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AN EXPERIMENTAL INVESTIGATION ON PRE-PROCESSING OF ARECA LEAF FOR SHREDDING USING A DOMESTIC MIXER

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ABSTRACT

An experimental investigation has been carried out on pre-processing of areca leaf to achieve powdered form to prepare organic fertilizer at home using a domestic high-speed mixer. From the preliminary study, it is found that time taken to decompose for the grain size in the range of 0.1 to 0.6 mm is 4-5 days. A process study is carried out by conducting experiments on various samples of pre-processed areca leaf. The fixed parameters considered for the study are the blade profile of the mixer, RPM, Power and sample quantity (0.02 kg). Controllable parameters are Moisture content in samples (Dry, soaked (15 minutes), soaked (72 minutes)), leaf size (120x20 mm, 40x20 mm, 20x20 mm and 5x5 mm), sliced, grated and combination controllable parameters (Dry, Dry-Compact, Dry-Torched, Dry-Compact-Torched, and Wet) are considered. For all the samples, time taken to bring down the powdered form (time taken for crushing) is studied.

Disciplinary: Agricultural Waste Management, Mechanical Engineering.

1. INTRODUCTION

Areca is a species of palm which grows in much of tropical Asia, parts of East Asia and Africa Pacific. Areca leaves are disposable, biodegradable and are a great substitute for plastic/paper disposables. A large quantity of areca sheath remains unutilized because of handling, storage, and management related difficulties. The reasons for this are its low bulk density, large area/volume requirement for storage, hence the farmers burn most of these or dispose them of in an inefficient way wherein the bulky waste is dumped and left to degrade in open pits. This takes more time to disintegrate and it remains as a heap for a long time posing various environmental problems.

Shredding proves to be the best way to use these wastes and to gain economic benefits from it.

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Shredding of leaves into smaller pieces makes it easy for handling and management. This shredded mass can also be used for the preparation of animal fodder and organic fertilizers. In the present paper tape, scale and digital Vernier calipers are used for measuring the size of the powder.

Kishore *et al.* (2019) studied on the mechanical behavior of constant volume fraction of areca leaf fibre reinforced epoxy composite along with different fiber orientations. Ashok *et al.* (2018) studied chemical treatment effects on areca fibres of different lengths and also areca powder. Shashikumar *et al.* (2017) worked on an areca sheath shredder that has been designed for chopping of areca sheath into small pieces suitable for animal fodder. The areca sheath passes horizontally against the rotating knives and gets reduced into small pieces. Desai *et al.* (2016) concluded that areca fibers are good in mechanical properties with bio-degradable in nature, it can be used as a reinforcement material. Chethan and Krishna (2016) worked on different volume fractions of natural-polymer composites, the strength of the natural-polymer composites changes by varying the volume fractions. Pickering *et al.* (2016) compared the specific modulus of areca leaf fiber with synthetic and natural fibers. By comparing the specific modulus value of areca fibers got the seventh position out of 11 various natural and synthetic fibers. Nithyananth *et al.* (2014) studied the design of an agro-waste shredder machine which is powered by a 'Kamko tractor. The waste shredder machine converts the agro-waste into different size particles and useful for nourishing the fertilizer. Kumar and Kumar (2015) studied on design and development of a Shredder machine, which focuses on the chopping of areca leaves along with other various agricultural wastes.

Mohanraj *et al.* (2017) worked on an improved areca leaf plate manufacturing machine where cutting, punching operations are done simultaneously and waste areca leaf converted into powder form. Srinivasa and Bharath (2011) studied areca fiber such that the strength of areca fiber composites increases with an increase in the volume fraction of fiber in the composite and post composite curing time.

From the literature survey, it is found that there is no work carried out on the pre-processing of the areca leaf before shredding. In this paper, the pre-processing process parameters for areca leaf shredding is studied.

2. METHODOLOGY

In this investigation, an experimental study is been carried out for pre-processing of the areca leaf, the task aims to explain the variation of controllable/uncontrollable input variables under conditions that are hypothesized to reflect the variation in the grinding time.

