cheese locally known as "kesong puti" (white cheese). This cheese is normally eaten as fresh or within a few days of manufacture. It is one of the most saleable type of cheese as other cheeses are imported which are unaffordable by the pockets of the majority of the people. Another type of cheese dominating the local market is the processed cheese where the main raw materials used are also imported.

Buffalo's milk and/or carabao's milk has high solids content, (Alim, 1975), hence giving higher yield compared with cow's milk. The colour of the cheese produced is white due to the absence of carotene pigment which is present in cow's milk. Nevertheless, the product is still highly acceptable to cheese eaters despite the impression especially among the Westerners that cheese colour is creamy. However, the production of buffalo's milk or carabao's milk in the Philippines is very minimal relative to the demand on soft cheese production. The difficulty in supply yet the popularity of the product led to the idea of extending milk to develop similar product.

It is therefore the purpose of this study to assess the suitability of soybean milk, coconut cream and skimmilk powder as milk extenders simulating the composition of buffalo's milk or carabao's milk in producing unripened soft-type cheese.

Specifically, the objectives of this project are:

1. To formulate a prototype product utilising the readily available raw materials such as soybean milk, coconut cream and skimmilk powder.

2. To develop and process an acceptable and nutritious product that best fits the low income consumer purchasing group.

3. To determine the acceptability for the prototype product.

4. To characterise the prototype product in terms of composition, sensory qualities and shelf life.

5. To evaluate the feasibility of production in terms of costs.

This study was conducted at the Pilot Plant, Department of Food Technology, Massey University, Palmerston North, New Zealand during the period from March 1988 to January 1989.

CHAPTER 2

A REVIEW ON THE PROPERTIES AND EFFECTS OF MILK EXTENDERS FOR CHEESEMAKING

Milk substitutes or milk extenders have received world-wide interest in order to overcome the relatively limited milk supply especially in developing countries (Abou El-Ella, 1980). The technological status of research trends is directed toward creation of dairy product analogues based fully or partially on vegetable protein raw materials. The short supply of animal proteins and high cost of animal fats have pointed toward the direction of more national use of vegetable proteins and fats as supplements or partial replacements of animal proteins and fats in foods (Jonas, 1975).

2.1 QUALITY OF CHEESES FROM RECONSTITUTED OR RECOMBINED MILK

Gilles and Lawrence (1981) reviewed the manufacture of cheese and other fermented products from recombined milk. They stated that many cheese varieties can be manufactured satisfactorily from recombined milk using low heat skimmilk powder and anhydrous milkfat, however, young cheese usually possesses a slight "anhydrous milkfat" or "powder" flavour, hence not acceptable for the production of many fresh, white cheeses which are traditionally eaten within a few days of manufacture. On the other hand, the use of starter cultures which lower down the pH due to acid development is advantageous and the presence of an active oxygen reducing system markedly reduces off-flavours that may result from oxidation of the anhydrous milkfat used (Gilles and Lawrence, 1981).

As a result of the powder-making process, the cheesemaking properties using skimmilk powder are somewhat different compared with the original milk and to compensate for the differences such as slower coagulation rate, reduced coagulum strength and decreased rate of syneresis, minor modifications in the cheese manufacturing procedures are required (Gilles and Lawrence, 1981).

Lablee (1980) reported the use of recombined milk prepared from dried skimmilk and anhydrous milkfat, in the production of soft surface-mould cheeses, semi-cooked pressed cheeses, processed cheese and white cheese with 35% solids by ultrafiltration. Satisfactory results were obtained and the methods are recommended for use in countries with shortage of local milk production.

Cottage cheese has been made satisfactorily from reconstituted skimmilk for many years in the United States, particularly at times of the season when fresh milk is in short supply. Feta cheese of good flavour, colour and body was successfully made from recombined milk (Gilles, 1974).

Moneib *et al.* (1981) studied on soft cheese making from whole and skimmilk powder. As reported, the best results were obtained with cheese from a mixture of whole and skimmilk powder (7:3) and reconstituted to a level of 30% solids, thus giving higher cheese yield and better organoleptic properties.

On the other hand, Ranas and Dulay (1982) studied the quality of soft cheese prepared from cows milk with added 10% and 20% reconstituted skimmilk containing 10% total solids. They reported that the yield decrease with addition of reconstituted skimmilk but scores for flavour, aroma, body and texture, colour and general acceptability were not significantly affected. A similar study using fresh buffalo's milk and cow's milk with increased total solids by addition of skimmilk powder was investigated by Saleem and Abd El-Salam (1979). Their findings showed that heat treatment improved the quality of the resultant cheese, particularly that made from buffalo's milk and appear to have little effect on the changes in cheese composition and pickling solution during storage. The use of reconstituted or recombined milk for pickled soft cheeses decreases the moisture content of the cheese, however, raising the reconstitution ratio, i.e. total solids content of cheesemilk, increases the moisture content (Fox, 1987).

Low-heat skimmilk powder classified as having a Whey Protein Nitrogen Index (WPNI) greater than 6 mg/g, is essential for the manufacture of all cheese varieties from recombined or reconstituted milk where coagulation is carried out by the addition of calf rennet or enzymes of similar action (Gilles and Lawrence, 1981). They further stated that rennetability is strongly and adversely affected by the extent to which the powder has been subjected to temperatures above 60°C during manufacture. Complicated interactions take place when milk is heated, thus the cause of the reduced rennetability is still not well understood (Wilson and Wheelock, 1972). Complex formation between K-casein and β-lactoglobulin possibly occurs and perhaps also denaturation of the K-casein (Gilles and Lawrence, 1981). In addition, heat treatment has a consider - able effect on the distribution of calcium in the milk which inevitably affects the rennet-clotting time since ionic calcium is involved both in milk coagulation and in the syneresis of the curd (Kannan and Jenness, 1961). In general low-heat skimmilk powders contained more ionic calcium and resulted in recombined milks with higher curd tensions than high heat skimmilk powders (Muldoon and Liska, 1972).

There are only very few varieties of cheese made from pure fresh skimmilk or reconstituted skimmilk due to inferior texture and flavour observed. In countries where there is shortage of fresh milk and a very rapidly increasing popula - tion, it is of interest to manufacture cheese from recons -

tituted skimmilk with the addition of non-dairy ingredients such as vegetable fats or proteins to improve flavour and texture and to extend the available milk supply.

2.2 PROPERTIES AND EFFECTS OF SOYBEAN MILK ADDITION

Soybean (*Glycine max* (L.) Merill) is nutritionally attractive as human food having a high protein content of good quality and fat of which over 50% is in the form of polyunsaturated fatty acids (Arnold and Choudbury, 1962) as cited by Beddows and Wong (1987). However, according to Steinkraus *et al.* (1962) as cited by Hang and Jackson (1967) soybeans in their whole, unmodified form are relatively indigestible and have never been highly acceptable as a food. In Asia where soybeans have been consumed for centuries as a protein and fat source (Abou El-Ella *et al.*, 1978), they are extracted, fractionated or fermented before eating (Hang and Jackson, 1967). Soybeans are utilised in low technology processes to give a series of products such as soybean milk, soybean curd, tofu, tahoe and many more.

Another potential drawback to the acceptability of soybean is the "beany" off-flavour which can develop in the crushed bean due to the action of lipoxygenase on the unsaturated liquid (Wilkins *et al.*, 1967; Schroder and Jackson, 1972) as cited by Beddows and Wong (1987). Soybean milk and their products are widely accepted in the Asian diet particularly in China and

Japan. However, soybean milk has not become a popular product in the Western world mainly because of the soybean taste (Moller, 1987) or products do not fit optimally into their consumption pattern (Visser and Thomas, 1987). Many attempts have been made to eliminate or produce soybean milk with less "beany" flavour (Khaleque *et al.*, 1972; Al-Kishtaini, 1972; Lao, 1972; Pontecorvo and Bourne, 1978). The use of Na_2CO_3 at 0.4 M concentration in presoaking soybeans had a significant effect on the reduction of "beany" flavour in soymilk (Khaleque *et al.*, 1972).

Soybean milk like whole milk contains protein, fat, carbo - hydrates and minerals. According to Metwalli *et al.* (1982a) the nutritive value of soymilk is about 80-90% that of cow's milk. It is a good source of all the essential amino acids except methionine, tryptophan and cystine present in limited amount (Wolf, 1972; Schroder and Jackson, 1972; Visser and Thomas, 1987). Findings of Metwalli *et al.* (1982a) showed that acidity, pH value and protein level were the same in both milk and soybean milk. The gross composition of whole milk and soybean milk in percentages were presented as follows:

COMPOSITION	WHOLE MILK[1]	SOYBEAN MILK 1[2]	SOYBEAN MILK 2[3]
pH value	6.48	6.43	6.43
Acidity	0.17	0.16	0.16
Total Solids	13.87	8.99	8.64
Fat	5.58	2.28	2.21
Total Protein	3.69	3.55	3.15
Carbohydrates	4.93	2.50	2.40
Ash	0.83	0.65	0.63

[1] A 1:1 mixture of cow's milk and buffalo's milk.

[2] Soymilk 1 was prepared by soaking in H_2O at 4°C for 24 hr, dehulled and extracted at 1:3 ratio with warm tap H_2O (40°C).

[3] Soymilk 2 was prepared by steaming the beans at 60°C, milled and soyflour obtained was extracted at 1:8 ratio with H_2O.

(Reference: Metwalli *et al.*, 1982a).

Results of several studies showed that soybean milk can supplement as well as act as a substitute for cow's milk to a large extent. Accordingly, mixing soybean milk with whole milk enriched the nutritive value of both milks (Metwalli *et al.*, 1982a).

Soybean milk has been introduced to the dairy industry (Hang and Jackson, 1967) and different dairy products are manufact - ured from milk-soymilk mixture (Abou El-Ella, 1978). There is an increasing number of reports on blends of soybeans and dairy ingredients suggesting that such blends may possess functional and nutritional properties which, in certain applications, are superior to those found when the ingredients are used separately (Mann, 1982).

The use of soybean milk into cheese manufacture was introduced in 1971 (Abou El-Ella, 1977) but its use is being limited by the bitter beany taste which is undesirable to many. It has minimal commercialisation and is still at the research level (Schmidt and Morris, 1984). A number of reports on properties and application of milk-soymilk mixtures have been conducted (Hang and Jackson, 1967 a & b; Schroder and Jackson, 1972; Hofi *et al.*, 1976; El-Safty *et al.*, 1979; Lee and Marshall, 1979; Abou El-Ella, 1978; Metwalli *et al.*, 1982 a & b; Del Valle *et al.*, 1984).

Metwalli *et al.* (1982) studied the effect of soybean milk percentages in milk-soymilk mixtures, rennet concentrations, varying levels of calcium chloride ($CaCl_2$) and pH on rennet coagulation during soft cheese making as well as the compositional quality, changes during ripening (pickling) and organoleptic properties of Domiati cheese - a popular soft cheese in Egypt and the Arab world. Hofi *et al.* (1976) studied the yield and composition of Domiati cheese from buffalo's and soymilk mixture. Addition of soybean milk greatly affects rennet clotting time and firmness of the curd (Metwalli *et al.*, 1982a). The effect was found to be more obvious as the amount of soybean milk was increased and concentrations of 25-30% resulted in a very weak curd. Yamanaka and Furukuwa (1972) as cited by Metwalli *et al.* (1982a) reported that the increase in rennet clotting time is attributed to the inhibiting effect of soybean milk solids. Another alternative explanation presented is that the majority of soybean milk proteins are of the globulin type and contain free sulphydryl groups, hence there is a possibility of an interaction between soybean milk protein and milk casein (Metwalli *et al.*, 1982a). This is similar to that reported between the casein and whey proteins which inhibits rennet action (Shalabi and Wheelock, 1976; Wheelock and Kirk, 1974).

Moreover, Metwalli *et al.* (1982a) stated that mixing soybean milk with raw milk in the ratio of 1:4 was found to be the most suitable proportion for cheesemaking. Their findings further stated that the cheesemaking process has to be altered by increasing the amount of rennet to 0.15%, addition of calcium chloride at 0.02% and lowering the pH to 5.0 or 5.5 in order to improve the rennet clotting and curd firmness. In addition to their findings, autoclaving soymilk at 120°C for 15 min before mixing with milk greatly improved curd firmness and was thought to be due to soymilk protein denaturation however, a slight loss of amino acid contents was observed. Furthermore, there was a noticeable difference observed on amino acid contents having the same protein concentrations as affected by methods of extraction. This indicates that methods of preparation may affect the composition of the soybean protein.

Knowledge about interactions between soybean protein and milk protein is essential to work on improving the texture of cheeselike foods containing soy proteins. According to Lee and Marshall (1981) soy proteins can be separated into 4 major components having ultracentrifugal sedimentation constants approximately 2, 7, 11 and 15 S; the 7 S and 11 S components accounted for about 70%, each fraction having different functional properties. Bean curd made from the 7 S fraction was reported as soft and low in chewiness whereas bean curd made from the 11 S fraction was hard and chewy. The gel from 7 S fraction became hard and lighter in weight because of its lost water-holding capacity as calcium was added. Lee and Rha (1978) found that heat treatment of soy protein initiated formation of the three dimensional network and increased springiness of the soy protein curd.

Lee and Marshall (1979) studied and evaluated rennet curds from mixtures of raw milk and unfractionated protein and/or the 11 S protein-rich fraction. Their study was focused on yield to determine whether soy proteins are incorporated with casein in rennet curd; addition of $CaCl_2$ to improve texture and the effect of preheating soy proteins on yield. Their findings showed that soy proteins were able to coagulate with milk protein in rennet coagulated curds however, texture was soft and mealy; texture did not improve by added $CaCl_2$; and addition of soy proteins caused an excessive loss of milk fat. The higher quantity of protein in curd containing preheated 11

S soy protein in comparison with curd containing unfractionated soy protein was attributed to the unfolding of soy proteins by heat, thus greatly increasing the quantity of soy proteins coagulated with casein. Furthermore, the increased fat losses in mixture with soy protein was interpreted as the result of casein curd interruption by loosening microstructures due to the presence of soy protein (Lee and Marshall, 1979). In general, incorporation of soy protein into the rennet curd resulted in increased water-holding capacity, decreased firmness and decreased fat-holding capacity (Jonas, 1975).

A similar study was conducted by Abou El-Ella *et al.* (1978) on some properties of milk/soymilk mixture such as the effect of different soymilk percentages, sodium chloride, renneting temperature and amount of rennet on coagulation time and firmness. Their results showed that no coagulation was observed when 30% soymilk was added in cow's milk and addition of 40% soymilk or more in buffalo's milk prolonged the coagulation time to 10 min. Their findings were in agreement with Metwalli *et al.* (1982). They further stated that coagulation time for both milks increased with increasing salt content and decreased as renneting temperature increased from 95°F to 105°F while curd firmness showed steady increase at this accelerated temperature.

Abou El-Ella *et al.* (1977) studied the use of soybean milk in "Karish" cheese, another type of pickled soft cheese from Egypt. Karish cheese was manufactured from buffalo skimmilk with added 20% soymilk and coagulated with 2% lactic starter culture, *Streptococcus lactis*, at 86°F. Results of their experiment showed that addition of 20% soymilk increased the cheese yield during ripening which they attributed as due to the absorption of water and salt from the pickling solution. Their overall evaluation on the finished product showed lower scores than the control but still acceptable and the fresh cheese was comparable with cheese from skim milk alone in terms of appearance, colour, body and texture and flavour.

Another attempt on the use of soymilk was in manufacture of a substitute for "Ras" cheese, a kind of hard cheese in the Middle East (Abou El-Ella, 1980). Their results showed that cheese made from soymilk alone gave a cheesy flavour during 3 months of ripening however, sensory scores were lower than those made from milk/soymilk mixture or pure cow's milk. As the proportion of soymilk to cow's milk decrease (1:3) the product showed a more acceptable properties. From the technological point of view, they concluded that soymilk could be used successfully in the manufacture of a hard cheese substitute. Similarly, a U.S. patent was issued on a soya curd blue cheese fortified with milkfat and non-fat milk solids (Lundstedt & Lo, 1973).

Several patents were issued by different countries on the production of cheese-like products utilizing soy proteins. Alekseev *et al.* (1986) introduced a method for producing a cheese product by substituting 15% of the casein which involves addition of 0.5 kg soy isolate to 99.5 kg milk. Their results indicated that no differences were established in organoleptic properties between that cheese and the control. Another cheese-like product which is sliceable and grateable was produced by ultrafiltration of soymilk with optional additives such as flavours, colours, bacterial cultures, animal proteins, etc. (Andersen and Bojgaard, 1988). Likewise, a camembert cheese-like product was made from soymilk with 6% solids treated with suitable starters and coagulant, salted and ripened (Kuppers, 1988). The resulting product had similar texture and sensory characteristics to conventional camembert cheese.

A recent study by Aworh *et al.* (1987) on partial substitution of cow's milk with soymilk on Western African soft unripened cheese, Warankasi, showed that cheeses containing soymilk were comparable with controls (cow's milk) in terms of yield, nitrogen and fat contents,and flavour. Moreover, cheeses with 10% soymilk had a slight brownish colour but overall acceptab - ility was not impaired relative to control and cheeses with 20% soymilk were acceptable although inferior to controls.

The effect of addition of soy protein on the textural properties and microstructure of reconstituted nonfat dry milk coagulum was studied by Mohamed and Morris (1987). Their results showed that soy protein at 5% of the total solids resulted in a reduction in firmness, a decrease in syneresis and a looser microstructure of the coagulum, as did levels of 10% and 20% soymilk, which agrees with the findings of Lee and Marshall (1979).

2.3 PROPERTIES AND EFFECTS OF COCONUT MILK ADDITION

With the increasing concern over the world food supply, considerable international attention has been directed towards the possibility of the utilisation of coconut protein as a source of human food (Jonas, 1975). The possible routes of utilisation are coconut milk, coconut cream and coconut protein isolate.

Coconut milk is the name commonly given to the liquid prepared by aqueous extraction of ground-up coconut meat (Hagenmaier *et al.*, 1974). It has about ten times as much oil as protein which differs markedly from that of cow's milk having about equal amounts of oil and protein (Hagenmaier *et al.*, 1974). Banzon (1978) reported that coconut milk apart from its protein and high fat (oil) content has growth factors and is rich in emulsifiers; this also avoided the long, expensive and nutritionally hazardous process of extracting oil from copra which when explored deeply could give similar if not better effect on recombination or reconstitution. Also, he further stated that extraction of coconut milk involves only low-level technology and its use for reconstitution is suitable for small-scale industry in places where cheap coconuts are abundant throughout the year and there is a shortage of milk. Of course skimmilk powder still has to be imported but coconut milk can be used as a replacement for the costly butterfat (Banzon, 1978).

Sanchez and Rasco (1983) studied the utilisation of coconut milk in white soft cheese production. Results showed that acceptable texture was obtained from 50% and 60% coconut milk which is comparable to the control (pure cow's milk) in terms of flavour, texture and general acceptability however, the yield decreased as coconut milk percentage increased.

It was also demonstrated that a low-fat but protein rich white soft cheese (Cadtri) could be made from a skimmilk powder - coconut milk blend (Davide *et al.* (1985). Moreover, studies were conducted on water-extracted coconut milk - skimmilk powder blends to develop cheap new dairy foods. These include fruit-flavoured Niyogurt, a variety of plain and flavoured milk drinks, and blue cheese (Davide *et al.*, 1986).

Nielsen and Pihl (1983) demonstrated the utilisation of coconut oil at 40% level mixed with other vegetable oils to give similar fatty acid composition to milkfat and successfully used to produce Havarti and Danish blue cheese with acceptable quality and reduced costs.

There are various milk substitutes containing coconut oil being sold for human consumption. Coconut oil consists mainly of saturated medium chain triglycerides and as the main fat in large parts of the world, was used without objection until a few decades ago but reaction changed when the so-called "polyunsaturated" fats were introduced (Kaunitz, 1979). Since then people became conscious on intake of dietary fat and several questions were brought up concerning the effects of lipids (especially cholesterol) metabolism and if its disturbance is of prime importance in the pathogenesis of arteriosclerosis or heart attack.

As cited by Kaunitz (1979) studies on Polynesians were conducted by Hunter (1962) and Shorland *et al.* (1969). In one study it was found that those consuming coconut oil as 89% of their fat had lower blood pressures than those eating 7% and heart attacks were not observed in either group. In another study it was found that Pukapukans consuming large amount of coconut oil had lower serum cholesterol levels and a lower incidence of arteriosclerosis than the Maoris and Europeans who ate a European-type of diet.

Steinkraus *et al.* (1968) as cited by Jonas (1975), under the sponsorship of U.S. AID, conducted development of flavoured soya milks and soya-coconut milk for the Philippine market. Their findings showed that unflavoured soya milks were unacceptable in flavours to the majority of the Filipino children as their taste panelists and flavoured soya milk has an increased acceptance to 96% level and addition of coconut milk generally increased acceptability. It was further observed that protein fraction of coconut milk coagulates on heat exposure however, when combined with soya milk the product showed no visible coagulation and the milk remained liquid (Jonas, 1975). Until recently no further research works have been published on the utilisation of soya-coconut milk blends.

2.4 EFFECT OF LACTIC STARTER ORGANISMS

Lactic starter cultures are selected species of lactic acid bacteria grown in sterile milk or skimmilk or whey and are indispensable in the manufacture of ripened cheeses, butter and fermented milk products. Their action on milk constituents is responsible for the characteristic flavour and aroma, body and texture and shelf-life of many dairy products but their importance in the manufacture of unripened soft-type cheeses has not been fully investigated (Dulay *et al.*, 1986).

Recently, Dulay *et al.* (1986) studied the influence of cheese starter cultures on the quality, shelf-life and yield of DTRI*soft cheese prepared from fresh cow's milk. Their findings showed that cheese samples treated with 10% and 15%

* DTRI - Dairy Training and Research Institute (Philippines)

starter culture gave smoother texture and an appealing appearance, more full-bodied consistency, richer, mellow with clean delicate flavour and aroma, higher cheese recovery and better shelf-life both at room and refrigerator temperature than the non-starter cheese (control) and experimental sample with 5% starter culture.

Karish from Egypt is a soft acid cheese made either from fermented buttermilk or from sour defatted milk or reconstituted skimmilk coagulated with rennet. Starter culture *Lactobacillus bulgaricus* is added to improve flavour.

Addition of extenders to cheesemilk such as soybean milk and coconut milk could influence the flavour, texture, yield and composition of finished cheese, hence modification of the cheesemaking procedures are required.

Metwalli *et al.* (1982) stated that pH reduction to 5.5 or 5.0 before renneting greatly improved the curd firmness of soymilk/milk mixture while with whole milk it resulted in fast curd syneresis.

In a study by Tratnik and Jaksic (1982), production of fresh cheese from cow's milk added with 10% and 20% soya milk by fermentation with 2% *Streptococcus lactis* starter, with or without rennet, showed that the products did not differ substantially from controls made from cow's milk only.

Hang and Jackson (1967) was able to prepare a satisfactory cheeselike product, using *Streptococcus thermophilus* as fermenting organism, only by incorporating rennet extract and skimmilk into soybean milk. No acceptable product has resulted from soybean milk alone by conventional cheesemaking or yoghurt processes (Wang *et al.*, 1974; Tratnik and Jaksic, 1982). As cited by Wang *et al.* (1974), Obara (1968) suggested that an acceptable cheeselike product could be produced from soybean milk using a mixture of *Streptococcus cremoris* and *Streptococcus lactis* provided the soy protein was first treated with appro - priate proteolytic enzymes.

Characteristics of soybean cheese prepared using acetic acid, calcium sulfate ($CaSO_4$) and lactic starter organisms (*S. thermophilus*) were evaluated by Hang and Jackson (1967). They reported that the highest yield of precipitated protein was found with acetic acid precipitation but outweighed by the very gritty curd which has never been used as human food. The yield of protein by $CaSO_4$ and lactic fermentation was less but the resulting cheese was superior in body and texture. In the lactic fermentation, the gradual production of acid facilitates drainage of whey from the interior of the soybean curd, resulting in a cheese of different physical characteristics (Hang and Jackson, 1967).

Moreover, Hang and Jackson (1967) reported that addition of skimmilk to soybean milk together with rennet extract and starter bacteria reduced the coagulation time. They inter - preted this as a result probably of the action of rennet extract on skimmilk or is the possibility that skimmilk had a stimulating action on the growth of starter culture, thus resulting in a more rapid utilisation of fermentable substrates and increased acid production. They observed that this mechanism improved the flavour of the finished product.

In a study by Metwalli *et al.* (1982), cheese flavour greatly improved with ripening (pickling) and the presence of soymilk enhances ripening of cheeses although considerable weight loss was observed.

Angeles and Marth (1971a, b, c, d) investigated very thoroughly the growth and activity of lactic acid bacteria in soymilk. Lactic acid formation, lipolytic and proteolytic enzyme actions are of valuable considerations if soyamilk is to serve as a base or even just extender for production of cheese-like products.

CHAPTER 3

COMPARISON OF SOFT CHEESES WITH DIFFERENT LEVELS OF MILK EXTENDERS

3.1 INTRODUCTION

The composition and properties of cheese depend on the methods of manufacture, composition of milk and previous treatments of milk as cited by Metwalli *et al.* (1982).

In this study an attempt has been made to manufacture soft-type cheese from cheesemilk simulating the composition of buffalo's milk or carabao's milk known to contain higher total solids than cow's milk. The cheese is a simple type of soft cheese, easy to prepare on a laboratory or pilot plant scale and can be ready for consumption after preparation.

