

BIBLIOGRAPHY

CLAUDIO, ARIEL L. AND EMONG, JOSEPH P., MAY 2007. DESIGN AND FABRICATION OF COCONUT MILK CENTRIFUGAL EXTRACTOR WITH GRATER. Benguet State University, La Trinidad, Benguet.

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ABSTRACT

This study was conducted to design and fabricate a coconut milk centrifugal extractor with grater, evaluate its performance, compare its extraction efficiency and milking capacity to the piston type coconut extractor.

The device is simple, easy to operate and affordable to small business entrepreneurs.

Grated coconut meat were used both in the seven treatments (A. no liquid added B. 200 grams of coconut water C. 210 grams of coconut water D. 220 grams of coconut water E. 200 grams of hot water F. 210 grams of hot water G. 220 grams of hot water) in getting the extraction efficiency, time of extraction and capacity of the device. Evaluation involved weighing of the unextract coconut meat, milk extracted, time of extraction and weight of the desiccated coconut meat.

Through its evaluation, the highest extraction efficiency was computed to be 54% resulting extraction time of 15 minutes, milking capacity of 2280g/hr.

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INTRODUCTION

Background of the study

Coconut (*Cocos nucifera*) is one of the agricultural crops that serve as a source of income to farmers most especially in the lowlands. The Philippines has about 2.9 million hectares of coconut lands and about one third of its population depends on coconut production, processing and marketing for livelihood. Coconut is grown in fifty five provinces of the country and remains a major crop of thirty five of these. Surveys have shown that its entire parts may be used for different purposes. Its fresh meat has many uses in food industries and households, particularly in the preparation of pastries, cakes and in the production of oil and milk. It was revealed by Banson (1982) that the fresh grated coconut meat is often used in food preparation. The coconut meat has to be grated prior to extraction of cream or oil.

Coconut milk is a very important ingredient for food, source of oil, and raw material for pharmaceuticals. In application in food alone, the extraction of coconut meat is usually done manually by small industries and mechanically by some medium scale industries.

Commercial extractors who use the principle of compression cost \$1056 freight excluded, and while the screw type costs \$ 486 excluding freight. This means that commercial extractors cost from P 25,000 to 70,000 per unit. The high cost of mechanical coconut extractors makes small industries turn back to the usual manual means which is time and effort consuming and often times unsanitary because of the direct use of hands in handling coconut meat to be extracted. The existing coconut milk extractor makes use of compression as means of extraction. The process does not efficiently extract the



coconut milk because of the difficulty of the machine to compress small particles of the grated coconut. In order to minimize the laborious of extracting coconut milk, high cost of the devices, and energy it needs man's creative abilities hence this driving force of the study.

Importance of the Study

The result of the study is used or important to the following:

To the coconut farmer, the result of the study may motivate them to produce more coconut because the demand of coconut in the market will increase which tends the price of coconut also may increase.

The people engaged in food business, they may able to afford the low cost coconut milk centrifugal extractor which make their work easier and faster which make their business to expand resulting to increase their income.

The enterprising people may find interest in fabricating this low cost coconut milk centrifugal extractor.

Objectives of the Study

General objective

To design and fabricate a coconut milk centrifugal extractor with grater.

Specifically it aims to:

1. To evaluate the efficiency of the designed coconut milk centrifugal extractor with grater.
2. To determine the required time for extracting a coconut milk using this device.



3. To compare its performance with the piston type milk extraction in terms of milking

Capacity and extraction efficiency.

Time and Place of the Study

The study is to be conducted for a period of three months starting March to May at La Trinidad, Benguet.



REVIEW OF RELATED LITERATURE

The scarcity of equipment, both in terms of hand tools and machines is a problem of ordinary farmers and even in academic schools and so we need to adopt appropriate technology to suit small time farmers and to overcome high cost of labor as pointed out by Dulay (1985) .

Richey (1961) stated that the frame design is important in field machine because the frame must be light to reduce cost, soil compaction and propelling power but strong enough to resist the shocks due to rough ground obstacle.

It was revealed by Henderson (1976) that materials, tools and equipment should be positioned that a minimum of the physical movement is required to perform an operation.