The chart of the pre-processed samples is shown in Figure 1. For dry samples, the moisture content is almost zero. For the soaked samples, two types of soaking are considered namely soaked for 15 min and soaked for 12 Hours. In 15 minutes absorption time is minimum and for 720 minutes absorption time is maximum.

Three types of Dry Areca leaf considered for the study are 1. Dry, 2. Rammed and 3. Torched. Dry areca leaf sample refers to sun-dried leaf. Rammed sample refers to sun-dried leaf hand rammed for 10 min to increase the stiffness of the leaf. Torched areca leaf sample refers to heating the dry leaf in a vessel for 5 minutes to achieve brittleness.

The sample sizes considered for the investigation are grouped into three groups, 1. Grated, 2. Sliced and 3.strip-sizes (120x20 mm, 40x20 mm, 20x20 mm, 5x5 mm).

Uncontrollable or fixed parameters are Blade profile, Quantity of the sample used, speed (7000 rpm) and voltage (220-240 V) of the domestic mixer. The blade profile is shown in Figure 2. Table 1 gives controllable and fixed input variables considered for this experimentation.

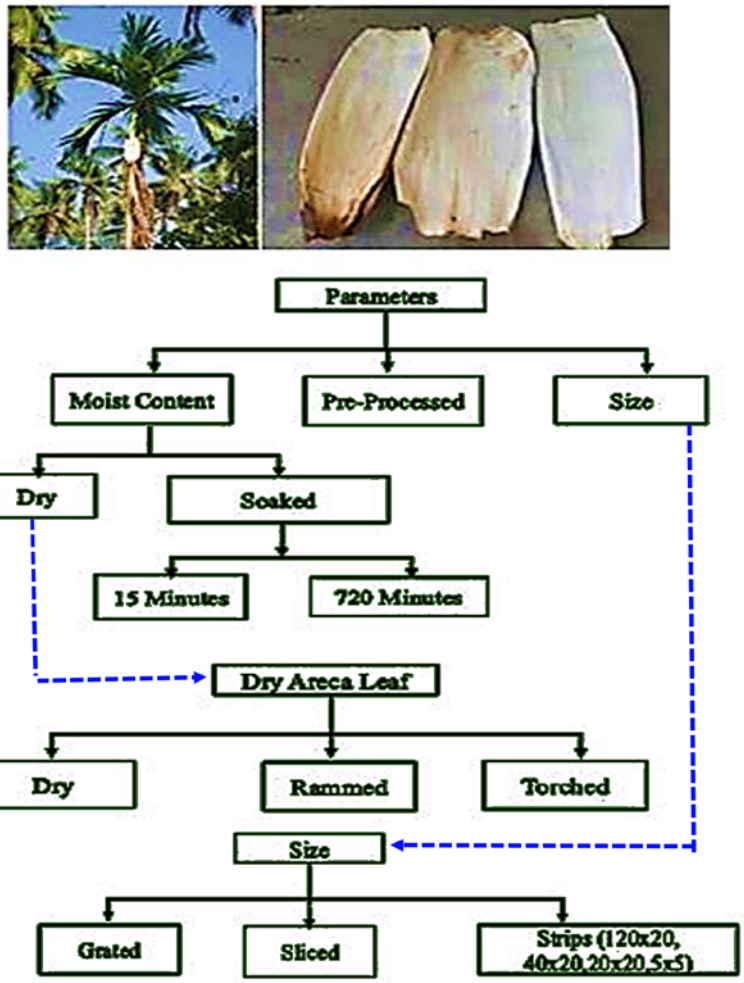

Figure 1: Process chart of the major parameters studied for areca leaf shredding.

Figure 2: Blade profile considered in a domestic grinder.

Table 1: Controllable and fixed input variables.

Controllable Parameters	Combination of Controllable Parameters	Fixed Parameters
Dry	Dry (sizes: 120x20, 40x20, 20x20 and 5x5 mm)	Blade Profile
Moist 1 (Soaked for 15 min)	Dry-Compact	RPM
Moist 2 (Soaked for 12 Hrs)	Dry-Torched	Torque
-	Dry-Compact-Torched	Power

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Testing procedure: Collected leaves are cut into the required sizes, rammed, torched and soaked. After the pre-processing of the samples crushing operation is carried out using a household mixer and crushing times for each sample are tabulated.

