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Prototype of the chopping machine for the fronds and leaves of oil palms

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Abstract

Oil palm waste is the residue from the main product of the oil palm tree that is not utilized. Oil palms can produce solid waste in the form of stems, empty fruit bunches, shells, fiber (coir), and fronds. One oil palm tree can produce 40 to 50 fronds within one year. Oil palm fronds are obtained from the rest of the crop and when caring for the tree. This research aims to make and test a prototype chopper machine to utilize and reduce the waste of palm fronds and leaves. The driving motor on this prototype uses a 2 hp electric motor with 1450 rpm rotation, pulley 1, which is on a 4-inch electric motor, and pulley 2, which is on a 6-inch blade shaft, so there are 2 v-belts used with a size B-55. Calculations made during the design process of the prototype counter machine for palm fronds and leaves are circumferential speed of pully, circumferential force of pully, belt tension, maximum belt tension, number of belt rotations, number of belts, belt age and calculation of speed and torque on the blade shaft. The chopped ingredients are fresh or wet palm fronds and leaves. The chopped ingredients produced by the prototype is 206 kg/hour with an average of 5 repetitions. For prototype yield, the average yield produced from 5 repetition was 94.41%, and the resulting chopped results were 20-40 mm long.

Keywords*: chopping machine; design; blades; oil palms waste; fronds and leaves*

1. INTRODUCTION

The palm oil industry is the largest foreign exchange-earning agricultural commodity in the Indonesian economy. Indonesia's oil palm plantations are experiencing rapid growth, especially on the islands of Kalimantan and Sumatra. These two islands produce 90% of oil palm plantations. Kalimantan has had a significant increase in agriculture. In 2011 it had a land area of 716,320 ha, and in 2021 it had a land area of 1,374,543 ha (East Kalimantan Province's Plantation Office, 2021). With the continued increase in oil palm plantations, palm oil waste will also increase year by year, both in the form of liquid and solid waste.

Oil palm waste is the residue from the main product of the oil palm tree that is not utilized. Oil palm can produce solid waste such as empty fruit bunches, shells, fiber (coir), and fronds (1). One oil palm tree can produce 40 to 50 fronds in a year. Fronds of oil palm are obtained from the rest of the harvest, and when the farmer care the tree the natural decomposition process of fronds of oil palm is approximately occurring for 4 months (2).

The utilization of oil palm fronds and leaves as animal feed is beneficial to the farmers. In making it easier to be consumed by the cattle, the fronds and leaves are chopped into small pieces. It is aimed to fasten the fermentation process of the chopped ingredients. The fronds and leaves of oil palm has been proven to increase the weight of beef cattle to 60% than those that are fed by only leaves (1). Apart from being used as animal feed, palm fronds and leaves can also be used as a mixture of compost

ingredients (3). During the composting process, the size of the chopped product is very influential because the smaller the chopped size the more decomposing bacteria can quickly spread on the chopped media (4). Then palm fronds can also be used as material for making briquettes, which can be used as alternative fuels (5).

The problem related to the ignorance of utilizing the waste of the fronds and leaves of oil palms is it needs long time to decompose, and it causes large accumulation. Therefore, it can become the nest for pests before the waste is decomposed. This problem leads to the research of building prototype of the chopping machine for the fronds and leaves of oil palms.

This research is aimed to build and test the prototype of a chopping machine to utilize and reduce the waste of fronds and leaves of oil palms. The utilization of the fronds and leaves is expected to give an alternative to the farmers on the cattle feed. Moreover, it is also expected to facilitate them in processing the feed from the fronds and leaves. It is also expected to bring a solution in reducing the pests from the waste accumulation.

This research is limited to the ingredients that will be chopped. It uses wet or fresh fronds and the leaves of oil palms. Furthermore, the blade used in this prototype is spiral-shaped and the machine is built in a prototype.

2. METHODS

A chopping machine is a tool used to reduce the size of waste by chopping it into small parts, with a chopping machine can undoubtedly make work easier and save time. In the beginning, the chopping process only used the manual method by using a machete or sickle, chopping it into small pieces with a long processing time. Now we can do it quite quickly and the results obtained can be more with the help of a chopping machine (6). The number of various chopping machines is adjusted to the needs and the type of work being done to make work easier.

The chopping machine generally consists of several main parts, namely the frame as the seat for the chopping machine mechanism, the drive motor as the prime mover, the shaft, pulley, and v-belt, which function as the power distributor for the drive motor, the input hopper as the entry point for the waste to be chopped and the hopper output as a waste exit path after being chopped (7). The chopping machine works by rotating the pulley on the drive motor, which is connected to the v-belt to the pulley on the blade shaft of the chopper, then the rotation of the blade will chop the waste, which then the chopped waste comes out through the output hopper (8)(9).

Design is the stage of the activity of making a product from scratch. Good design is expected to be able to produce an optimal product per the desired conditions (10). During the process of designing a product, new ideas are needed to form a different product, and equipment and materials in the design process must be entered in detail, complete with dimensions, so as to obtain an overview of the product to be made. The results of the description in the form of machine drawings can be done in 2-dimensional shapes in detail so that it is easy to understand during the product manufacturing process. 2-dimensional manufacturing can use CAD applications to make product designs that will be carried out (11)(12).