The cheesemilk for this soft-type cheese was formulated by blending different proportions of coconut cream, soybean milk and reconstituted skimmilk. In countries where dairy industry is still in its infancy or stepping up milk production like the Philippines milk is much in demand, therefore, any attempt to replace part of the milk with possible extenders to develop new dairy foods like cheese would be of great economical interest.

3.2 EXPERIMENTAL PLAN

3.2.1 Design of Experiment

The experiment was set-up using the factorial experiment in a randomised block design (Hicks, 1964). There were two fixed levels for each three experimental variables designated as a, b, c or eight experimental conditions (2^3). The treatment combinations were 1, a, b, ab, c, ac, bc, abc. A layout in which these eight treatment combinations were randomised per replication is shown in Appendix I. A control sample was prepared for comparison.

The experimental variables at two levels each were soybean milk (a), coconut cream (b) and starter culture (c). The response variables were evaluated in terms of flavour, texture, appearance and general acceptability by the trained sensory panelists. The composition of the product was also determined for comparison.

The data obtained were statistically analysed by the Analysis of Variance (ANOVA) using the SAS Program in the Prime Computer (Faculty of Agricultural & Horticultural Sciences, Massey University). Tukey's Test (LSD) was used to determine significant differences among sample means (Gomez and Gomez, 1976).

3.2.2 Selection and Training of Panelists

The selection of panelists was based on the method of Zook and Wessman (1977). In the selection of panelists or judges, several factors were to be considered (Martin, 1973; Bressan and Behling, 1977; Larmond, 1977; Zook and Wessman, 1977). Among those factors considered were interest and motivation, availability, ability to deal analytically, attitude towards the product, good health, stable personality and ability to verbalise.

The prospective panelists selected were postgraduate students in the Faculty of Technology and Faculty of Agricultural and Horticultural Sciences, Massey University, Palmerston North, New Zealand. They were mostly from Asian countries having been familiar with and have high acceptance of the taste of soybean milk and coconut milk as these were ingredients of the product in test. The prospective panelists or judges were screened using the triangle test as described by Larmond (1977). A sample of the questionnaire was presented in Appendix II. The aim of the screening was to expose the judges to a range of discriminating tasks and to include in the series some of the types of variables which would later be described by the panelist. Tests were administered twice for each character - istic, once with two A samples and once with two B samples differentiating degree of saltiness, firmness and colour of cheese samples. Panelists were ranked on their ability to discriminate between samples.

The selected panel, consisted of 7-8 judges were trained further by presenting several cheese samples from actual experiment without identifying the ingredients at first but only after a need for them was indicated. This was done to avoid bias judgement which might influence the expectation in their first impressions of the product. During this training programme, experimental and standard samples were presented. Trial score sheets were prepared and the sensory character - istics were discussed and defined to the panel members to make understand, clarify confusion and feel comfortable with the descriptive terms (Appendix III) used for effective grading. Suggestions by the judges to improve the descriptive terms used were encouraged. The judges agreed on the meaning of each term used. During the actual evaluation sessions the panelists work individually. Sensory evaluation took place at the sensory room of the Food Technology Department to provide quiet, comfortable environment with optimal setting for unbiased judgement.

3.2.3 Questionnaire Design

The descriptive analysis with scaling was used. Descriptive analysis is a valuable tool in difference testing and in product development work (Larmond, 1977).

Unstructured scales with verbal anchors at the ends only was adopted to eliminate the problem of unequal intervals associated with structured scales. The scale was a horizontal line 10 cm long with anchor points from each end. Each anchor point was labelled with the agreed word i.e. absent - intense; very soft - very firm; etc. A separate line was used for each sensory property evaluated. A sample of the questionnaire is presented in Appendix IV.

3.3 PREPARATION AND SOURCES OF RAW MATERIALS

3.3.1 Soybean Milk

The Amsoy variety, dried, machine dressed soybeans obtained commercially from Henry Berry Ltd., New Zealand was used in the preparation of soybean milk.

The extraction method used was based on Metwalli *et al.* (1982) with some modifications. The soybeans were soaked in water at 4°C for 24 hr. The soak water was discarded and the beans were washed in running water for several times while rubbing them to free the hulls. The hulls were separated from the beans by flotation in water, using a coarse mesh sieve. The washed, dehulled beans were weighed and placed in the Jeffco disinte - grator. Warm tap water at 40°C was added in the ratio of 250 ml water for every 100 g soaked soybeans and ground for 1 minute. The extract was filtered using a basket centrifuge lined with a clean cotton case (e.g. new pillow case was used) and spun until all the soybean milk has been separated from the mash. The soybean milk was canned and sterilised at 15 psi for 15 minutes for uniformity of cheese production having one source of supply. The canned soybean milk was stored at 5°C prior to use. Results of yield and compositional analysis are shown in Appendix V.

During soaking, the water extracts the oligosaccharides and phospholipids causing bitter taste (Visser and Thomas, 1987). The heat treatment removes the beany flavour and destroys antidigestive factors or trypsin inhibitors present in raw soy beans (Hang and Jackson, 1967).

3.3.2 Coconut Cream

The commercially available tinned Samoa coconut cream, Premium Strength Coconut Milk (PE[1]EPE[1]E) produced by Samoa Tropical Products Ltd, Apia, Western Samoa was used throughout the experiment. The contents were coconut milk, water, polysorbate 60 at .002%. This milk has been pasteurised, homogenised and emulsified.

3.3.3 Skimmilk Powder

The low to medium heat skimmilk powder used in this study was manufactured at the Manawatu Cooperative Dairy Company, New Zealand. The proximate analysis of the powder as indicated in the label is shown in Appendix V. The antibiotic-free skim-milk powder was reconstituted to 14% w/w solids, to approximate the total solids content of buffalo's milk. This reconstituted skimmilk was used in the experiment as milk base.

3.3.4 Cow's Milk

The pasteurised-homogenised town milk sold in glass bottles was used for making the control cheese or standard due to the unavailability of buffalo's or carabao's milk.

3.3.5 Rennet and Starter Cultures

The rennet and lactic starter cultures used were obtained from the New Zealand Dairy Research Institute, Palmerston North. The actively grown cultures were consisted of *Streptococcus lactis* (ML_8) and *Streptococcus cremoris* (134).

3.3.5.1 Culture maintenance and propagation

The cheese cultures were grown separately in prepared 10 ml sterile 10% w/v reconstituted, antibiotic-free skimmilk inoculated at 1% level. The tubes were incubated at 25-26°C for 16 hrs at the Food Microbiology Laboratory, Department of Food Technology. Right after the clotting period, the tubes were stored at 4-5°C cold storage. The organisms were sub-cultured in tubes of sterile skimmilk twice a week to keep them actively growing.

3.3.5.2 Preparation of cheese starter cultures

The sterile 10% w/v reconstituted, antibiotic-free skimmilk was prepared in Erlenmeyer flasks for bigger volumes. Separate flasks were inoculated with each freshly grown cheese inocula and incubated at 25-26°C for 16 hours. After clotting, the flasks were kept refrigerated until used for the same day's cheese manufacture.

3.3.5.3 Test of acid development on salted medium

To satisfy the doubt on the inhibitory effect of salt on acid production by lactic starter cultures on salted milk, a preliminary trial was performed. The test was run separately in sterile reconstituted skimmilk and pasteurised-homogenised milk. 100 ml of each milk was measured into a sterile 250 ml Erlenmeyer flasks. The salt was added at the levels of 2.0%, 2.5% and 3.0%, approximating the level of salt to be used for cheesemaking. In each level of salt, the milk was treated with 3% v/v each of mixed starter culture consisted of *S. lactis* (ML_8) and *S. cremoris* (134) and *S. lactis* (ML_8) culture only. The milk samples were tempered at 30°C. The initial acidity was determined and every half an hour thereafter, until an increase was observed. To determine the acidity, 9 ml of milk was pipetted with care from each flask to avoid contamination and titrated according to the method of Ling (1963).

3.4 CHEESEMILK PREPARATION

A 2-kg mix formulation for each treatment was prepared in the cheese production section of the Food Technology Pilot Plant. The eight treatments were randomised (Appendix I) and preparation was carried out with 4 treatments per day. The soybean milk was added at 10% and 20% w/w levels, the coconut cream at 20% and 30% w/w levels and the cheese starter cultures at 1% and 3% w/v levels. The amount of reconstituted skimmilk was adjusted depending on the combinations of soybean milk and coconut cream for each total mix formulation per treatment. The levels of extenders used were decided based on the literature reviewed.

The reconstituted skimmilk was prepared in bulk for all the treatments used for the day's cheese manufacture. The skim-milk powder was dissolved in warm water (50°C) at 14% w/w reconstitution with constant but not so vigorous stirring to prevent from frothing. The amount of skimmilk needed per treatment was weighed into a 10 kg stainless steel bucket. The soybean milk depending on the proportion used was weighed in separate container and mixed with the skimmilk. The coconut cream was strained first before addition into the mixture to remove the coconut meal particles present. A 2% w/v salt was added in all treatments.

Parallel to these, a 2 kg pasteurised-homogenised cow's milk was prepared as control. The quantity of each ingredient is shown in Table 3.1

Table 3.1: Quantity of ingredients for cheesemilk preparations at different treatment combinations

INGREDIENTS (grams)	TREATMENTS[1] A	B	C	D	E	F	G
Code:	control	(1)	(a)	(b)	(ab)	(c)	(bc)
Cow's milk	2000	-	-	-	-	-	-
Reconstituted skim milk	-	1400	1200	1200	1000	1400	1200
Soybean milk	-	200	400	200	400	200	200
Coconut cream	-	400	400	600	600	400	600
Starter culture	-	20	20	20	20	60	60
Salt	40	40	40	40	40	40	40
Rennet (ml)	5	5	5	5	5	5	5
TOTAL[2]	2040	2060	2060	2060	2060	2100	2100

1 Note that treatment codes ac and abc (Appendix I) were not included due to their failure in soft cheese manufacture. Statistical design was modified to fit the data collected.

2 The volume of rennet added was excluded in the computation for total amount of cheesemilks (plus starter and salt).

3.5 CHEESE MANUFACTURE

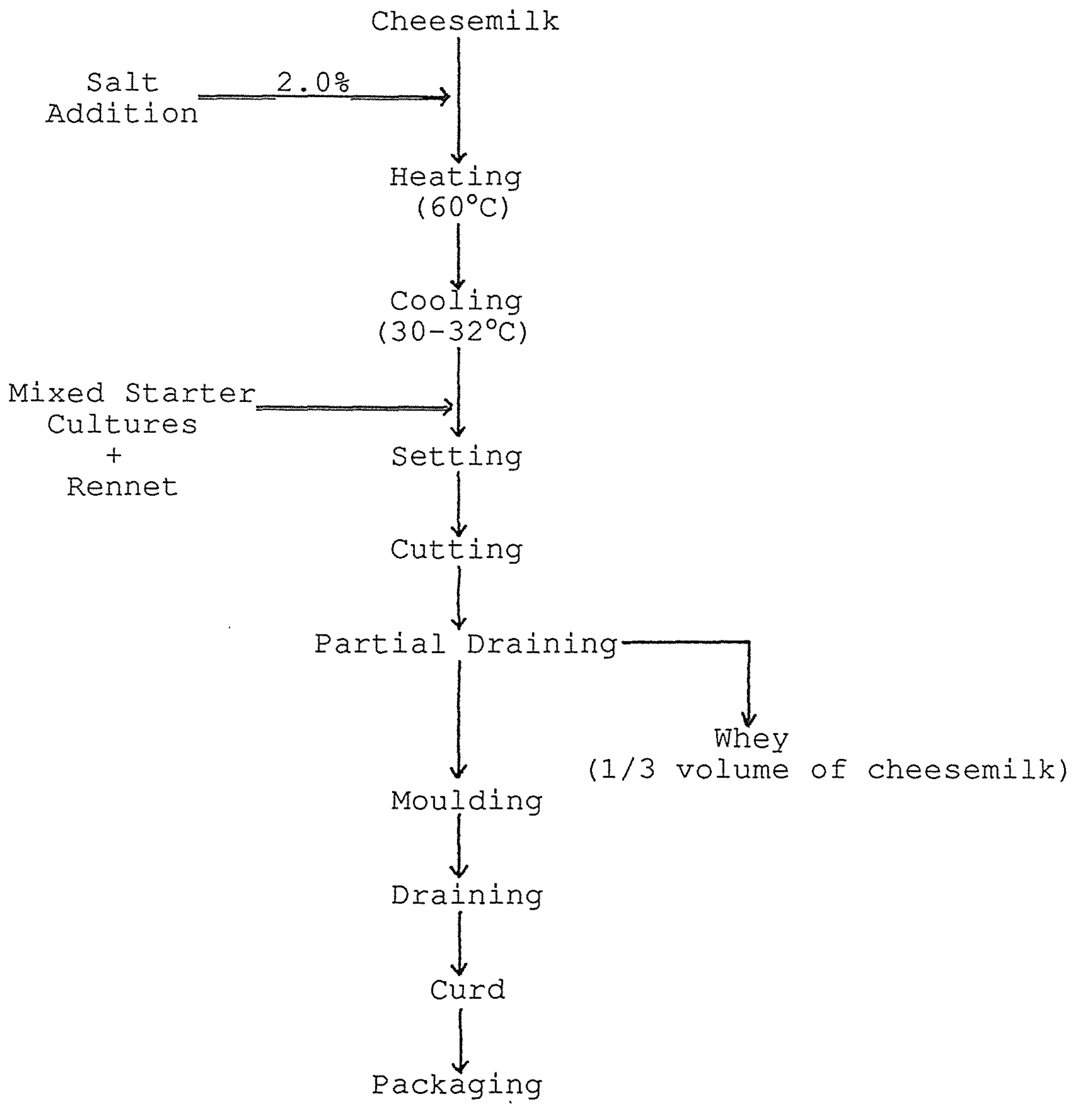
The UPLB-DTRI* procedure patterned after the method of Dulay (1972) was adopted for soft cheese manufacture. Slight modifications of the method was done because it was observed during the first cheesemaking experiments that most treatments gave very soft curd and solubilised during the draining period overnight in the cold storage. The pasteurisation temperature used was lowered without holding time and the setting temperature was also lowered down.

Heating was done by placing the stainless steel bucket with cheesemilk in the steam-jacketed concave vessel and filled with water at the same level as cheesemilk. Steam was supplied into the jacket to boil the water, thus heating the cheesemilk up to 60°C. Without delay, the cheesemilk was cooled immediately to 30°C with iced water. The bucket with cheesemilk was placed into a double-jacketed cheesevat and filled with water at the same level as cheesemilk. The cheesemilk was added with mixed starter cultures before it was set for about 30 to 60 minutes depending on treatments. About 0.25% (5 ml) of the rennet was used in the setting of the cheese and holding the milk at 30°C by supplying steam into the double-jacketed cheesevat from time to time. Subsequently, the firm coagulum was cut, allowed to stand for another 30 minutes to let the expulsion of whey from the cut curds. Part of the whey, about 1/3 of the cheesemilk volume, was removed by scooping into a measuring container.

*UPLB-DTRI - University of the Philippines at Los Banos - Dairy Training and Research Institute

The remaining curd and whey mixture was transferred into a draining tray lined with cheesecloth. The cheese curd was drained overnight in cold storage (5°C). The following day, the cheeses were wrapped in polyethylene sheets prior to sensory evaluation. The manufacturing scheme is presented in Figure 3.1.

Figure 3.1: Schematic diagram for soft cheese manufacture



3.6 FABRICATION AND MODIFICATION OF EQUIPMENT

Since soft cheese formulation was made only on a laboratory scale, the facilities available for cheesemaking are not applicable. The 10 kg stainless steel bucket was used for coagulation instead of the 100 kg capacity cheesevat. Stainless steel ladle was used for stirring and kitchen knife for cutting the curd into about 3 cm cubes. The cheese trays were fabricated from stainless steel solid frame about 14.5 cm square and 5 cm thick with perforated aluminium bottom tray to allow for whey drainage. The whey was collected through a plastic container underneath.

3.7 SENSORY EVALUATION

The selected panelists were composed of 5 Filipinos, 2 Chinese, 1 Indian and 1 Swiss. Sensory evaluation of the product took place in the sensory room under controlled conditions to minimise distractions during independent judgements.

The test samples were divided into squares of about 3 cm, coded accordingly using three digit number and placed in plates with their corresponding codes arranged at random order. The coded samples were served to panelists at room temperature and water is provided for oral rinsing between samples.

The cheese samples were evaluated for flavour characteristics of creaminess, saltiness, beany, rancid and acid; for textural characteristics of firmness, and smoothness; for colour; aftertaste and overall acceptability.

After the panelists completed their judgements, numerical values were given to the ratings by measuring the distance of the judge's mark from the left end of the line in the units of 0.1 cm. These values were tabulated and statistically analysed.

3.8 ANALYTICAL METHODS

3.8.1 Sampling

Cheesemilk samples for the different physico-chemical analyses were taken in suitable quantity (50 ml) after cooling upon addition of starter cultures. The whey samples were drawn during the partial draining stage of cheese manufacture. The cheese samples were taken by cutting small squares in different portions of the block, approximately 100 g per treatment. These were mixed and each treatment was separately placed in clean sample bottles. All samples were kept in the cold storage (4-5°C) until ready for analysis.

3.8.2 Analysis of Cheesemilk

Total solids were estimated by drying 2.0 g sample in an oven at 100-105°C for 3 hr. Acidity was determined by titrating 9 ml of milk with N/10 NaOH, using phenolphthalein as indicator. The fat content was determined by the Röse-Gottlieb method (AOAC, 1975). Total protein was estimated by the semi-micro Kjeldahl method (Dairy Chemistry Laboratory Manual). The pH was taken using the PHM 61 Laboratory pH meter (Radiometer A/S Copenhagen, DK). All tests were in duplicate for each sample and results were averaged.

3.8.3 Analysis of Cheese

Moisture content was determined by drying 2.0 g well mixed sample in an oven at 100°-150°C for 3 hours. Total protein was estimated by the semi-micro Kjeldahl method. About 2.0 g of the prepared sample was weighed. Digestion and distillation followed and the ammonia was received in an excess, 10 ml of 2% boric acid. The excess was titrated with 0.02 M Hydrochloric Acid (HCl).

The fat content was determined by the Röse-Gottlieb method, FAO/WHO method (AOAC, 1975). The pH was taken with a PHM 61 Laboratory pH meter. Salt content was analysed according to the modified Volhard method of Silvermann *et al.* (1959). All tests were in duplicate for each sample and results were averaged.

The firmness of the cheese was determined with a penetrometer (Cental Ignition Co. London, England). Different probes were tried and the polygon cone probe had the most capability of differentiation. Penetration time was 4.7 seconds. Firmness was represented as distance of penetration measured by a penetrometer in mm with the polygon cone probe. The greater the penetration distance, the less firm was the curd.

3.8.4 Analysis of Whey

The methods used for the determination of total solids, fat, total protein, acidity and pH were the same as those used for cheesemilk analysis.

3.9 RESULTS AND DISCUSSION

3.9.1 Effect of Salt Addition on Acid Development

A test experiment was conducted to determine the inhibitory effect on acid production by salting cheesemilk prior to commence cheese manufacture. Results of the trials are presented in Figures 3.2 a and b.

Figure 3.2a shows the influence of salt addition on acid development using reconstituted skimmilk as milk base with 3% mixed starter cultures (*S. cremoris* and *S. lactis*). The salt was added at the levels of 2.0, 2.5 and 3.0 percent. An increase in acidity was observed after one and a half hours

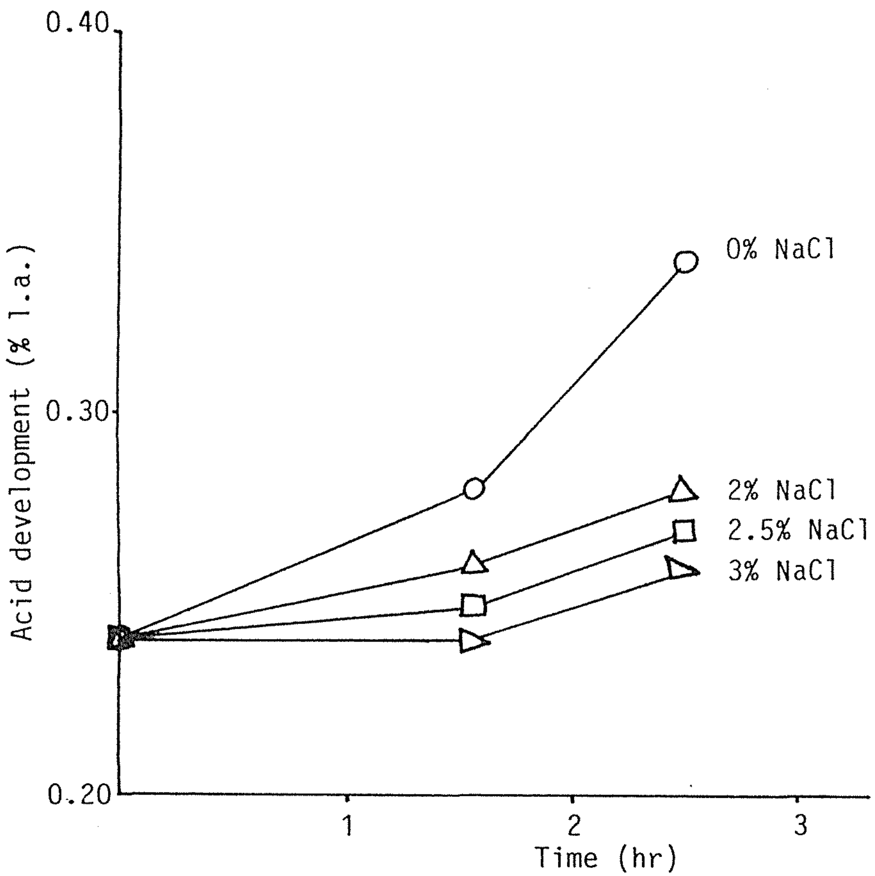


Figure 3.2a. Acid development at different salt concentrations in reconstituted skim-milk added with 3% mixed starter cultures

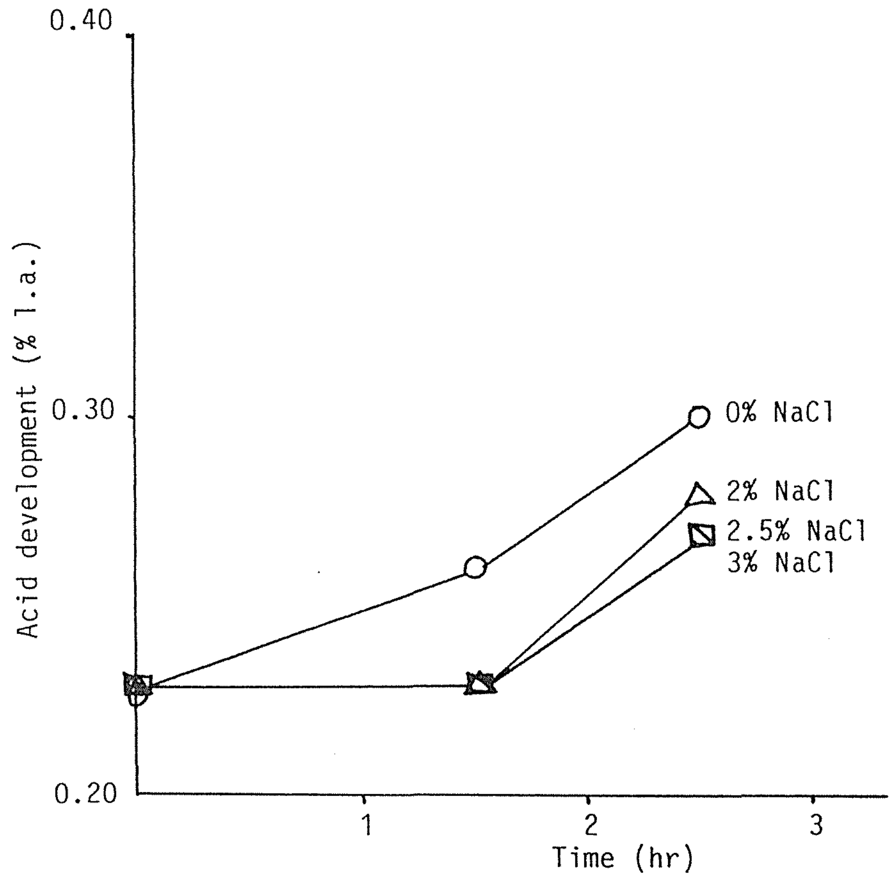


Figure 3.2b. Acid development at different salt concentrations in pasteurised-homogenised milk added with 3% mixed starter cultures

from the time the starter cultures were added in milk. Among the experimental treatments, acid development was highest in milk with 2.0% salt in comparison with milk having 2.5% and 3.0% salt. It shows that the development in acidity appeared to be quite slow at higher salt concentrations, hence the lower acidity values obtained. Even after two and a half hours, there was a little increase in the acidity values for all treatments and the same trend was observed.