3. RESULTS AND DISCUSSION

3.1 STRIPS (120 MM LENGTH, 20MM WIDTH)

Figures 3 to 6 show before and after crushing of 120x20 mm the samples sizes of for Dry, Dry-compact, Dry-Torched, Dry-Compact-Torched respectively. Grinding time to bring it to powder form found to be 50, 40, 33 and 40 seconds respectively.

Figure 3: Dry (50seconds grinding time).

Figure 4: Dry and Compact (40seconds grinding time).

Figure 5: Dry and Torched (33seconds grinding time).

Figure 6: Dry, Compact and Torched (40seconds grinding time).

3.2 STRIPS (40 MM LENGTH, 20MM WIDTH)

Figures 7 to 10 show the before and after crushing of the sample size of 40x20 mm for Dry, Dry-compact, Dry-Torched, Dry-Compact-Torched respectively.

Grinding time to bring it to powder form found to be 43, 45, 36 and 42 seconds for Dry, Dry-compact, Dry-Torched, Dry-Compact-Torched respectively.

Figure 7: Dry (43seconds grinding time).

Figure 8: Dry and Compact (45seconds grinding time).

Figure 9: Dry and Torched (36seconds grinding time).

Figure 10: Dry, Compact and Torched (42seconds grinding time).

3.3 SQUARE (20 × 20 MM)

Figures 11 to 13 show the before and after crushing of the sample size of 20x20 mm for Dry, Dry-compact, Dry-Compact-Torched respectively. Grinding time to bring it to powder form found to be 45, 36 and 35 seconds for Dry, Dry-compact and Dry-Compact-Torched respectively.

Figure 11: Dry (45seconds grinding time).

Figure 12: Dry and Compact (36seconds grinding time).

Figure 13: Dry, Compact and Torched (35seconds grinding time).

Figures 14-15 show the before and after crushing of the sample size of 20x20 mm for wet soaked for 15 min and wet soaked for 12 hours respectively. For these samples, no results were found.

Figure 14: Wet (Soaked for 15 mins).

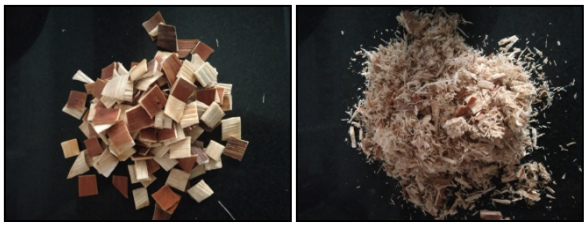

Figure 15: Wet (Soaked for 12 hours)

3.4 SQUARE (5 MM × 5MM)

Figures 16 to 18 show the before and after crushing of the sample size of 5x5 mm for Dry, Dry-compact, Dry-Compact-Torched respectively. Grinding time to bring it to powder form found to be 45, 34 and 33seconds for Dry, Dry-compact and Dry-Compact-Torched respectively.

Figure 16: Dry (45seconds grinding time).

Figure 17: Dry and Compact (34seconds grinding time).

Figure 18: Dry, Compact and Torched (33seconds grinding time).

3.5 SLICED

Figures 19 and 20 show the before and after crushing of the sample of sliced for Dry and Dry-compact respectively. Grinding time to bring it to powder form found to be 26 and 35 seconds for Dry and Dry-compact.

Figure 19: Dry (26seconds grinding time).

Figure 20: Dry and Compact (35seconds grinding time).

3.6 GRATED

Figure 21 shows the before and after crushing of the sample of Dry grated. Grinding time to bring it to powder form found to be 35 seconds.

Figure 21: Grated (35seconds grinding time).

From the above experiments, it is found that without slicing the leaf it is impossible to achieve the powdered form. Also, it is found that soaking the leaf makes grinding very difficult. Figure 22 shows a plot of sample type (Dry (D), Dry and Compact (DC), Dry and Torched (DT) and Dry, Compact and Torched (DCT)) vs crushing time in seconds.

