

Development of Coconut Meat Chipper

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Coconut chip products are an emerging innovation or delicacy in the Philippines and are liked especially by tourists. Supply of coconut chip products is coming from local producers who are just using an improvised manually-operated equipment in the absence of machines, that will suit their product requirements. This method is tedious, low in capacity, unsafe, and generates a considerable amount of waste. In addition, the increase in demand urges local producers to scale up production and need advanced machinery and equipment to cope. Thus, this study is aimed to develop a mechanized coconut meat chipper. The machine was evaluated in terms of chip thickness, chipping capacity, and efficiency. Results of the study showed that the average thickness achieved was 0.55 mm which met the standard requirement of the local coconut chips producer. The chipping capacity and efficiency were 14 kg/hr and 96 %, respectively. Generally, the machine's overall performance showed a lot of potential and advantage, especially to the local producer of coconut chips in terms of production capacity, labor cost, quality, and safety.

Keywords: chipping capacity, chipping efficiency, coconut chips, coconut meat chipper, coconut chip thickness.

1. Introduction

Coconut is one of the major commodities in the Philippines and other Asian countries, the Pacific, South and Central America, and Africa. It is a source of livelihood for many families and a vital part of their diet. Coconut is a good source of carbohydrates and plant protein with an appreciable amount of fiber [1]. Local production of coconut chip products particularly in Palawan, Philippines generally includes removal of husk, pairing, chipping, adding flavor, air frying, and packaging. One of the tedious works in coconut chip production is the chipping process. The unique configuration of coconut meat requires a specific machine design to do the chipping process. Currently, the Reals Food Products company which is one of the few producers of coconut chips in Palawan, Philippines and other local producers across the country, has not found any machine that can provide their required chip specifications, particularly on the thickness. With this, the company has used manual chipping using improvised equipment. This method is slow, labor-costly, risky, and relatively generates much coconut meat waste. Each person can only produce around 2.5 kg of coconut chips per hour. Wastes, on the other hand, are produced particularly from unavoidable small fragments of coconut meat generated during the deshelling process and leftovers during manual chipping.

The preferred thickness of the company is around 0.30 mm to 0.70 mm. The company needs a machine to augment its production capacity, lessen labor costs, and avoid waste.

Few coconut meat chippers can be found but the specification of the chips produced do not meet their product requirement. Reference [2] developed a coconut meat chipper. Its major problem is the configuration of the blades which has limited adjustment. The average thickness of the chip produced is not suited to the requirement of the local producer. In addition, the cutting disk assembly had considerable vibration causing a larger difference in chip thickness. Reference [3] cited a commercial production of coconut chips using a potato slicer with the requirement thickness not to exceed 0.75 mm. A coconut chipper is also used in producing coconut oil production [4]. It is used to facilitate easy extraction of oil during the pressing process. It uses blades attached vertically on a shaft with a 20 mm distance between blades. There are also several patented models of coconut meat chippers however the application is for size reduction of copra and not for coconut chips delicacies [5], [6], [7].

Generally, the majority of small to medium coconut chip producers are still using the manual method and the use of improvised equipment for slicing coconut meat in the absence of an appropriate slicing machine intended for coconut chips.

Thus, this study aims to develop a coconut meat chipping machine to help the local producers of coconut chips particularly in the Philippines such as Reals Food Products Company and others to meet their coconut chips growing demand. The availability of locally developed coconut-slicing machines could be a catalyst to foster the coconut chips industry and enhance the local economy.

2. OBJECTIVE

Generally, this study is aimed at developing a coconut meat chipping machine. Specifically, it is aimed to design, fabricate, and evaluating a new coconut meat chipper in terms of the thickness of chips, chipping capacity, and chipping efficiency.

3. Methodology

The paradigm (Figure 1) shows the general flow of activities in the conduct of the study. Limitations of existing machines and the desired specifications from the partner industry were the bases of innovation to come up with an improved prototype. The identified machine specifications were considered the ultimate criteria in the development. The conceptualized design was made using Computer Aided Drafting (CAD) and SolidWorks Software for easy simulation. The completed machine design and specifications served as a guide and reference in the procurement and fabrication processes. Fabrication was made at the Technology Innovation Center of the Western Philippines University. Evaluation of machine performance was conducted after the criteria had been met. To ensure the functionality of the machine, pilot testing was done at the industry partner. In the pilot testing, the machine was subjected to actual operation and its components were tested for a more extended period to determine its strength over fatigue.