Figure 3.2b shows the influence of salt addition using pasteurised - homogenised milk as base. After one and a half hours from the time starter cultures were added, no increase in acidity was observed in milk at all levels of salt concentra - tions. However, acid development was observed after two and a half hours. In a similar pattern to that observed using reconstituted skimmilk, acid production was highest in the treatment having the lowest (2.0%) salt concentration. In comparison, the control treatment (no salt added in milk) as expected gave the highest value of acid development at the times considered in the experimental treatments. As salt concentration increases the acid production decreases yet, still shows that mixed starter cultures can work on salted medium depending on concentrations and milk composition.

On the other hand results of the trials using 3% single starter culture only (*S. lactis*) are presented in Table 3.2.

Table 3.2: Acid development at different salt concentrations in reconstituted skimmilk and pasteurised milk added with 3% single starter culture*

MILK BASE	ACIDITY (% l.a.) 0 hr	1.5 hr	2.5 hr
A. Reconstituted Skim milk			
0 % NaCl	0.23	0.26	0.28
2.0% NaCl	0.23	0.25	0.27
2.5% NaCl	0.23	0.25	0.27
3.0% NaCl	0.23	0.26	0.26
B. Pasteurised Homogenised milk			
0 % NaCl	0.23	0.25	0.28
2.0% NaCl	0.23	0.23	0.22
2.5% NaCl	0.23	0.24	0.23
3.0% NaCl	0.23	0.23	0.23

* Initial acidity of single starter culture = 0.87% l.a.
Initial acidity of mixed starter cultures = 0.89% l.a.

It could be observed that less acid was developed in reconsti - tuted skimmilk with single starter culture only and even much less or no acid development at all in pasteurised-homogenised milk at the levels of salt tested. The variations in the performance of starter cultures in different types of milk could be attributed to the differences in the composition of milk and the types of organisms involved. The acid production by a single strain of culture organism was more affected by salt addition than the mixed starter culture organisms. This aspect has to be kept in view in the selection of suitable cultures for the manufacture of product with special treatment, for instance, salting the cheesemilk first before to commence manufacture. It was demonstrated in these results that acid production was not stopped by salting cheesemilk having selected the suitable starter cultures for product manufacture. The mixed cultures of fast (*S. lactis*, ML_8) and slow (*S. cremoris*, 134) acid producers proved a better activity than the single starter (*S. lactis*, ML_8) only.

3.9.2 Cheesemilk Composition

Table 3.3 presents the composition of different cheesemilk preparations. Results of the analysis showed that total solids, fat and acidity values of the different treatments vary significantly ($P > .05$). The protein content did not differ significantly in all treatments because of variation in milk composition for treatment A (Appendix VI-B).

Table 3.3: Comparison of the composition and clotting time of cheesemilks prepared from pure cow's milk and from different treatment combinations of milk extenders[1]

TREATMENT	TOTAL SOLIDS (%)	TOTAL PROTEIN (%)	CRUDE FAT (%)	ACIDITY (% l.a.)	CLOTTING TIME (min)
A	12.73^{c}	3.48	3.21^{e}	0.21^{e}	49
B	16.18^{b}	4.32	3.95^{c}	0.30^{a}	41
C	15.36^{b}	3.94	3.66^{d}	0.26^{c}	54
D	17.93^{a}	3.94	5.42^{b}	0.25^{d}	55
E	17.35^{a}	3.91	6.04^{a}	0.25^{d}	34
F	15.98^{b}	4.35	3.82^{cd}	0.29^{b}	47
G	17.37^{a}	4.01	6.00^{a}	0.29^{b}	38
LSD .05	0.9666	NS	0.1738	0.0079	NS

1 Values are the average from duplicate analysis of 2 batches of cheesemilk preparations.

Means in the same column with different letter superscripts are significantly different in LSD Test (alpha = .05, 7)

NS = means are not significantly different.

As reconstituted skimmilk was used as milk base, the amount of solids was adjusted near the total solids in cow's milk. Part of the milk in the given amount (2.0 kg) was then replaced by different percentages of coconut cream (CCM) and soybean milk (SBM) as milk extenders and treated with two levels of mixed starter cultures (MSC). The treatments having high level (30% w/w) of CCM were D, E and G and those with low level (20% w/w) of CCM were B, C and F. The high level (20% w/w) of SBM was represented by treatments C and E while low level (10% w/w) was in treatments B, D, F and G. The MSC at high level (3% w/v) was in treatments F and G while tretments B, C, D and E contained low level (1% w/v) of MSC. Treatment A was prepared from pure cow's milk as control.

It could be observed that total solids of treatments B, C, D, E, F and G (ranging from 15.56 to 17.93%) approaches that of buffalo's milk (19.10%). In particular, treatments D, E and G had higher total solids which could be explained by added CCM at high level containing 26.55% total solids (see Appendix V). The same treatments were observed to have higher fat content contributed mainly by the coconut cream (24.70% fat). The fat content of experimental treatments was higher than the control treatment (A). The acidity values were observed higher than the control as MSC were added in all experimental treatments to mask beany flavour.

3.9.3 Soft Cheese Composition

Table 3.4 listed the gross composition, pH and firmness of control and experimental treatments of fresh soft cheeses. Moisture content, protein, fat and pH of soft cheeses were significantly different ($P > .05$). There was no significant difference in salt content among treatments.

Soft cheeses from mixtures containing CCM and SBM were weak in texture. At the time of cutting, the coagulum containing CCM and SBM with MSC was more fragile than that made from control milk. Mean coagulation time took from 34 to 55 minutes. However, the same was observed for control milk using the commercially available pasteurised-homogenised bottled milk.

Firmness of curd was represented as distance of penetration measured by a penetrometer. The greater the penetration distance, the less firm was the curd. Curds containing CCM and SBM with MSC were less firm than milk curd. Among the experimental treatments, only B and D gave a firm curd but still less firm than the control.

The highest moisture content (73.04%) was found in experimental treatment C having high level of SBM (20%) and low level of CCM (20%) while the lowest moisture content (64.39%) was observed in experimental treatment D containing high level of CCM (30%) and low level of SBM (10%). The incorporation of soy proteins into the rennet curd seemed to increase water-holding capacity and decrease firmness. This finding was in agreement with

Table 3.4: Gross composition, pH and firmness of fresh soft cheeses made from pure cow's milk and from different treatment combinations of milk extenders[1,2]

TREATMENT	MOISTURE (%)	PROTEIN (%)	FAT (%)	SALT (% NaCl)	pH	FIRMNESS (mm)
A	68.38^{b}	9.62^{d}	12.94^{b}	1.57	6.72^{a}	115
B	65.76^{c}	12.76^{a}	13.82^{a}	1.64	5.54^{c}	151
C	73.04^{a}	8.50^{e}	10.60^{d}	1.73	5.45^{d}	>400
D	64.39^{d}	9.63^{d}	14.06^{a}	1.64	5.92^{b}	279
E	66.15^{c}	8.71^{e}	10.78^{d}	1.74	5.84^{c}	>400
F	68.28^{b}	11.45^{b}	11.90^{c}	1.66	5.20^{e}	>400
G	65.32^{c}	10.28^{c}	11.71^{c}	1.59	5.54^{c}	>400
LSD .05	1.1935	0.5156	0.4405	NS	0.0540	-

1 Values are the average from duplicate analysis of 2 batches of soft cheesemaking.

2 Means in the same column with different letter superscripts are significantly different in LSD test (alpha = .05, 7)

NS = means are not significantly different

Jonas (1975) and Lee and Marshall (1979) on adding soy proteins alone in milk. The higher moisture content of curds with high level of SBM apparently resulted from the higher water-holding capacity of soy proteins (Lee and Marshall, 1979).

Fat in cheese exists as physically distinct globules dispersed in the aqueous protein matrix (Fox, 1987). In general, increasing the fat content results in a slightly softer curd since the protein framework is weakened as the volume fraction of protein molecules decreases. However, this is not the case in this experiment conducted. Although the fat content in cheesemilks was higher in general but the amount was not efficiently incorporated into the curds as shown by the remarkable difference in fat content of the wheys (Table 3.6). Therefore some other factors might be responsible. The starter added affects the pH of the curd. Consequently, a lower pH may somewhat affect cheese texture with the consistency becoming slightly softer (Abd El-Salam, 1987). Moreover, acidity developed brings the pH of the cheese close to the isoelectric point and partially solubilises the colloidal calcium which leads to shrinkage of the cheese matrix through exudation of cheese serum. Also, addition of NaCl to milk decreases the rate of particle aggregation during renneting and decreases the stability of structural elements of the coagulum, hence contributes to the high protein and fat losses in whey (Abd El-Salem, 1987).

3.9.4 Soft Cheese Yield and Percentages Recovery of Constituents

Table 3.5 summarises the mean percentages of yield, total solids, protein and fat recovered in soft cheeses from cow's milk and experimental treatment.

The percentage of yield was calculated by dividing the grams of fresh cheese obtained by the initial volume of the mixture of milk. The yield of all treatments did not differ signifi - cantly. The yield was expected to be higher in treatments with high total solids in cheesemilk on the assumption that losses had been equal. However, this was not observed here in this experiment. There were significant ($P > .05$) losses of protein and fat in wheys (Table 3.6). The presence of high level of SBM disturbed the microstructure, thus contributed to high protein and fat losses. On the other hand, it increases the water-holding capacity, hence contributes to the increased yield. Therefore, the losses of other constituents were compensated by the increased moisture content.

There was no significant differences in the percentages of protein recovered. Since SBM and CCM were in the mixtures at approximately the same concentration as milk protein in the control (Table 3.3) they should have been incorporated in the curd in at least the same percentage as casein. The slightly higher quantity of protein in curd for some experimental

Table 3.5: Mean percentages of yield, total solids, protein and fat recovered in soft cheeses from cow's milk and experimental treatments[1]

TREATMENT	WEIGHT OF MILK (g)	WEIGHT OF CHEESE (g)	YIELD[2] (%)	TOTAL SOLIDS[3] RECOVERED (%)	PROTEIN[4] RECOVERED (%)	FAT[5] RECOVERED (%)
A	2,040	456.0	22.35	55.52^{a}	61.78	90.11^{a}
B	2,060	485.4	23.56	49.87^{c}	69.32	82.41^{ab}
C	2,060	516.3	25.06	44.00^{e}	54.12	72.60^{cd}
D	2,060	559.7	27.17	53.96^{a}	66.47	70.46^{d}
E	2,060	500.0	24.27	47.38^{d}	54.12	43.35^{f}
F	2,100	546.2	26.01	51.64^{bc}	68.38	81.05^{bc}
G	2,100	557.6	26.55	53.02^{b}	68.05	51.83^{e}
LSD.05	-	-	NS	2.2374	NS	8.4302

1 Means in the same column with different letter superscripts are significantly different in LSD (alpha = .05, 7).

2 Gram of cheese per gram of milk x 100.

3 Gram of total solids in cheese per gram of total solids in milk x 100.

4 Gram of protein in cheese per gram of protein in milk x 100.

5 Gram of fat in cheese per gram of fat in milk x 100.

treatments could be attributed to milk proteins displaced by SBM and CCM proteins being composed of approximately 20% whey proteins which were not precipitable. This finding was in agreement with Lee and Marshall (1979).

The greater loss of fat from curd containing SBM and CCM can be interpreted as the result of interruption of casein curd by soy proteins present in the mixture.

3.9.5 Whey Composition

Table 3.6 presents the total solids, protein, fat and their losses and acidity values in whey. Analysis of whey revealed that there were significantly ($P < .05$) higher losses of protein and fat in the experimental treatments.

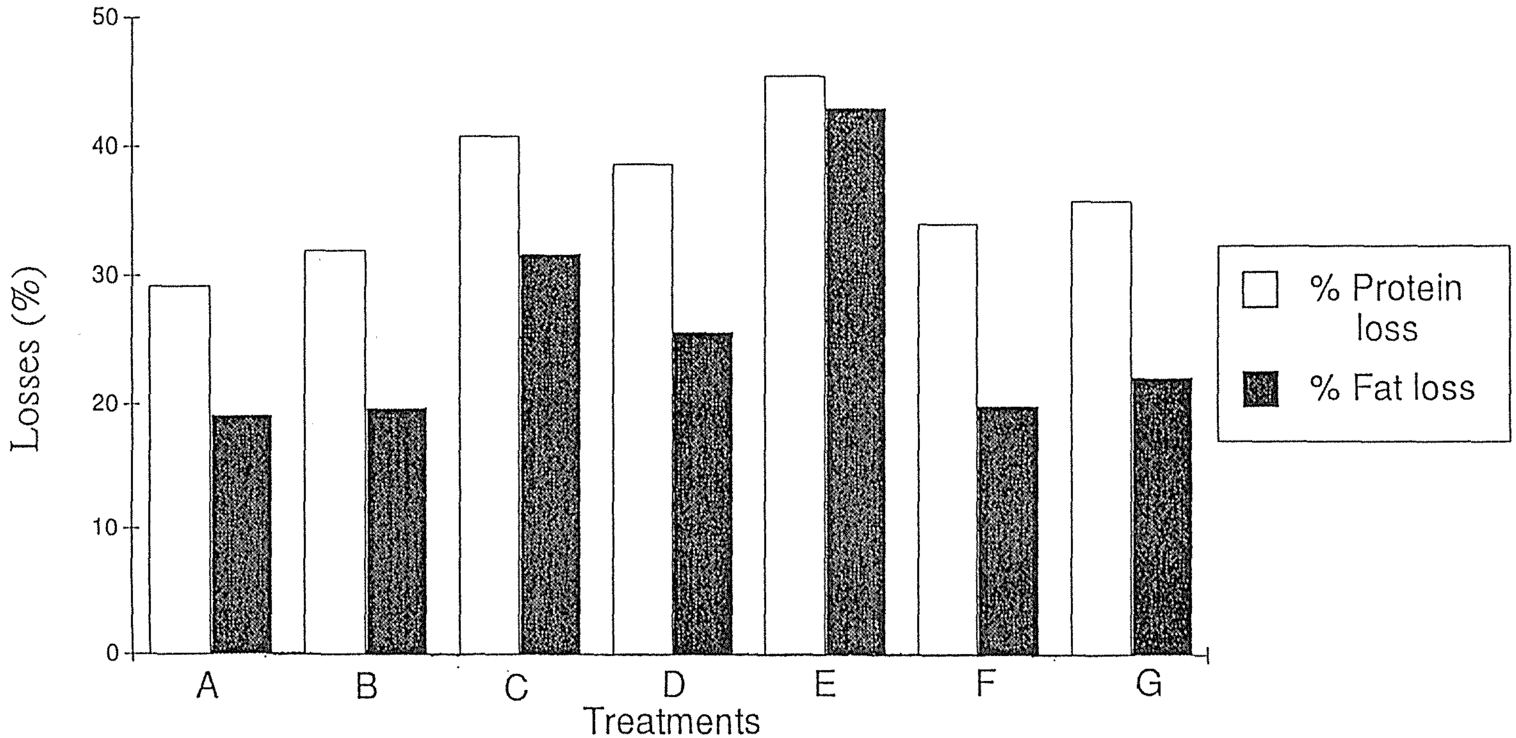
Figure 3.3 shows the effect of treatments on the protein and fat losses in whey. It could be observed that treatments E and C having high level of SBM gave the highest protein and fat losses. Consequently, treatments E and C had the lowest protein and fat recovered in the curd. As reported by Lee and Marshall (1979), soy proteins increased fat losses as a result of a casein curd interruption by the soy proteins and more fat globules were lost during stirring and cooking. Curds containing soy proteins have less matting ability during stirring and cooking, thus casein curds easily break into particles due to loosened microstructures. The percentages of fat and protein losses in the whey were estimated from the

Table 3.6: Total solids, protein and fat and their losses and acidity values of whey[1,2]

TREATMENT	TOTALSOLIDS (%)	PROTEIN (%)	PROTEIN % Losses	FAT (%)	FAT % losses	ACIDITY
A	8.28^{d}	1.02^{e}	29.38^{e}	0.63^{e}	19.36^{d}	0.13^{c}
B	10.50^{c}	1.39^{d}	32.19^{d}	0.79^{d}	19.89^{d}	0.19^{b}
C	10.54^{c}	1.62^{b}	41.00^{b}	1.17^{c}	31.92^{b}	0.19^{b}
D	11.57^{b}	1.53^{bc}	38.87^{b}	1.40^{b}	25.83^{c}	0.19^{b}
E	12.51^{a}	1.79^{a}	45.71^{a}	2.61^{a}	43.21^{a}	0.19^{b}
F	10.44^{c}	1.49^{c}	34.25^{cd}	0.77^{d}	20.13^{d}	0.21^{a}
G	11.22^{bc}	1.45^{cd}	36.10^{c}	1.35^{b}	22.42^{cd}	0.19^{b}
$LSD_{.05}$	0.8127	0.0930	2.1988	0.1469	3.6620	0.0117

1 Values are the average from duplicate analysis of 2 batches of soft cheesemaking.

2 Means in the same column with different letter superscripts are significantly different in LSD Test (alpha = .05, 7)



(A = cow's milk; CE = high SBM; BDFG = low SBM; DEG = high CCM; BCF = low CCM; FG = high MSC; BCDE = low MSC)

Figure 3.3. The protein and fat losses in whey as affected by different treatment combinations of milk extenders

analysis of the whey while the percentage recovery reported in Section 3.9.4 was calculated from the analysis of the cheese. The losses do not correlate directly with the reported recovery in Table 3.5 but the general trends are the same.

Similarly, treatments B, D, F and G still contain SBM although at low level of addition, hence its presence likewise affects the microstructures which contributes to the protein and fat losses but at lesser degree. In addition, CCM which is the main source of fat creams quite rapidly and forms a layer after being left undisturbed for less than 10 minutes as observed by Davide *et al.* (1987). Presumably, the fat in CCM is not incorporated into the cheese. This occurs despite the coconut cream used being homogenised.

3.9.6 Sensory Qualities of Soft Cheeses

Table 3.7 presents the mean scores of the sensory qualities of fresh soft cheese samples. A two-way analysis of variance (ANOVA) was employed to determine significant differences among treatments (see Appendices IX A and B). Linear correlation analysis was performed to measure the degree of association between two variables based on the amount of variability in one character that can be explained by a linear function of the other. The simple linear correlation coefficients (r) are given in Appendix IX-C. The statistical significance of the correlation coefficients was determined with df = n-2 = 5 (Gomez and Gomez, 1976). It should be noted that a high

Table 3.7 Mean scores of the sensory qualities of fresh soft cheese samples.

	TREATMENTS							
ATTRIBUTES	A	B	C	D	E	F	G	$LSD_{.05}$
FLAVOUR								
Creaminess	5.55	4.42	4.30	5.18	4.35	4.94	5.20	NS
Saltiness	4.02^{d}	4.51^{cd}	4.89^{bcd}	5.24^{abc}	5.68^{ab}	5.02^{abc}	5.93^{a}	0.9772
Beany	1.23^{c}	2.72^{ab}	3.84^{a}	3.67^{ab}	3.24^{ab}	2.48^{b}	3.25^{ab}	1.2281
Rancid	0.76^{b}	0.79^{b}	2.67^{a}	2.22^{a}	2.15^{a}	2.14^{a}	2.74^{a}	1.0521
Acid	1.60^{d}	3.38^{c}	3.91^{abc}	3.47^{bc}	4.27^{abc}	4.60^{ab}	4.94^{a}	1.1628
TEXTURE								
Firmness	6.83^{a}	5.46^{b}	1.39^{e}	5.26^{b}	1.82^{de}	3.07^{c}	2.53^{cd}	0.9430
Smoothness	5.32^{b}	4.98^{b}	7.33^{a}	5.42^{b}	7.51^{a}	5.70^{b}	6.44^{ab}	1.5367
COLOUR	6.72^{a}	4.73^{b}	3.48^{c}	3.35^{c}	3.98^{bc}	4.30^{bc}	4.10^{bc}	1.0061
AFTERTASTE	1.91^{b}	2.86^{ab}	3.36^{a}	3.44^{a}	3.71^{a}	3.39^{a}	3.99^{a}	1.3505
OVERALL ACCEPTABILITY	7.23^{a}	5.59^{b}	3.12^{c}	6.06^{ab}	2.77^{c}	3.56^{c}	3.12^{c}	1.1878

Means in the same row with different letter superscripts are significantly different in LSD Test (alpha = .05, 78)

NS = means are not significantly different correlation coefficient does not necessarily mean that there is a cause and effect relationship between the two parameters; it only means that some statistical correlations exist. Since the value of r ranges from -1 to +1, the extreme values indicate perfect association which means that all the variability in one character can be accounted for by a linear function of the other. The value of r is negative when a positive change in one character is associated with a negative change in the other and positive when the two variables change in the same direction. An r-value of zero indicates the absence of a linear relationship between the two variables which can mean that there is no association whatsoever between the two variables or they are associated but not in a linear form.

Among the different parameters or attributes measured, the texture firmness and acid flavour gave highly significant correlation coefficients with overall acceptability (OA). A significant ($P \leq .05$) correlation coefficient of $r = 0.977$ ($r^2 = 0.954$) between firmness and overall acceptability was obtained. This means that 95.4% of the variation in values of Y (overall acceptability) can be explained in terms of values of X (firmness), and that 1-0.954, or 4.6% of the variations in Y is not associated with X, but with other factors or with error. In the same manner, the correlation coefficient between acid flavour and overall acceptability was $r = 0.879$ ($r^2 = 0.773$). However, a statistically significant correlation may not necessarily be adequate for accurate prediction of results because it does not provide reasons for such an association (Gomez and Gomez, 1976).

Overall acceptability, generally a criterion for judging treatment performance is a product of several attributes, each of which is, in turn, affected by the treatments applied. Therefore, the effects of treatments on these attributes are finally reflected in the overall acceptability.

With regression analysis, the combined effects of flavour attributes, (creaminess, saltiness, beany and rancid) and texture attributes (firmness and smoothness) to overall acceptability were determined. The flavour attributes gave a significant ($P \geq .05$) R-squared value of 98.48% and the texture attributes with significant ($P = \leq .05$) R-squared value of 96.82%. The fitted equations are shown in Appendix VIII-D. Considering each individual parameters, the change in overall acceptability is very much affected by firmness and acid flavour. Using the equations (Appendix IX-D) the predicted values were computed and compared against observed values (Figures 3.4 and 3.5). With significant regression coeffi - cients obtained between these parameters and overall accepta - bility, firmness and acid flavour appeared to be important indices of sensory quality in soft cheeses. Other parameters were not discussed individually anymore as they gave insignif - icant correlation coefficients if not very low. However, further observations showed that smoothness is significantly correlated also to overall acceptability and firmness. As

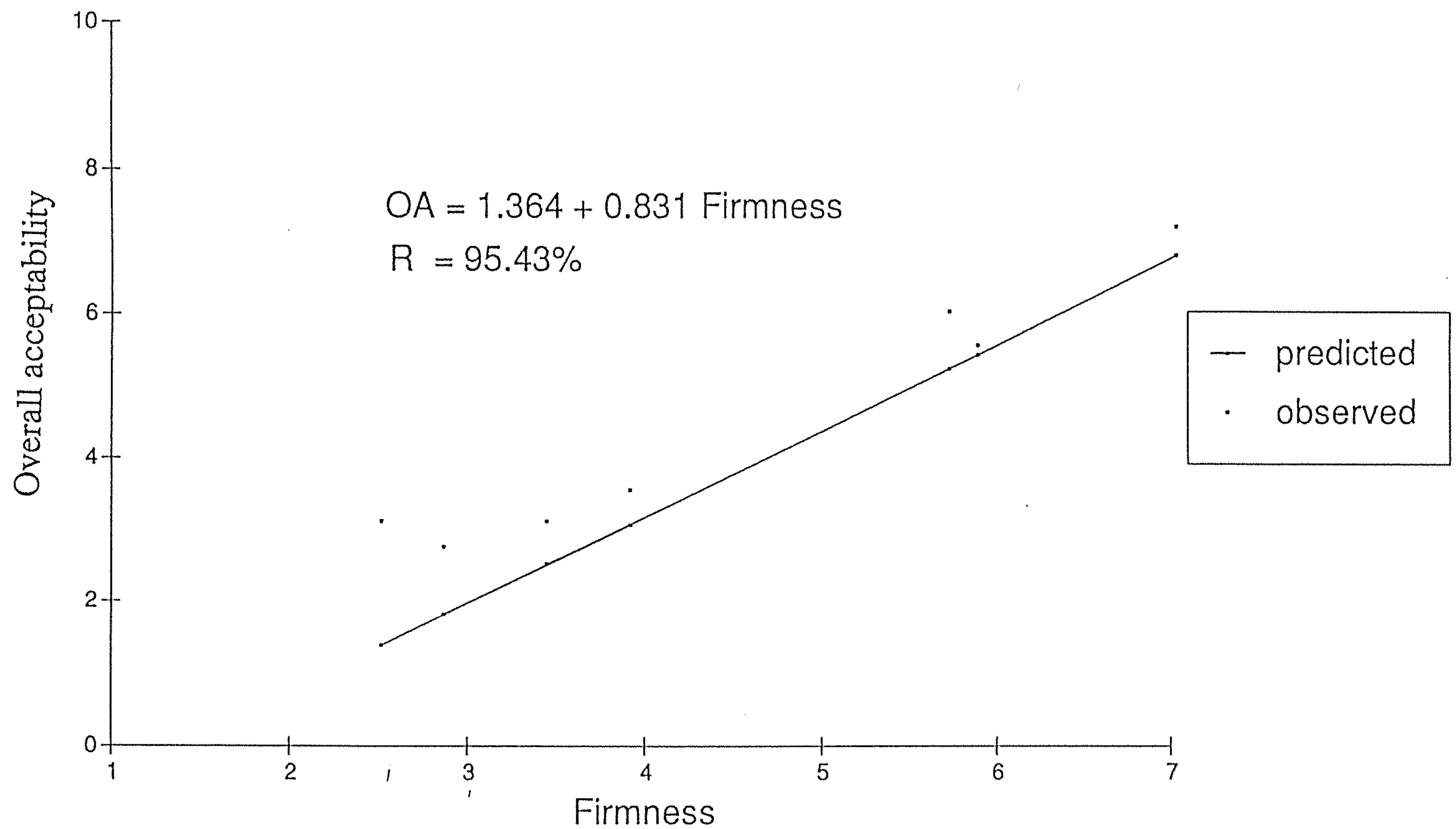


Figure 3.4. The relationship between firmness and overall acceptability of soft cheese samples