Wang (1957) pointed out that the layout of any structure depends largely on the function of the structure, the loading conditions and the properties of the material to be use.

According to Southworth (1974), the design and introduction of any machine should be based on the cultural factors and agricultural production and needs of the society.

Hunt (1982) claims that the speed, ease, and accuracy and completeness, operation of the machine is of greater importance because the efficiency of operation determines the returns.

Banson (1982) also noted that fine tooth graters are advantageous for the purpose of grating fine coconut meat.



Kent (1950) claims that from various tests in bevel gears, an efficiency of 98% were obtained if properly assembled. With the exemption of high ratio gears, efficiency of 96 to 98% were obtained

Henderson, SM and RL Perry (1976) stated that in extracting juice from a product size of individual particles should be taken into considerations that juice can be extracted easier when size of particles are small.



MATERIALS AND METHODS

Materials

The tools in fabrication of the device were: hacksaw portable drill and drill bits, grinding tools, electric and welding machine, hacksaw, Steel Square, iron flat sheet scissors.

In materials used in construction of the device are stainless flat sheet, ball bearings, stainless shaft, bolts and nuts, stainless welding rod, angular bars, ordinary welding rod, hinges, timer, extension wire electrical switch and Stainless pot.

Design Criteria and Consideration

1. The device is made out of corrosion resistant materials because it is use for processing for human consumption.
2. Simple and easy to operate.
3. Strength.
4. Easy to clean
5. Low operating cost

Methods

Methods that will be employed include construction, principle of operations, evaluation and data analysis.



Evaluation

The machine is tested and evaluated by the following parameters:

1. Extraction Efficiency (by Theoretical) = $(t_{\text{actual}}/t_o) * 100\%$

Where in:

t actual for without mixture of water

$$t_{\text{actual}} = (w_1/6)$$

=weight actual coconut milk extracted

t_o = in every 100g of coconut meat it contains 63.7 liquid.

= It was based on the article from

<http://www.aphorticulture.com/coconut 1.htm> which states that the ideal milk can be extracted in every 100grams of mature grated coconut meat is 63.7grams.

w_1 = weight of coconut milk that was extracted in the treatment.

t actual for with mixture of water (cold /hot)

$$t_{\text{actual}} = (w_1 - x_1/6)$$

w_1 = grams of water that was added (cold/hot) + 600g of grated coconut meat to be extracted

x_1 = grams of water that was added

2. We will put the grated coconut in the device and play it, then we will time for 15 minutes but we will separate the extracted coconut milk in every 5 minutes.
3. We will compare the result of piston type extractor to the device.

To evaluate the device in terms of capacity stopwatch was used in determining the time of operation.



Principle of Operation

The principle of spin dryer is the idea that a machine could be so devised to separate the wet particles of the residue. The grated coconut is placed in a bag, which is made of cloth and properly closed before placing in the extractor column. The load is exactly distributed over the base of the perforated column to prevent imbalance in configuration or rotation. The power is then switched on and timer is set to the desired time

Parts and Construction

The coconut milk centrifugal extractor with grater consists of five main parts: The cylinder casing that houses the extractor column, the frame, the extractor column, the cylinder that houses grater, and the power transmission mechanism.

The cylinder casing is made up of stainless pot. It houses the spinning perforated cylinder.

The extractor column is made up of stainless pot. It has a dimension of 20cm height and 20cm diameter. It has a frame at the bottom made up of stainless flat bars which is welded to stainless shafting where it is connected to the power transmission.

The frame is made up of angular bars and it was covered with GI sheet. This is where the cylinders and power transmission are attached. The cylinder grater was made of stainless pot with a dimension of 30 cm diameter and 15cm length. This is housing of the blade of coconut grater and also serves as a collector of that grated coconut.

The power transmission is compose of motor, (1/4 hp), shaft, bearings.



RESULT AND DISCUSSIONS

General Description

The device is a motor operated centrifugal type coconut extractor with grater. Its power transmission used .25 horsepower. The power transmission is composed of bearings, and shaft.