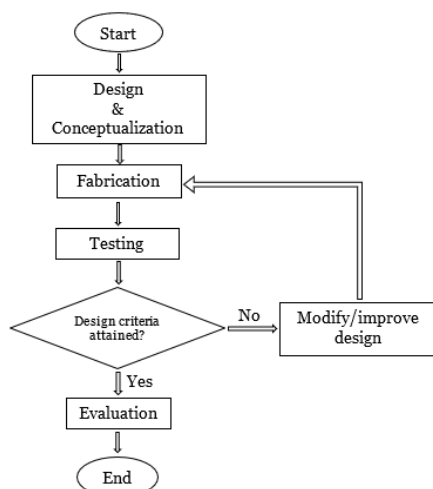


Figure 1. Paradigm of the study

A. Design Criteria and Design Concept

The following were the criteria for the development of the coconut meat chipper. These were solicited from the prospected end user to suit their product standards and requirements: a) chips thickness between 0.03 mm to 0.70 mm; b) minimizes coconut meat waste; c) replaceable cutting blades; d) uses food-grade materials; e) has better capacity and efficiency; and f) safe to use. The coconut chipper (Figure 2) resembles the common chipper. It consists of five major parts: a) cutting disk; b) feeding hopper and presser; c) prime mover and transmission system; d) cover; and e) frame. The cutting disk is made of fiberglass and covered with a stainless sheet. It uses a pair of surgical stainless blades which serve as the slicer. The blades were installed on the disk at an angle for the feeding hopper to enhance the completeness of the cut and uniformity of thickness. The blades are designed to be fully adjustable in terms of tilt angle, height, and lateral movement to optimize blade use and application. It is provided with a manually operated and lever-type presser to lessen the effort of pushing the coconut meat against the cutting disk and to avoid direct contact with the blades. The presser has a specified length not to reach the blades despite varying the amount of force applied to it. The prime mover of the machine is a 1-hp electric motor and uses a belt and pulley transmission system. The frame is made of angled steel bars and the cover is made of stainless sheet.

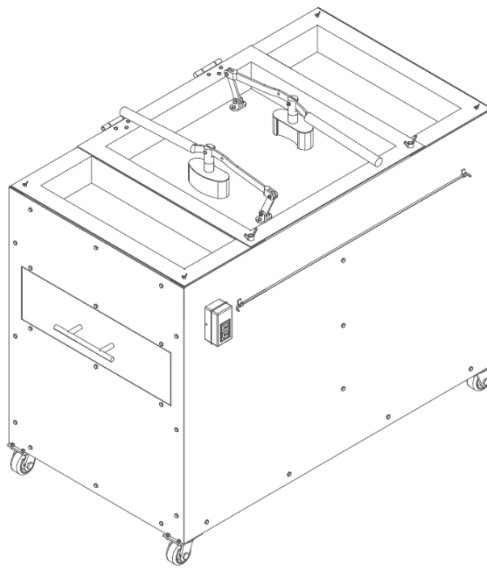


Figure 2. Computer-aided design (CAD) drawing of the machine

B. Fabrication

The machine was fabricated at the Technology Innovation Center of the College of Engineering and Technology at Western Philippines University. Fabrication was guided by detailed drawings and specifications. Fabrication started with the frame followed by the cutting disk, feeding hopper, outlet hopper, transmission system, and cover.

C. Preliminary Testing

Before the final evaluation, the machine was subjected to preliminary testing to determine the right angular speed of the cutting disk and the quality of the chips. Several modifications were made before the designed criteria were met. The thickness also of the chips was examined by the partner industry before the final evaluation of the machine's capacity and efficiency.

D. Preparation of Coconut Meat for Chip Production

Coconut used in the production of chips by the partner industry is a completely matured one. Matured coconut can be easily identified by its brown color. Coconut which is stocked for a long period is not advisable for chip production as this may produce a low-quality product of chips. Before chipping, the brown layer of the coconut meat must be removed. This is to add aesthetic value to the coconut chips and avoid a possible negative effect on the quality of the product. As much as possible, the removal of the coconut meat must be done carefully to avoid small fragments of the coconut meat. Longer chips, but not more than 5 cm, are preferred because they curl when cooked and add a good appearance to the product like the common finger-food snacks. The coconut meat must be washed properly before chipping because cooking using the air frying method will follow.

E. Performance Evaluation

The performance of the machine was evaluated in terms of the thickness of chips, capacity, and efficiency. The angular speed and blade settings were predetermined based on the result of the preliminary testing. In performance evaluation, four trials were made using 2 kg of coconut meat per trial. The thickness was determined using a Vernier Caliper instrument. Ten samples per trial were taken randomly for thickness measurement. Chipping capacity (Equation 1) and efficiency (Equation 2) were computed using the following formulas.

$$C = \frac{W}{T} \quad \text{Equation 1}$$

Where

C - Capacity, kg/hr

W - Weight of coconut meat, kg

T - Time elapsed in chipping, hr

$$Eff = \frac{W_t - W_u}{W_t} \times 100 \quad \text{Equation 2}$$

Where

Eff - Efficiency, %

W_t - Total weight of coconut meat, kg

W_u - Unsliced or wasted coconut meat, kg

4. Results and Key Findings

A. Machine Description and Procedure of Operation

Figure 3 shows the prototype of the new coconut meat chipper. Two persons can use the machine simultaneously as it is provided with two feeding hoppers and pressers. The raw coconut meat can be placed at the two basins provided on top of the machine to easily access the coconut meat for chipping.