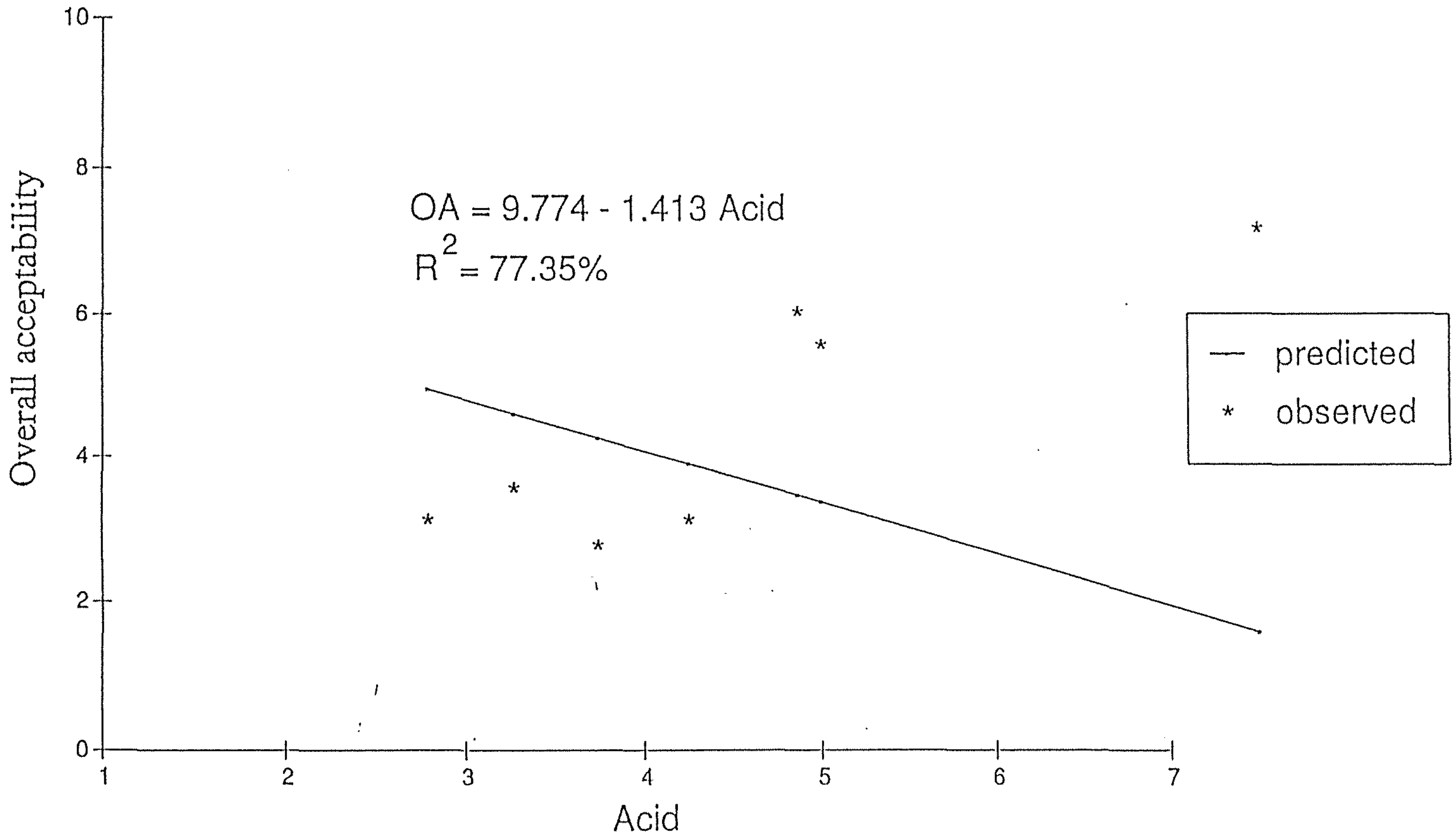


Figure 3.5. The relationship between acid flavour and overall acceptability of soft cheese samples

smoothness increases the firmness of cheeses decreases, thus becoming soft.

Moreover, aftertaste gave a significant ($P \leq .05$) correlation with saltiness, beany, rancid and acid flavours. The panelists, despite the training given, still considered beany as off-flavour and sometimes associated rancid taste with coconut flavour. By accepting the beany taste as part of the natural flavour of the new product and freshly prepared coconut cream is used, most likely the overall acceptability of the soft cheese would increase.

The colour of experimental cheeses was often described as greyish which agreed with the observation of Lee and Marshall (1979) on curd containing soy protein having a greyish tint rather than the creamy colour of milk curd.

In general, considering all the parameters examined, the treatment that showed potential for further evaluation and development was B although treatment D closely compete in rank except that rancid taste was significantly higher and colour was graded inferior than treatment B.

3.9.7 Effect of SBM and CCM Levels on Sensory Attributes and Yield

As mentioned earlier, the treatment combinations with three factors involved at two levels each were formed using factorial design (Appendix I). However, the two treatments both with high levels of SBM and MSC failed in actual experiments. Thus, statistical analysis was modified to fit the data gathered.

Figure 3.6 shows the effect of treatment combinations on creaminess, firmness, overall acceptability and yield of soft cheeses. At increasing level of SBM and decreasing level of CCM (Fig. 3.6 a), a decrease in creaminess was observed. This could be due to the decreased amount of CCM which is the main source of fat in the formulation. However, the changes were not found significant.

The firmness has the same decreasing trend (Fig. 3.6 b) even at constant CCM and so with overall acceptability (Fig. 3.6 c). As has been discussed earlier, SBM decreased firmness and in effect lowers also the overall acceptability tremendously. On the other hand, at constant levels of SBM and increasing levels of CCM, the yield was observed to increase (Fig. 3.6 d) although the changes were not statistically significant.

Further analysis showed that interaction between SBM and CCM is not significant in terms of other parameters observed e.g.

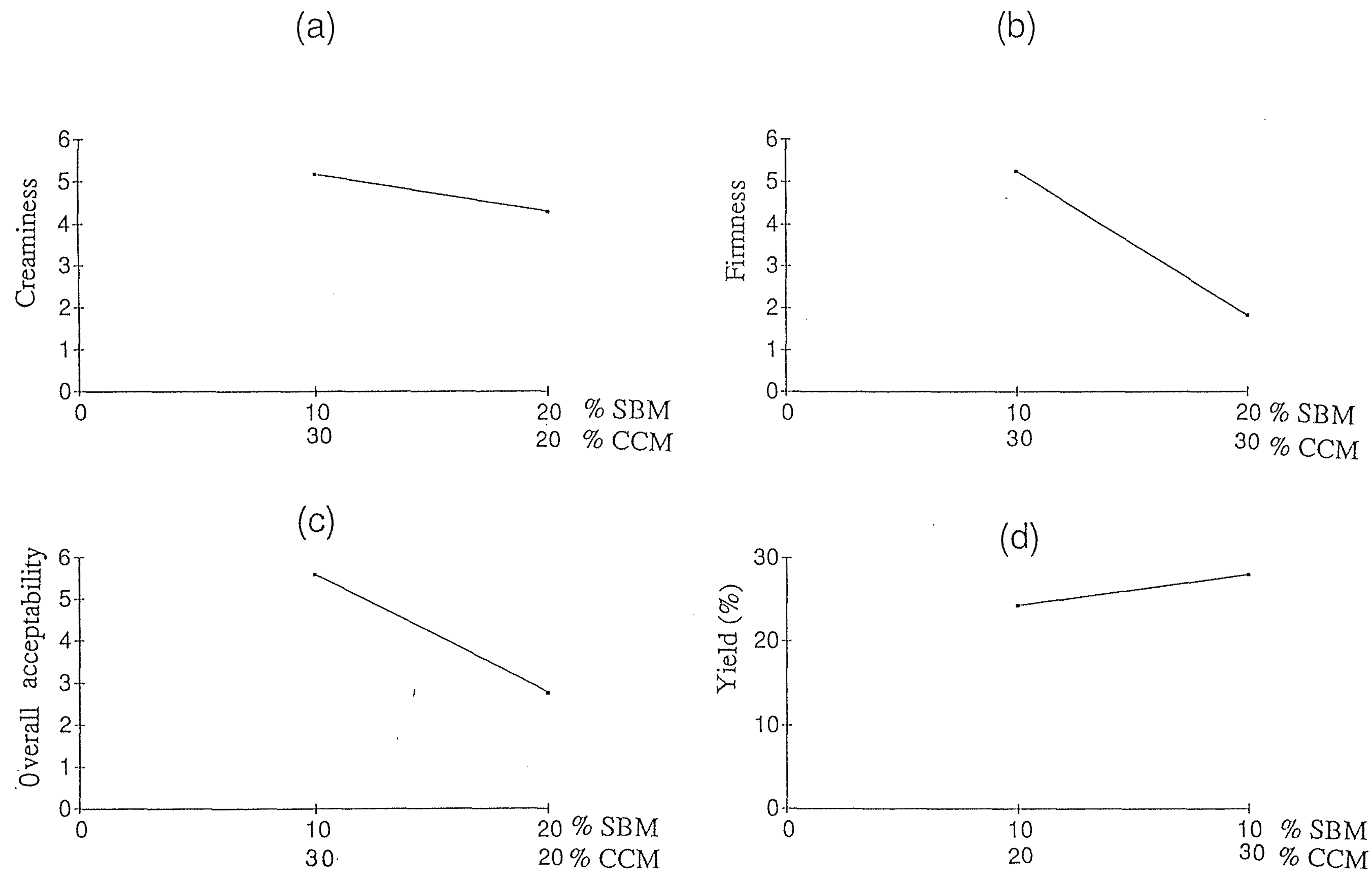


Figure 3.6. The effect of treatment combinations on (a) creaminess (b) firmness (c) overall acceptability and (d) yield of soft cheeses

beany, rancid, colour, protein and fat. The relative performance of soft cheeses with 20% and 30% CCM is not influenced by different levels of SBM. In other words, the influence of these two factors are considered as single effects.

For instance, the rancid score increased tremendously (Table 3.7) in samples with 10% SBM at 30% CCM (from 0.79 to 2.22). However, the rancid score which was high at 20% CCM (2.67) decreases (2.15) at 30% CCM with addition of 20% SBM. As rancid taste is often associated with coconut flavour, hence dilution with 20% SBM lowers the intensity of the previously detected rancid taste at low concentration of CCM. It does not show however, that rancid taste would decrease or increase in the absence of other factor. Probably, other constituents also that were already present in the product are contributing to the rancid taste detected.

3.10 CONCLUSION

This study showed that replacing part of the reconstituted skimmilk with SBM and CCM increased the total solids of mixtures however, it did not have any significant effect on the yield of cheese and protein recovery. The presence of soybean protein loosened the microstructure of casein which resulted in high fat and protein losses, increased water-holding capacity and decreased firmness. Coconut cream provides mainly the source of fat for the mixtures but the higher level despite its being homogenised is not efficiently incorporated into the curd. Soft cheeses from mixtures containing SBM and CCM were weak in texture as compared with the control. Addition of MSC lowers the pH, thus contributes to less firm curd. Despite these factors affecting the quality of soft cheeses produced, the treatments having low levels of SBM, CCM and MSC had the potential for further evaluation and development, having had satisfactory sensory results.

CHAPTER 4

EVALUATION OF SELECTED POTENTIAL PRODUCT FORMULATION

4.1 INTRODUCTION

The product formulation selected for further evaluation on the basis of product quality, stability and production costs analysis was that having low levels of soybean milk, coconut cream and starter cultures for acid development. The product was manufactured with reconstituted skimmilk as milk base. It was anticipated that the soft cheese which is unripened and consumed as fresh would be purchased by the consumers in the processing area as a breakfast or snack bread filling (sandwiches) and lunch food for children and adults.

The basic product formulations were firstly established from a review of the literature and applying the established process for unripened soft cheese manufacture in the Philippines. This experiment did not involve the series of complicated stages possible for product development (Gordon, 1986) but rather simply aimed to develop a product which could supplement the less available nutritional and health foods by utilising indigenous raw materials. The main objective of this experiment is to evaluate the quality, acceptability and stability of the result of potential product formulation in comparison with those products developed using the milk extenders singly as reported in the literature.

4.2 EXPERIMENTAL

A control sample using cow's milk and the potential formulation were prepared in parallel experiments of 4 kg each. The first batch of soft cheese manufactured was without starter culture and the second batch of cheese manufactured had an added 1% starter culture on experimental treatments. The control sample used throughout the experiment did not have any starter cultures for the purpose of simulating the soft cheese from cow's milk commercially available in the Philippine market. Also, soft cheeses were made using only one extender at a time with the reconstituted skimmilk as milk base and compared with the potential formulation using two extenders and with the control in terms of composition, sensory qualities and storage stability.

4.3 PREPARATION AND SOURCES OF RAW MATERIALS

The same as used and described in Chapter 3 with the addition of commercial cheese colour obtained from the Dairy Research Institute, Palmerston North. A new batch of soybean milk was prepared.

4.4 CHEESEMILK PREPARATION

The procedures followed were the same as described in Chapter 3. The proposed formulations and raw materials are given below:

RAW MATERIALS	CHEESEMILK COMPOSITION (%)			
	A	B	C	D
Cow's milk	100	-	-	-
Skimmilk (14% reconstitution)	-	70	70	80
Soybean milk	-	10	-	20
Coconut cream	-	20	30	-
Starter culture	-	0-1	0-1	0-1
Salt	2	2	2	2
Rennet	0.35	0.35	0.35	0.35
Cheese colour	-	0.006	0.006	0.006

4.5 CHEESE MANUFACTURE

Using the modified equipment and other utensils, the cheese-milks were heated and manufactured into soft cheeses by following the methods described in Chapter 3. Two sets of cheesemaking were done, with and without mixed starter cultures. The same lactic starter cultures as in the previous experiment were used in the set requiring the addition. The colour of the experimental cheeses was adjusted using the commercial cheese colour and the amount of rennet used was increased.

4.6 SENSORY EVALUATION

The same selected trained panelists were used in the evaluation of the cheese samples. Sensory evaluation of the products took place in the same room under the same controlled conditions as in the previous experiment. In the first few sessions of the sensory testing, the members of the panel were asked to mark a point along the scale (1-10 cm) of each attribute according to his/her own perception to serve as ideal point. Assuming that these ideal points were obtained from a consumer panel, the mean ideal value for each sensory attribute was calculated (Appendix X). After the preliminary sessions of the sensory evaluation the mean ideal values were used correspondingly as fixed ideal points for all attributes. In the final sensory profile the ideal points were marked on the scale for all the attributes evaluated. The panelists were asked to rate the samples with reference to the ideal point. The ratios were tabulated and analysed statistically using a two-way analysis of variance (ANOVA) for significant differences and Tukey's Test (LSD) was performed for significant results.

A sample of the score sheet is shown in Appendix XI.

4.7 STORAGE STABILITY TEST

Although the shelf life of the product was expected to be short as it has a high moisture content, trials to determine storage stability were conducted to have concrete results. Small blocks of soft cheese samples wrapped individually in polyethylene plastic sheets were grouped and placed in square plastic containers. Twelve sets of 4 treatments each per group of cheesemaking (with and without mixed starter cultures) were prepared and half of the sets were stored in cold storage with temperature setting of 5°C. The other half was stored in the refrigerator where temperature setting was adjusted to 10°C. Separate samples were drawn at 0 day (after overnight draining) and every five days thereafter for microbiological/physico-chemical analyses and sensory evaluation until signs of spoilage were observed. Care had been taken in the preparation of the samples and during storage to avoid unnecessary contamination.

4.8 METHODS OF ANALYSIS

4.8.1 Chemical Analysis

The methods used for the analysis of cheesemilks, wheys and cheese samples were the same as mentioned in Chapter 3.

4.8.2 Microbiological Analysis

This analysis was done on cheese samples only. Counts for total bacteria, coliforms, yeasts and moulds were determined using the standard methods of the American Public Health Association (1972). A 1:10 homogenate prepared by digesting for 2 minutes in a Colworth Stomacher the 10 grams sample in 90 ml Ringer's solution, was used to commence the analysis for all organisms under test. For total bacterial counts, dilutions of 10^{-1}, 10^{-2}, 10^{-3} and 10^{-4} were plated; for coliform counts, dilutions of 10^{-1}, 10^{-2} and 10^{-3} were plated and for yeasts and moulds, 10 ml homogenate divided approximately into 3.3 ml was pipetted into each of three petri dishes.

4.9 RESULTS AND DISCUSSION

4.9.1 Gross Composition of Control and Experimental Samples

The results of the compositional analyses are summarised in Table 4.1. The experimental samples (B, C and D) were prepared without (NSC) and with 1% addition of starter cultures (WMSC) while the control sample (A) was used throughout the experiment without starter culture addition (NSC). Sample B was from the formulation resulted from the previous experiment (Chapter 3) having the potential for further evaluation and development. For more information, samples C and D were prepared using milk extenders individually containing coconut cream (CCM) and

Table 4.1: The gross composition of cheesemilk, soft cheese and whey samples with and without starter cultures added on experimental treatments.[1]

COMPOSITION	A	B		C		D	
	NSC	NSC	WMSC	NSC	WMSC	NSC	WMSC
CHEESEMILK							
Total Solids %	13.36	16.94	16.99	17.41	17.13	13.79	13.68
Total Protein %	3.39	4.63	4.64	4.86	4.38	5.03	5.02
Fat %	2.98	3.51	4.01	4.12	4.13	0.38	0.37
pH	6.55	6.50	6.50	6.50	6.50	6.45	6.50
CHEESE							
Moisture %	65.52	66.25	66.07	66.82	66.39	76.40	75.93
Total Protein %	10.70	12.12	9.18	12.59	11.38	13.80	11.13
Fat %	14.79	13.43	12.89	12.94	13.57	1.22	1.21
Salt %	1.49	1.55	1.59	1.64	1.47	1.74	1.66
pH	6.35	6.30	5.30	6.30	5.50	6.40	5.35
S/M	2.27	2.34	2.34	2.45	2.21	2.28	2.18
WHEY							
Total Solids %	8.59	10.99	11.04	11.05	11.22	10.32	10.74
Total Protein %	1.33	1.07	1.60	1.15	1.32	1.35	1.59
Fat %	0.09	0.35	0.17	0.54	0.69	0.37	0.48
pH	6.48	6.40	6.35	6.40	6.40	6.40	6.45

[1] Data were average from duplicate analyses of samples

[2] Legend: A = Soft cheese from cow's milk (control)
B = Experimental soft cheese (mixture of CCM and SBM added)
C = Coco cheese (only CCM was added)
D = Soya cheese (only SBM was added)
NSC = No starter cultures added
WMSC = With mixed starter cultures added at 1% level
S/M = Salt-in-moisture

soybean milk (SBM), respectively. All experimental samples used the reconstituted skimmilk as milk base with nearly similar total solids (14%) as in cow's milk.

Given the different proportions of each ingredient in the formulations (see Section 4.4), samples B and C gave higher total solids in cheesemilks than samples A and D which is attributed to the high fat content of coconut cream.

Sample D, prepared with SBM only has total solids approaching that of Sample A (cow's milk). It could be observed that by substituting parts of the amount of cheesemilk with milk extenders, the commercially available tinned CCM used (see Appendix V for composition) greatly increases the fat content but does not increase much the protein content. On the contrary, addition of SBM contributes to the protein content but not the fat content of cheesemilk as shown by its very low fat content in Sample D. The pH of the cheesemilks was not affected by either addition.

The moisture content of the prototype cheese (B) was 66.25% and 66.07% in without and with 1% MSC, respectively, which is quite higher than the reference soft cheese (65.52%). On the other hand, its moisture content was slightly lower than the sample with added CCM alone (C) (66.82% and 66.39% in NSC and WMSC, respectively) and very much lower than the sample with added SBM alone (D) which has retained relatively high moisture (76.40% and 75.93% in NSC and WMSC, respectively). It is apparent from this observation that addition of SBM increases the capacity to hold moisture. Findings by Davide *et al.* (1983) stated that the capacity of the fat-modified fresh soft cheese to retain moisture is somewhat directly influenced by its fat content. Thus, freshly made non-fat skimmilk cheese or those with the higher protein retained the most moisture. A high fat or a high moisture content weakens the alpha-s framework of the cheese structure since the protein molecules must of necessity be further apart (Lawrence *et al.*, 1983).

Higher total protein value (12.12%) was obtained for cheese B (NSC) than that for control cheese (10.70%) but lower than those for cheeses C (12.59% in NSC) and D (13.80% in NSC). The protein content of those WMSC treatments was observed to be lower than those NSC treatment within their respective sample formulation. It seems that the developed acidity as reflected by their low pH values on those WMSC treatments being not inhibited by salting the cheesemilk, has affected the curd matrix which leads to curd shrinkage and exudes those salt-soluble proteins with cheese serum, thus alter the gross composition i.e. lowering the protein content (Abd El-Salam, 1987). The salt content did not vary so much in both treatments and within samples but higher values were found in samples with high moisture content. This substantiates the findings of Gewaily (1968) as cited by Abd El-Salam (1987) on fresh Domiati cheese that high salt content in the cheese curds retains more moisture.

Analysis of whey from soft cheesemaking with milk extenders (experimental) and cow's milk (control) revealed that there were higher total protein and fat losses in all treatments undertaken. Apart from those reasons discussed (Chapter 3), Abd El-Salam (1987) reported that addition of NaCl to milk increases particle dispersion and solubilises some of the individual caseins, thus leads to a decrease in the rate of casein aggregation during rennet coagulation and a decrease in the stability of the structural elements of the coagulum. This, in turn, contributes to the high losses of proteins and fat in whey.

4.9.2 Sensory Characteristics of Soft Cheeses

Some modifications were incorporated into the cheesemilk of potential formulation (B) by adding cheese colour, increasing rennet concentrations and excluding starter culture addition. The sensory qualities of the prototype product together with the control and those cheeses with individual milk extender were evaluated with reference to the ideal points set by the same trained panelists for each attribute. The mean ratio scores of sensory qualities of fresh soft cheeses without starter culture addition are presented in Table 4.2a. Results of the evaluation gave a satisfactory score for the prototype product (B). The mean ratio scores of soft cheeses with 1% mixed starter culture added are presented in Table 4.2b.

