A Coconut Deshelling Machine for Improved Safety and Productivity

Ayesh Bandara
Department of Mechanical Engineering
University of Moratuwa
Moratuwa, Sri Lanka
https://orcid.org/0009-0003-1512-8488

Dilshan Jayawickrama
Department of Mechanical Engineering
University of Moratuwa
Moratuwa, Sri Lanka
https://orcid.org/0009-0003-0250-9396

Bhagya Kuladasa
Department of Mechanical Engineering
University of Moratuwa
Moratuwa, Sri Lanka
https://orcid.org/0009-0006-6342-9260

Akila Dinuka
Plant Engineering Manager
Silvermill Group of Companies
Loluwagoda, Sri Lanka
dinuka@silvermillgroup.com

Lihil Uthpala Subasinghe
Department of Mechanical Engineering
University of Moratuwa
Moratuwa, Sri Lanka
lihis@uom.lk

Janaka Ranganath Gamage
Department of Mechanical Engineering
University of Moratuwa
Moratuwa, Sri Lanka
gamagejr@uom.lk

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I. INTRODUCTION

Coconut is the third largest cash crop grown in Sri Lanka. There are a variety of coconut-based products available, and deshelling is an essential step in the manufacturing processes of all those products. However, the deshelling process faces several safety concerns which are yet to be addressed. It was found through field visits that on average, 4 accidents per month are reported by the laborers who work in deshelling machines. These injuries are caused by slippage of coconut when it is held onto the cross cutter of the deshelling machine. Another concern was that the coconut kernel was damaged slightly by the cross-cutter, the cutting wheel of the current machine. This damage is significant when a large-scale coconut processing plant with over 200,000 nuts daily capacity is considered. The scarcity of skilled laborers to operate the deshelling machines is another challenge. Training new laborers is both a time-consuming and costly process.

Therefore, this research aims to develop a new mechanism for coconut deshelling to be used in an industrial setup. The mechanism intends to enhance the safety of the operation while reducing the damage to the kernel and to reduce human intervention in the process. The scope of this project is limited to deshelling a coconut starting from dehusked coconut and the intended output is kernel with brown skin while dehusking and paring will be out of the scope.

II. LITERATURE REVIEW

A. Previous proposals of coconut deshelling methods

Fig. 1 represents a motor-driven coconut deshelling machine developed to deshell split and partially dried coconuts older than 12 months or more. The coconuts were first dried inside a hot air electric oven up to 25-66% moisture level (dry basis) and the output was deshelled by an impact force created by the collision of coconuts with each other inside a rotating drum. The study claims that the machine can deshell a batch of 400 split coconuts in 4 min when the machine rotates at an optimum speed of 10 rpm. This means it works with one-fourth of the time compared to manual deshelling. It also claims that the coconuts must be dried up to 35% to achieve the maximum efficiency of 82% [1].

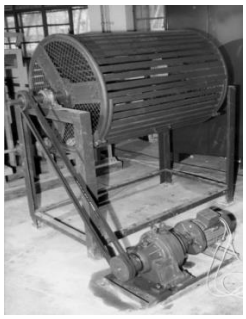

Fig. 1: View of the coconut deshelling machine [1]

Fig. 2 depicts a proposed machine to deshell coconuts by first segmenting the coconut shell into six rings using a "Dremel" cutting tool, then letting those partially cut coconuts to collide with each other inside a rotating drum. The study claims that skilled labour requirement is reduced since an operator is only needed to feed the coconuts, to switch the machine on and off and to monitor the process. Even though it ensures a reduction of human intervention in the deshelling process, the average time estimated for deshelling, which is 35 s is much higher than the manual deshelling time taken by a skilled labourer [2].