The device is made up of locally available materials such as stainless pot, flat sheet, water hose, faucet and angular bars. It is composed of different components such as frame, grater with casing, extractor column and the cylinder milk collector.

Table 1-a. Weight of extracted coconut milk at different treatment and different time.

Where treatments are the following:

Treatment 1=600grams of grated coconut (no water added)

Treatment 2= 600grams of grated coconut +200grams of coconut water.

Treatment 3=600grams of grated coconut +210grams of coconut water.

Treatment 4=600grams of grated coconut +220grams of coconut water.

Treatment 5=600grams of grated coconut +200grams of hot tap water.

Treatment 6=600grams of grated coconut +210grams of hot tap water.

Treatment 7=600grams of grated coconut +220grams of hot tap water.

Treatment	Time (min)	Replication			Total	Mean
		1	2	3		
1	5	141.5	107	130	378.5	126.17
2		116.5	92	104	312	104
3		87	79	82	249	83
4		110	119	109	338	112.67
5		190	188	192	570	190
6		188	186	189	563	187
7		189	191	185	565	188



Table 1-b

Treatment	Time (min)	Replication			Total	Mean
		1	2	3		
1	10	165	126	150	441	147
2		136	114	124	374	124.67
3		110	98	92	300	100
4		135	135.5	132	402.5	134.17
5		203	203	204	610	203.33
6		206	205	205	616	205.33
7		207	206	199	612	204

Table 1-c

Treatment	Time (min)	Replication			Total	Mean
		1	2	3		
1	15	168	128	154	450	150
2		141	118	126	385	128.33
3		114	104	97	315	105
4		139	135.5	132	406.5	134.17
5		210	208	208	626	208.67
6		209	209	211	629	209.67
7		211	208	205	624	208

Table 1 Show that the weight of milk using 600g of grated coconut meat in different treatment and time. Result shows that adding of hot water in different extraction time for extracting coconut using this device produced the highest weight of milk.

Table 2 Extraction Efficiency at Different time and Treatments

Table 2-a

Treatment	Time (min)	Mean of weight of extracted milk (gm)	Efficiency %
1	5	126.17	33
2		104	27.21
3		83	21.72
4		112.67	29.48
5		190	49.71
6		187.67	49.10
7		188.33	49.27



Table 2-b

Treatment	Time (min)	Mean of weight of extracted milk (gm)	Efficiency %
1	10	147	38.46
2		124.67	32.62
3		100	26.16
4		134.19	35.11
5		203.33	54.59
6		205.33	53.72
7		204	53.37

Table 2-c

Treatment	Time (min)	Mean of weight of extracted milk	Efficiency %
1	15	150	39.25
2		128.33	33.49
3		105	27.47
4		139.17	36.41
5		208.67	54.59
6		209.67	54.86
7		208	54.2

Table 2-a, b, c Shows the results of extraction efficiency of the device. From the results, efficiency of the device was evaluated. The efficiency of the extractor was based on the article from http://www.aphorticulture.com/coconut_1.htm which states that the ideal milk can be extracted in every 100grams of mature grated coconut meat is 63.7grams.

Table 3 Coconut milking capacity of the Device (grams/hr)

Table 3-a

TREATMENT	Time of extraction (Min.)	Mean of weight of Extracted Coconut Milk	Coconut Milk Extraction Capacity
1	5	126.17	1514.04
2		104	1248
3		83	996
4		112.67	1352.04
5		190	2280
6		187.67	2252
7		188.33	2259.96



Table 3-b

TREATMENT	Time of Extraction (Min.)	Mean of Weight of Extracted Coconut Milk (gm)	Coconut Milk Extraction Capacity (gm)
1	10	147	882
2		129.67	748.02
3		100	600
4		134.19	805.14
5		203.33	1219.98
6		205.33	1231.98
7		204	1224

Table 3-c

TREATMENT	Time of Extraction (Min.)	Mean of Weight of Extracted Coconut Milk (gm)	Coconut Milk Extraction Capacity (gm)
1	15	150	610
2		128.33	513.32
3		105	420
4		139.7	556.68
5		208.67	834.68
6		209.67	838.68
7		208	832

Table 3-a, b, c shows the coconut milking capacity of the device. The result shows that the highest coconut milking capacity is adding hot water in 5 minutes of extraction.