Table 4.2a: Mean ratio scores of the sensory qualities of fresh soft cheeses without starter culture addition[1]

ATTRIBUTES	TREATMENTS[2] A	B	C	D
FLAVOUR				
Creaminess	0.958^{a}	0.956^{a}	0.841^{a}	0.550^{b}
Saltiness	0.973^{b}	1.156^{a}	0.921^{b}	0.958^{b}
Beany	0.797^{b}	1.089^{b}	0.981^{b}	1.539^{a}
Rancid	1.250^{b}	2.664^{a}	1.478^{b}	1.643^{b}
Acid	0.747^{a}	0.927^{a}	0.727^{a}	0.739^{a}
TEXTURE				
Firmness	1.059^{a}	0.891^{b}	1.016^{a}	0.921^{b}
Smoothness	0.915^{ab}	1.014^{a}	0.888^{b}	0.976^{ab}
COLOUR	1.019^{ab}	0.950^{ab}	0.909^{b}	1.095^{a}
AFTERTASTE	1.472^{b}	2.961^{a}	2.164^{b}	3.192^{a}
OVERALL ACCEPTABILITY	0.764^{a}	0.609^{b}	0.668^{b}	0.392^{c}

1 Mean ratio scores in the same row with different letter superscripts are significantly different in LSD test (alpha = .05, ,42)

2 A = Cow's milk soft cheese (control)
B = Experimental soft cheese
C = Coco cheese
D = Soya cheese

Table 4.2b: Mean ratio scores of the sensory qualities of fresh soft cheeses with 1% mixed starter

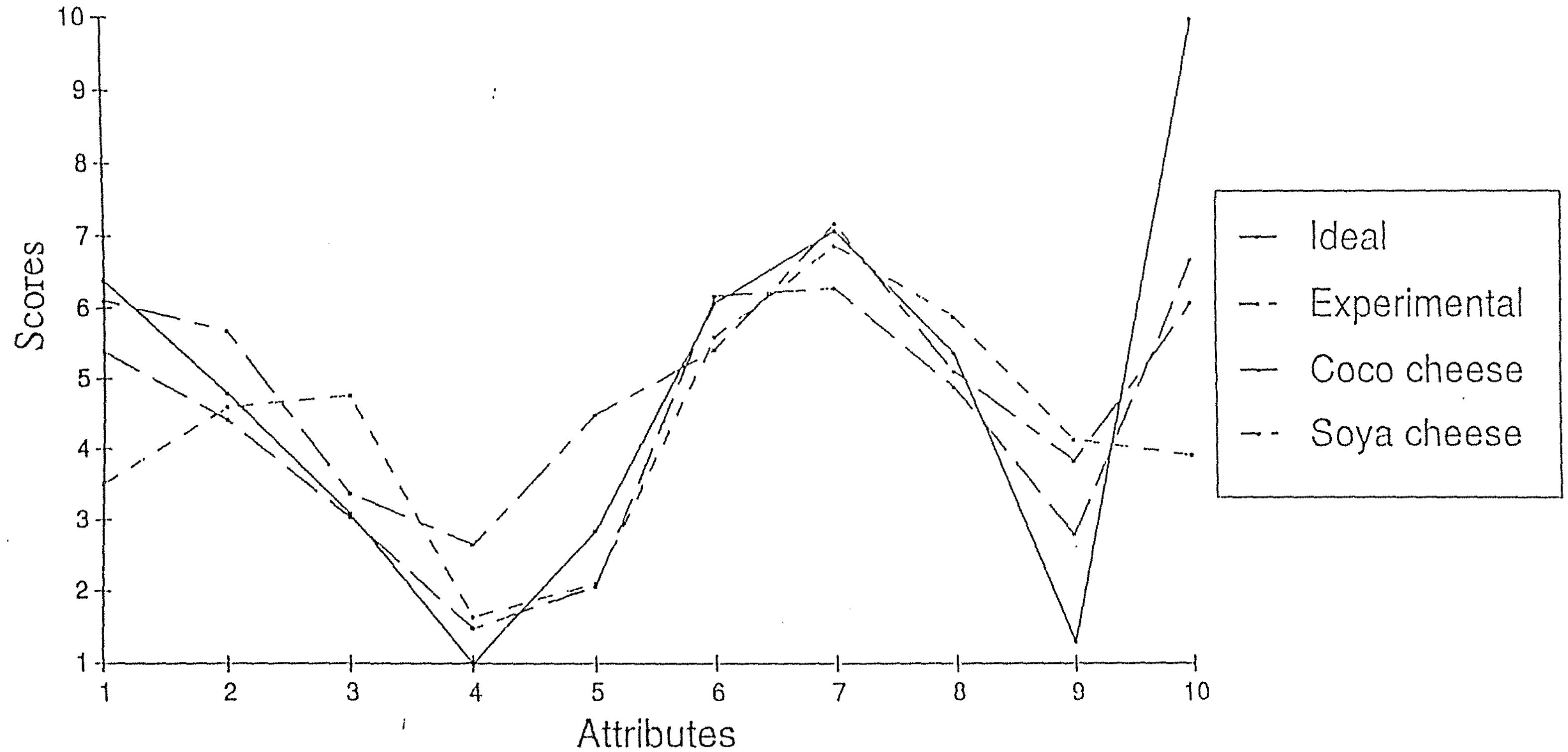
ATTRIBUTES	TREATMENTS[2]			
	A	B	C	D
FLAVOUR				
Creaminess	0.958^{a}	0.942^{a}	0.860^{a}	0.563^{b}
Saltiness	0.973^{b}	1.235^{a}	1.015^{b}	0.947^{b}
Beany	0.797^{b}	1.175^{ab}	0.917^{b}	1.504^{a}
Rancid	1.250^{b}	2.864^{a}	2.121^{ab}	1.664^{ab}
Acid	0.747^{b}	1.615^{a}	1.058^{b}	0.881^{b}
TEXTURE				
Firmness	1.059^{a}	0.679^{c}	0.990^{ab}	0.907^{b}
Smoothness	0.915^{b}	1.127^{a}	0.943^{b}	0.997^{b}
COLOUR	1.019^{ab}	0.917^{bc}	0.824^{c}	1.116^{a}
AFTERTASTE	1.472^{b}	3.225^{a}	2.434^{a}	2.742^{a}
OVERALL ACCEPTABILITY	0.764^{a}	0.529^{c}	0.665^{b}	0.432^{d}

1 Mean ratio scores in the same row with different letter superscripts are significantly different in LSD test (alpha = .05, 42)

2 A = Cow's milk soft cheese (no starter cultures added)
B = Experimental soft cheese
C = Coco cheese
D = Soya cheese

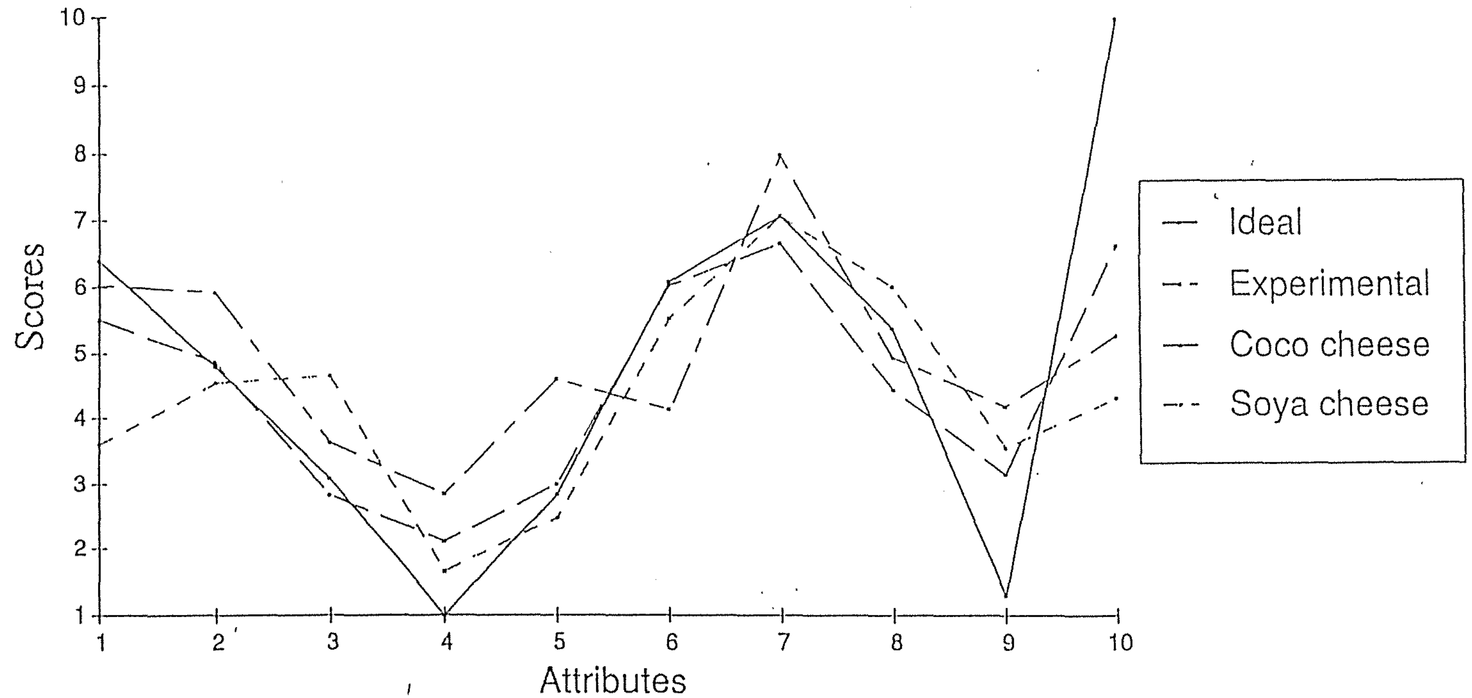
Overall evaluation showed that sensory qualities of fresh soft cheeses without starter culture addition improved satisfact - orily in comparison with soft cheeses having an added 1% mixed starter culture. Sample B without starter culture gave an acid flavour ratio score of 0.927 which is a little bit down than the ideal score whereas sample B with added mixed starter culture gave a ratio score much over than the ideal, hence giving the sample a too acidic taste. In effect, this taste keeps lingering into the tongue and palate which adds up to the aftertaste score. Probably a too acid taste and beany flavour do not give a compatible combination of flavour, hence downgrading the cheese. Also, firmness decreased with developed acidity. The overall acceptability mean ratio score of sample B without starter cultures was recorded as 0.609 while that of sample B with mixed starter culture was 0.529. On the other hand, sample C (with and without MSC) in some degree showed higher sensory qualities than sample B, however, overall acceptability in treatment without MSC did not give any significant difference. Sample D gave the lowest sensory evaluation scores which shows that the beany flavour is more objectionable than the coconut flavour in soft cheese. As expected the control sample still gets the highest score.

To illustrate the differences between given scores of the samples and ideal scores, Figures 4.1 and 4.2 show the relationships of each sensory attribute evaluated (see Appendix X for ideal values). It could be noted that sample C ranks closer to the ideal scores in terms of overall acceptability



(1) creaminess (2) saltiness (3) beany (4) rancid (5) acid (6) firmness (7) smoothness (8) colour (9) aftertaste (10) overall acceptability

Figure 4.1. The relationships of various sensory attributes of soft cheeses using milk extenders to the ideal sensory scores without starter culture addition



(1) creaminess (2) saltiness (3) beany (4) rancid (5) acid (6) firmness (7) smoothness (8) colour (9) aftertaste (10) overall acceptability

Figure 4.2. The relationships of various sensory attributes of soft cheeses using milk extenders to the ideal scores with starter culture addition

however, in some instances sample B (Figure 4.1) also gave nearly the same values as the ideal, for instance at points 1, 3, 6, 7 and 8 in the X-axis. The same ranking was observed in treatment with added MSC. Figure 4.3 shows the appearance of freshly manufactured control and experimental soft cheese samples.

4.9.3 Storage Stability of Soft Cheeses

4.9.3.1 Sensory evaluation

The mean ratio scores of the sensory evaluation of soft cheese samples with (WMSC) and without starter culture (NSC) addition stored at 5°C and 10°C are given in Tables 4.3a and 4.3b, respectively.

The overall acceptability of cheese samples B (WMSC) stored at 5°C gave an amazingly high ratio score of 0.933 at its initial storage time and recorded to be the highest among samples evaluated but decreased tremendously on the 5th day of storage at both temperatures. Probably at a certain point of acid development when combined with the beany and coconut flavour, it gives a very pleasing taste otherwise, just a little excess

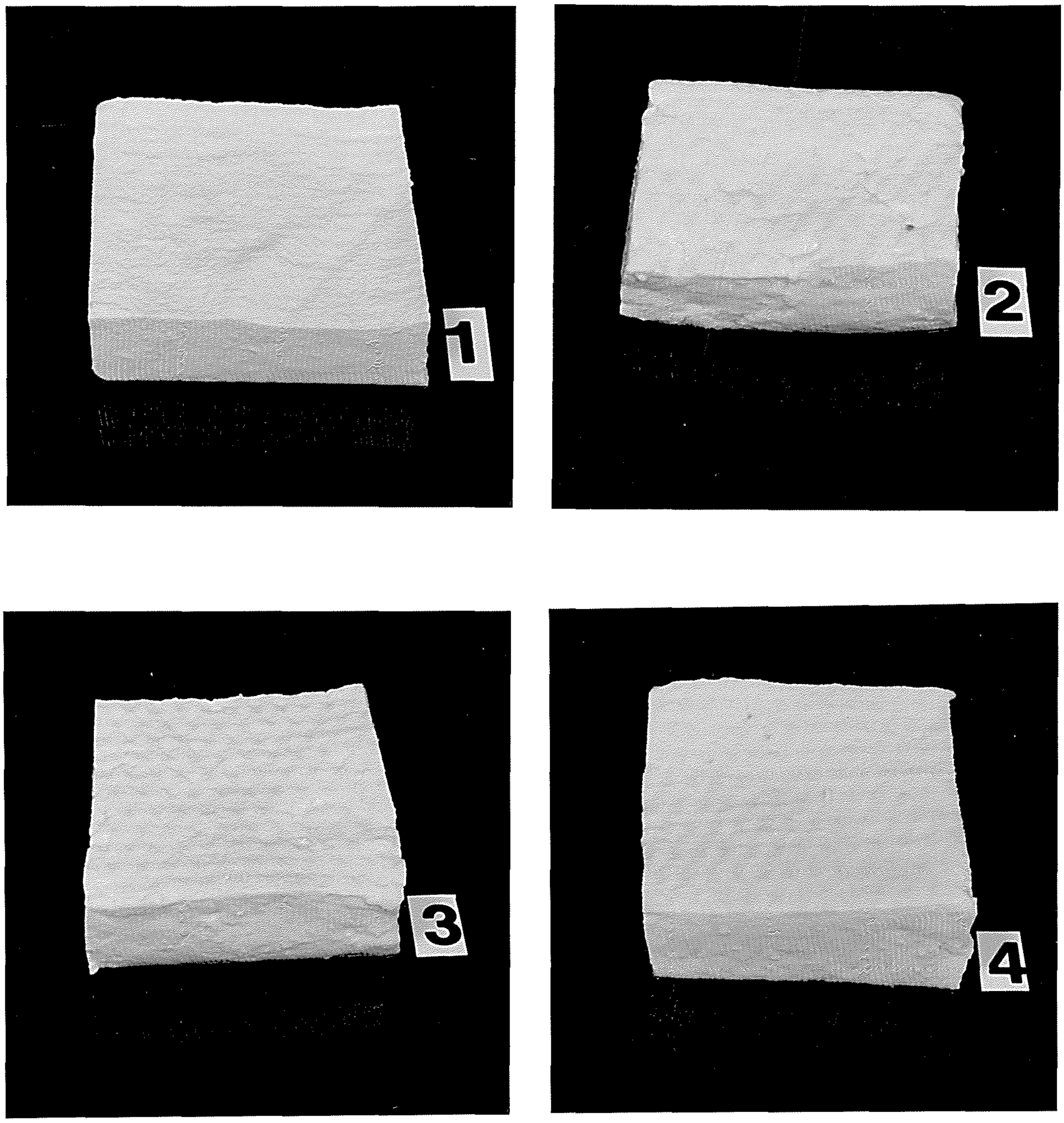


Figure 4.3. The control and experimental soft cheeses 1) pure cow's milk (control) 2) mixture of SBM and CCM in RSKM 3) CCM in RSKM 4) SBM in RSKM

Table 4.3a: Mean ratio scores of sensory qualities of soft cheese samples with and without starter culture addition on experimental treatments stored at 5°C[1]

SAMPLES	SENSORY QUALITIES[2]											
	ACID I=2.85		RANCID I=1.00		OFF-FLAVOUR I=1.00		COLOUR I=5.40		FIRMNESS I=6.10		OVERALL ACCEPTABILITY I=10.0	
	NSC	WMSC	NSC	WMSC	NSC	WMSC	NSC	WMSC	NSC	WMSC	NSC	WMSC
A												
day 0	0.742	*	1.370	*	1.100	*	0.962	*	1.092	*	0.778	*
5	0.784	*	1.180	*	1.160	*	0.903	*	1.189	*	0.884	*
10	0.814	*	0.529	*	1.180	*	0.897	*	1.036	*	0.818	*
15	0.704	*	1.000	*	1.000	*	0.947	*	1.080	*	0.836	*
B												
0	1.010	1.499	1.670	2.486	3.010	2.629	0.869	1.028	0.697	0.622	0.608	0.933
5	1.055	1.742	1.500	3.636	2.070	4.229	0.939	1.241	0.871	0.319	0.772	0.404
10	1.231	-	2.480	-	3.430	-	0.868	-	0.685	-	0.721	-
15	1.002	-	1.120	-	1.340	-	0.795	-	0.762	-	0.736	-
C												
0	0.990	1.288	1.710	2.243	2.810	1.721	0.889	0.792	0.940	0.898	0.733	0.653
5	0.997	1.752	1.960	3.636	1.890	3.593	0.960	0.782	0.950	0.996	0.784	0.597
10	1.100	-	2.620	-	2.790	-	0.927	-	0.789	-	0.749	-
15	1.057	-	1.900	-	3.040	-	0.788	-	0.893	-	0.748	-
D												
0	0.897	1.501	2.120	2.057	3.840	2.829	0.914	1.033	0.953	0.807	0.489	0.554
5	1.022	1.862	1.980	2.871	1.900	3.493	0.872	1.012	0.968	0.679	0.754	0.464
10	1.057	-	2.160	-	2.640	-	0.962	-	0.872	-	0.684	-
15	0.867	-	1.230	-	1.850	-	0.902	-	0.933	-	0.714	-

1 Mean ratio scores were the average from 7 judges.

* Control sample with added starter cultures was not prepared.

\- The dash sign means that no evaluation was undertaken as the samples were no longer acceptable.

Table 4.3b: Mean ratio scores of sensory qualities of soft cheese samples with and without starter culture addition on experimental treatments stored at 10°C[1]

SAMPLES		SENSORY QUALITIES[2]											
		ACID I=2.85		RANCID I=1.00		OFF-FLAVOUR I=1.00		COLOUR I=5.40		FIRMNESS I=6.10		OVERALL ACCEPTABILITY I=10.0	
		NSC	WMSC	NSC	WMSC	NSC	WMSC	NSC	WMSC	NSC	WMSC	NSC	WMSC
A													
day	0	0.742	*	1.370	*	1.100	*	0.961	*	1.093	*	0.778	*
	5	0.809	*	1.230	*	1.214	*	0.960	*	1.158	*	0.824	*
	10	0.672	*	1.310	*	1.414	*	0.896	*	1.036	*	0.832	*
	15	-	*	-	*	-	*	-	*	-	*	-	*
B													
	0	1.009	1.499	1.671	2.486	3.007	2.629	0.869	1.028	0.698	0.622	0.608	0.933
	5	0.940	1.887	1.929	4.479	2.307	4.557	0.853	1.475	0.839	0.279	0.656	0.392
	10	1.155	-	2.679	-	3.179	-	0.862	-	0.726	-	0.696	-
	15	-	-	-	-	-	-	-	-	-	-	-	-
C													
	0	0.989	1.288	1.707	2.243	2.814	1.721	0.889	0.792	0.940	0.898	0.733	0.653
	5	0.917	2.283	2.071	4.414	1.964	5.136	0.879	0.949	0.964	0.638	0.723	0.428
	10	0.998	-	2.750	-	2.764	-	0.907	-	0.802	-	0.736	-
	15	-	-	-	-	-	-	-	-	-	-	-	-
D													
	0	0.897	1.501	2.121	2.057	3.836	2.829	0.914	1.033	0.953	0.807	0.489	0.554
	5	0.972	2.198	1.979	4.357	1.936	4.950	0.937	1.451	1.016	0.430	0.705	0.382
	10	1.040	-	2.379	-	3.021	-	0.974	-	0.851	-	0.627	-
	15	-	-	-	-	-	-	-	-	-	-	-	-

1 Mean ratio scores were the average from 7 judges.

* Control sample with added starter cultures was not prepared.

\- The dash sign means that no evaluation was undertaken as the samples were no longer acceptable.

of acid taste could aggravate the undesirable beany taste resulting in objectionable flavour. In contrast to this observation, sample B (NSC) improves its overall acceptability during storage at 5°C and 10°C. This is probably due to the flavour development contributed by other factors e.g. rennet enzymes, as some reactions had been taking place, thus producing some flavourful compounds. The same trend was observed with other sample without starter culture.

The developed acidity as detected to be highest in sample B during the storage time at both temperatures, tend to partially solubilise the colloidal Ca which leads to shrinkage of the cheese matrix (Abd El-Salam, 1987). A too acid cheese weaken the body resulting in pasty, soft texture (Nelson and Trout, 1964), thus probably explained the decreased firmness even just after 5 days of storage only as chemical changes tend to occur as early as that. This soft cheese is easily affected because of its very high moisture content that could easily responds to any reactions taking place.

4.9.3.2 Microbiological quality

A comparison of the microbiological quality of soft cheeses with milk extenders (NSC and WMSC) and control (NSC) stored at 5°C and 10°C are summarised in Tables 4.4a and 4.4b.

Results showed that the prototype product (NSC) intitially has the lowest TBC but it increases by one logarithmic cycle each

Table 4.4a: Microbiological quality of soft cheese samples with and without starter culture addition on experimental treatments stored at 5°C[1]

PROPERTIES (colonies/gram)	SAMPLES						
	A	B		C		D	
	NSC	NSC	WMSC	NSC	WMSC	NSC	WMSC
Coliform							
day 0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
10	0	0	-	0	-	0	-
15	0	0	-	0	-	0	-
TBC							
0	2.80×10^{3}	2.35×10^{2}	9.0×10^{6}	5.15×10^{2}	7.95×10^{7}	1.85×10^{3}	1.21×10^{8}
5	3.15×10^{3}	2.50×10^{3}	1.42×10^{8}	*	-	*	-
10	9.15×10^{3}	1.97×10^{4}	-	*	-	*	-
15	2.90×10^{4}	1.70×10^{5}	-	1.51×10^{7}	-	3.20×10^{6}	-
Y and M							
0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
10	0	0	-	0	-	0	-
15	6.5×10^{1}	15.5×10^{1}	-	4.5×10^{1}	-	39×10^{1}	-

1 Data given were the average from duplicate determinations

* Analysis was not completed due to time constraints

\- The dash sign means that no analysis was undertaken as the samples were no longer acceptable

TBC = Total Bacterial Count

Y and M = Yeast and Mould Count

Table 4.4b: Microbiological quality of soft cheese samples with and without starter culture addition on experimental treatments stored at 10°C[1]

PROPERTIES (colonies/gram)	SAMPLES A	B		C		D	
	NSC	NSC	WMSC	NSC	WMSC	NSC	WMSC
Coliform							
day 0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
10	0	0	-	0	-	0	-
15	-	-	-	-	-	-	-
TBC							
0	2.80×10^3	2.35×10^2	9.0×10^6	5.15×10^2	7.95×10^7	1.85×10^3	1.21×10^8
5	4.80×10^4	3.13×10^4	4.6×10^8	4.95×10^4	3.58×10^8	5.10×10^4	2.75×10^9
10	3.25×10^5	4.60×10^5	-	3.75×10^5	-	4.40×10^5	-
15	-	-	-	-	-	-	-
Y and M							
0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
10	0	0	Mouldy	0	Mouldy	0	Mouldy
15	Mouldy	Mouldy	-	Mouldy	-	Mouldy	-

1 Data given were the average from duplicate determinations

\- The dash sign means that no analysis was undertaken as the samples were no longer acceptable

TBC = Total Bacterial Count

Y and M=Yeast and Mould Count

observation as storage proceeds. An increase in TBC for other samples were also observed. Obviously, cheeses with MSC gave higher initial counts as determination did not exclude lactic starter bacteria and TBC increased tremendously during storage, thus the reason for high acidity developed. No coliform growth was observed in all samples at any storage time.

The growth of yeasts and moulds was observed in all samples on the fifteenth day of storage only at 5°C. For samples with starter cultures, the conditions became too acidic already on the tenth day of storage which renders all samples unaccept - able, hence determination was stopped. Samples (WMSC) stored at 10°C turned out mouldy on its tenth day of storage while those samples without starter culture (NSC) were observed mouldy on its fifteenth day of evaluation. Even only a little increase in temperature storage from usually recommended or ideal, the quality of the products being exposed can rapidly deteriorate. This is explained by the high water available (Aw) to the microorganisms. This result also agrees with the sensory evaluation particularly those samples with MSC where increased off-flavour and undesirable acid taste are well pronounced on storage period with high count of microbial growth observed. This, in turn, resulted in rejection of the samples.

4.9.3.3 Objective measurements

The changes in pH, moisture and firmness of soft cheese samples (NSC and WMSC) stored at 5°C and 10°C are shown in Tables 4.5a and 4.5b.

The pH value of samples (NSC) showed a slight increase during the 15 days of storage however, the pH value of samples with MSC was relatively low initially and still observed to decrease with storage time. As the starter culture affects the pH of the curd which later affects the concentrations of Ca and inorganic PO_4, in effect it gives a lower buffering capacity. Consequently, it gives a slightly lower pH that may somewhat affect cheese texture, the consistency becoming slightly softer (Abd El-Salam, 1987).

The moisture content showed a decreasing trend with storage time. This is also affected by the acidity developed which leads to the shrinkage of the cheese matrix as a result of the partial solubilisation of some components. The cheese serum exudes or syneresis continuous, thus lowers the moisture content available in the cheese.

In the same manner, the cheese firmness was also affected. From the penetration reading, the greater the distance of penetration, the less firm was the curd. Thus, cheese samples (WMSC) had increased acidity developed giving higher penetra - tion values which indicate that cheeses were becoming softer in texture with storage time.