Machine research and manufacture are carried out at the Mechanical Engineering Laboratory, Faculty of Science and Technology, Muhammadiyah University, East Kalimantan. Which is located at Jl. Ir. H. Juanda No. 15, Sidodadi, Kec. Samarinda Ulu, City of Samarinda, East Kalimantan 75124.

The research was carried out in August - December 2022, starting with making machine designs, preparing tools and materials, machine design, machine testing, and processing test results data.

In this study, palm fronds and leaves were used as ingredients to be chopped. Iron with an L profile of 40 × 40 (angle iron), 2 hp electric motor, Grinding and sharpening discs, Electrodes RD-460, Electrodes RB-26, Bolts and nuts, blades, seated bearings, pulleys, and belts, 2 mm thick iron plate, ST 37 steel shaft size 1”, paint and thinner. Then the tools used in this study are as follows welding machine, grinder, drill, measuring tool, milling machine, and lathe.

2.1 Research design

The research design carried out is as follows:

1. Drafting of the machine design
   The calculation was conducted before the drafting. The design of the machine was drafted by using Autodesk Inventor software.
2. Preparation of tools and materials
   In this step, the tools and devices were prepared to build the chopping machine. The materials for building the chopping machine of oil palm fronds and leaves were also prepared.
3. Building the chopping machine
   After preparation was conducted, the building of the chopping machine was conducted by using the tools and materials that have been prepared.
4. Machine testing
   The testing process to the chopping machine was conducted to obtain the data based on the capacity of the machine. The data was recorded and reported as the result of the research.
5. Reporting
   The result of the test was tabulated and analyzed. Furthermore, the data of the chopping machine was discussed and presented.

2.2 Working principle of the chopping machine

The working principle of the palm fronds and leaves counter machine that will be made is to use an electric motor as the main driver of the chopping machine, which will then rotate pulley 1, which is on the electric motor, and then will rotate pulley 2 which is directly connected to the shaft and blade. When the knife shaft rotates, the object to be chopped, namely the fronds and leaves of the palm oil, will be put through the intake line (input hopper), after the palm fronds and leaves are inserted, they will be chopped by the knife blade on the machine shaft. The results of chopped palm fronds and leaves that have been chopped and are considered large enough will be filtered and then chopped again. Furthermore, small, chopped results will come out through the output hopper. The schematic of the principle of the chopping machine can be seen in Figure 1 below.

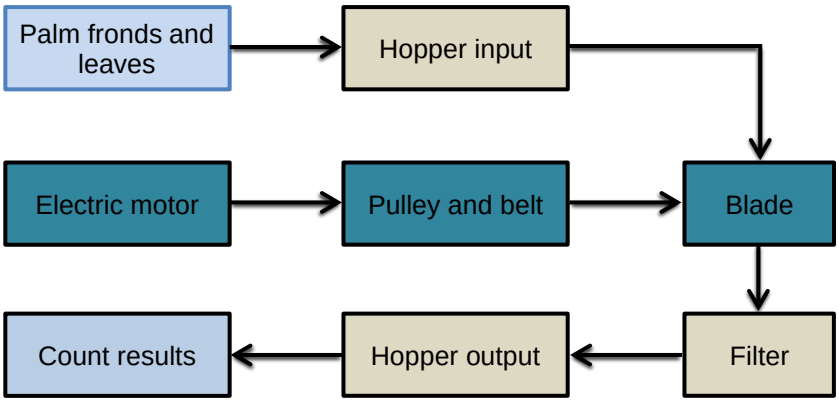

Figure 1. Working Scheme of Palm Oil Palm Frond and Leaf Waste Counting Machine

2.3 The design of the chopping machine

After knowing the scheme of the palm frond and leaf counter machine, the next step is to design the chopper machine. The design of the enumerator was made using the Autodesk Inventor 2020 software. The design that has been made can be seen in Figure 2.

