

Storage of Frozen Coconut Pulp and Quality of Coconut Milk Extracted¹

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ABSTRACT

Studies conducted on the storage of coconut pulp showed this product can be stored frozen at -10°C without changes that impair the flavor of coconut milk prepared from it. The same study demonstrated that extraction of coconut milk from frozen coconut pulp yielded about 50% of that obtained from pulp at room temperature ($25\text{--}28^{\circ}\text{C}$). The chemical composition of coconut milk extracted and press-cake residue was altered. Fat content in milk from frozen coconut pulp was about 2% of that extracted from pulp at room temperature. Press-cake obtained from frozen pulp contained 15% more fat than press-cake resulting from the standard practice.

INTRODUCTION

Freezing whole or partially processed fruits and vegetables for future processing has been practiced extensively. Frozen coconut is being transported from regions of abundant production to industrial sites for processing purposes to preserve the raw materials and maintain the quality of the final product (1). The literature provides no information related to freezing and storage of coconut pulp and the effect on quality of coconut milk prepared from it. As a process for the extraction of coconut milk from fresh coconut pulp was developed by this Station (2), it seemed proper to investigate the effect, if any, of freezing and storage on the quality of the extracted milk.

MATERIALS AND METHODS

The coconuts used were purchased at a fresh produce market. They were husked and the nuts sorted before processing. Nuts soft in the eyes at the embryo end, cracked, or immature were discarded. Selected nuts were heated at 153°C (307°F) or 13.2 kg steam pressure for 8 min in a high-pressure vessel (3). The retort was equipped for a fast coming-up and an instant release of pressure during the operation. Immediately

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after the heat treatment the coconuts were broken in a coconut breaking machine (4). The broken nuts were carried by a conveyor to a sorting table where the pulp was separated, trimmed and fed into a washing reel. The clean pulp was weighed into 18-lb lots, bagged in polyethylene and placed in the -10° C freezer for storage. Polyethylene bags used were $38 \times 23 \times 61$ cm in size and 0.038 mm film thickness.

Lots of frozen pulp were taken out of the freezer according to a predetermined schedule; daily for the first 2 weeks, weekly for the following 2 weeks and monthly for the next 5 months, leaving some samples for organoleptic evaluation of the coconut milk obtained from them after a year in storage.

Samples taken from the freezer were comminuted in a hammer mill equipped with a #3 screen (36, 3.1 mm diameter perforations in 6.45 cm²). During this operation 2.1 kg ($4\frac{1}{2}$ lb) of tap water were added per lot. Water added during milling helps in dislodging ground pulp and accelerates the operation. The water added is the amount recommended in a previous work (5) on the extraction of coconut milk. After milling, the material was collected as quantitatively as possible and weighed. Temperature of ground pulp was recorded at this step.

Comminuted pulp was pressed by the rack and cloth method. The coconut milk was separated with a hydraulic press, using two nylon press-cloths and aluminum press-racks. Appropriate quantities of comminuted pulp were wrapped; first, in a finely-woven, then a coarsely-woven nylon cloth. The prepared packs were loaded on the press platen, placing a press-rack between packs to provide drainage for the milk pressed out during the operation. Pressure in the machine was raised slowly until a gauge reading of 27.2 metric tons (30 tons) was obtained. This pressure was maintained for one minute. This pressure in the system used is equivalent to 13.0 kg/cm² (185 lb/in²) in the material being pressed. Coconut milk and press-cake were collected carefully to insure total recovery of products. They were weighed and samples separated for analysis.

For organoleptic evaluation of the coconut milk, the press-cake and the milk were thoroughly mixed back after weighing. The mixture was heated to about 30° C in a steam kettle and pressed again to separate the coconut milk. This was because it was observed that coconut milk separated in the first pressing had a waterlike appearance, confirmed later in the course of the experimentation. The coconut milk obtained from the second extraction was used in the experimental kitchen to prepare *tembleque* (a pudding-like dessert prepared with coconut milk, cornstarch, sugar and seasoning). An organoleptic evaluation of this dessert was carried out using a hedonic scale for rating.

RESULTS AND DISCUSSION

Results of experiments are presented in table 1. Frozen storage effect on weight of the coconut pulp showed a loss ranging from 0 to 0.56 kg (0 to 1.23 lb) without demonstrating any tendency to increase with the length of storage. The average weight loss per lot of 8.16 kg (18 lb) of pulp was 0.13 kg (0.28 lb). This loss in weight is a result of the water vapor permeability of the packaging film and the usual water evaporation action associated with the frozen storage of food products (8). During comminution the weight loss varied from 0 to 0.23 kg (0 to 0.51 lb) with an average value of 0.05 kg (0.12 lb). Evaporation during milling (7) and improper recovery of material could be responsible for this loss.