Table 4.5a: Objective measurements of some physico-chemical qualities of soft cheeses with and without starter culture addition on experimental treatments stored at 5°C[1]

QUALITIES	SAMPLES						
	A	B		C		D	
	NSC	NSC	WMSC	NSC	WMSC	NSC	WMSC
pH							
day 0	6.30	6.30	5.30	6.30	5.50	6.40	5.35
5	6.30	6.35	5.05	6.40	5.20	6.45	5.10
10	6.30	6.35	-	6.40	-	6.40	-
15	6.30	6.35		6.40	-	6.40	-
MOISTURE, %							
0	65.52	66.25	66.07	66.82	66.39	76.40	75.93
5	63.56	65.51	64.78	66.74	63.74	74.41	74.54
10	63.74	65.50	-	65.92	-	74.80	-
15	63.54	64.87	-	65.73	-	74.04	-
FIRMNESS							
0	63.0	155.0	190.0	123.5	138.5	103.0	111.5
5	72.5	108.5	225.0	112.0	149.0	83.0	126.0
10	72.0	109.0	-	108.0	-	81.0	-
15	53.0	89.0	-	108.0	-	92.0	-

1 Data given were the average from duplicate analysis of samples

2 Values were the average from 4 determinations at different points in the samples using the penetrometer

\- The dash sign means that no analysis was undertaken as the samples were no longer acceptable

Table 4.5b: Objective measurements of some physico-chemical qualities of soft cheeses with and without starter culture addition on experimental treatments stored at 10°C[1]

QUALITIES	SAMPLES						
	A	B		C		D	
	NSC	NSC	WMSC	NSC	WMSC	NSC	WMSC
pH							
day 0	6.30	6.30	5.30	6.30	5.50	6.40	5.35
5	6.40	6.45	4.95	6.50	4.95	6.50	4.90
10	6.40	6.50	-	6.50	-	6.50	-
15	-	-	-	-	-	-	-
MOISTURE, %							
0	65.52	66.25	66.07	66.82	66.39	76.40	75.93
5	63.92	66.32	64.67	65.98	64.53	75.43	74.73
10	62.80	65.02	-	65.87	-	74.05	-
15	-	-	-	-	-	-	-
FIRMNESS							
0	63.0	155.0	190.0	123.5	138.5	103.0	111.5
5	59.5	130.0	too soft	103.5	155.5	92.0	151.5
10	58.5	122.0	-	111.5	-	102.0	-
15	-	-	-	-	-	-	-

1 Data given were the average from duplicate analysis of samples

2 Values were the average from 4 determinations at different points in the samples using the penetrometer at different points in the samples

\- The dash sign means that no analysis was undertaken as the samples were no longer acceptable

Linear correlation analyses were performed to measure relationships among the different parameters. The correlation coefficients are given in Table 4.6. The statistical significance of the correlation coefficients was determined with df = n - 2 = 2 (Gomez and Gomez, 1967).

Table 4.6: Correlation coefficients among the quality parameters in soft cheeses without starter cultures stored at 5°C

	Time	pH	Moisture
pH	0.968*		
Moisture	0.878	0.730	
Firmness	0.393	0.568	0.002

* Significant at p = .05

A significant correlation coefficient between time and pH with r = 0.968 (r^2 = 0.937) was obtained. This means that 93.7% of the variations in values of Y (pH) can be explained in terms of values of X (time), and that 1 - 0.937, or 6.3% of the variations in Y are not associated with X, but with other factors or with error. But although the pH does show an increase with storage time, the change is very slight. For other parameters, also there exist some degree of association

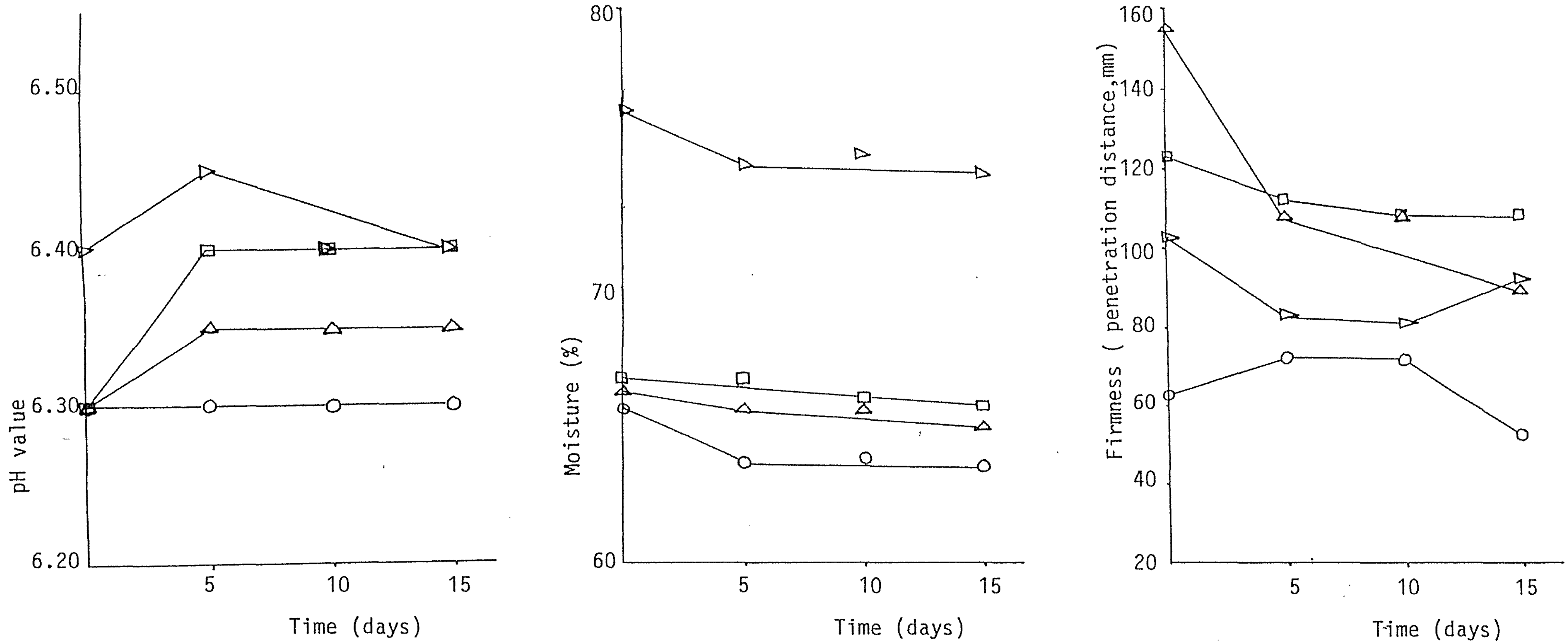


Figure 4.4. Quality changes in soft cheeses without starter culture addition stored at 5°C
(○ = cow's milk; △ = SBM + CCM in RSKM; □ = CCM in RSKM; ▷ = SBM in RSKM)

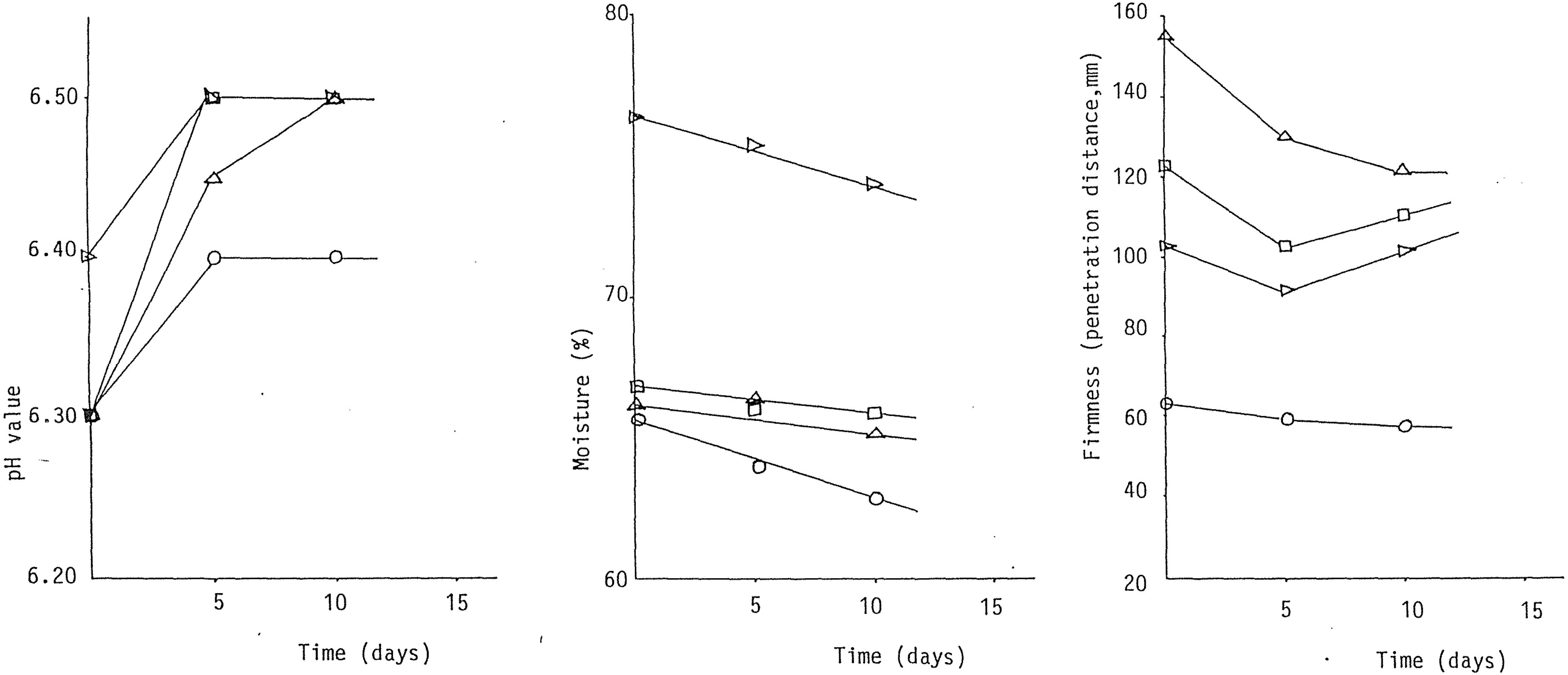


Figure 4.5. Quality changes in soft cheeses without starter culture addition stored at 10°C

(○ = cow's milk; △ = SBM + CCM in RSKM; □ = CCM in RSKM; ▷ = SBM in RSKM) but correlation coefficients are quite low if found not significant.

Figures 4.4 and 4.5 show the quality changes in soft cheeses without starter culture addition stored at 5°C and 10°C, respectively. For other treatment, only two points were observed which may not give reliable results when plotted.

4.9.3.4 <u>Shelf life</u>

When samples with MSC were stored at 10°C and 5°C, the shelf life was less than 5 days or better be consumed as freshly as possible after manufacture while samples without MSC can be kept for up to 10 days when stored at 10°C with little deterioration in quality such as decreased firmness and slightly acidic taste. On the other hand, samples without starter cultures when stored at 5°C can last up to 15 days and samples still remained organoleptically good.

4.10 <u>CONCLUSION</u>

This study showed that coconut cream and soybean milk at these low levels of addition are suitable milk extenders when blended with reconstituted skimmilk, either by themselves (C and D) or in combination (B). The starter culture added to soft cheese can mask the beany flavour to some extent provided acid development was produced under strict controlled conditions.

On the other hand, soft cheese without starter cultures has organoleptically good acceptance and storage life, besides being produced easily, and hence finds more practical application for a cottage industry.

CHAPTER 5

COMPARATIVE PRODUCT COSTS ANALYSIS

5.1 INTRODUCTION

Basically, cheeses consist of an aggregation of water, fat and protein (mainly casein) plus small amounts of sodium chloride (NaCl) and lactic acid (Lawrence and Gilles, 1987). In a cheesemaking enterprise, the financial return depends on the quality and quantity of the product it makes which is measured in terms of product yield and grade (Lelievre, 1983). As further stated, the yield and grade of cheese are interrelated since both depend on cheese composition.

The yield in terms of quantity of fresh cheese produced per kilogram of initial milk depends on the total solids present in that milk and the recovery of those solids and the quantity of water incorporated with them in the cheese. In addition to these factors, pH and bacterial composition also influence the cheese composition and quality. Obviously, the cheese has to be acceptable to the consumer. This factor limits the quantity of water that can be incorporated as too high a moisture content tends to soften the body of the cheese too much. This study evaluates the feasibility of production in terms of production costs.

5.2 METHOD OF COSTING

A 50 kg formulation to be processed as a cottage industry was considered. The production costs were estimated using the quoted prices in pesos (Appendix XIII) which is prevalent in the Philippine markets as of January 1989. The average yield, calculated by weighing the cheese obtained after draining and dividing by the amount of cheesemilk manufactured regardless of the composition but as long as within the permitted acceptable range e.g. moisture content, was used directly in expressing the output. A breakdown of production costs are given as follows:

5.2.1 Labour Costs

5.2.2 Raw Material Costs

5.2.3 Processing/Packaging Costs

5.2.4 Overheads

This project does not need big and sophisticated equipment and facilities hence, total capital investment in building and equipment is negligible.

5.2.1 Labour Costs

The main operations for soft cheese production are listed in Table 5.1 indicating the total hours required per day and wages per day. It was assumed that the average wage was ₱ 52.00 per day with 8 working hours (₱ 6.50/hour).

Table 5.1: Breakdown of operations, hours and cost per day

	OPERATION	NUMBER OF WORKERS	TOTAL HOURS	WAGES (Pesos)
1.	Preparation	1	1/2	3.25
2.	Mixing	1	1/6	1.08
3.	Heating	1	1/2	3.25
4.	Cooling	1	1/3	2.17
5.	Cutting	1	1/12	0.54
6.	Partial Draining	1	1/3	2.17
7.	Moulding	1	1/3	2.17
8.	Wrapping	1	1	6.50
		TOTAL	3 1/4	₱ 21.13
				($NZ 1.758)*

* Conversion rate of NZ$ = ₱ 12.0151 (BNZ as of May 24, 1989)
₱ 1.00 = 100 centavos

5.2.2 Raw Material Costs

A breakdown of raw material costs for three different types of soft cheeses are given in Table 5.2.

Table 5.2: Breakdown of costs for three different types of soft cheeses

RAW MATERIALS	QUANTITY (kg)	UNIT COST (Pesos/kg)	TOTAL COST (Pesos)
A. Cheese from Carabao's milk			
Carabao's milk	50.0	9.50	475.00
Salt	1.0	5.00	5.00
Rennet Substitute[1]	0.2	200.00	40.00
			₱ 520.00
			($NZ 43.28)
B. Cheese from Cow's milk			
Cow's milk	50.0	5.75	287.50
Salt	1.0	5.00	5.00
Rennet Substitute	0.2	200.00	40.00
			₱ 332.50
			($NZ 27.67)
C. Cheese from Extended milk			
Skimmilk powder	4.9	45.80	224.42
Soybean milk	5.0	2.50	12.50
Coconut milk[2]	10.0	7.00	70.00
Salt	1.0	5.00	5.00
Rennet substitute	0.2	200.00	40.00
Cheese colour[3]	0.0125	30.00	0.38
Water	30.1	-	-
			₱ 352.30
			($NZ 29.32)

1 Rennet substitute is locally prepared from adult abomasa having a rate of 4 ml/li cows milk.

2 Costing was based on the water extracted coconut milk by Davide *et al.* (1985) yielding an average of 431.83 ml per nut. The extracted coconut milk contains on the average 18.22% total solids; 14.36% fat; 1.55% protein; 0.51% ash and pH value of 6.29.

3 Cheese colour is locally prepared by extracting annatto seeds in alkaline H_2O solution (rate = 25 ml/100 L milk).

5.2.3 Processing/Packaging Costs

The polyethylene plastic sheet measuring approximately 25 x 30 cm is used for wrapping the soft cheese. The cost per sheet is 37 centavos. The number of sheets needed depends on the cheese yield. Each piece weighs 200 gms. Thus, based on 50 kg formulation given in our example, the number of sheets needed for each kind of soft cheese are as follows:

Cheese A: $\dfrac{20,000 \text{ gms}}{200 \text{ gms}}$ = 100 pcs x 0.37 = ₱ 37.00

Cheese B: $\dfrac{11,400 \text{ gms}}{200 \text{ gms}}$ = 55 pcs x 0.37 = ₱ 20.35

Cheese C: $\dfrac{12,140 \text{ gms}}{200 \text{ gms}}$ = 58 pcs x 0.37 = ₱ 21.46

It was estimated that the packaging costs would be the major component of any processing costs for soft cheeses.
Alternative packaging materials that could be used are the plastic cups or tubs.

5.2.4 Overheads

The overheads were estimated as 23 centavos per 50 kg batch of production. The overheads accounted for in the production of soft cheese were gas, water, electricity, utensils.

5.2.5 Total Production Costs

The total production cost is the sum total of labour costs, raw material costs, processing/packaging costs and overheads. Total production costs for three different types of soft cheeses are shown in Table 5.3.

Table 5.3: An estimate of total production costs for three different types of soft cheeses

PRODUCTION COSTS	CHEESES		
	A	B	C
INPUT			
Labour Costs	21.13	21.13	21.13
Raw Material Costs	520.00	332.50	352.30
Processing/Packaging Costs	37.00	20.35	21.46
Overheads	0.23	0.23	0.23
TOTAL	₱ 578.36 ($NZ 48.13)	₱ 374.21 ($NZ 31.15)	₱ 395.12 ($NZ 32.89)
OUTPUT			
Yield, %	40.00*	22.35	23.56
Amount, kg	20.00	11.18	11.78
No. of pieces (200 gms/pc)	100	55	58
COST PER PIECE:	₱ 5.78 ($NZ 0.48)	₱ 6.80 ($NZ 0.57)	₱ 6.81 ($NZ 0.57)

* DTRI-UPLB Annual Report 1977

5.3 RESULTS AND DISCUSSION

The final product costs were based on raw material costs, labour costs, processing/packaging costs and overheads. Considering the data from previous experiment (Chapter 3) these costs were determined from a given 50 kg formulation as basis for computation.

As the production is not aiming yet for a highly sophisticated equipment and facilities nor a multi-million profit, the big capital investment for these was negligible. The production would be on a low-level technology just to have an available cheap source of protein and other nutrients needed by the body which could compete in quality equally if not better than the existing products which are of limited supply at the moment. Moreover, it was assumed that consumers would come to the place to buy the product, hence distribution and marketing were out of the picture.

An estimate of total production costs for the three different types of soft cheeses are shown in Table 5.3. It could be observed that cheese A (carabao's milk) has the highest production cost followed by cheese C (extended milk). Cheese B (cow's milk) had the lowest production cost. However, the cost per piece was lowest for cheese A while cheeses B and C were almost the same. This is explained by the amount of fresh cheese recovered from milk manufactured expressed as percent yield, thus compensating for the high cost of production and therefore lowering the unit cost of the product.

Although the cost comparison shown indicated that cheese produced from carabao's milk appeared the cheapest, still the use of skimmilk plus extenders has major advantage of not being limited by the quantity of milk (either cow or carabao) available. Hence, the market demand can be satisfied and product consumption is encouraged. The cost of using skimmilk powder plus extenders is greater (17.82%) than the traditional product. However, this cost difference can still be reduced by a decrease in the protein and fat losses, thus increased solids recovery. Considering that the total solids in experimental cheesemilk is higher than cow's milk there is the potential for higher yield than that obtained for cow's milk. Also, the cost is very dependent on the prices of skimmilk powder which have doubled during the course of this study.

At present, a piece of DTRI soft cheese sells at P 12.00 ($NZ 0.99) while a commercial dairy company sells similar product at P 14.95 ($NZ 1.24) per 200 grams (see Appendix XIII). Based on the comparison of production costs (Table 5.3), there is a potential for a good return as selling price is more or less double the production cost and considering also that no middlemen are involved.

A comparison of the gross composition of the three soft cheeses is given in Table 5.4.

Table 5.4: Gross composition of experimental, cow's milk and carabao's milk soft cheeses[1]

	SOFT CHEESES		
Composition	Extended Milk[2]	Cow's Milk[3]	Carabao's Milk[4]
Moisture, %	66.25	65.52	60.80
Fat, %	13.43	14.79	19.00
Total Protein, %	12.12	10.70	17.50
Salt, %	1.55	1.49	1.69

[1] Values were the results of analysis of non-starter soft cheeses

[2,3] Results of analysis from Chapter 4

[4] DTRI Annual Report 1977

It could be observed that the control cheeses from cow's milk produced in New Zealand were satisfactory in quality and composition relative to carabao's milk therefore it is valid to compare.

5.4 CONCLUSION

This study shows that it is feasible to produce soft cheese using milk extenders which could likely compete with soft cheese made from cow's milk in terms of compositional quality and manufacturing costs provided the cost of skimmilk powder exported by countries with developed dairy industries does not increase tremendously. Also, it is possible to produce a product that is available all year round when and as required and in the quantities needed, regardless of the fresh milk supplies.

CHAPTER 6

OVERALL DISCUSSION AND CONCLUSION

An assessment was made of the suitability of soybean milk, coconut cream and reconstituted skimmilk as milk extenders in the manufacture of unripened soft-type cheese. Reconstituted skimmilk with solids near the solid content of cow's milk was used as milk base. Part of the skimmilk in a given amount of cheesemilk was then replaced by different percentages of soybean milk and coconut cream with or without addition of mixed starter cultures. It has been observed that addition of coconut cream increased the fat content of the mixture but not the protein content. On the contrary, addition of soybean milk contributed to the protein content but not the fat content of mixture. This was more obvious when using milk extenders individually.

Soybean milk and coconut cream increased the total solids of the mixture however, they did not have any significant effect on yield and protein recovery in cheese due to high losses of fat and protein observed from whey analysis. The presence of soybean protein interrupts the casein coagulation with rennet, and thus loosened the microstructure as indicated by the high losses of constituents, high moisture retained and decreased firmness. As a result, the fat from coconut cream was not efficiently incorporated. Soft cheeses from mixtures containing soybean milk and coconut cream were weak in texture as compared with the control. Addition of mixed starter cultures lowered the pH and thus contributed to a less firm curd.

With the different treatment combinations formulated, the product formulation that showed potential for development was that having low levels of soybean milk (10% w/w), coconut cream (20% w/w) and mixed starter cultures (1% w/v) for acid development to mask the beany taste. Further evaluation was conducted using the milk extenders individually.

The sensory evaluation of the experimental soft cheese with milk extenders in combination gave scores which were satisfactory although inferior to control cheese. The starter cultures added to soft cheese can mask the beany flavour to some extent but an unacceptable acid taste was developed during prolonged storage which resulted in the rejection of the cheese. The experimental cheese without starter cultures had an organoleptically good acceptance and good storage life (15 days) at 5°C. Compositional analysis showed that the experimental soft cheese is equally nutritious relative to soft cheese produced from cow's milk.

A cost analysis showed that soft cheese with milk extenders could compete with soft cheese made from cow's milk despite the high losses in the experimental work.

This study showed that coconut cream and soybean milk at low addition levels are suitable extenders of reconstituted skim milk in the manufacture of soft white cheese. The manufac - turing process is suitable for cottage industry and has the advantage of year-round availability regardless of fresh milk supply.

SUGGESTED FURTHER STUDY

An in-depth study of the microstructure of the curd from the mixture of extenders used should be considered for better understanding of the complexes formed.

Measures to prevent high losses of the constituents, and thus increase the output (yield) would be of economic importance.

Use of smaller amount of starter cultures and further screening of the strains to be used is recommended for better control of acid development.

The textural property of the curd during storage demonstrated an increase in softness. The utilization of this curd in other products e.g. cheese spread where flavourings can be added may be a worthwhile study.

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APPENDIX I

A LAYOUT OF THE 8 TREATMENT COMBINATIONS RANDOMISED WITHIN EACH REPLICATION

Treatment Code	Experimental Variables A	B	C	Randomised Order of Runs: Replication I	II
1	-	-	-	7	8
a	+	-	-	2	6
b	-	+	-	1	2
ab	+	+	-	8	3
c	-	-	+	5	7
ac	+	-	+	4	5
bc	-	+	+	6	1
abc	+	+	+	3	4

Legend:

A = Soybean milk
B = Coconut cream
C = Starter culture

negative (-) sign = low level
positive (+) sign = high level
Letters in treatment code signify experimental variable(s) with high level

APPENDIX II

SAMPLE QUESTIONNAIRE FOR TRIANGLE TEST

NAME: ______________________________ DATE: ____________________

PRODUCT: Soft Cheese (Fresh)

Two of these three samples are identical, the third is different.

1. Taste the samples in the order indicated and identify the odd sample.

Sample Code	Check Odd Sample
__________	__________
__________	__________
__________	__________

2. Indicate the degree of difference between the duplicate samples and odd sample (Put check)

Slight	__________
Moderate	__________
Much	__________
Extreme	__________

3. Acceptability

Odd Sample more acceptable	__________
Duplicate samples more acceptable	__________

4. Comments ____

____

____

APPENDIX III

DEFINITION OF SENSORY TERMS USED

1. *Creamy* refers to the rich, pleasing flavour associated with the fat content of the product.

2. *Salty* due to high salt content which causes a sharp, piercing, biting taste sensation that detracts the pleasant flavour.

3. *Beany* taste due to the presence of soybean milk but not always objectionable especially if no bitter taste persists. This is more pronounced in *tofu*, a product from soybean.

4. *Rancid* it is closely associated with the milkfat and caused by the activity of the enzyme lipase. The flavour is bitter, soapy, very disagreeable and repulsive.

5. *Acid* a "clean" flavour similar to that of a dilute solution of mineral acid usually perceived at the back and sides of the tongue while sour is a "dirty" flavour often associated with fermented-type flavour perceived at the back and sides of the tongue and tending to linger in the mouth as an aftertaste.

6. *Firmness* Desirable body is one that is neither too firm, nor too soft, curd should be sufficiently firm to hold its general shape.

7. *Smoothness* The absence of grainy particles which could be detected by the palate as it breaks down during mastication.

8. *Colour* natural cream colour obtained from the fat. The presence of soybean milk and coconut cream gives a greyish white colour to the product.

