Physico-chemical and shelf life evaluation of pasteurized coconut milk

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ABSTRACT

A study was conducted to develop a pasteurized coconut milk pouch for household consumption. The study determined the stabilizer to reduce layer separation of coconut milk, optimum conditions for pasteurization, suitable packaging materials for storage and product acceptability by consumers. Coconut cream extracted using a hydraulic press from fresh coconut gratings, diluted to a fat content of 20% was the base material. The combination of 0.5% Sodium casienate and 0.5% Sodium stearoyl lactate was the more effective stabilizer for coconut milk. The optimum condition for pasteurization of coconut milk for household consumption was 72°C for 30 minutes. The FFA (Free fatty acids) content of coconut milk processed at 72°C was below 1% for the 26 days of storage. The Nylon polyethylene and aluminum laminated polyethylene pouches were equally effective as the packaging materials for packing of coconut milk. No significant differences were observed in the sensory parameters (at 0.05%) level between fresh and stored milk for two weeks. However after a storage period of 4 weeks there was a significant difference (at 0.05% level) between the texture of fresh and the stored milk, other attributes were not significant. The study showed that coconut milk pasteurized at 72°C for 20-30 minutes can be stored for one month without affecting its overall acceptability.

Key words: *Coconut milk, fat, stabilizer, pasteurization, Free fatty acids, shelf life*

INTRODUCTION

Coconut milk is a milky fluid obtained by manual or mechanical extraction of fresh coconut (*Cocos nucifera L.*) kernel with or without addition of water. It is a white, opaque protein-oil-water emulsion and essentially free from fiber (Gwee and Seow, 1997). It is valued mainly for its characteristic nutty flavor and for its nutritional content and finds its use in preparation of various dishes like meat, fish, chicken, vegetable as well as many types of cakes and desserts.

The preparation of coconut milk is done manually as a household exercise. According to the reports Sri Lanka consumes 70% of its annual nut production for domestic use and only 30% nuts are utilized by industries. Commercial production of coconut milk will help to reduce the wastage of nuts and effective utilization of by- products.

Coconut milk can be preserved by pasteurization and refrigeration. Nevertheless, such a product does not exist on the consumer market, perhaps because home refrigeration is scarce in most coconut producing countries (Hagenmaeir, 1983). The coconut milk processing is too expensive and too sophisticated for small and home-based businesses. As a matter of fact coconut plantations are mostly owned by small holders who cannot afford such expensive and sophisticated technologies. This study was carried out to find possibility of making pasteurized coconut milk with a relatively low investment and simple processing equipments. This study determined the

effectiveness of a stabilizer for coconut milk processing, optimum conditions for pasteurization and suitability of packaging materials with respect to shelf life of the product.

MATERIALS AND METHODS

Raw materials

Matured fresh coconuts were obtained from the Bandirippuwa Estate, Coconut Research Institue, Lunuwila. Food additives, Casein soluble powder and Sodium stearoryl lactylate were purchased from Hemsons International (Pvt) Ltd., and C & T world wide (pvt) Ltd. Colombo-8 respectively. The Packaging materials were purchased from Varna Ltd.

Preparation of coconut milk pouches

Initially matured fresh nuts were de-husked and splitted manually. The split coconuts were washed thoroughly with water containing 100 ppm H_2O_2 solution followed by potable water. The coconuts were shredded using coconut scraper (Odiris Electri Scraper) manually without brown testa.

The shredded coconut was steam blanched for 10 minutes and milk was extracted using hydraulic press (Sakaya -12 Model) without adding water. Calculated amounts of warm water was added to the extracted coconut milk to reduce fat content to 20% and the milk was heated to 55°C using a water bath. Vitamin E was added as an antioxidant (200 mg/kg). Then the milk was homogenized at 11,000 rpm for 15 minutes using a homogenizer. While homogenizing the stabilizers were added. Then the milk sample was pasteurized in a water bath with continuous stirring and packed in pouches. Pasteurized coconut milk was stored at 4°C.

Trials

Three experiments were carried out for standardization of different parameters.