The average coconut milk yield obtained from the frozen coconut was 16.8%, varying from 11.3 to 21.1. The following relation was used in calculating the extraction yield:

Coconut milk yield (%)

$$= \frac{(\text{weight of coconut milk} - \text{weight of water added})}{\text{weight of comminuted coconut pulp}} 100$$

The average press-cake yield obtained was 77.2%, ranging from 73.3% to 81.7%. In adding these two values (94.0%) a 6.0% amount of material was not accounted for. Reviewing the results presented in the table it was found a loss of weight occurred during the pressing operation. This amounted to an average value of 5.6% and agreed with the total value expected (77.2% press-cake plus 16.8% coconut milk plus 5.6% material lost in pressing adding to 99.6%). As the liquid component is the most difficult to recover from the pressing operation due to the wetting action that takes place, the 5.6% loss can be accounted for as coconut milk extracted but not recovered from the pulp. This value will diminish in a continuous extraction process and will result in a negligible value when the amount pressed is increased to commercial scale. From the above interpretation it can be concluded that the most accurate form of calculating the efficiency in the extraction process is through the use of the weight of the press-cake residue:

$$100 \left(1 - \frac{\text{weight of press-cake}}{\text{weight of comminuted coconut pulp}} \right) = \text{coconut milk yield}$$

The average value for coconut milk yield extracted from the frozen pulp (calculated using the press-cake residue) was 22.8%. This is equivalent to 49.6% of the milk extracted from the unfrozen coconut pulp. This is an important factor to consider for extrapolation into commercial processing calculations.

TABLE 1.—Effect of frozen storage of coconut pulp on the extraction and quality of the coconut milk

Storage	Frozen pulp		Comminuted pulp		Press-cake		Coconut milk		Press-cake yield	Coconut milk yield	Fat in press-cake	Fat in coconut milk	Solids in press-cake	Solids in coconut milk	Organoleptic evaluation
	Days	Kg	Lb	Kg	Lb	Kg	Lb	Kg	Lb	%	%	% ¹	%	%	
Control	8.16	(18)	8.05	(17 ^{3/4})	4.42	(9 ^{3/4})	5.22	(11 ^{1/2})	54.0	39.4	66.7	28.0	53.1	37.5	Acceptable
1	8.16	(18)	8.05	(17 ^{3/4})	6.01	(13 ^{1/4})	3.40	(7 ^{1/2})	74.7	16.9	77.4	0.3	65.1	9.3	
2	8.05	(17 ^{3/4})	7.94	(17 ^{1/2})	6.01	(13 ^{1/4})	3.51	(7 ^{3/4})	75.8	18.6	78.7	1.1	66.8	8.9	
3	8.05	(17 ^{3/4})	8.05	(16 ^{3/4})	5.90	(13)	3.74	(8 ^{1/4})	73.3	21.1	77.3	0.9	67.9	7.6	
4	8.05	(17 ^{3/4})	8.05	(17 ^{3/4})	6.01	(13 ^{1/4})	3.51	(7 ^{3/4})	74.7	18.3	76.0	0.6	68.2	9.1	
7	8.05	(17 ^{3/4})	7.94	(17 ^{1/2})	6.12	(13 ^{1/2})	3.63	(8)	77.2	20.0	78.8	0.3	68.5	8.3	
8	8.05	(17 ^{3/4})	8.05	(17 ^{3/4})	6.12	(13 ^{1/2})	3.63	(8)	76.0	18.3	82.9	0.5	67.4	8.4	
9	8.05	(17 ^{3/4})	8.05	(17 ^{3/4})	6.12	(13 ^{1/2})	2.95	(6 ^{1/2})	76.1	11.3	76.6	0.4	66.6	9.1	
10	8.05	(17 ^{3/4})	8.05	(17 ^{3/4})	6.01	(13 ^{1/4})	3.74	(8 ^{1/4})	74.6	21.1	76.7	0.6	68.4	7.9	
11	8.05	(17 ^{3/4})	8.05	(17 ^{3/4})	6.24	(13 ^{3/4})	3.51	(7 ^{3/4})	77.5	18.3	75.6	0.4	64.3	8.0	
21	7.94	(17 ^{1/2})	7.94	(17 ^{1/2})	6.46	(14 ^{1/4})	2.95	(6 ^{1/2})	81.4	11.4	76.0	0.7	62.5	10.1	Acceptable
29	8.05	(17 ^{3/4})	7.94	(17 ^{1/2})	6.46	(14 ^{1/4})	3.18	(7)	81.4	14.3	76.9	0.4	62.3	8.6	
56	8.05	(17 ^{3/4})	8.05	(17 ^{3/4})	6.24	(13 ^{3/4})	3.63	(8)	77.5	19.7	76.7	0.2	66.8	7.8	
84	8.05	(17 ^{3/4})	8.05	(17 ^{3/4})	6.58	(14 ^{1/2})	3.18	(7)	81.7	14.1	75.7	0.3	64.6	8.7	Acceptable
105	7.60	(16 ^{3/4})	7.60	(16 ^{3/4})	5.78	(12 ^{3/4})	3.18	(7)	76.1	14.9	76.5	1.3	62.3	9.4	Acceptable
134	8.16	(18)	7.94	(17 ^{1/2})	6.24	(13 ^{3/4})	3.18	(7)	78.6	14.3	74.6	0.5	63.3	8.5	
165	8.05	(17 ^{3/4})	7.94	(17 ^{1/2})	6.24	(13 ^{3/4})	3.29	(7 ^{1/4})	78.6	15.7	75.4	0.3	64.2	8.8	

¹ Dry base.

