Formulation of a Cheese Spread with the Highest Possible Substitution of Coconut Skim Milk for Non-Fat Dry Milk

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ABSTRACT

Studies were conducted to formulate a low-cost cheese spread from coconut skim milk and to determine its storability. Prepared coconut skim milk was used to develop two formulations of cheese spread with 30 % of non-fat dry milk (NFDM) with 70 % of coconut skim milk (CSM) and 20 % of NFDM with 80 % CSM respectively. Sensory evaluation (5-point hedonic scale) was conducted to select the more acceptable formulation. It was subjected to 4 different antioxidant levels and the best level was selected through a sensory evaluation. The selected coconut cheese spread was compared with a market available cheese spread through a sensory evaluation served with no carriers and the final sensory evaluation was conducted to compare both the samples with carriers. Chemical and microbiological analyses were conducted to check protein (%), fat (%), sugar (%), mineral (%), moisture (%), salt content, fatty acid profile; total yeast and mould count. The cost analysis was also done.

Except for a pleasant mild coconut flavour, other sensory qualities were comparable to those of market available cheese spread. The modified food product is rich in protein (13.0 %) and apart from its significantly lower fat (2.8 %) and higher moisture contents compared to market available cheese spread, it has the compositional equivalence of cheese spread made from fresh cow's milk.

Coconut cheese spread is easy to make even without emulsifiers, thus making this cheaper and nutritious modified food product for low-income consumers.

Further studies are suggested in extending the shelf life and improving the colour of the acceptable product.

KEY WORDS: Cheese Spread, Coconut Skim Milk, Cost Analysis, Sensory Evaluation, Storability

INTRODUCTION

Coconut (*Cocos nucifera* L.), which belongs to the family Palmae is one of the major plantation crops cultivated in Sri Lanka which is the fourth largest coconut producer in the world. As central bank estimated it accounts for about 2 % (Anon, 2004a) to the Gross Domestic Production and generated Rs.8,926 million (Anon, 2004b) export earning in year 2003.

Coconut is an important source of edible fats and proteins in the daily diet providing 22 % of the caloric intake (Jayasekara, 2004). As an important sector of the economy of Sri Lanka, the viability of coconut industry should be improved through product development and diversification. On the other hand, when there is an abundant supply of coconut, it results in a drop of prices. Therefore, alternatives for the utilization of coconut products must be explored to improve the viability of the industry.

Majority of Sri Lankans, in general, are not traditional cheese consumers since the cheese made from dairy milk are much expensive. Hence, there is a need to develop inexpensive yet nutritious high energy, value added food products such as cheese particularly for low income bracket.

Various substitutes also referred to as cheese analogs, imitation cheese, and so on, are increasingly entering the market place. They commonly have all or some of the milk fat replaced with vegetable protein. The incentives for developing such products are lower cost, ready availability of substitute ingredients, changing consumer tastes, and real or perceived health benefits. Newer products for which there is demand include cheese substitutes with reduced levels of fat, cholesterol, and sodium (Potter and Hotchkiss, 1995).

While the local dairy industry is still stepping up its milk production and the cheese made from dairy milk are much expensive, it is timely that vegetable milks such as coconut be tapped to develop new products utilizing cheaper and indigenous resources.

Coconut milk is rich in fat and emulsifiers (Banzon, 1978) and, like cow's milk is a natural oil-in-water emulsion; hence, both can mix easily. An earlier study by Sanchez and Rasco (1983) showed that formulations having higher amount of NFDM (10 % coconut milk + 90 % NFDM to 40 % coconut milk + 60 % NFDM) produced hard curd while those with low amount of NFDM (70 % of coconut milk + 30 % NFDM to 90 % coconut milk + 10 % NFDM) produced curd that were too soft to be cut.

The objectives of this study were therefore, to utilize coconut milk as cow's milk extender in processing low cost, nutritious soft cheese (coconut cheese spread); to establish the best level of substitution of coconut skim milk for non-fat dry milk through sensory tests; to determine the suitable antioxidant level for the best formulation through a sensory evaluation in terms of appearance, colour, taste, texture and overall acceptability; to compare the formulated soft cheese spread with a commercially available cheese spread; to determine the stability of the acceptable products at ambient (30±2 ^{0}C) and refrigerated (5±2 ^{0}C) temperature, and to establish the approximate cost of production of coconut cheese spread.