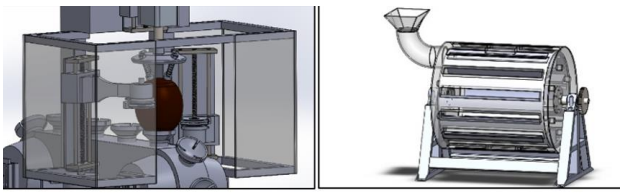

Fig. 2: Finalized design of cutting section (left) and rotary drum (right) [2]

Fig. 3 shows a coconut deshelling machine powered by a motor which is much similar to the existing machine in the industry (see Fig. 4). Coconut has to be fed manually and held against a rotating cross cutter which can break the coconut shell by applying a crushing force. In this research deshelling capacity and efficiency are evaluated based on the number of well deshelled fruits with respect to the time taken, and average deshelling efficiency and capacity are calculated as 90% and 195 nuts per hour respectively [3].

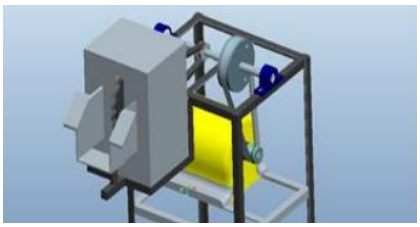

Fig. 3: 3D model of the proposed machine [3]

B. *Existing deshelling machine in the industry*

The Loluwagoda factory of Silvermill Group was visited by us, and it was found that the existing machine had two cross cutters instead of one. This was done to reduce the risk of coconuts slipping and causing injuries to the operators' fingers. The machine can deshell about 200 coconuts per hour. The company claims that this is the best possible machine available for deshelling considering the deshelling rate and the cost, but the safety concerns mentioned in introduction section are still the same with this machine as well.

Fig. 4: Existing deshelling machine

III. MATERIALS AND METHODS

An industrial visit to Loluwagoda factory was conducted to collect data and information about coconut-related product manufacturing process, especially focusing on the deshelling step. Several interviews were conducted with industry professionals within the day of the field visit. To find information about deshelling technologies and their advantages and limitations, a literature review was conducted by studying articles published in peer-reviewed journals, international conferences, and other coconut-related research bodies such as coconut research institution in Lunuwila, Sri Lanka.

IV. RESULTS AND DISCUSSION

The three coconut deshelling methods discussed before have their own merits and demerits. TABLE I shows a comparison of those methods. TABLE I further shows that even though the first two methods solve two major concerns (safe operation and no need of skilled labor), they can still break the kernel. This is problematic for the next phase in the manufacturing process, which is paring (removing brown skin of the kernel), because both manual and semi-automatic paring methods need kernel as a whole. Therefore, it is understood that a novel approach is required to mechanize the deshelling process with improved safety while ensuring unharmed coconut kernel.

TABLE I. ADVANTAGES AND DISADVANTAGES OF DESHELLING METHODS

Deshelling Method	Advantages	Disadvantages
Fig. 1	High deshelling rate	Prone to kernel damages
	Safe operation	Suitable for copra only
	No need of skilled labor	
	Low manufacturing and operating costs	
Fig. 2	Safe operation	Low deshelling rate
	No need of skilled labor	Prone to kernel damage
	Suitable for coconuts of any age	
Fig. 3	High deshelling rate	Prone to kernel damages
	Low manufacturing and operating costs	Operation is unsafe
		Need of skilled labor

V. CONCLUSION

The coconut industry is a vital sector in Sri Lankan economy, and deshelling is a key process in the production process. In this research, we conducted a comprehensive background study on the existing deshelling mechanisms and compared their pros and cons to understand the bottlenecks in the process. Our findings reveal that the existing machines do not provide an all-in-one solution for the major concerns identified earlier in this paper. Therefore, it is required to develop an improved deshelling machine that can overcome these limitations and enhance the quality of coconut products.

VI. FUTURE WORK

As the next phase, several concepts will be generated combining the technologies found in the literature. The best possible combination for deshelling will be selected through scientific methods such as morphological analyses and decision matrices. Then, a 3D model of the machine will be generated to evaluate the functionality and to optimize the design. After finalizing the design, a prototype will be built to validate the concept.

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