Table 4. Extraction Capacity (grams/hr)

Treatment	Time of extraction (min)	W1 (gm)	Extraction Capacity (gm)
1 to 7	5	600	7200
	10	600	3600
	15	600	2400

Table 4. Shows the different time in extracting grated coconut. The result shows that the extractor has the highest capacity of extraction by using 5 minutes as the time.



Table 5. Extraction efficiency of the piston type extractor.

Treatment	Procedures	Mean (grams)	Efficiency
600g of grated coconut	No water added	235.7	61.66
600g of grated coconut	210 grams of coconut water added	174.3	45.53
600g of grated coconut	210 grams of hot water added	276.57	72.37

Table 5, shows the results of extraction efficiency of the piston type extractor. From the results, efficiency of the piston type extractor was evaluated. The efficiency of the extractor was based on the article from [http//.....](http://.....) which state that the ideal milk can be extracted in every 100 grams of mature grated coconut is 63.7 grams.

Table 6. Milking capacity of the piston type extractor.

Treatment	Procedures	Mean of extraction (min)	Mean of milk extracted (grams)	Coconut milk extraction capacity
600g of grated coconut	No water added	3.64	235.7	3885.16
600g of grated coconut	210 grams of coconut water added	3.57	174.3	2929.4
600g of grated coconut	210 grams of coconut water added	3.3	276.57	5028.6

Table 6 shows the weight of milk that the piston type extractor can extract at different treatment. The results show that the extractor has the highest capacity of extraction by using the grated coconut with hot water as an input.



SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary

This study was conducted to design and to fabricate a coconut milk centrifugal extractor with grater using available material. The objective of the study is to fabricate the extractor with grater and to test the efficiency in terms of weight of milk extracted from grated coconut meat and what is the best time for extracting 600grams using the device. The study is to be conducted at Engineering shop, Benguet State University, La Trinidad, Benguet from a period of March to May. The testing and evaluation of the study was conducted at engineering building ground floor at the farm power machinery room from month of May 14 to 18 2007.

The testing and evaluation of the extractor was conducted through operating the machine, weight of milk collected, time of extraction, and weight of grated coconut meat, weight of desiccated meat, extraction efficiency, milking capacity, and extraction capacity. The testing had been conducted indoor on which the machine is to be operated, tested on the weight of milk extracted and the time of extraction at a different treatments. The treatments' done by extracting a 600grams of coconut meat, first treatment is no liquid to be added, a second treatment is by adding 200grams of coconut water, the third is adding 210grams of coconut water, the fourth is adding 220grams of coconut water, the fifth to seventh treatment is the same process as the 2nd to 4th treatment but, instead of using coconut water use hot water. In all of these treatments it was set to 5, 10, and 15 minute's extraction time. This enabled the computation of the extraction capacity, milking capacity, and extraction capacity.



Findings

The following are the findings of the study:

The testing of the device showed that the highest weight of extracted coconut milk is the treatment 5 to 7 that was added 200grams, 210grams, 220grams of hot water. The test on time finds that the best time of extraction is 5minutes in all the treatments. For the extraction efficiency it was revealed that adding hot water was the highest efficiency.

The evaluation test reveals that the extractor is easy to operate and the product is more sanitary compared to manual extraction, it was also found out that the device has a lesser efficiency and lesser capacity compare to the piston type extractor.

The motor of the extractor is found out that it cannot turn the extractor if it will be loaded with heavy input of grated coconut meat. Since the hole of the extractor column is only few, the milk was blocked in the operation.

Conclusion

The evaluation of the device in terms of efficiency of the designed coconut milk centrifugal extractor with grater is found out that it has the highest efficiency of 54.86% in adding 210grams of hot water in 15 minutes of extraction time. It was also determined that the required time for extracting 600grams of grated coconut meat using this device is 5minutes.

