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RESEARCH ARTICLE

HULLING MACHINE: DESIGN, FABRICATION, AND PERFORMANCE

***Alberto Paulo Cercado**

College of Engineering, Architecture and Technology, Capiz State University, Roxas City, Capiz, Philippines

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ABSTRACT

The purpose of this research was to develop de-huller machine which can hull beans without broken parts. Specifically it sought to: 1. Find out the time rate of de-hulling; 2. Determine the efficiency of the machine; and 3. Find out the percentage recovery of de-hulled beans. Trial method was employed by the researchers which are within the realm or scope of true experiment. Statistical tools were utilized in the analysis of the data through the average value or mean. Mean was computed to determine the weight of coffee beans, time and percentage recovery of beans. The results shows that the machine made was found to be more efficient than the previous manual operated de-huller machine.

INTRODUCTION

Hulling was once a manual process, but it is now automatically handled by machines. It takes place if the coffee is still in bean form. Machines are responsible for the hulling process. The parchment layer of the coffee, which is also known as the endocarp, is removed when the coffee is wet. Dry processed coffee hulling is a process that entails removing the husk once it is dried. The whole dry husk, including the exocarp, endocarp, and mesocarp, are removed from the cherries that are already dry. The different types of hulling are important to the coffee making process. In 1894, the first coffee hulling machinery was patented by C.E Lip, who also patented and designed many helpful inventions. It was designed to make the hulling process easier by separating and cleaning the coffee berries. The machine was the very first of its kind. It completely changed the way that coffee was made. Coffee making companies enjoyed the increased production and a finer accuracy of the hulling process. The development of the coffee hulling machine was a very big deal for coffee companies. Their speed and accuracy greatly improved production. The extensive coffee making process requires hulling on a regular basis. Mechanical handling of hulling operation will encourage development of other relevant equipment to handle some other stages in dry processing of coffee such that there may be a fully mechanized dry processing method. Mechanical processing of the crop will also encourage engagement of many members of the rural communities of the growing regions in production of coffee which will automatically improve their economy.

****Corresponding author:*** **Alberto Paulo Cercado,**
College of Engineering, Architecture and Technology, Capiz State University, Roxas City, Capiz, Philippines

Mechanical processing of coffee will also lead to handling its large quantity and production of reasonable amount of by-products. Production of coffee by-products in large quantities may result in the development of various processes of utilizing such by-products as animal feeds, bio-fuel, fertilizer and soil conditioner. This may also has significant effects on the income and livelihood of the farmers.

MATERIALS AND METHODS

Evaluation Procedure: The following test procedures were applied in evaluating the machine.

1. Place the machine in a safe place where we can perform the evaluation.
2. Prepare 1 kilogram of coffee beans and put it inside the machine.
3. Record the time rate of the de-hulling operation according to its weight.
4. Weighing of Coffee Beans after de-hulling
5. After the de-hulling process, place the coffee beans into the place that exposed to the sun for drying process.
6. Record and analyze or interpret the data gathered.

Instrumentation Data to be Gathered: The time rate of de-hulling was recorded using a stop watch. This was used to identify the efficiency of the machine. Weight of coffee bean was recorder before or after the de-hulling.

Parameters of the Study

1. Percentage recovery of the de-hulled coffee beans.
2. Hulling time-rate.

Table 1. Percentage of Recovery for 1 kilogram coffee beans

Treatment	Trials			Mean
	1	2	3	
Wt. of coffee before hulling (kg)	1 kg	1 kg	1 kg	1 kg
Wt. of coffee after hulling (kg)	0.45 kg	0.65 kg	0.70 kg	0.65 kg
Percentage Recovery	45%	65%	70%	65%

Table 2. Time rate of de-hulling of 1 kilogram coffee bean

Treatment	Trials			Mean
	1	2	3	
Wt.of coffee before hulling (kg)	1 kg	1 kg	1 kg	1 kg
Time of De-Hulling	1min 49sec	1min 32sec	1min 34sec	1min 32sec
Time rate of Dehull	0.671 kg/min	0.758 kg/min	0.746 kg/min	0.758 kg/min

3. To determine the machine efficiency.
4. To test the machine.

Statistical Data Analysis

The statistical tool used in this study was the average or arithmetic mean. It is used in determining the amount of coffee beans taken from the Machine; hulling time; and Coffee quality.