Experiment 1

This experiment was carried out to select suitable stabilizers to prevent layer separation of coconut milk. Sterilized jam bottles were used and shelf life was evaluated for a period of three weeks. Samples were pasteurized at 72°C for 20 minutes. The treatments were as follows: 1% Sodium casinate; 1% Sodium stearoryl lactylate; 0.5 % Sodium caseinate + 0.5 % Sodium stearoryl lactylate; and control with no stabilizer.

Experiment 2

This experiment was carried out to find correct time-temperature combination for pasteurization of coconut milk. Sterilized jam bottles were used and shelf life was evaluated for a period of four weeks. The pasteurization was carried out at 72°C for 10, 20 and 30 minutes. The control sample was left unpasteurized.

Experiment 3

This experiment was carried out to select the suitable packaging material for pasteurized coconut milk. Coconut milk was pasteurized at 72°C for 30 min. and packed in nylon polyethylene and aluminum laminated polyethylene pouches. Each pack contained 100 ml of coconut milk. The shelf life of the product was evaluated for a period of four weeks.

Shelf life studies

The following parameters were evaluated:

pH, Brix value, layer separation, Free Fatty Acids (FFA) at 2-3 days intervals. The microbial plate count was determined according to the SLS: 516 (1991).

Consumer preference studies

Sago cooked with fresh and stored coconut milk (two weeks) was served to 33 untrained panelists for evaluation of taste, color, aroma and overall

acceptability, using a 9-point hedonic scale (9 - dislike extremely and 1 - like extremely) at the University of Peradeniya..

The study was repeated after a four weeks shelf life period with 22 untrained panelists at Coconut Research Institute, Lunuwila.

Statistical analysis

The sensory evaluation results were analyzed statistically using MINITAB 14. Balanced ANOVA was used at a 95% confidence level ($p < 0.05$). Total Plate Count was stastically analyzed using SAS 6.12, where two-way ANOVA is used and Mean separation was done using Dunnett's method.

RESULTS AND DISCUSSION

Coconut milk was extracted from fresh coconut meat using a hydraulic press. The yield and fat content of each extraction are given in Table 1.

residue is used to prepare defatted desiccated coconut, edible oil, poonac for animal feed, coconut flour etc. Coconut flour is prepared from coconut residue called 'sapal' using the meal discarded after milk extraction. This residue can be used as a dietary component for constipation, obesity and diabetic patients (Ramaswamy, 2006). Average fat content of house hold coconut milk is about 15% and desired fat content for culinary purposes is 20% (Perera, 2007). Therefore the milk extracted without adding water was further diluted by adding water (up to 50%) to make coconut milk pouch with 20% fat for direct consumption.

Suitable stabilizer for coconut milk

Different stabilizers, 1% Sodium caseinate, 1% Sodium stearoryl lactate, and 0.5% Sodium caseinate and 0.5% Sodium stearoryl lactate were added to the coconut milk while mixing at 55°C. Then the milk was pasteurized at 72°C for 20 minutes and stored under refrigerated conditions

Table 1. *Efficiency of milk extraction*

	No. of nuts	Wt of scraped coconuts (g)	Wt of milk extracted (g)	Yield of milk (%)	Fat content(%)
	34	8672	4953.6	57.1	35.8
	26	6733	3806.6	56.6	35
	29	7234	4205.5	58.1	-
Average	30	7546	4321.9	57.3	35.4

According to the results 57.3 % of coconut milk can be extracted from scraped coconut using hydraulic press with a fat content of 35.4%. The fat content of coconut milk extracted without adding water is 39.8-33.4 using different methods (Gwee and Seow ,1997). Chemical composition of coconut milk shows wide variation because of differences in factors such as variety, geographical location, cultural practices, and maturity of the nut, method of extraction, and the degree of dilution with added water or liquid endosperm. The advantage of processing coconut milk is the efficient utilization of coconut residue and other by products. Coconut

for 3 weeks. Fig.1 shows the changes of pH of coconut milk processed with diferent stabilizers during storage. The initial pH of coconut milk is 6-6.3. The pH value of fresh coconut milk is 5.9-6.3 (Banzon and Velasco, 1982). The pH value of the samples with no stabilizer and the samples with 1% Sodium caseinate showed a pH below the range 5.9-6.3 after 17 days. Other samples are within the range of the pH of fresh coconut milk.