MATERIALS AND METHODS

The study was conducted at the laboratory of Coconut Processing Research Division of Coconut Research Institute, Lunuwila from December 2004 to May 2005.

The major raw materials used in the study consisted of coconut skim milk (CSM) and non-fat dry milk (NFDM). The CSM along with NFDM and fresh cow's milk was analysed for proximate composition.

1. Preparation of Coconut Skim Milk and Analysis of Proximate Composition

Well-matured, dehusked coconuts were split opened and scraped using a motorized rotary scraper. The scraped coconut meat was kept under refrigeration (5 ±2 ^{0}C) overnight. Coconut milk was obtained by pressing the chilled coconut with the use of a hydraulic pressing machine (Sakaya). Three extractions were done for the same coconut meat sample. The first extraction was done without using water and other two extractions were obtained each with (5:1 w/v) cold water. Proximate composition of extracted coconut milk was analyzed according to the methods given in Table 1.

2. Preparation of Coconut Cheese Spread

Coconut cheese spread was prepared by modifying the method of Dulay (1980).

The cheese starter was prepared by boiling 90ml of fresh cow's milk for 10 minutes, then cooled to 42 ^{0}C and inoculated with 1 % inoculum (starter culture). The cultures were incubated at 42 ^{0}C. After 12-16 hrs of incubation, the cultures were transferred to 5±2 ^{0}C storage until use.

Two hundred and fifty grams of CSM was weighed and heated at 72 ^{0}C for 5 minutes in a water bath with constant stirring. CSM was cooled to 60 ^{0}C and 75 g of NFDM and 2.5 g of white pepper powder were added and the mixture was homogenized at 12,000 rpm at 30 ± 2 ^{0}C for 3 minutes.

Table 1. Analytical methods adapted to measure approximate composition of food samples

Component	Method	Reference
Moisture	Standard oven method	Pearson,1973
Total sugar	Lane- Eynon method	Pearson,1973
Crude protein	Micro Kjeldahl method	AOAC 991.20,1999
Crude fat	Rose-Gottlieb method	Pearson, 1973
Mineral	Dry ashing method	Pearson, 1973
Fatty acid profile	GC method	Anon, 1998

The homogenized mixture was cooled to 40 ^{0}C and 5 % (w/v) of starter culture (*Lactococcus lactis* subsp. *lactis* and *Lactococcus lactis* subsp. *cremoris*.) was added. This was allowed to stand for 15 minutes, and 2 % (w/v) of salt was added. This mixture was filtered through white cotton cloth, pasteurized at 72 ^{0}C for 5 minutes in a water bath and cooled immediately in an ice-cold water bath to 40 ^{0}C. Subsequently, 0.003 % (w/v) of commercial rennet was added, stirred, and kept in an incubator at 42 ^{0}C for 3 hours for coagulation. The curd was cut and mixed for 3 minutes by using a mixer. The cheese was transferred to a white cotton cloth and allowed to drain for 3-4 hrs at 5 ±2 ^{0}C. The coconut cheese spread was poured into sterilized glass bottles and stored under refrigeration. The process flow of the manufacture of coconut cheese spread is shown in Figure 1.