Formula for mean:

$$M = \frac{\sum x}{N}$$

Where:
M = Arithmetic mean
$\sum x$ = sum of the unbroken beans, time & amount of coffee
N = number of trials

Conducting three (3) trials for 0.5 kg and 1 kg of coffee beans on percentage of recovery in terms of weight of coffee before and after hulling and time rate of de-hulling in terms of weight of coffee before and time of de-hulling.

RESULTS AND DISCUSSION

Table 1 below shows the percentage of recovery for 1 Kilogram coffee bean in terms of weight of coffee after hulling and weight of coffee before hulling. It was shown that in 1 kilogram of coffee bean in three trials the mean percentage of recovery in de-hulling is 65%. The data implies that the coffee de-huller machine can perform efficiently in terms of percentage of recovery used in hulling the coffee beans. Thus, it is more efficient to use the mechanized coffee de-huller than the previous study having a 50% mean efficiency by using manual operated coffee de-huller machine.

Formula for mean:

$$M = \frac{\sum x}{N}$$

Where:
M = Arithmetic mean
$\sum x$ = sum of the unbroken beans, time & amount of coffee
N = number of trials

Solving of mean for first trial,

$$M = \frac{\text{Wt. of coffee before hulling (kg)}}{\text{Wt. of coffee after hulling (kg)}}$$

$$M = \frac{1kg}{0.45kg} \times 100\%$$

$$M = 45\%$$

Solving of mean for second trial,

$$M = \frac{\text{Wt. of coffee before hulling (kg)}}{\text{Wt. of coffee after hulling (kg)}}$$

$$M = \frac{1kg}{0.65kg} \times 100\%$$

$$M = 65\%$$

Solving of mean for third trial,

$$M = \frac{\text{Wt. of coffee before hulling (kg)}}{\text{Wt. of coffee after hulling (kg)}}$$

$$M = \frac{1kg}{0.70kg} \times 100\%$$

$$M = 70\%$$

Therefore; We get the mean percentage of recovery of de-hulling which is 65%.

Time rate of de-hulling of 1 kilogram coffee bean: Table 2 indicate the time rate of de-hulling of 1 kilogram coffee bean in terms of weight of coffee before de-hulling and time of de-hulling. After the three trials of 1 kilogram of coffee bean it was found out that the mean time rate of de-hulling is 0.758 minutes. The data reveals that the coffee de-huller machine performs efficiently in terms of time rate used in hulling the coffee beans. Thus, it is more efficient to use the mechanized coffee de-huller than the previous study having a 0.714kg/min mean efficiency in terms of time rate of de-hulling by using manual operated coffee de-huller machine.

Formula for mean:

$$M = \frac{\sum x}{N}$$

Where:
M = Arithmetic mean
$\sum x$ = sum of the unbroken beans, time & amount of coffee
N = number of trials

Solving of mean for first trial,

$$M=\frac{\text{Wt. of coffee before hulling (kg)}}{\text{Time of de-hulling (min)}}$$

$$M=\frac{1kg}{1.49min}$$

M = 0.671 kg/min

Solving of mean for second trial,

$$M=\frac{\text{Wt. of coffee before hulling (kg)}}{\text{Time of de-hulling (min)}}$$

$$M=\frac{1kg}{1.38min}$$

M = 0.758 kg/min

Solving of mean for third trial,

$$M=\frac{\text{Wt. of coffee before hulling (kg)}}{\text{Time of de-hulling (min)}}$$

$$M=\frac{1kg}{1.34min}$$

M = 0.746 kg/min

Therefore;

We get the time rate of de-hulling which is 0.758 kg/min.

Conclusions

This work has considerably met the dire need of the farmers to have an efficient, cost-effective, ergonomic, and durable and easily operated coffee processing machine which is also suitable for small scale industrialists that may boost productivity and enhance quality.

Findings from the conduct of testing and experimentation, the following conclusions were made:

- Table 1 shows that the percentage recovery of de-hulled seeds is 65%.
- Table 2 shows that the time rate of de-hulling of coffee beans is 0.758kg/min.
- The total economic cost of De-huller machine is P10,218.22 which is affordable for common coffee planter.(See Appendix 2)
- The machine made is found to be more efficient than the previous manual operated coffee de-huller machine.

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