The Fig. 2 shows the changes in the free fatty acid content during the storage of coconut milk processed with different stabilizers. All the

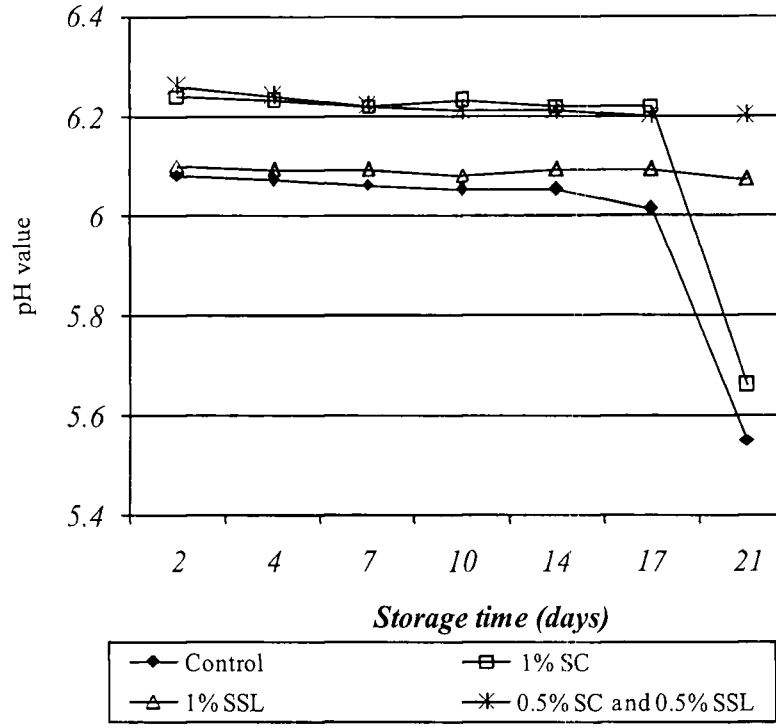

Fig.1. *Change of pH of coconut milk processed with different stabilizers during storage (SC- sodium caseinate; SSL-sodium stearoyl lactate)*

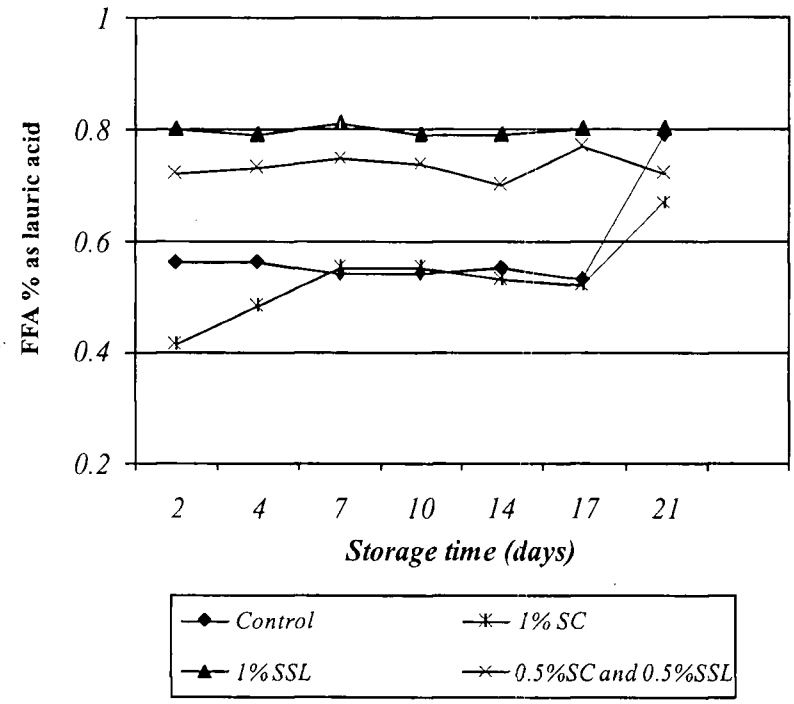

Fig.2. *Changes in FFA of coconut milk processed with different stabilizers during storage (SC- sodium caseinate; SSL-sodium stearoyl lactate)*