It was also found out that that the device has a highest milking capacity of 2280grams /hr in 5 minutes extracting time with 200grams of hot water + 600grams of grated coconut meat and has a highest extraction efficiency of 54.86% in 15 minutes



extraction time, comparing to the piston type extractor that has a highest milking capacity of 5028.6grams/hr and has a extraction efficiency of 72.37%. Therefore base on the data of piston type extractor and this device, the device has a lower extraction efficiency and milking capacity compared to piston type extractor.

Recommendations

Based on the findings the following are suggested:

1. The extractor needs to improve in terms of efficiency.
2. The further development in improvement of the device the following condition maybe first to consider.
 - a. The motor must be replaced with higher horsepower.
 - b. The holes of the perforated cylinder must be added so that the coconut milk will not be blocked
 - c. Further research should be made in relation to the study and testing other variables.



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Appendix A

Appendix A-1 Initial cost of the motor-operated coconut extractor with grater.

A. Materials

Description	Quantity	Unit	Unit cost	Total cost
1/4hp electric motor	2	pc	700	1400
1/8*1 angular bars	2	pc	156.5	313
Stock pot(stainless) small	1	pc	190	190
Stock pot (stainless) big	1	pc	262	262
1/4*3/4, bolt and nut(stainless)	12	pc	8	96
1/4 *1 bolt and nut (ordinary)	15	pc	2	30
Soldering paste	1	pc	65	65
Nicolite	4	pc	45	180
Pulley bolt	3	pc	20	60
Muscot faucet	1	Pc	80	80
Firefly switch	2	pc	28	56
Plastic plug	1	Pc	10	10
(3in * 1.5 dia) stainless tube	1	feet	15	45
Steel blade	1	pc	50	50
Ordinary welding rod	1	kilo	55	55
Dormer drill	2	pc	48	96
Hose clamp 5/8	1	pc	7	7
Blind rivets, 1/8*3/8	70	pc	.5	35
Screw 1/2*6	10	Pc	.5	5
G.I flat sheet (#18)	1/2	pc	555	277.5
Bearing	3	pc	350	1050
Shaft 3/4	2	pc	50	100

Sub-total= Php.4, 670.00

B. Labor cost 60% of the materials Php.2, 856.00

C. Miscellaneous N/A Php.2500.00

GRAND TOTAL **Php.10026.00**



Appendix A-2 Cost analysis of the motor-operated coconut milk extractor with grater

Assumptions:

Initial cost	Php.10026.00
Salvage value	10% of initial cost
Economic life span	6 years
Repair and maintenance	3% of initial cost
Operating time	5hrs/day
Interest rate	4% of initial cost
Tax and insurance rate	1.5% of initial cost
Interest of the investment	20% of initial cost
Power consumption	.9325kw-hr
Cost per extraction of 600 grated coconut	Php.5.00
Capacity	7200g/hr
Labor cost	Php.15/hr

A. Total revenue based on capacity

$$= 5 * (7200/600g) * 5hr/day * 317days/year$$

$$= \text{Php.}95, 100.00$$

B. Fixed cost

$$\begin{aligned}
 1. \text{ Depreciation cost} &= \frac{\text{Initial cost} - \text{salvage value}}{\text{Probable life}} \\
 &= \frac{10026 - 1002.6}{6 \text{ years}} \\
 &= \text{Php.}1, 503.90
 \end{aligned}$$



$$\begin{aligned}
 \text{2. Interest or investment} &= \frac{i(\text{NC} + \text{SV})}{2} \\
 &= \frac{.04(10026 + .1(10026))}{2} \\
 &= \text{Php.701.82}
 \end{aligned}$$

$$\begin{aligned}
 \text{3. Taxes and insurance} &= 1.5\% \text{ of initial cost} \\
 &= .015 * 10026 \\
 &= \text{Php.150.39}
 \end{aligned}$$

$$\begin{aligned}
 \text{Total Annual Fixed Cost} &= 1503.90 + 701.82 + 150.39 \\
 &= \text{Php.2356.11}
 \end{aligned}$$