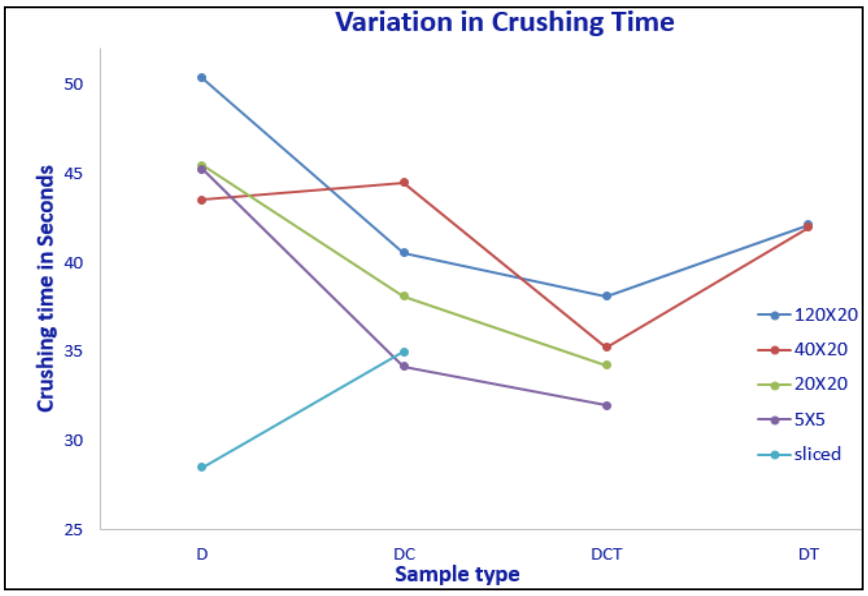

Figure 22: Sample type vs crushing time (seconds).

From the graph Figure 22, it is found that crushing time for the samples Sliced-Dry and Dry-Compact-Torched found to be 27 and 32 seconds respectively and could able to achieve a grain size of 0.1 to 0.6 mm.

Table 2 shows the quantity of crushed areca powder obtained during the grinding process. During the grinding operation, 20g of the areca sample was fed to the grinding machine and the quantity of crushed areca in powder form for different cases is recorded as below.

Table 2: Quantity of crushed areca powder obtained during the grinding process.

Case		Areca Powder from Grinding machine (g)
Strip 120 MM LENGTH, 20MM WIDTH	Dry	17.8
	Dry and Compact	18.1
	Dry and Torched	18.4
	Dry, Compact and Torched	18.4
Strip 40 MM LENGTH, 20MM WIDTH	Dry	18
	Dry and Compact	18.2
	Dry and Torched	18.5
	Dry, Compact and Torched	18.5
Square 20 × 20 MM	Dry	18.1
	Dry and Compact	18.1
	Compact and Torched	18.5
	Wet (Soaked for 15 mins)	18.2
	Wet (Soaked for 12 hours)	18.5
Square 5 MM × 5MM	Dry	18.4
	Dry and Compact	18.6
	Compact and Torched	18.6
Sliced	Dry	18.8
	Dry and Compact	19
Grated	Grated	19
Average		18.41

4. CONCLUSION

In this research, experiments are conducted on the pre-processed areca leaf to obtain a powdered form by grinding the pre-processed leaf in a domestic mixer. Experiments were carried out for measuring the factors affecting the crushing time for various samples. From the experiments, it is found that crushing time for the samples Sliced-Dry and Dry-Compact-Torched found to be 27 and 32 seconds respectively. During grinding operation out of 20g of sample on an average of 18.41g of the samples are crushed in to powder form and the efficiency of the grinding machine found to be 92.02%. From this experimental study, it is concluded that without slicing the leaf it is impossible to bring it to powdered form using a domestic mixer and also soaking of the leaf gives no effect in bringing it to the powdered form.

5. AVAILABILITY OF DATA AND MATERIAL

Information can be made available by contacting the corresponding author.

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