treatments showed acceptable free fatty acid contents, i.e less than 1% (Pearson, 1973). The free fatty acid contents of stored samples are stable up to 17 days. The sample treated with 1% Sodium caseinate and the control show increasing trend while the combinations of stabilizers and 1% Sodium stearoyl lactate show that the FFA content is stable. The FFA content of fresh coconut kernel is 0.45-0.65 % as lauric acid (Barlow *et al.*, 2006). During milk extraction and processing the FFA levels increased slightly due to handling and it was stabilized due to the heat treatment and low temperature storage. Table 2 shows that the changes in the Brix value of coconut milk processed with different stabilizers as an effect of storage period. Brix value of the control was 9 and 10 - 11 in other treatments. This may be due to the stabilizer added during processing. The addition of the stabilizer can cause the increase of total soluble solid content in coconut milk.

Table 2. *Variation of Brix value of stored coconut milk processed with different stabilizer*

No of days	Brix value (°)			
	Control	1% SC	1% SSL	0.5% SC + 0.5%SSL
2	9	10	11	11
4	9	10	11	11
7	9	10	11	11
10	9	10	11	11
14	9	10	10	11
17	9	10	11	11
21	7	8	11	11

SC- sodium caseinate; SSL-sodium stearoyl lactate

Layer separation

Fig. 3 shows the stability of emulsion with added stabilizers. Layer separation was not observed in treatment 3 where combination of stabilizers (0.5% Sodium caseinate and 0.5% Sodium stearoyl lactate) was added. Treatment 1 (1% Sodium caseinate) and the control samples showed a clear separation whereas sample treated with 1% Sodium stearoyl lactate (treatment 2) gave a comparatively low separation. The results indicated that combination of stabilizers are more suitable than the single stabilizer however, all the samples remainded with good organoleptic conditions at the end of 17 days.

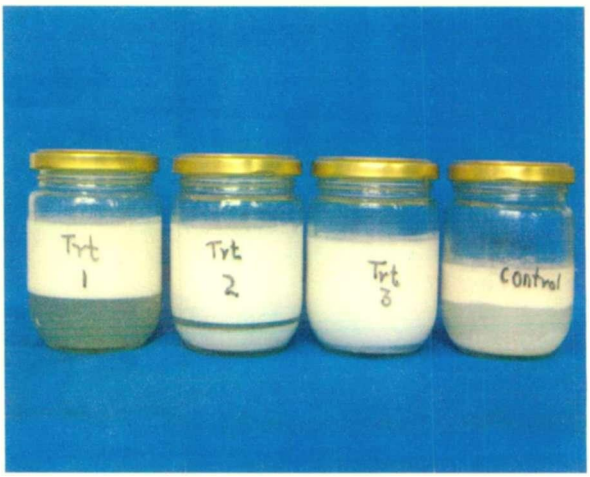

Fig.3. *Emulsion stability of processed coconut milk with stabilizers*

Pasteurization temperature

From the observation of the previous results a combination of stabilizers (0.5% Sodium caseinate and 0.5% Sodium stearoryl lactate) was added to the coconut milk at 55°C while shaking. Milk was pasteurized at 72°C for 10, 20, and 30 minutes intervals and non – pasteurized milk was used as control. The treated coconut milk was filled into jam bottles and was stored at 4°C for a period of 4 weeks.

Figs. 4 and 5 show the changes in pH value and FFA of the treated coconut milk stored for a period of four weeks. After 19 days of storage, the control samples were organoleptically unacceptable. This shows that initial sanitization and steam blanching were sufficient for about 15 days of storage at 4°C and reduced the microbial load as well as inactivated the lipase enzyme. Arumugham *et al.*, (1993) recommended the washing of the coconut meat with water containing 100 ppm H_2O_2, followed by blanching at 80°C for 10 minutes to reduce the