A lever-type manual presser provides enough force to drive the coconut meat against the cutting disk. Feeding can be done by inserting the coconut meat into the inlet chute corresponding to the shape of the chute. The coconut chips can be taken from the two drawer-type containers placed under the cutting assembly. Figure 4 shows a photo of the coconut chips produced by the machine.



Figure 3. Photo of the coconut meat chipper



Figure 4. Photo of the coconut chips produced

The following shows the procedure of operation of the machine. These operation and maintenance procedures must be observed to avoid damage to the machine, prolong its useful life, and keep the safety of the operator.

1. Prepare the coconut meat properly and observe proper hygiene protocols.
2. Check the major parts of the machine, such as belt tightness, the electric motor, the cutting disk, and wires for possible damage.
3. Clean the hoppers, cutting disk, chip containers, and all surfaces that have contact with the product.
4. Start the chipping operation by turning on the electric motor switch.
5. Feed the coconut meat into the hopper and press using the designed presser.
6. Feeding must be one piece of coconut meat at a time.
7. Clean the machine every after use.

C. Machine Performance

Results of the evaluation showed that the mean thickness of chips attained was 0.55 mm (Table 1). This thickness obtained is within the required thickness prescribed by the local industry partner between 0.30 mm to 0.70 mm. The quality of coconut chips was subjected to inspection by the Proprietor of Reals Food Products Company who is the industry partner of this project to ensure that the produced chips have satisfied their product requirement. Based on the result, it can be observed that the range of thickness achieved was ranging from 0.3 to 0.7 mm. This variation of thickness can be attributed to the magnitude of pressure exerted on the coconut meat against the cutting blade and from the slight vibration of the cutting assembly caused by the different moving parts of the machine. The hardness property and shape of coconut meat are the major challenges in attaining the required thickness and shape. Thus, further study on employing mechanized methods of feeding and pressing is suggested to improve the performance of the machine and provide a more consistent quality of chips. Through this, human effort in pressing will be eliminated. In addition, precision also in the fabrication process is very important to reduce vibration.

Table 1. The thickness of chips obtained

Trial	Thickness of coconut chip sample, (mm)										Mean
	1	2	3	4	5	6	7	8	9	10	
1	0.60	0.70	0.60	0.70	0.60	0.60	0.60	0.50	0.60	0.60	0.61
2	0.40	0.42	0.52	0.54	0.50	0.38	0.60	0.42	0.50	0.40	0.47
3	0.58	0.60	0.60	0.66	0.56	0.70	0.58	0.54	0.46	0.40	0.57
4	0.50	0.48	0.60	0.62	0.68	0.64	0.62	0.46	0.48	0.32	0.54
Overall Mean											0.55

Table 2. Chipping capacity and efficiency of the coconut chipper

Trial	Weight coconut meat, kg	Time elapsed in chipping, hr	Waste/unsliced coconut meat, kg	Capacity, kg/hr	Efficiency, %
1	2	0.13	0.09	15.00	95.55
2	2	0.17	0.07	11.85	96.60
3	2	0.14	0.06	14.67	96.89
4	2	0.14	0.08	14.02	95.86
Overall Capacity				13.88	
Overall Efficiency					96.22

The computed mean chipping capacity was 13.88 kg/hr of continuous operation (Table 2). This capacity obtained was from one person only operating the machine. This capacity can be doubled if two persons will operate the machine simultaneously as it is provided with two feeding hoppers. This feature can reduce energy costs in chipping and enhance the chipping capacity over time. The chipping capacity obtained by the machine is far better than the manual method which has a capacity of around 2 to 2.5 kg/hr only. The machine capacity obtained is sufficient for the current level of production of the industry partner. The machine can get rid of the tedious and unsafe method of chipping.

The average machine efficiency attained was 96 % which is relatively high. This implies that only a small amount of coconut meat can be wasted in the chipping process unlike in the

manual method.

5. Conclusion

Generally, the developed coconut chipper showed the potential to support the local small and medium coconut chip industries. It can help boost the level of production and lessen the labor cost in the chipping process. In addition, the unsafe manual method of chipping can be avoided as well as the amount of coconut meat waste generated. This innovation can potentially help the small local coconut farmers find another avenue to add value to their coconut, knowing the very unstable price of copra in the market where they are used to sell. Indirectly, this can foster profit, and livelihood, and help enhance the local economy.

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