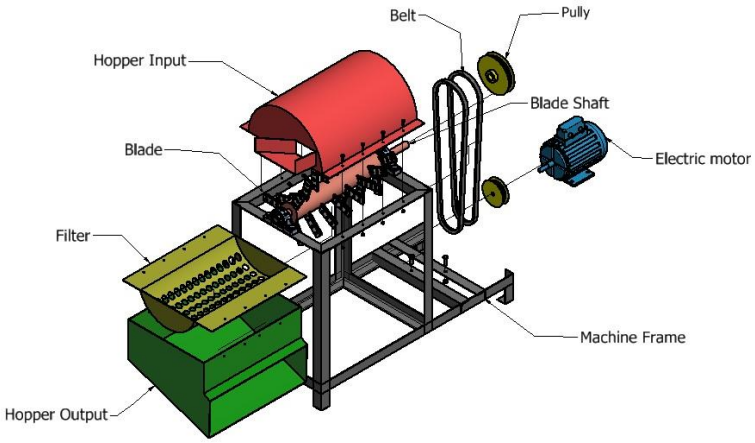

Figure 2. The design of the chopping machine

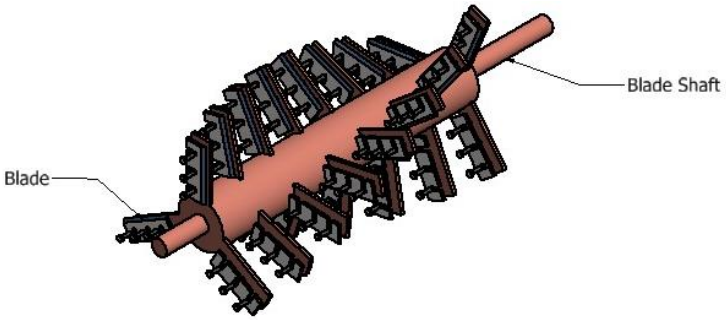

Figure 3. The Shape of the Chopper's Blade

Based on the figure, it can be seen that the parts of the palm frond and leaf counter machine are made, namely the frame, input hopper, shaft, blade, v-belt, pulley, bearing seat, filter, output hopper, and electric motor. For the electric motor, 2 hp is used with a rotation of 1450 rpm, pulley 1, which is on the electric motor, is 4 inches in size, and pulley 2, which is on the shaft of the blade, is 6 inches in size, then 2 belts are used with size B-55.

3. RESULT AND DISCUSSION

3.1 Calculation of pulley design and v-belt counting machine results

The following is a calculation of the planning results for the pulley and v-belt, which can be seen in the table.

Table 1. Pulley and Belt Planning Calculation Results

No.	Pulley Planning and V-belt Calculation Results	The calculation results
	Pully Circumferential Speed	7,709 m/s
	Pully Roving Force	19,741 kg.f
	Belt Tension	21,6 kgf/cm2
	Maximum Belt Tension	87,85 kgf/cm2
	Number of Belt Rounds	15,235 rad/s
	Number of Belts	1,46 (Minimum 1 belt)
	Belt Age	57.537 O'clock

3.2 Calculation of the results of the rotation and torque of the blade shaft of the chopping machine

The following is a calculation of the results of the shaft speed and blade shaft torque which can be seen in the table.

Table 2. Calculation of Speed and Torque of Blade Shaft

No.	Calculation of Speed and Torque on the Knife Shaft	The calculation results
	Blade Shaft Rotation Rate	966,66 rpm
	Blade Shaft Torque	97 kgf.mm

3.3 The chopped capacity of the prototype of the midrib counter machine

In this study, the materials to be chopped were freshly cut or wet oil palm fronds and leaves. The following are the results of testing the prototype chopper machine in the table.

Table 3. Rated Effective Capacity of Machine

Test	Frond input	Material weight (kg)	Chopped weight (kg)	The weight of the material is left (kg)	Machine effective capacity (kg/jam)
1	4	3.325	3.125	0.112	190
2	4	3.100	2.862	0.1	203
3	4	3.385	3.275	0.113	218
4	4	3.450	3.237	0.125	230
5	4	3.387	3.225	0.15	193
Amount	20	16.647	15.724	0.6	1.034
Average	4	3.329	3.144	0.12	206

Table 4. Count yield

Test	Frond input	Material weight (kg)	Chopped weight (kg)	The weight of the material is left (kg)	Yield (%)
1	4	3.325	3.125	0.112	93,98
2	4	3.100	2.862	0.1	92,32
3	4	3.385	3.275	0.113	96,75
4	4	3.450	3.237	0.125	93,82
5	4	3.387	3.225	0.15	95,21
Amount	20	16.647	15.724	0.6	472,08
Average	4	3.329	3.144	0.12	94,41

The results of the chopped palm fronds and leaves can be seen in the picture.

Figure 4. Chopped oil palm leaves

It can be seen in the picture that the chopped results of oil palm leaves can be chopped finely, and the fronds of the oil palm are also finely chopped.

3.4 Discussion of results

The prototype frond chopping machine can chop finely for waste and palm oil leaves. The capacity obtained from this study was 5 repetitions with as many as 4 fronds included

in each repetitionFor the chopped results of the prototype, it is 206 kg/hour with an average of 5 repetitions. For prototype yield, the average result from 5 repetitions is 94.41%. Yield is the ratio of the weight of the chopped material to the weight of the material before it was chopped. If the yield value produced is high, then the material left behind on the machine is small, and vice versa. If the yield value is low, the material left on the chopper is a lot. The chopped results of the prototype for oil palm leaves are acceptable, with a chopped length of 20-40 mm, while the palm frond, which is the hardest part, can also be chopped on the prototype.

4. CONCLUSION

Based on the prototype of the oil palm frond and leaf chopping machine that has been made using an electric motor with a power of 2 hp and a spiral blade model with many blades using 24 rotary blades, capable of finely chopping oil palm fronds and leaves, Furthermore, the average adequate capacity of the prototype in 5 tests was obtained, namely 206 kg/hour. The yield of the chopped palm fronds and leaves resulted in an average of 5 repetitions, 94.41%, and the chopped results obtained for the palm leaves had a length of 20-40 mm.

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