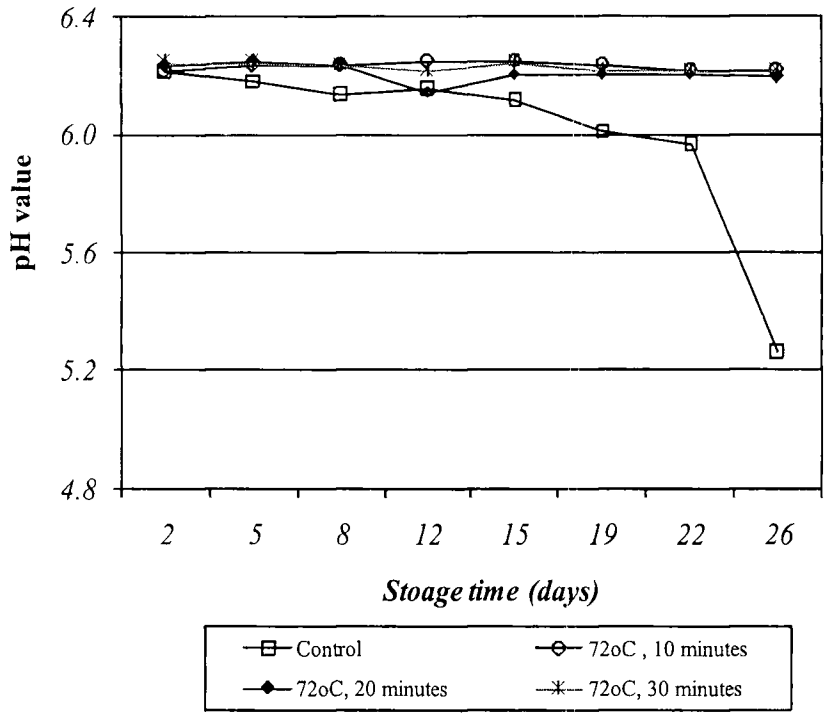

Fig.4. *Changes of pH value of coconut milk pasteurized at different conditions during storage.*

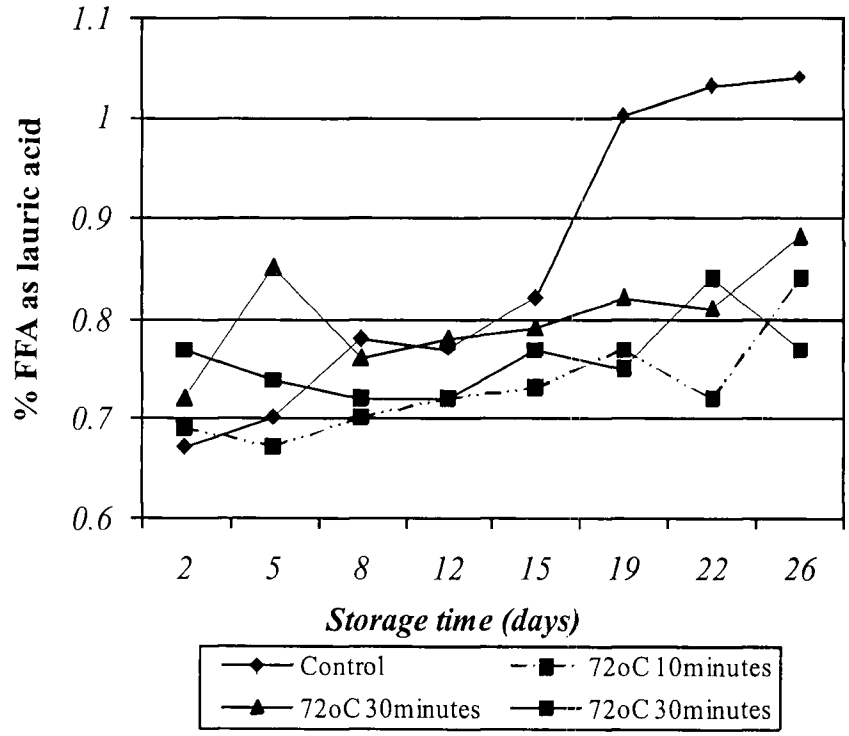

Fig. 5. *Changes of FFA of coconut milk pasteurized at different conditions during storage.*

initial microbial load and to inactivate lipase enzyme.

FFA value of pasteurized coconut milk stored at 4°C for four weeks is shown in Fig.5. The FFA value of control sample exceeded 1% (expressed as lauric acid) indicating that it is chemically unacceptable after 19 days of storage. All the other samples were within the acceptable level of FFA. Organoleptic evaluation showed that the samples remained in good condition during storage period.