APPENDIX IV

SAMPLE QUESTIONNAIRE USED TO EVALUATE CHEESE SAMPLES

NAME: ______________________________ DATE: ______________________

Please taste the soft cheese samples and answer each question by placing a vertical line across the horizontal line at the point that best describes that property in the sample. Label each vertical line with the code number of the sample it represents (overlapping of vertical lines is possible for 2 or more samples).

SAMPLE CODE NO. ____ ____ ____ ____ ____

1. FLAVOUR

   a) Creamy: ____
   absent intense

   b) Salty: ____
   bland very salty

   c) Beany: ____
   absent intense

   d) Rancid: ____
   absent intense

   e) Acid: ____
   absent intense

2. TEXTURE (MOUTHFEEL)

   a) Firmness: ____

very soft very firm

b) Smoothness: ____________________

grainy smooth

3. COLOUR: ____________________

white yellow

4. AFTERTASTE: ____________________

absent intense

5. GENERAL ACCEPTABILITY: ____________________

dislike very much like very much

COMMENTS: ____________________

____

____

APPENDIX V

COMPOSITIONAL ANALYSIS OF INGREDIENTS AND BUFFALO'S MILK (Percent)

ANALYSES	SOYBEAN MILK	COCONUT CREAM	SKIMMILK[1] POWDER	PASTEURISED HOMOGENISED COW'S MILK	BUFFALO'S[2] MILK
Fat	2.43	24.70	0.8	3.21	8.88
Protein	3.23	1.33	37.8	3.48	4.20
Lactose	-	-	49.8	-	5.10
Minerals	-	-	7.8	-	0.92
Total Solids	7.30	26.55	96.2	12.73	19.10
pH	6.61	6.0	-	6.6	6.79
Yield, kg/kg dried beans[3]	6.43	-	-	-	-

1 Data were taken as indicated in the label.

2 Alim, K.A. 1975. World Review of Animal Production

3 Value was average of 5 preparations of soybean milk. The rest were averages of duplicate analysis.

APPENDIX VI

ANALYSIS OF CHEESEMILKS

APPENDIX VI-A: TOTAL SOLIDS CONTENT OF CHEESEMILKS (%)

TREATMENT	ANALYSIS[1] Batch 1	Batch 2	TOTAL	MEAN	s.d.
A	13.66	11.80	25.46	12.73[c]	± 1.315
B	17.17	15.19	32.36	16.18[b]	± 1.400
C	16.19	14.52	30.71	15.36[b]	± 1.181
D	18.09	17.76	35.85	17.93[a]	± 0.233
E	17.26	17.45	34.71	17.35[a]	± 0.134
F	16.91	15.04	31.95	15.98[b]	± 1.322
G	18.17	16.57	34.74	17.37[a]	± 1.131

1 Values are the average from duplicate analysis for each batch.

ANOVA

SV	df	SS	MS	Fo	Ft,.05	.01
Sample	6	36.8947	6.14912	5.26*	3.87	7.19
Expt'l Error	7	8.1853	1.16933			
Total	13	45.0800				

* Significant at 5% level

APPENDIX VI-B: TOTAL PROTEIN CONTENT OF CHEESEMILKS (%)

TREATMENT	ANALYSIS Batch 1	Batch 2	TOTAL	MEAN	s.d.
A	3.03	3.93	6.96	3.48	± 0.636
B	4.43	4.21	8.64	4.32	± 0.155
C	4.01	3.87	7.88	3.94	± 0.099
D	3.90	3.97	7.87	3.94	± 0.049
E	3.90	3.91	7.81	3.91	± 0.007
F	4.43	4.26	8.69	4.35	± 0.120
G	4.10	3.92	8.02	4.01	± 0.127

ANOVA

SV	df	SS	MS	Fo	Ft,.05	.01
Sample	6	1.0163	0.1694	2.51^{NS}	3.87	7.19
Expt'l Error	7	0.4722	0.0674			
Total	13	1.4885				

NS = not significant

APPENDIX VI-C: FAT CONTENT OF CHEESEMILKS (%)

TREATMENT	ANALYSIS		TOTAL	MEAN	s.d.
	Batch 1	Batch 2			
A	3.26	3.16	6.42	3.21^{e}	± 0.071
B	3.99	3.90	7.89	3.95^{c}	± 0.063
C	3.32	4.00	7.32	3.66^{d}	± 0.481
D	5.49	5.35	10.84	5.42^{b}	± 0.099
E	6.12	5.96	12.08	6.04^{a}	± 0.113
F	3.85	3.79	7.64	3.82^{cd}	± 0.042
G	6.01	5.99	12.00	6.00^{a}	± 0.014

ANOVA

SV	df	SS	MS	Fo	Ft, .05	.01
Sample	6	17.1151	2.8525	75.39**	3.87	7.19
Expt'l Error	7	0.2649	0.03783			
Total	13	17.3799				

** Significant at 1% level

APPENDIX VI-D: ACIDITY VALUES OF CHEESEMILKS (% l.a)

TREATMENT	ANALYSIS		TOTAL	MEAN	s.d.
	Batch 1	Batch 2			
A	0.20	0.22	0.42	0.21[e]	± 0.014
B	0.30	0.30	0.60	0.30[a]	± 0.000
C	0.26	0.27	0.53	0.26[c]	± 0.007
D	0.25	0.26	0.51	0.25[d]	± 0.007
E	0.26	0.25	0.51	0.25[d]	± 0.007
F	0.29	0.29	0.58	0.28[b]	± 0.000
G	0.30	0.28	0.58	0.29[b]	± 0.014

ANOVA

SV	df	SS	MS	Fo	Ft, .05	.01
Sample	6	0.01137	0.0018952	24.12**	3.87	7.19
Expt'l Error	7	0.00055	0.0000786			
Total	13	0.01192				

** Significant at 1% level

APPENDIX VI-E: CLOTTING TIME OF CONTROL AND EXPERIMENTAL CHEESEMILKS

	CLOTTING TIME			
Treatment	Batch 1	Batch 2	Total	Mean
A	43	55	98	49
B	30	52	82	41
C	52	55	107	54
D	50	60	110	55
E	30	37	67	34
F	48	45	93	47
G	35	40	75	38

			ANOVA			
SV	df	SS	MS	Fo	Ft.05	.01
Sample	6	789.7140	131.6190	2.25 NS	3.87	7.19
Error	7	410.0000	58.5714			
Total	13	1199.7140				

NS = Not Significant

APPENDIX VII

ANALYSES OF SOFT CHEESES

APPENDIX VII-A: MOISTURE CONTENT OF SOFT CHEESES (%)

TREATMENT	ANALYSIS Batch 1	Batch 2	TOTAL	MEAN	s.d.
A	67.38	69.38	136.76	68.38^{b}	± 1.414
B	65.77	65.75	131.52	65.76^{c}	± 0.012
C	72.69	73.39	146.08	73.04^{a}	± 0.495
D	64.64	64.14	128.78	64.39^{d}	± 0.354
E	64.27	68.04	132.31	66.15^{c}	± 2.666
F	69.37	67.19	136.56	68.28^{b}	± 1.542
G	64.76	65.88	130.64	65.32^{c}	± 0.792

ANOVA

SV	df	SS	MS	Fo	Ft, .05	.01
Sample	6	102.2771	17.046183	9.56**	3.87	7.19
Expt'l Error	7	12.4800	1.782857			
Total	13	114.7571				

** Significant at 1% level

APPENDIX VII-B: TOTAL PROTEIN CONTENT OF SOFT CHEESES (%)

TREATMENT	ANALYSIS Batch 1	Batch 2	TOTAL	MEAN	s.d.
A	10.14	9.09	19.23	9.62^{d}	± 0.742
B	12.63	12.88	25.51	12.71^{a}	± 0.177
C	8.50	8.50	17.00	8.50^{e}	± 0.000
D	9.06	10.20	19.26	9.63^{d}	± 0.806
E	8.89	8.53	17.42	8.71^{e}	± 0.255
F	10.74	12.16	22.90	11.45^{b}	± 1.004
G	10.17	10.39	20.56	10.28^{c}	± 0.156

ANOVA

SV	df	SS	MS	Fo	Ft,.05	.01
Sample	6	27.6878	4.614563	13.87**	3.87	7.19
Expt'l Error	7	2.3295	0.33279			
Total	13	30.0173				

** Significant at 1% level

APPENDIX VII-C: FAT CONTENT OF SOFT CHEESES (%)

TREATMENT	ANALYSIS		TOTAL	MEAN	s.d.
	Batch 1	Batch 2			
A	13.44	12.44	25.88	12.94^{b}	± 0.421
B	13.74	13.90	27.64	13.82^{a}	± 0.113
C	10.61	10.59	21.20	10.60^{d}	± 0.014
D	13.84	14.28	28.12	14.06^{a}	± 0.346
E	10.13	11.43	21.56	10.78^{d}	± 0.495
F	11.65	12.15	23.80	11.90^{c}	± 0.354
G	11.95	11.46	23.41	11.71^{c}	± 0.346

ANOVA

SV	df	SS	MS	Fo	Ft, .05	.01
Sample	6	23.0392	3.8398	15.81**	3.87	7.19
Expt'l Error	7	1.6995	0.2428			
Total	13	24.7387				

** Significant at 1% level

APPENDIX VII-D: SALT CONTENT OF SOFT CHEESES (%)

TREATMENT	ANALYSIS Batch 1	Batch 2	TOTAL	MEAN	s.d.
A	1.59	1.55	3.14	1.57	± 0.028
B	1.76	1.51	3.27	1.64	± 0.177
C	1.85	1.61	3.46	1.73	± 0.169
D	1.74	1.54	3.28	1.64	± 0.141
E	1.84	1.64	3.48	1.74	± 0.141
F	1.88	1.45	3.33	1.66	± 0.304
G	1.71	1.47	3.18	1.59	± 0.169

ANOVA

SV	df	SS	MS	Fo	Ft,.05	.01
Sample	6	0.0500	0.008833	0.26^{NS}	3.87	7.19
Expt'l Error	7	0.2221	0.031729			
Total	13	0.2721				

NS = not significant

APPENDIX VII-E: THE pH VALUE OF SOFT CHEESES

TREATMENT	ANALYSIS		TOTAL	MEAN	s.d.
	Batch 1	Batch 2			
A	6.71	6.73	13.44	6.72[a]	± 0.014
B	5.50	5.59	11.09	5.54[c]	± 0.063
C	5.43	5.48	10.91	5.45[d]	± 0.035
D	5.85	5.99	11.84	5.92[b]	± 0.099
E	5.78	5.89	11.67	5.84[c]	± 0.078
F	5.19	5.21	10.40	5.20[e]	± 0.014
G	5.50	5.59	11.09	5.54[c]	± 0.063

ANOVA

SV	df	SS	MS	Fo	Ft, .05	.01
Sample	6	2.9010	0.483500	132.20**	3.87	7.19
Expt'l Error	7	0.0256	0.003657			
Total	13	2.9266				

** Significant at 1% level

APPENDIX VII-F: OBJECTIVE MEASUREMENT OF SOFT CHEESE FIRMNESS USING PENETROMETER

TREATMENT	ANALYSIS		TOTAL	MEAN
	Batch 1	Batch 2		
A	113	117	230	115
B	155	147	302	151
C	>400	>400	>800	>400
D	265	293	558	279
E	>400	400	>800	>400
F	>400	>400	>800	>400
G	>400	>400	>800	>400

APPENDIX VII-G: YIELD OF SOFT CHEESES

TREATMENT	ANALYSIS		TOTAL	MEAN	s.d.
	Batch 1	Batch 2			
A	23.21	21.50	44.71	22.35	± 2.701
B	24.62	22.50	47.12	23.56	± 1.541
C	27.93	22.19	50.12	25.06	± 4.179
D	27.60	26.73	54.33	27.17	± 0.629
E	24.20	24.34	48.54	24.27	± 0.106
F	28.52	23.50	52.02	26.01	± 3.726
G	26.44	26.65	53.09	26.55	± 0.156

ANOVA

SV	df	SS	MS	Fo	Ft,.05	.01
Sample	6	35.4006	5.9001	1.24^{NS}	3.87	7.19
Expt'l Error	7	33.1935	4.7419			
Total	13	68.5941				

NS = not significant

APPENDIX VII-H: RECOVERY OF TOTAL SOLIDS (%) IN SOFT CHEESES

TREATMENT	% Recovery Batch 1	Batch 2	TOTAL	MEAN
A	55.43	55.78	111.21	55.52[a]
B	49.09	50.73	99.82	49.87[c]
C	47.12	40.67	87.79	44.oo[e]
D	53.95	53.98	107.93	53.96[a]
E	50.09	44.59	94.68	47.38[d]
F	51.66	51.27	102.93	51.64[bc]
G	51.29	54.88	106.17	53.02[b]

ANOVA

SV	df	SS	MS	Fo	Ft.05	.01
Sample	6	198.3909	33.0652	5.28*	3.87	7.19
Error	7	43.8528	6.2647			
Total	13	242.2437				

* Significant at 1% level

APPENDIX VII-I: RECOVERY OF TOTAL PROTEIN (%) IN SOFT CHEESES

TREATMENT	% Recovery		TOTAL	MEAN
	Batch 1	Batch 2		
A	77.68	49.72	127.40	61.78
B	70.20	68.83	139.03	69.32
C	59.21	44.80	104.01	54.12
D	64.12	68.68	132.80	66.47
E	55.16	53.11	108.27	54.12
F	69.14	67.08	136.22	68.38
G	65.56	70.64	136.20	68.05

ANOVA

SV	df	SS	MS	Fo	Ft.05	.01
Sample	6	611.9252	101.9875	1.36^{NS}	3.87	7.19
Error	7	523.1663	74.7380			
Total	13	1135.0915				

NS Not significant

APPENDIX VII-J: RECOVERY OF FAT (%) IN SOFT CHEESES

TREATMENT	% Recovery		TOTAL	MEAN
	Batch 1	Batch 2		
A	95.69	84.62	180.31	90.11[a]
B	84.78	80.19	164.97	82.41[ab]
C	89.26	58.74	148.00	72.60[cd]
D	69.58	71.35	140.93	70.46[d]
E	40.05	46.69	86.74	43.35[f]
F	86.30	75.33	161.63	81.05[bc]
G	52.59	50.99	103.58	51.83[e]

ANOVA

SV	df	SS	MS	Fo	Ft.05	.01
Sample	6	3469.3714	578.2286	6.50*	3.87	7.19
Error	7	622.6034	88.9433			
Total	13	4091.9748				

* Significant at 5% level

APPENDIX VIII

ANOVA FOR WHEY COMPOSITION

TOTAL SOLIDS

SV	df	SS	ANOVA MS	Fo	Ft, .05	.01
Sample	6	20.5869	3.43115	4.15*	3.87	7.19
Error	7	5.7861	0.82659			
Total	13	26.3730				

* Significant at 5% level

TOTAL PROTEIN

SV	df	SS	ANOVA MS	Fo	Ft, .05	.01
Sample	6	0.6765	0.11275	10.41**	3.87	7.19
Error	7	0.0758	0.01083			
Total	13	0.7523				

** Significant at 1% level

FAT

SV	df	SS	ANOVA MS	Fo	Ft, .05	.01
Sample	6	5.4490	0.9082	33.61**	3.87	7.19
Error	7	0.1891	0.0270			
Total	13	5.6381				

** Significant at 1% level

ACIDITY

SV	df	SS	ANOVA MS	Fo	Ft, .05	.01
Sample	6	0.0080	0.00133	7.82**	3.87	7.19
Error	7	0.0012	0.00017			
Total	13	0.0092				

** Significant at 1% level

APPENDIX IX

STATISTICAL ANALYSIS OF SENSORY SCORES (Chapter 3)

Appendix IX-A. ANOVA for various sensory attributes of soft cheeses

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: CREAMINESS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	19	110.66168368	5.82429914	1.88
ERROR	78	241.51290816	3.09631934	
CORRECTED TOTAL	97	352.17459184		

SOURCE	DF	ANOVA SS	F VALUE	PR > F	F-value(table) 0.05	F-value(table) 0.01
BLOCK	6	66.87209184	3.60 **	0.0033	2.22	3.04
TIME	1	7.66081633	2.47 NS	0.1198	3.96	6.97
SAMPLE	6	20.42494898	1.10 NS	0.3704	2.22	3.04
TIME*SAMPLE	6	15.70382653	0.85 NS	0.5390	2.22	3.04

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: SALTINESS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	19	78.34631429	4.12349023	2.44
ERROR	78	131.54768571	1.68650879	
CORRECTED TOTAL	97	209.89400000		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	25.93885714	2.56 *	0.0256
TIME	1	1.48904490	0.88 NS	0.3503
SAMPLE	6	36.10285714	3.57 **	0.0036
TIME*SAMPLE	6	14.81555510	1.46 NS	0.2015

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: BEANY

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	19	316.50	16.6579	6.25
ERROR	78	207.78	2.6638	
CORRECTED TOTAL	97	524.28		

SOURCE	DF	ANOVA SS	MS	F VALUE	PR > F
BLOCK	6	181.47	30.25	11.35**	0.0049
TIME	1	42.09	42.09	15.80**	0.0908
SAMPLE	6	66.03	11.005	4.13**	0.1388
TIME*SAMPLE	6	26.91	4.485	1.68NS	0.2693

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: RANCID

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	19	278.58687041	14.66246686	7.50
ERROR	78	152.48248980	1.95490372	
CORRECTED TOTAL	97	431.06936020		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	107.92193878	9.20 *	0.0001
TIME	1	95.04265408	48.62 **	0.0001
SAMPLE	6	56.65799592	4.83 **	0.0003
TIME*SAMPLE	8	18.96428163	1.62 NS	0.1536

Appendix IX-A cont'd.

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: ACID

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	19	354.76501939	18.67184313	7.82
ERROR	78	186.26885102	2.38806219	
CORRECTED TOTAL	97	541.03387041		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	217.25346327	15.16 **	0.0001
TIME	1	29.21755204	12.23 **	0.0008
SAMPLE	6	101.80060612	7.10 **	0.0001
TIME*SAMPLE	6	6.49339796	0.45 NS	0.8406

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: FIRMNESS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	19	416.97066429	21.94582444	13.97
ERROR	78	122.50818571	1.57061777	
CORRECTED TOTAL	97	539.47885000		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	40.67592857	4.32 **	0.0008
TIME	1	0.03269490	0.02 NS	0.8857
SAMPLE	6	363.37780000	38.56 **	0.0001
TIME*SAMPLE	6	12.88424082	1.37 NS	0.2384

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: SMOOTHNESS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	19	154.96267653	8.15593034	1.96
ERROR	78	325.28902245	4.17037208	
CORRECTED TOTAL	97	480.25169898		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	21.00946327	0.84 NS	0.5431
TIME	1	18.14600918	4.35 *	0.0403
SAMPLE	6	85.69136327	3.42 **	0.0047
TIME*SAMPLE	6	30.11584082	1.20 NS	0.3134

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: COLOUR

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	19	372.27569898	19.59345784	10.96
ERROR	78	139.43557551	1.78763558	
CORRECTED TOTAL	97	511.71127449		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	88.49219592	8.25 **	0.0001
TIME	1	169.14859694	94.62 **	0.0001
SAMPLE	6	108.26302449	10.09 **	0.0001
TIME*SAMPLE	6	6.37188163	0.59 NS	0.7341

Appendix IX-A cont'd.

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: AFTERTASTE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	19	323.89273571	17.04698609	5.29
ERROR	78	251.26011429	3.22128352	
CORRECTED TOTAL	97	575.15285000		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	211.53180000	10.94 **	0.0001
TIME	1	64.44368265	20.01 **	0.0001
SAMPLE	6	38.83651429	2.01 NS	0.0743
TIME*SAMPLE	6	9.08073878	0.47 NS	0.8287

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: GENERAL ACCEPTABILITY

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	19	339.89918878	17.88943099	7.18
ERROR	78	194.34513061	2.49160424	
CORRECTED TOTAL	97	534.24431939		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	62.65826939	4.19 **	0.0011
TIME	1	5.44971531	2.19 NS	0.1432
SAMPLE	6	262.51826939	17.56 **	0.0001
TIME*SAMPLE	6	9.27293469	0.62 NS	0.7135

* significant at 5% level

** significant at 1% level

NS not significant

Appendix IX-B. Tukey's Test (LSD) for significant results

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: CREAMINESS
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=78 MSE=3.09632
CRITICAL VALUE OF T=1.99085
LEAST SIGNIFICANT DIFFERENCE=1.3241

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING	MEAN	N	SAMPLE
A	5.5464	14	1
A	5.2036	14	7
A	5.1750	14	4
A	4.9393	14	6
A	4.4179	14	2
A	4.3500	14	5
A	4.3036	14	3

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: SALTINESS
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=78 MSE=1.68651
CRITICAL VALUE OF T=1.99085
LEAST SIGNIFICANT DIFFERENCE=.9772

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING			MEAN		N	SAMPLE	
	A		5.9250	a	14	7	G
B	A		5.6821	ab	14	5	E
B	A	C	5.2429	abc	14	4	D
B	A	C	5.0214	abc	14	6	F
B	D	C	4.8964	bcd	14	3	C
	D	C	4.5143	cd	14	2	B
	D		4.0179	d	14	1	A

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: BEANY
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=78 MSE=2.6638
CRITICAL VALUE OF T=1.99085
LEAST SIGNIFICANT DIFFERENCE=1.2281

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING			MEAN		N	SAMPLE
	A		3.843	a	14	3
B	A		3.671	ab	14	4
B	A		3.254	ab	14	7
B	A		3.246	ab	14	5
B	A		2.721	ab	14	2
B			2.48	b	14	6
		C	1.231	c	14	1

Appendix IX-B cont'd.

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: RANCID
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=78 MSE=1.9549
CRITICAL VALUE OF T=1.99085
LEAST SIGNIFICANT DIFFERENCE=1.0521

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING	MEAN	N	SAMPLE	
A	2.7464	14	7	G
A				
A	2.6714	14	3	C
A				
A	2.2214	14	4	D
A				
A	2.1536	14	5	E
A				
A	2.1429	14	6	F
B	0.7964	14	2	B
B				
B	0.7614	14	1	A

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: ACID
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=78 MSE=2.38806
CRITICAL VALUE OF T=1.99085
LEAST SIGNIFICANT DIFFERENCE=1.1628

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING			MEAN		N	SAMPLE	
	A		4.9429	a	14	7	G
	A						
B	A		4.6036	ab	14	6	F
B	A						
B	A	C	4.2750	abc	14	5	E
B	A	C					
B	A	C	3.9107	abc	14	3	C
B		C					
B		C	3.4714	bc	14	4	D
		C					
		C	3.3836	c	14	2	B
	D		1.6036	d	14	1	A

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: FIRMNESS
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=78 MSE=1.57062
CRITICAL VALUE OF T=1.99085
LEAST SIGNIFICANT DIFFERENCE=.94303

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING		MEAN		N	SAMPLE	
	A	6.8307	a	14	1	A
	B	5.4571	b	14	2	B
	B					
	B	5.2571	b	14	4	D
	C	3.0679	c	14	6	F
	C					
D	C	2.5286	cd	14	7	G
D						
D	E	1.8179	de	14	5	E
	E					
	E	1.3857	e	14	3	C

Appendix IX-B. cont'd.

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: SMOOTHNESS
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=78 MSE=4.17037
CRITICAL VALUE OF T=1.99085
LEAST SIGNIFICANT DIFFERENCE=1.5367

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING	MEAN		N	SAMPLE	
A	7.5143	a	14	5	E
A	7.3286	a	14	3	C
B A	6.4393	ab	14	7	G
B	5.7036	b	14	6	F
B	5.4214	b	14	4	D
B	5.3171	b	14	1	A
B	4.9750	b	14	2	B

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: COLOUR
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=78 MSE=1.78764
CRITICAL VALUE OF T=1.99085
LEAST SIGNIFICANT DIFFERENCE=1.0061

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING	MEAN	N	SAMPLE	
A	6.7236	14	1	A
B	4.7250	14	2	B
C B	4.3000	14	6	F
C B	4.1000	14	7	G
C B	3.9821	14	5	E
C	3.4757	14	3	C
C	3.3500	14	4	D

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: AFTERTASTE
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=78 MSE=3.22128
CRITICAL VALUE OF T=1.99085
LEAST SIGNIFICANT DIFFERENCE=1.3505

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING	MEAN	N	SAMPLE	
A	3.9857	14	7	G
A	3.7071	14	5	E
A	3.4393	14	4	D
A	3.3893	14	6	F
A	3.3571	14	3	C
B A	2.8607	14	2	B
B	1.9057	14	1	A

Appendix IX-B cont'd.

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: GENERAL ACCEPTABILITY
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=78 MSE=2.4916
CRITICAL VALUE OF T=1.99085
LEAST SIGNIFICANT DIFFERENCE=1.1878

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING		MEAN	N	SAMPLE	
	A	7.2271	14	1	A
	A				
B	A	6.0607	14	4	D
B					
B		5.5929	14	2	B
	C	3.5643	14	6	F
	C				
	C	3.1179	14	7	G
	C				
	C	3.1179	14	3	C
	C				
	C	2.7714	14	5	E

NOTE: Results of LSD (.05) is exactly the same as DMRT (Duncan's Multiple Range Test).