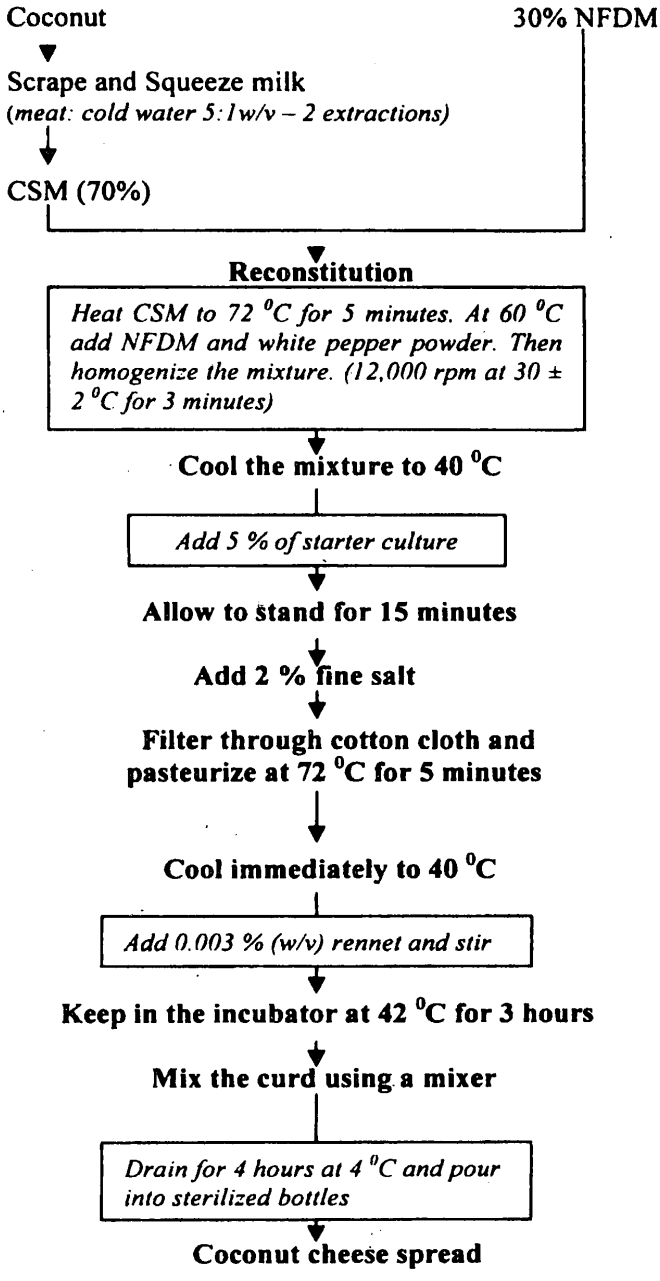

Figure 1. Process flow of the manufacture of coconut cheese spread

3. Preparation of Three Various Formulations of Coconut Cheese Spread

The following three formulations were done using various combinations of CSM and NFDM.

C1 - 70 % CSM + 30 % NFDM
C2 - 80 % CSM + 20 % NFDM
C3 - 90 % CSM + 10 % NFDM

4. Selection of the most acceptable Formulation

Since the formulation of 90 % CSM + 10 % NFDM did not produce a curd it was not sensory evaluated. Other two processed coconut cheese spreads were evaluated for sensory attributes; appearance, colour, taste, texture and overall acceptability by using 40-member semi-trained panelists. Modified 5-point hedonic scale was used to evaluate the cheese spreads as follows.

Like very much	5
Like moderately	4
Neither like nor dislike	3
Dislike moderately	2
Dislike very much	1

Results of sensory evaluation were analysed using non-parametric Wilcoxon Rank Sum Test in the Statistical Analysis System (SAS) software package (Anon, 1999).

5. Selection of the most acceptable Level of Antioxidant

The better cheese spread of the two formulations was selected on the results of sensory evaluation and was prepared in bulk. The entire cheese spread was divided into 4 groups and subjected to 4 different treatments.

T1 - Not treated (Control)
T2 - Treated with 0.1 % antioxidant
T3 - Treated with 0.5 % antioxidant
T4 - Treated with 1 % antioxidant

Sensory attributes such as appearance, color, taste, texture and overall acceptability of four treated cheese spreads were evaluated using 40-member semi-trained panelists. The samples were stored under refrigeration ($5 \pm 2\ ^{0}C$).

The data obtained in this evaluation were analysed using non-parametric Kruskal Wallis test in the Statistical Analysis System (SAS) software package (Anon, 1999). The best treatment was selected and used for further analysis.

6. Comparison of Formulated Cheese Spread with Market available Cheese Spread

6.1 Served with no carriers

The formulated cheese spread was compared with randomly selected market available cheese spread. The two cheese samples were presented to a 40-member semi-trained panel for evaluation of sensory attributes; appearance, color, taste, texture and overall acceptability with no carriers.

6.2 Served with carriers

Since the cheese spread is a food product consumed with some carriers such as crackers, cookies and bread, the sensory attributes of cheese spread served with carriers were evaluated by presenting them to 35- member semi-trained panelists.

The data obtained for the above two evaluations were analysed using the non-parametric Wilcoxon Rank Sum Test of the Statistical Analysis System (SAS) software package (Anon, 1999).