The composition of the coconut milk and press-cake was greatly altered when the coconut pulp was processed in the frozen form. Fat content in the press-cake from frozen pulp showed an increase of 15% over the press-cake obtained from the control or unfrozen pulp. Fat content of the coconut milk was one of the components most seriously affected. It decreased to an average value of 0.5% in the milk from frozen pulp, which is 1.8% of the average amount found in the milk extracted from the control.

The total solids in the coconut milk from the frozen pulp averaged 8.6%, equivalent to 23.0% of the solids found in the milk extracted from the unfrozen pulp. Total solids in the press-cake from frozen pulp were high compared to the values obtained from the control and the ones reported in the literature (6).

The organoleptic evaluation of the coconut milk extracted from frozen pulp showed that pulp under storage did not suffer change capable of inducing off-flavors in the products prepared from it. Tembleque was found acceptable throughout the study and after one year of storage.

The study showed coconut pulp can be stored frozen for a year without undergoing changes that impair flavor. Results also showed the composition of milk prepared from frozen coconut pulp was low in fat content and in total solids. The extraction yield in this case also was lower than those previously reported. Heat treatment given to the comminuted coconut pulp just before pressing showed that yield and composition of the milk can be brought close to those reported.

RESUMEN

Se estudió el efecto de la congelación en la pulpa de coco y en la calidad de la leche extraída.

Los cocos usados en el estudio se obtuvieron en el mercado. Estos se trataron siguiendo los métodos para separar la pulpa descritos en la literatura.

Una vez preparada, la pulpa se dividió en lotes de 8.16 kg. (18 lb.) y se envasó en bolsas de polietileno de un laminado de 0.038 mm. de espesor, las cuales se almacenaron en un congelador a -10° C.

El estudio se llevó a cabo por un período de seis meses, dejando algunas latas de pulpa para evaluación organoléptica al cabo de un año.

El procedimiento de trituración y extracción se llevó a cabo de la siguiente manera: antes de congelar la pulpa (control), y de pulpa congelada, diariamente hasta completar dos semanas; semanalmente hasta completar un mes; y mensualmente hasta completar seis meses. Este proceso empezó inmediatamente después de sacar la pulpa del congelador.

Luego de pesada, la pulpa se molió en un molino de martillos equipado con un cedazo número 3 (36 perforaciones de 3.1 mm. de diámetro en 6.45 cm.²). Durante la cominución se le añadieron 2.04 kg. (4½ lb.) de agua corriente. La pulpa molida se recuperó cuantitativamente y se pesó. Para extraer la leche de coco se usó el método de prensado con paños y rejillas sometiendo el material a una presión de 13.0 kg./cm.² en una prensa hidráulica de platos. De esta operación se separaron muestras para análisis de grasa y

humedad. Una vez registrados los datos de la extracción se mezcló la cachipa³ y la leche correspondientes de cada lote, se calentó a 28-30° C. y se prensó otra vez para extraer la leche que se usó en las pruebas organolépticas. Estas pruebas se realizaron preparando tembleque⁴ y usando una escala hedónica para la evaluación.

El estudio demuestra que la pulpa de coco se puede almacenar congelada a -10° C. por un año sin que sufra cambios que le produzcan sabores indeseables a la leche. Los datos obtenidos indican que la extracción de leche de pulpa congelada tiene un rendimiento equivalente a aproximadamente 50 por ciento de la extracción cuando se usa pulpa sin congelar. La composición de la leche obtenida de pulpa congelada es de baja calidad. El contenido de grasa es aproximadamente el 2 por ciento del valor que da una extracción de pulpa sin congelar y el contenido de sólidos totales es 23 por ciento del valor normal. Por el contrario, la cachipa de coco resultante contiene 15 por ciento más de grasa. Todo lo cual indica que, para la extracción de leche de coco de pulpa congelada hay que calentar la pulpa antes de molerla o una vez molida, antes de prensarla. En esta forma el rendimiento puede llevarse a los niveles obtenidos para pulpa sin congelar.

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³ Localismo puertorriqueño para el residuo resultante en la extracción de la leche de coco.

⁴ Manjar confeccionado con leche de coco, almídon de maíz, azúcar, sal, vainilla y azahar.