C. Operating cost

$$\begin{aligned}
 \text{1. Repair and maintenance cost} &= 3\% \text{NC} \\
 &= .03 * 10026 \\
 &= \text{Php.300.78} \\
 \text{2. Labor cost} &= 5(15/\text{hr}) * 317 \text{days} \\
 &= \text{Php}23,775.00 \\
 \text{3. Power} &= .9325 \text{kw-hr/day} * 317 \text{days} * \text{php.8.89/kw-hr} \\
 &= \text{php}2627.9
 \end{aligned}$$

$$\begin{aligned}
 \text{Total Annual Operating Cost} &= 300.78 + 23775.00 + 2627.9 \\
 &= \text{php}26703.6
 \end{aligned}$$

$$\begin{aligned}
 \text{D. Grand Total} &= \text{Total Annual Fixed cost} + \text{Total Annual Operating cost} \\
 &= 2356.11 + 26703.6 \\
 &= \text{php}29059.79
 \end{aligned}$$

$$\begin{aligned}
 \text{E. Profit} &= \text{total revenue} - \text{Grand total} \\
 &= 95100 - 29059.79 \\
 &= \text{php.66040.20}
 \end{aligned}$$

$$\begin{aligned}
 \text{F. Pay Back Period} &= \text{NC}/(\text{profit}/12) \\
 &= 10026 / (66040.20/12) \\
 &= 1.31 \text{ months}
 \end{aligned}$$

$$\begin{aligned}
 \text{G. Net Savings/ year} &= \frac{\text{Profit} * 6 - \text{NC}}{6} \\
 &= 66040.20 - 10026 \\
 &= \text{php}56014.2
 \end{aligned}$$



Sample Computation Extraction Efficiency

1. Extraction Efficiency (by Theoretical) = $(t_{\text{actual}}/t_0) * 100\%$

Where in:

t actual for without mixture of water

$$t_{\text{actual}} = (w_1/6)$$

= weight actual coconut milk extracted

t_0 = in every 100g of coconut meat it contains 63.7 liquid.

= It was based on the article from

http://www.aphorticulture.com/coconut_1.htm which states that the ideal milk can be extracted in every 100grams of mature grated coconut meat is 63.7grams.

w_1 = weight of coconut milk that was extracted in the treatment.

t actual for with mixture of water (cold /hot)

$$t_{\text{actual}} = (w_1 - x_1/6)$$

w_1 = grams of water that was added (cold/hot) + grams of coconut milk that was extracted.

x_1 = grams of water that was added

Extraction Efficiency (NO water added) for 5min. = $\frac{t_{\text{actual}}}{t_0} * 100$

$$= \frac{(126.17/6)}{63.7} * 100$$

$$= 33\%$$

$$\text{For 10 min.} = \frac{(147/6)}{63.7} * 100$$

$$= 38.46\%$$

$$\text{For 15 min.} = \frac{(150/6)}{63.7} * 100$$

$$= 39.25\%$$



Extraction Efficiency (mixture of grated coconut and water (hot/cold))[treatment 2to7]

Using treatment 2

$$\begin{aligned} \text{For 5 min.} &= \frac{(w_1 - x_1)}{6} * 100 \\ &= \frac{t_o}{63.7} \\ &= \frac{(304 - 200)}{6} * 100 \\ &= 27.21\% \end{aligned}$$

$$\begin{aligned} \text{For 10 min} &= \frac{(324.67 - 200)}{6} * 100 \\ &= 32.62\% \end{aligned}$$

$$\begin{aligned} \text{For 15 min.} &= \frac{(328.33 - 200)}{6} * 100 \\ &= 33.49\% \end{aligned}$$

Computation of extraction capacity

$$\text{A. Coconut milk extraction capacity} = \frac{1 \text{ hr}}{\text{Time of extraction}} * t \text{ actual}$$

Where in; t actual = weight of coconut milk extracted.