7. Physico-chemical Analysis of Formulated Cheese Spread and Market available Cheese Spread

Proximate composition of formulated and market available cheese spreads was analysed for components according to the methods given in Table 1 except the method for crude fat - Werner-Schmid process; salt content (Pearson, 1973). In addition pH was measured using pH meter. The significance of each physico-chemical parameter of the two samples was tested using the two sample t-test in the Statistical Analysed System (SAS) software package (Anon, 1999).

8. Shelf Life Studies

Shelf life studies were done every week for 3 months. Peroxide values, free fatty acid (FFA) content were estimated by titration methods (Pearson, 1973) and the moisture content was determined by the standard oven method (Pearson, 1973).

Yeast and mould counts were recorded as a measure of microbial parameter using the Petrifilm™ method (AOAC 997.02, 1999).

9. Cost Analysis

The current cost of materials, energy and labour was used in the calculation of the cost of production of coconut cheese spread.

RESULTS AND DISCUSSION

1. Proximate Composition of CSM compared to NFDM and Fresh Cow's Milk

According to the data illustrated in Table 2, the composition of CSM approximately meets the average gross composition of fresh cow's milk. The reason for adding NFDM was to increase the total soluble solids.

Table 2. Composition of CSM, NFDM and Cow's milk

Component	CSM[1]	NFDM [a]	Fresh cow's milk[b]
Moisture %	84.5	3.0	87. 2
Total sugar %	6.4	52.3	4.9
Crude protein %	4.4	35.9	3.5
Crude fat %	3.6	0.8	3.7
Mineral %	1.1	8.0	0.7

[1] *Values are the average of triplicate analyses.*
[a] *Source: Hangrove and Alford, 1974.*
[b] *Source: Johnson, 1974.*

Table 3. Fatty acid composition of coconut skim milk

Name of fatty acid		Peak area %
Capric acid	(C10:0)	2.0
Lauric acid	(C12:0)	46.1
Myristic acid	(C14:0)	24.2
Palmitic acid	(C16:0)	11.7
Stearic acid	(C18:0)	2..9
Oleic acid	(C18:1)	8.7
Linoleic acid	(C18:2)	4.4

Analysis of fatty acid composition showed that Lauric acid was the most abundant fatty acid (46.1 %) whereas the Capric acid content was the lowest in CSM (Table 3). The Fat globules may have not ruptured due to the use of chilled coconut meat and cold water for the extraction of coconut milk resulting the absence of Caprilic and Caproic acids in CSM.

2. Sensory Attributes of Two Formulations

The results indicate that all the sensory attributes for both formulations were significantly different (Table 4). Out of the two formulations, 30 % NFDM + 70 % CSM (C1) formulation showed higher mean scores for all the sensory attributes; appearance, colour, taste, texture and overall acceptability (50.1, 49.7, 46.8, 46.9 and 46.4 respectively). Among the mean scores of all the sensory attributes of C1 formulation, the highest mean score (50.1) was for the appearance. It was followed by the colour and more or less similar mean scores were for the other sensory attributes (Table 4). Comparatively lower mean scores for all the sensory attributes for C2 formulation may be due to increased coconut flavour and characteristic white colour with higher substitution of CSM. Therefore, C1 was selected as the better formulation for further studies.

Table 4. Probability values and mean scores of sensory attributes of two formulations of cheese spread

Attributes	p Value	Mean scores	
		C1	C2
Appearance	<.0001	50.1	30.9
Colour	0.0001	49.7	31.3
Taste	0.0116	46.8	34.2
Texture	0.0096	46.9	34.1
Overall acceptability	0.0162	46.4	34.6

Probability value ($p \leq 0.05$) significantly different, N = 40
C1 = 70 % CSM + 30 % NFDM
C2 = 80 % CSM + 20 % NFDM

3. Sensory Attributes of Treated Cheese Spread Samples

Table 5. Probability values and mean scores of sensory attributes of four types of cheese spread with different level of antioxidants

Attributes	p Value	Mean scores			
		T1	T2	T3	T4
Appearance	<.0001	53.3	70.0	104.6	94.2
Colour	0.0009	61.9	73.7	99.7	86.7
Taste	0.0050	63.7	80.8	99.5	78.0
Texture	<.0001	58.4	71.2	104.7	87.6
Overall acceptability	0.0013	59.2	78.5	97.4	87.0