Microbial analysis

Table 3 shows the effect of pasteurization on reducing the microbial load. The results are obtained by pasteurized coconut milk at 72°C for 10, 20 and 30 minutes and the non-pasteurized sample The initial microbial count of the control treatment and the treatment of heating 10 minutes show higher values than the other treatments. The initial value increased during the storage and the microbial count decreased with the time of heating.

Suitable packaging materials

Coconut milk was processed with conditions selected from previous experiments and then packed in two types of packaging materials; Nylon polyethylene and aluminum laminated polyethylene for storage. The pouches were stored at 4°C for 4 weeks. The Fig. 6 shows that the FFA values for both packaging materials were less than 1% and they are acceptable as good for consumption. The ANOVA showed that there is no significant difference ($p>0.05$) in FFA value between nylon and Aluminum pouches ($p= 0.107$).

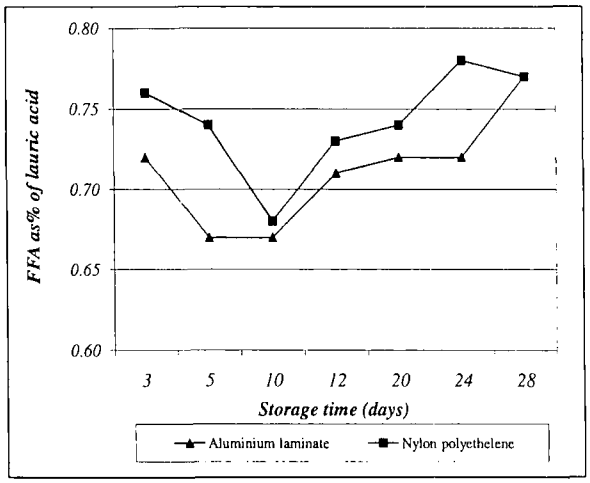

Fig. 6. *Changes of FFA of processed coconut milk packed in different packaging materials during storage.*

Sensory evaluation

Consumer preference test was performed on processed coconut milk pouches. Two sensory evaluations were carried out with different storage intervals. Sago was cooked using stored and fresh coconut milk (control) with 2 weeks and 4 weeks stored coconut milk pouches. They were served the panelists for evaluation of sensory attributes; taste, texture, aroma and overall acceptability. The results are given in Table 4. No significance difference (at $p=0.05$) between the fresh and stored coconut milk samples was observed.

Table 2. *Total Plate Count (colonies/ml) of coconut milk stored for three weeks.*

Days	Colonies/ml			
	Control	72°C; 10 minutes	72°C; 20 minutes	72°C; 30 minutes
0	2.03×10^5	2.23×10^5	4.32×10^3	3.6×10^3
7	4.3×10^6	1.02×10^6	1.62×10^5	1.05×10^5
14	5.42×10^6	1.49×10^6	1.74×10^5	3.2×10^5
21	1.21×10^7	2.23×10^6	6.15×10^5	4.2×10^5

Table 4. *Probability values and mean sensory scores for processed coconut milk stored for different time intervals.*

Attribute	Mean sensory scores					
	Two weeks			Four weeks		
	P value	Fresh milk	Stored milk	P value	Fresh milk	Stored milk
Taste	0.361	6.85	6.54	0.323	7.45	7.04
Aroma	0.495	6.42	6.15	0.633	6.54	6.27
Texture	0.100	6.61	5.91	0.006	7.50	6.14
Overall acceptability	0.855	6.82	6.39	0.219	7.45	6.91

The processed coconut milk contained a stabilizer that could change the texture of the cooked sago. However, this did not affect the panelists' decision when the coconut milk was stored for two weeks. The texure of cooked sago was significant when coconut milk stored for four weeks. The results shows that processed coconut milk remained in good condition even after 4 weeks when stored at 4°C.

CONCLUSIONS

Coconut milk can be preserved using mild heat treatments. Layer separation can be overcome by using combination of stabilizers of 0.5% sodium caseinate and 0.5% sodium stearoyl lactate. The optimum heat treatment for pasteurization was 72°C for 20 and 30 minutes. Both nylon polyethylene and aluminum laminated polyethylene are suitable for packing processed coconut milk. The processed coconut milk can be preserved for 4 weeks at 4°C.

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