Using treatment 2

$$\begin{aligned} \text{For 5 min} &= \frac{60 \text{ min}}{5 \text{ min}} * 104 \\ &= 1248 \text{ g/hr} \end{aligned}$$

$$\begin{aligned} \text{For 10 min} &= \frac{60 \text{ min}}{10 \text{ min}} * 184.67 \\ &= 1108.02 \text{ g/hr.} \end{aligned}$$

$$\begin{aligned} \text{For 15 min.} &= \frac{60 \text{ min}}{15 \text{ min}} * 128.33 \\ &= 513.33 \text{ g/hr} \end{aligned}$$

B. Grated coconut meat extraction capacity (g/hr)

$$= \frac{1 \text{ hr}}{\text{Time of extraction}} * \text{weight of grated coconut to be extracted}$$

$$\begin{aligned} \text{For 5 min.} &= \frac{60 \text{ min}}{5 \text{ min}} * 600 \\ &= 7200 \text{ g/hr} \end{aligned}$$

$$\begin{aligned} \text{For 10 min.} &= \frac{60 \text{ min}}{10 \text{ min}} * 600 \\ &= 3600 \text{ g/hr} \end{aligned}$$

$$\begin{aligned} \text{For 15 min.} &= \frac{60 \text{ min}}{15 \text{ min}} * 600 \\ &= 2400 \text{ g/hr} \end{aligned}$$



APPENDIX B

Appendix B-1: ANOVA of the weight of milk extracted at diff. treatment

Treatment	Time	Replication			Total	Mean
		1	2	3		
1	5	141.5	107	130	378.5	126.17b
2		116.5	92	104	312	104c
3		87	79	82	249	83d
4		110	119	109	338	112.67bc
5		190	188	192	570	190a
6		188	186	189	563	187a
7		189	191	185	565	188a

Means with the same letter are not significantly different.

Source of variation	DF	Sum of Squares	Mean square	F Value	Pr>F
Water	6	37677.45238095	6279.5754	83.62	0.0001
Error	14	1051.33333	75.0952		
Corrected total	20	38728.7875			

C.V= 6.114945

Table 1-b

Treatment	Time	Replication			Total	Mean
		1	2	3		
1	10	165	126	150	441	147b
2		136	114	124	374	124.67c
3		110	98	92	300	100d
4		135	135.5	132	402.5	134.17bc
5		203	203	204	610	203.33a
6		206	205	205	616	205.33a
7		207	206	199	612	204a

Means with the same letter are not significantly different.

Source of variation	DF	Sum of Squares	Mean square	F Value	Pr>F
Water	6	34660.1190	5776.6865	65.69	0.0001
Error	14	1231.16667	87.94047		
Corrected total	20	35891.2857			

C.V= 5.868897



Table 1-c

Treatment	Time	Replication			Total	Mean
		1	2	3		
1	15	168	128	154	450	150b
2		141	118	126	128.33	128.33c
3		114	104	97	105	105d
4		139	135.5	132	134.17	134.17bc
5		210	208	208	208.67	208.67a
6		209	209	211	629	209.67a
7		211	208	205	624	208a

Means with the same letter are not significantly different,

Source of variation	DF	Sum of Squares	Mean square	F Value	Pr>F
Water	6	3476.7858	5791.1309	63.88	0.0001
Error	14	1269.16667	90.65476		
Corrected total	20	36015.95238			

C.V= 5.801447

Appendix B-2 Mean weight of extracted coconut milk at different treatment and time.

Treatment	Time of extraction		
	5minutes	10 minutes	15 minutes
600g of grated coconut meat (no water added) (1)	126.17b	147.00b	150.00b
600g of grated coconut meat + 200g of coconut water (2)	104.17c	124.67c	128.33c
600g of grated coconut meat + 210g of coconut water (3)	83.00d	100.00d	105.00d
600g of grated coconut meat + 220g of coconut water (4)	112.67bc	134.17bc	139.17bc
600g of grated coconut +200g of hot water (5)	190.00a	203.33a	208.67a
600g of grated coconut + 210g of hot water (6)	187.67a	205.33a	209.67a
600g of grated coconut + 220g of hot water (7)	188.33a	204.33a	208.00a

Means with the same letter above do not differ, (DMRT at .05)



Appendix C



Appendix C-1. Isometric view of the device.



Appendix C-2. Front view of the device.





Appendix C-3. Back view of the device.



Appendix C-4. The device during operation



Appendix C-5. The coconut heads used in the evaluation.



Appendix C-6. The grated coconut meat used in the evaluation.





Appendix C-7. Weighing the grated coconut.



Appendix C-7. Weighing the extracted coconut milk.