Probability value ($p \leq 0.05$) significantly different, N = 40
T1 – Not treated (Control)
T2 – Treated with 0.1 % antioxidant
T3 – Treated with 0.5 % antioxidant
T4 – Treated with 1 % antioxidant

The appearance, colour, taste, texture and overall acceptability were significantly different (Table 5) among the four treatments (T1, T2, T3 and T4). The control (T1) scored the lowest, while the one which was subjected to 0.5 % of antioxidant showed the highest mean score value for all the sensory attributes. The mean score for appearance, colour, taste, texture and overall acceptability were 104.6, 99.7, 99.5, 104.7 and 97.4 respectively. Therefore, T3 (treated with 0.5 % antioxidant) could be regarded as the best treatment for further analysis.

4. Sensory Attributes of the Formulated and Market available Cheese Spread

Results of the evaluation of both cheese spreads served without carriers showed that, colour, taste and overall acceptability of formulated cheese spread were significantly different from those of market available cheese spread (Table 6). No significant difference was observed in appearance and texture between the two samples. SC2 showed higher mean scores for taste, colour and overall acceptability (49.4, 45.3 and 49.2 respectively). The lower score for taste of SC1 (31.6) compared to that of SC2 (49.4) could be due to its distinct coconut oily taste. Some panelists commented that it should be served with some carriers such as crackers, bread and cookies to overcome the oily taste and those who did not like the coconut flavour in the formulated cheese spread suggested the addition of other flavors to mask the coconut flavour. It is common observation that if a product is to be developed to substitute for another, it has to be presented continuously so that consumers will accustom themselves to the new flavour and product characteristics (Davide *et al.*, 1985).

The colour of SC1 could be improved with permitted food colouring hence the market available cheese spread contains the artificial food colouring. The lower mean score for overall acceptability of SC1 may be due to the above mentioned reasons for the taste and colour.

Table 6. Probability values and mean scores of sensory attributes of formulated and the market available cheese spreads

Attributes	p Value	Mean scores	
Without carriers*		**SC1**	**SC2**
Appearance	0.0562	36.0	50.0
Colour	0.0482	35.7	45.3
Taste	0.0002	31.6	49.4
Texture	0.1156	36.8	44.2
Overall acceptability	0.0001	31.8	49.2
With carriers**		**SC1**	**SC2**
Appearance	0.1764	32.6	38.4
Colour	0.0002	26.9	44.1
Taste	0.0928	31.9	39.1
Texture	0.1334.	32.3	38.7
Overall acceptability	0.0903	32.2	38.8

*Probability value ($p \leq 0.05$) significantly different, *N1 = 40, **N2=35*
SC1 = Formulated cheese spread
SC2 = Market available cheese spread

The results revealed that there was no significant difference ($p \leq 0.05$) for appearance, taste, texture and overall acceptability except for colour between the 2 samples served with carriers (Table 6). However, the SC2 showed higher mean scores for all sensory attributes (38.4, 44.1, 39.1, 38.7 and 38.8 respectively). Results showed that the mean score for colour of SC1 (26.9) was significantly lower when compared to that of SC2 (44.1). Addition of white pepper may have contributed to the bad colour of SC1. However, it could be improved with permitted colouring.

Overall comments by the panelists indicated that the formulated cheese spread was highly acceptable despite its coconut flavour.

Table7.Chemical composition of formulated cheese spread and market available cheese spread

Parameters	SC1	SC2	p Value
Moisture (%)	78.84	52.20	<0.0001
Crude protein (%)	13.10	16.00	0.0528
Crude fat (%)	2.76	26.00	0.0014
Total sugar (%)	2.00	2.50	0.0125
Salt (%)	2.00	1.90	0.424
Mineral (%)	1.30	1.40	0.4818
pH	5.05	5.35	<0.0001

Each value represents the mean of triplicate analyses.
Probability value ($p \leq 0.05$) significantly different
SC 1 = Formulated cheese spread
SC 2 = Market available cheese spread

5. Chemical Analysis

The results of chemical analysis of the both cheese spreads showed that there was significant difference in moisture, crude fat, total sugar and the pH value between the two samples (Table 7). The coconut cheese spread showed higher moisture (78.84%) than that of market available cheese spread (52.20 %). It may be due to considerably lower fat content in SC1 (2.76 %) compared to that of market available cheese spread (26 %). Total sugar content was slightly higher in cheese spread made from dairy milk. The pH value SC1 was slightly low since it was fermented.