APPENDIX IX-C: CORRELATION COEFFICIENTS AMONG THE DIFFERENT PARAMETERS MEASURED AND EVALUATED IN SOFT CHEESES

	OA	CREAM	SALT	BEANY	RANCID	ACID	FIRM	SMOOTH	COLOUR	A.TASTE	MOIST	TP	FAT	NaCl	pH
CREAM	0.574														
SALT	-0.741	-0.179													
BEANY	-0.588	-0.548	0.673												
RANCID	-0.765*	-0.182	0.812*	0.758*											
ACID	-0.879*	-0.396	0.850*	0.654	0.782*										
FIRM	0.977*	0.599	-0.696	-0.661	-0.815*	-0.807*									
SMOOTH	-0.808*	-0.531	0.574	0.542	0.679	0.492	-0.883*								
COLOUR	0.628	0.516	-0.705	-0.964*	0.803*	-0.751	0.675	-0.474							
A.TASTE	-0.816*	-0.360	0.950*	0.807*	0.863*	0.941*	-0.784*	0.567	-0.858*						
MOIST	-0.239	-0.315	0.068	0.501	0.489	0.403	-0.713	0.572	-0.500	0.306					
TP	0.245	0.028	-0.256	-0.312	-0.493	0.056	0.405	-0.728	0.206	-0.157	-0.249				
FAT	-0.557	-0.306	0.517	0.097	0.186	0.324	-0.504	0.667	0.003	0.359	-0.044	-0.319			
NaCl	-0.642	-0.861*	0.304	0.609	0.454	0.414	-0.718	0.724	-0.624	0.445	0.691	-0.401	0.253		
pH	0.717	0.562	-0.472	-0.589	0.545	-0.852*	0.659	-0.245	0.703	-0.701	-0.625	-0.340	0.032	-0.452	
YIELD	-0.449	0.091	0.723	0.648	0.806*	0.749	-0.433	-0.132	-0.761*	0.799*	0.170	-0.010	-0.193	0.070	-0.610

df = 7-2 = 5

* Correlation coefficients are significant at p = .05

APPENDIX IX-D: REGRESSION ANALYSIS

Flavour Attributes

The fitted equation is:

Overall Acceptability = -4.600 + 2.820 (creaminess) - 1.109 (saltiness) + 1.675 (Beany) - 2.017 (Rancid)

Column	Coeff	SD (Coeff)	t-value
constant	-4.600	2.803	-1.64
creaminess	2.820	0.416	6.78
satliness	-1.109	0.401	-2.77
beany	1.675	0.359	4.66
rancid	-2.017	0.391	-5.16

R-squared = 98.48%

Analysis of Variance

Due to	SS	df	MS	Fo	Ft.05	.01
Regression	18.474	5	3.695	25.84*	19.30	99.30
Residual	0.286	2	0.143			
Total	18.760	7				

* Significant at 5% level

Texture Attributes

The fitted equation is:

Overall Acceptability = -2.034 + 1.020 (Firmness) + 0.441 (Smoothness)

Column	Coeff	SD (coeff)	t-value
Constant	-2.034	2.593	-0.78
Firmness	1.020	0.162	6.30
Smoothness	0.441	0.334	1.32

R-squared = 96.82%

Analysis of Variance

Due to	SS	df	MS	Fo	Ft.05	.01
Regression	18.163	3	6.054	40.63**	6.59	16.69
Residual	0.597	4	0.149			
Total	18.760	7				

** Significant at 1% level

Firmness

The fitted equation is:

Overall Acceptability = 1.364 + 0.831 (Firmness)

Column	Coeff	SD (Coeff)	t-value
Constant	1.364	0.344	3.97
Firmness	0.831	0.081	10.22

R-squared = 95.43%

Analysis of Variance

Due to	SS	df	MS	Fo	Ft.05	.01
Regression	17.902	2	8.951	52.35**	5.79	13.27
Residual	0.857	5	0.171			
Total	18.760	7				

** Significant at 1% level

Acid

The fitted equation is:

Overall Acceptability = 9.774 - 1.413 (Acid)

Column	Coeff	SD (Coeff)	t-value
Constant	9.774	1.325	7.38
Acid	-1.413	0.342	-4.13

R-squared = 77.35%

Analysis of Variance

Due to	SS	df	MS	Fo	Ft.05	.01
Regression	14.510	2	7.255	8.54*	5.79	13.27
Residual	4.250	5	0.850			
Total	18.760	7				

* Significant at 5% level

APPENDIX X

IDEAL VALUES

ATTRIBUTES	JUDGES*								MEAN
	1	2	3	4	5	6	7	8	
Creaminess	5.8 6.6	7.0 7.4	- 6.8	6.2 6.9	7.10 7.15	5.2 4.7	- 7.1	4.2 7.45	6.40
Saltiness	5.0 4.2	3.2 4.0	- 5.1	6.1 6.0	4.3 5.0	4.3 5.05	- 5.1	4.5 5.35	4.80
Beany	2.8 3.65	4.5 5.1	- 1.1	1.0 1.75	3.2 2.8	1.6 1.70	- 3.4	5.8 5.5	3.10
Rancid	1.0 1.0	1.0 1.0	- 1.0	1.0 1.0	1.0 1.0	1.0 1.0	- 1.0	1.0 1.0	1.00
Acid	2.0 2.9	2.1 1.5	- 1.8	2.4 2.25	6.2 6.1	3.0 4.1	- 1.6	1.4 2.6	2.85
Firmness	4.4 5.35	6.9 7.3	- 7.0	6.2 5.2	4.8 5.35	6.6 5.3	- 6.85	6.5 8.0	6.10
Smoothness	6.4 7.6	5.6 5.4	- 10.0	5.5 5.2	6.9 5.5	8.2 8.0	- 6.8	9.6 9.0	7.10
Colour	6.5 5.7	4.5 5.4	- 2.0	5.8 6.0	6.7 5.60	5.7 5.0	- 6.70	4.6 5.50	5.40
After taste	1.3 1.5	1.5 1.6	- 1.3	1.3 1.8	1.1 1.1	1.2 1.1	- 1.3	1.0 1.5	1.30
Overall Acceptability	10 10	10 10	- 10	10 10	10 10	10 10	- 10	10 10	10.00

* Note that judges 3 and 7 did not have any judgement in the first set marked with dash (-) in the column due to their unavailability.

APPENDIX XI

APPENDIX XI-A: SAMPLE OF SCORE SHEET INDICATING IDEAL POINTS FOR EACH ATTRIBUTE EVALUATED

NAME: ______________________ DATE: ____________________

Please taste the soft cheese samples and answer each question by placing a vertical line across the horizontal line at the point that best describes that property in the sample. Label each vertical line with the code number of the sample it represents (overlapping of vertical lines is possible for 2 or more samples). Score the samples with reference to ideal point (marked "I" at the horizontal line).

SAMPLE CODE NO. ___ ___ ___ ___

1. FLAVOUR
   a) Creamy — absent ________I________ intense
   b) Salty — bland ______I__________ very salty
   c) Beany — absent ___I_____________ intense
   d) Rancid — absentI________________ intense
   e) Acid — absent __I______________ intense

2. TEXTURE (MOUTHFEEL)
   a) Firmness — very soft ________I________ very firm
   b) Smoothness — grainy ___________I_____ smooth

3. COLOUR — whitish _______I_________ yellowish

4. AFTERTASTE — absentI________________ intense

5. GENERAL ACCEPTABILITY — dislike extremely ________________I like extremely

COMMENTS: ____

____

____

____

APPENDIX XI-B: SAMPLE OF STORAGE STABILITY TEST FORM

NAME: ______________________________ DATE: ______________________

Please score the soft cheese samples presented to you according to the ideal which is marked "I" on the scale by placing a vertical line accross and label with the code number it represents.

SAMPLE CODE NO. ___ ___ ___ ___

1. FLAVOUR AND TASTE
   a) Sourness
      not sour I______________________________________ very sour
   b) Rancid
      absent I____ intense
   c) Off-flavour
      not present I___________________________________ present

   Please describe: ____
   ____

2. APPEARANCE
   d) Colour
      whitish ________________I________________________ yellowish

3. TEXTURE
   e) Firmness
      very soft __________________I____________________ very firm

4. ACCEPTABILITY
   f) Freshness
      unacceptable _____________________________________I acceptable

COMMENTS: ____
____
____
____

APPENDIX XII

STATISTICAL ANALYSIS OF MEAN RATIO SCORES OF VARIOUS SENSORY ATTRIBUTES TO IDEAL SCORES

Appendix XII-A. ANOVA for mean ratio scores of soft cheeses without MSC

CHEESE

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: CREAMINESS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	13	1.87625504	0.14432731	5.63
ERROR	42	1.07695639	0.02564182	
CORRECTED TOTAL	55	2.95321143		

SOURCE	DF	ANOVA SS	F VALUE	PR > F	Ft.05	0.1
BLOCK	6	0.24730218	1.61 NS	0.1690	2.32	3.26
TIME	1	0.00138007	0.05 NS	0.8177	4.07	7.27
SAMPLE	3	1.54624586	20.10 **	0.0001	2.83	4.29
TIME*SAMPLE	3	0.08132693	1.06 NS	0.3774	2.83	4.29

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: SALTINESS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	13	2.05777845	0.15829065	3.25
ERROR	42	2.04676454	0.04873249	
CORRECTED TOTAL	55	4.10454298		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	1.05223261	3.60 **	0.0057
TIME	1	0.19387545	3.98 NS	0.0526
SAMPLE	3	0.46291805	3.17 *	0.0341
TIME*SAMPLE	3	0.34875234	2.39 NS	0.0826

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: BEANY

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	13	14.89610921	1.14585455	3.55
ERROR	42	13.55538650	0.32274730	
CORRECTED TOTAL	55	28.45149571		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	10.16511721	5.25 **	0.0004
TIME	1	0.31861029	0.99 NS	0.3261
SAMPLE	3	4.18186471	4.32 **	0.0096
TIME*SAMPLE	3	0.23051700	0.24 NS	0.8693

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: RANCID

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	13	42.53482143	3.27190934	2.30
ERROR	42	59.84071429	1.42477891	
CORRECTED TOTAL	55	102.37553571		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	24.43928571	2.86 *	0.0200
TIME	1	0.19446429	0.14 NS	0.7137
SAMPLE	3	16.39053571	3.83 *	0.0163
TIME*SAMPLE	3	1.51053571	0.35 NS	0.7869

Appendix XII-A cont'd.

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: ACID

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	13	2.95166548	0.22705119	2.20
ERROR	42	4.33688936	0.10325927	
CORRECTED TOTAL	55	7.28855484		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	2.15343121	3.48 **	0.0070
TIME	1	0.14760045	1.43 NS	0.2386
SAMPLE	3	0.38050305	1.23 NS	0.3114
TIME*SAMPLE	3	0.27013077	0.87 NS	0.4632

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: FIRMNESS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	13	0.55895473	0.04299652	3.47
ERROR	42	0.51975582	0.01237514	
CORRECTED TOTAL	55	1.07871055		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	0.04809818	0.65 NS	0.6915
TIME	1	0.06797145	5.49 *	0.0239
SAMPLE	3	0.26299048	7.08 **	0.0006
TIME*SAMPLE	3	0.17989462	4.85 **	0.0055

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: SMOOTHNESS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	13	0.46364998	0.03566538	1.86
ERROR	42	0.80740800	0.01922400	
CORRECTED TOTAL	55	1.27105798		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	0.13865486	1.20 NS	0.3233
TIME	1	0.05947545	3.09 NS	0.0859
SAMPLE	3	0.13736363	2.38 NS	0.0830
TIME*SAMPLE	3	0.12795605	2.22 NS	0.1000

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: COLOUR

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	13	0.54330259	0.04179251	1.01
ERROR	42	1.74019239	0.04143315	
CORRECTED TOTAL	55	2.28349498		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	0.23194161	0.93 NS	0.4816
TIME	1	0.00002445	0.00 NS	0.9807
SAMPLE	3	0.28230405	2.27 NS	0.0942
TIME*SAMPLE	3	0.02903248	0.23 NS	0.8725

Appendix XII-A cont'd.

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: AFTERTASTE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	13	95.92805955	7.37908150	8.02
ERROR	42	38.64389957	0.92009285	
CORRECTED TOTAL	55	134.57195913		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	69.81073700	12.65 **	0.0001
TIME	1	0.15277902	0.17 NS	0.6857
SAMPLE	3	25.89625534	9.38 **	0.0001
TIME*SAMPLE	3	0.06828820	0.02 NS	0.9947

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: GENERAL ACCEPTABILITY

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	13	1.37609464	0.10585343	7.54
ERROR	42	0.58938929	0.01403308	
CORRECTED TOTAL	55	1.96548393		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	0.29789643	3.54 **	0.0063
TIME	1	0.00394464	0.28 NS	0.5988
SAMPLE	3	1.04131964	24.73 **	0.0001
TIME*SAMPLE	3	0.03293393	0.78 NS	0.5105

* significant at 5% level

** significant at 1% level

NS not significant

Appendix XII-B. Tukey's Test (LSD) for significant results

CHEESE

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: CREAMINESS
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=42 MSE=.0256418
CRITICAL VALUE OF T=2.01808
LEAST SIGNIFICANT DIFFERENCE=.12214

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING	MEAN	N	SAMPLE
A	0.95750	14	1
A			
A	0.95600	14	2
A			
A	0.84136	14	3
B	0.55029	14	4

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: SALTINESS
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=42 MSE=.0487325
CRITICAL VALUE OF T=2.01808
LEAST SIGNIFICANT DIFFERENCE=.16838

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING	MEAN	N	SAMPLE
A	1.15629	14	2
B	0.97329	14	1
B			
B	0.95829	14	4
B			
B	0.92121	14	3

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: BEANY
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=42 MSE=0.322747
CRITICAL VALUE OF T=2.01808
LEAST SIGNIFICANT DIFFERENCE=.43333

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING	MEAN	N	SAMPLE
A	1.5392	14	4
B	1.0897	14	2
B			
B	0.9816	14	3
B			
B	0.7972	14	1

Appendix XII-B cont'd.

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: RANCID
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=42 MSE=1.42478
CRITICAL VALUE OF T=2.01808
LEAST SIGNIFICANT DIFFERENCE=.91047

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING	MEAN	N	SAMPLE
A	2.6643	14	2
B	1.6429	14	4
B	1.4786	14	3
B	1.2500	14	1

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: ACID
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=42 MSE=0.103259
CRITICAL VALUE OF T=2.01808
LEAST SIGNIFICANT DIFFERENCE=.24511

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING	MEAN	N	SAMPLE
A	0.9273	14	2
A	0.7469	14	1
A	0.7393	14	4
A	0.7268	14	3

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: FIRMNESS
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=42 MSE=.0123751
CRITICAL VALUE OF T=2.01808
LEAST SIGNIFICANT DIFFERENCE=.08485

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING	MEAN	N	SAMPLE
A	1.05971	14	1
A	1.01629	14	3
B	0.92143	14	4
B	0.89093	14	2

Appendix XII-B cont'd.

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: SMOOTHNESS
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=42 MSE=.019224
CRITICAL VALUE OF T=2.01808
LEAST SIGNIFICANT DIFFERENCE=.10576

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING		MEAN	N	SAMPLE
	A	1.01400	14	2
	A			
B	A	0.97643	14	4
B	A			
B	A	0.91536	14	1
B				
B		0.88814	14	3

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: COLOUR
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=42 MSE=.0414332
CRITICAL VALUE OF T=2.01808
LEAST SIGNIFICANT DIFFERENCE=.15526

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING		MEAN	N	SAMPLE
	A	1.09514	14	4
	A			
B	A	1.01979	14	1
B	A			
B	A	0.94957	14	2
B				
B		0.90857	14	3

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: AFTERTASTE
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=42 MSE=0.920093
CRITICAL VALUE OF T=2.01808
LEAST SIGNIFICANT DIFFERENCE=.73165

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING	MEAN	N	SAMPLE
A	3.1923	14	4
A			
A	2.9613	14	2
B	2.1646	14	3
B			
B	1.4723	14	1

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: GENERAL ACCEPTABILITY
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=42 MSE=.0140331
CRITICAL VALUE OF T=2.01808
LEAST SIGNIFICANT DIFFERENCE=.09036

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING	MEAN	N	SAMPLE
A	0.76357	14	1
B	0.66786	14	3
B			
B	0.60857	14	2
C	0.39214	14	4

Appendix XII-C. ANOVA for mean ratio scores of soft cheeses with MSC

CHEESE

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: CREAMINESS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	13	1.51792257	0.11676327	3.99
ERROR	42	1.23013079	0.02928883	
CORRECTED TOTAL	55	2.74805336		

SOURCE	DF	ANOVA SS	F VALUE	PR > F	Ft .05	.01
BLOCK	6	0.07882236	0.45 NS	0.8419	2.32	3.26
TIME	1	0.01114464	0.38 NS	0.5407	4.07	7.27
SAMPLE	3	1.41196636	16.07 **	0.0001	2.83	4.29
TIME*SAMPLE	3	0.01598921	0.18 NS	0.9081	2.83	4.29

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: SALTINESS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	13	2.85675218	0.21975017	5.90
ERROR	42	1.56362375	0.03722914	
CORRECTED TOTAL	55	4.42037593		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	1.50321168	6.73 **	0.0001
TIME	1	0.04920714	1.32 NS	0.2568
SAMPLE	3	0.67062079	6.00 **	0.0017
TIME*SAMPLE	3	0.63371257	5.67 **	0.0023

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: BEANY

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	13	14.24172977	1.09551767	3.62
ERROR	42	12.72302607	0.30292919	
CORRECTED TOTAL	55	26.96475584		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	9.87385221	5.43 **	0.0003
TIME	1	0.00818445	0.03 NS	0.8702
SAMPLE	3	4.12312134	4.54 **	0.0076
TIME*SAMPLE	3	0.23657177	0.26 NS	0.8536

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: RANCID

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	13	74.25214286	5.71170330	2.22
ERROR	42	108.19285714	2.57602041	
CORRECTED TOTAL	55	182.44500000		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	46.47000000	3.01 *	0.0155
TIME	1	2.08285714	0.81 NS	0.3737
SAMPLE	3	20.08214286	2.60 NS	0.0648
TIME*SAMPLE	3	5.61714286	0.73 NS	0.5417

Appendix XII-C cont'd.

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: ACID

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	13	14.54032325	1.11848640	5.17
ERROR	42	9.08245446	0.21624892	
CORRECTED TOTAL	55	23.62277771		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	7.74131296	5.97 **	0.0001
TIME	1	0.02402857	0.11 NS	0.7405
SAMPLE	3	6.12693529	9.44 **	0.0001
TIME*SAMPLE	3	0.64804643	1.00 NS	0.4028

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: FIRMNESS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	13	1.49023646	0.11463357	6.60
ERROR	42	0.72983204	0.01737695	
CORRECTED TOTAL	55	2.22006850		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	0.05399025	0.52 NS	0.7914
TIME	1	0.08864257	5.10 *	0.0292
SAMPLE	3	1.15057664	22.07 **	0.0001
TIME*SAMPLE	3	0.19702700	3.78 *	0.0173

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: SMOOTHNESS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	13	0.57238325	0.04402948	1.58
ERROR	42	1.16721096	0.02779074	
CORRECTED TOTAL	55	1.73959421		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	0.17556846	1.05 NS	0.4057
TIME	1	0.00091207	0.03 NS	0.8571
SAMPLE	3	0.37286921	4.47 **	0.0082
TIME*SAMPLE	3	0.02301350	0.28 NS	0.8424

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: COLOUR

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	13	0.95563314	0.07351024	2.78
ERROR	42	1.11017936	0.02643284	
CORRECTED TOTAL	55	2.06581250		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	0.14938950	0.94 NS	0.4756
TIME	1	0.00176064	0.07 NS	0.7976
SAMPLE	3	0.67273093	8.48 **	0.0002
TIME*SAMPLE	3	0.13175207	1.66 NS	0.1898

Appendix XII-C cont'd.

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: AFTERTASTE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	13	96.74540132	7.44195395	6.34
ERROR	42	49.26979011	1.17309024	
CORRECTED TOTAL	55	146.01519143		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	73.27095618	10.41 **	0.0001
TIME	1	0.00092829	0.00 NS	0.9777
SAMPLE	3	22.97103500	6.53 *	0.0010
TIME*SAMPLE	3	0.50248186	0.14 NS	0.9337

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: GENERAL ACCEPTABILITY

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	13	1.30357321	0.10027486	6.35
ERROR	42	0.66312500	0.01578869	
CORRECTED TOTAL	55	1.96669821		

SOURCE	DF	ANOVA SS	F VALUE	PR > F
BLOCK	6	0.37596071	3.97 **	0.0031
TIME	1	0.00621607	0.39 NS	0.5338
SAMPLE	3	0.89921964	18.98 **	0.0001
TIME*SAMPLE	3	0.02217679	0.47 NS	0.7060

* significant at 5% level

** significant at 1% level

NS not significant

Appendix XII-D. Tukey's Test (LSD) for significant results

CHEESE

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: CREAMINESS
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=42 MSE=.0292888
CRITICAL VALUE OF T=2.01808
LEAST SIGNIFICANT DIFFERENCE=.13054

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING	MEAN	N	SAMPLE
A	0.95750	14	1
A			
A	0.94236	14	2
A			
A	0.86029	14	3
B	0.56343	14	4

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: SALTINESS
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=42 MSE=.0372291
CRITICAL VALUE OF T=2.01808
LEAST SIGNIFICANT DIFFERENCE=.14717

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING	MEAN	N	SAMPLE
A	1.23521	14	2
B	1.01493	14	3
B			
B	1.00921	14	1
B			
B	0.94650	14	4

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: BEANY
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=42 MSE=0.302929
CRITICAL VALUE OF T=2.01808
LEAST SIGNIFICANT DIFFERENCE=.41982

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING		MEAN	N	SAMPLE
	A	1.5046	14	4
	A			
B	A	1.1749	14	2
B				
B		0.9170	14	3
B				
B		0.7972	14	1

Appendix XII-D cont'd.

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: RANCID
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=42 MSE=2.57602
CRITICAL VALUE OF T=2.01808
LEAST SIGNIFICANT DIFFERENCE=1.2242

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING		MEAN	N	SAMPLE
	A	2.8643	14	2
	A			
B	A	2.1214	14	3
B	A			
B	A	1.6643	14	4
B				
B		1.2500	14	1

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: ACID
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=42 MSE=0.216249
CRITICAL VALUE OF T=2.01808
LEAST SIGNIFICANT DIFFERENCE=.3547

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING	MEAN	N	SAMPLE
A	1.6152	14	2
B	1.0577	14	3
B			
B	0.8805	14	4
B			
B	0.7469	14	1

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: FIRMNESS
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=42 MSE=.017377
CRITICAL VALUE OF T=2.01808
LEAST SIGNIFICANT DIFFERENCE=.10055

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING		MEAN	N	SAMPLE
	A	1.05971	14	1
	A			
B	A	0.99064	14	3
B				
B		0.90743	14	4
	C	0.67921	14	2

Appendix XII-D cont'd.

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: SMOOTHNESS
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=42 MSE=.0277907
CRITICAL VALUE OF T=2.01808
LEAST SIGNIFICANT DIFFERENCE=.12716

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING	MEAN	N	SAMPLE
A	1.12743	14	2
B	0.99793	14	4
B	0.94257	14	3
B	0.91536	14	1

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: COLOUR
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=42 MSE=.0264328
CRITICAL VALUE OF T=2.01808
LEAST SIGNIFICANT DIFFERENCE=.12401

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING		MEAN	N	SAMPLE
	A	1.11643	14	4
B	A	1.01979	14	1
B	C	0.91671	14	2
	C	0.82407	14	3

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: AFTERTASTE
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=42 MSE=1.17309
CRITICAL VALUE OF T=2.01808
LEAST SIGNIFICANT DIFFERENCE=.82614

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING	MEAN	N	SAMPLE
A	3.2252	14	2
A	2.7415	14	4
A	2.4339	14	3
B	1.4723	14	1

ANALYSIS OF VARIANCE PROCEDURE

T TESTS (LSD) FOR VARIABLE: GENERAL ACCEPTABILITY
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE

ALPHA=.05 DF=42 MSE=.0157887
CRITICAL VALUE OF T=2.01808
LEAST SIGNIFICANT DIFFERENCE=.09584

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

T GROUPING	MEAN	N	SAMPLE
A	0.76357	14	1
B	0.66500	14	3
C	0.52857	14	2
D	0.43214	14	4

APPENDIX XIII

QUOTED PRICES AND SOURCES CONSIDERED IN THE COST ANALYSIS

(As of January 1989)

	ITEMS	SOURCE[1]	UNIT COST (Pesos)
1.	Carabao's milk (raw)	Selarce Farms	₱ 9.50/li
2.	Cow's milk (raw)	DTRI	5.75/li
3.	Cow's milk (pasteurised)	DTRI	12.00/li
4.	Dried Soybeans	Los Banos Market	15.00/kg
5.	Soybean milk (bottled)	Supermarket	2.00/200 g
6.	Skimmilk powder	Divisoria (Manila)	1,145.00/bag
7.	Coconut	Los Banos Market	3.00/nut
8.	Fresh Cream	DTRI	60.00/li
9.	Rennet Substitute	DTRI	200.00/li
10.	Salt	Los Banos Market	5.00/kg
11.	Cheese colour	DTRI	30.00/li
12.	Kesong Puti (White Cheese)	DTRI	12.00/pc
13.	Soft Cheese	Magnolia Dairy Co.	14.95/200 g
14.	Packaging Material	Liana Trading (Manila)	0.37/pc

1 Philippine distributors, retailers or local market