Table 8. Fatty acid composition of formulated cheese spread (SC1) and market available cheese spread (SC2)

Name of fatty acid		Peak area (%)		Ratio SC1 : SC2
		SC1	SC2	
Caproic acid	(C06:0)	0.5	0.8	1: 1.6
Caprylic acid	(C08:0)	7.8	0.9	8.7:1
Capric acid	(C10:0)	6.3	2.6	2.4:1
Lauric acid	(C12:0)	45.4	3.2	14.2:1
Myristic acid	(C14:0)	20.9	10.6	2.0:1
Palmitic acid	(C16:0)	9.1	25.7	1: 2.8
Stearic acid	(C18:0)	0.6	3.0	1: 5.0
Oleic acid	(C18:1)	7.1	22.4	1: 3.2
Linoleic acid	(C18:2)	2.3	8.4	1: 3.6
Others		-	22.4	

Analysis of fatty acid composition of both cheese spreads showed that Lauric acid was the most abundant fatty acid (45.4 %) found in the formulated cheese spread whereas it was Palmitic acid (25.7%) in the market available cheese spread made from dairy milk (Table 8). The content of Caproic, Palmitic, Stearic, Oleic, and Linoleic fatty acids of the SC1 (0.5 %, 9.1 %, 0.6 %, 7.1 % and 2.3 % respectively) were lower than those of SC2 while composition of Caprylic, Capric, Lauric and Myristic acids were higher than those of SC2. Calculations showed that there was a higher ratio of Caprylic, Lauric acid (8.6:1, 14.2:1) and lower ratio of Stearic acid (1:5.0) between SC1 and SC2. Results indicated that the market available cheese spread contained other unidentified fatty acids. The difference in fatty acid composition in the two products resulted the distinct flavour and taste for those products.

6. Shelf Life Studies

Total yeast and mould count below 3 colonies/g was observed during the 3 months period (Table 9). The international microbial legislation for soft cheese should not exceed 10^2-10^3 cfu /g with their freedom from all pathogenic microorganisms (Law, 1999).

Since the colony count was within the standard limits, the cheese spread could be kept for 3 months under refrigeration. FFA and moisture contents increased on storage (Table 9). However, the increments were very small. 1 % of FFA is the critical limit for most of food commodities. Peroxide value was negligible over the 3 months of storage.

Table 9. Physico-chemical and microbiological parameters of the formulated cheese spread at different shelf life periods

WAP	Moisture %	FFA %	Peroxide value (meq/kg)	Yeast & Mould Count (YMC)/g
1	73.68	0.0016	0	0
2	75.35	0.0059	0	$1x10^2$
3	78.14	0.0077	0	$1x10^2$
4	80.05	0.0086	0	$2x10^2$
5	82.10	0.0098	0	$2x10^2$
6	83.56	0.0143	0	$2x10^2$
7	84.93	0.0154	0	$2x10^2$
8	85.10	0.0256	0.0001	$3x10^2$
9	86.35	0.0543	0.0001	$3x10^2$
10	85.10	0.0723	0.0001	$3x10^2$
11	85.00	0.0956	0.0002	$3x10^2$
12	85.40	0.1630	0.0002	$3x10^2$

WAP = Weeks After Preparation
FFA % = Free Fatty Acids

7. Cost Analysis

Calculations showed that a 180 g bottle of coconut cheese spread cost Rs. 93.02 (Table 10) as compared to market available dairy cheese spread of the 140 g bottle, reflecting a 70 % cost reduction.

CONCLUSIONS

This investigation has demonstrated that a low cost technology for the production of a cheese spread from 70 % CSM and 30 % NFDM which is cheaper than the market available cheese spread. This new modified food product possesses good quality and high consumer's acceptance. The development of formulated cheese from CSM and NFDM must be viewed as a challenge rather than a threat to the local developing dairy industry since this could make available the highly nutritious, yet cheaper food product for low-income consumers.

Since the product stability is 3 months, further research should be carried out to extend the shelf life and to improve the colour of the product.

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Table 10. Cost of production of coconut cheese spread

Item	Unit	Value (Rs.)
1.Coconut @ Rs.12.00/nut	100 nuts	1200.00
2.Non-Fat Dry Milk @ Rs.440/kg	6 kg	2640.00
3.Starter culture (including dairy milk for sub culture preparation) @ Rs.200.00/20 g	22 g	240.00
4.Rennet (commercial) @ Rs. 200.00/20 g	5.9 g	59.00
5.Salt @ Rs.40.00/kg	392 g	15.68
6.Citric acid @ Rs.100.00/kg	98 g	9.80
7.White pepper: @ Rs.133/100 g	196 g	260.68
8.Filter cloth @ Rs.50.00/m	2 m	100.00
9.Nut processing - Labour charges for dehusking (@ Rs.300/1000nuts), pairing deshelling, & scraping (@ Rs.250.00/1000nuts)	100 nuts	105.00
10.Utilities:		
a. Electricity	Rs.5.00/unit	35.78
b. Packing materials @ Rs.5.00/180 g bottle	78 bottles	390.00
c. Labels @ Rs.3.00 / label	78	234.00
11.Labour charges (for processing, bottling and labelling) @ Rs.250.00/manday	3 mandays	750.00
12.Average machine depreciation cost @ 10% per initial value per year		3.47
13.Output (Coconut cheese spread)	14 kg	
Total Capital		6043.41
Interest on Capital @ 7 % /annum	Rs.1.16/ day	3.48
TOTAL COST		**6046.89**
Break-even price/180 g bottle		**77.52**
20 % profit margin		15.50
Price per 180 g bottle		**93.02**

REFERENCES

Anon, (1998). Gas Chromatography. Supelco. Bellefonate:USA.p. 24-25.

Anon, (1999). SAS/ATAT software, Institute inc.Cary, NC27513, USA.

Anon, (2004 a). Annual Report 2004. Colombo: Central Bank of Sri Lanka. p. 42-43.

Anon, (2004 b). Plantation Sector Statistical Pocket Book 2004. Colombo: Ministry of Plantation Industry. p. 3.

Banzon, J. A., (1978). Reconstitution of milk using coconut milk and non-fat dry milk. *Phil. J. of Coconut Studies*. **3** (2):1-8.

Davide, C.L., C.N. Peralta, I.G. Sarmago and L.E.Sarmago., (1985). Utilization of skim milk powder and water-extracted coconut milk in low-fat filled milk processing. *Phil. J. Coconut Studies*.**10** (1):48-59.

Dulay, T.A., (1980). Laboratory Manual in Dairy Science 135. College, Laguna. p. 99.

Hangrove, R.E. and J.A. Alford., (1974). Composition of milk products. *In*: Fundamentals of Dairy Chemistry, 2nd ed. B.H. Webb, A.H.Johnson and J.A. Alford (Editors). AVI Publishing Co., Inc. USA., p.71.

Jayasekara, C., (2004). Coconut Industry: New Challenges and Vision to increase Coconut Production, *In* Proceedings of the First Symposium on Plantation Crop Research-Current Trends and Future Challenges. (Eds A.K.N. Zoysa and M T Ziyad Mohamed). The Tea Research Institute of Sri Lanka, Talawakelle, p. 15-18.

Johnson, A.H., (1974). The composition of milk. *In*: Fundamentals of Dairy Chemistry, 2nd ed. B.H. Webb, A.H. Johnson and J.A. Alford (Editors). AVI Publishing Co., Inc. USA., p.6.

Law, B.A., (1999). Microbiological surveillance and control in cheese manufacture. *In* Technology of cheese making (Law, B.A. ed.) 1st Ed. Academic Press, p. 251-280.

AOAC International, Official methods of analysis, (1999). 16th ed; 5th Revision, Gathersburg, MD, methods, 991.20, 997.02.

Pearson, D., (1973). Laboratory Techniques in Food Analysis. 1st ed .London: Butterworth & Co. (Publishers) Ltd, p. 31-32,52-54, 56-57, 127-128, 134-136, 159-160.

Potter, N.N. and J.H. Hotchkiss, (1995). Food Science, 5th ed. D.R. Heldman (Editor). Chapman & Hall, Inc., New York. p. 291-292, 312-313.

Sanchez, P.C. and P.M. Rasco., (1983). Utilization of coconut in white soft cheese production. *Phil. J. of Coconut Studies*, 8:18-24.