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Effect of speed and turning time pulley on the quantity and quality of output multipurpose chopper machine

Kartika Sari[1*], Sunardi[1], Abiyyu Sayyid Muwaffaq[1], Jamrud Aminuddin[1], Ampala Khoryanton[2], Warso[3], Agung Bambang Budi Utomo[4]

[1]Jurusan Fisika FMIPA, Universitas Jenderal Soedirman, Purwokerto, 53122, Indonesia
[2]Jurusan Teknik Mesin, Politeknik Negeri Semarang, Semarang, 50275, Indonesia
[3]Jurusan Teknik Mesin, STT Wiworotomo Purwokerto, Purwokerto, 53134, Indonesia
[4]Departemen Fisika FMIPA, Universitas Gadjah Mada, Yogyakarta, 55281, Indonesia
*Corresponding author: kartika.sari@unsoed.ac.id

Abstract

The variation of pulley rotational speed on the yield and cut of the multipurpose chopper aims to determine the optimum quality and quantity of chopping results. Testing using cassava and bananas. The diameter of the pulley used is 2 inches and the driven pulley is 6, 7, and 10 inches with a pulley speed of 467, 400 and 275 rpm. The result of bananas shows that the average chopping was 573, 864 and 864 grams, respectively, with the spin pulley time being 46, 90 and 59 seconds. Meanwhile, for cassava, the results of chopping were 984, 995 and 823 grams, respectively, with the spin pulley time being 23, 59 and 35 seconds, respectively. The optimum chopping quality for bananas used a pulley diameter of 10 inches and an optimum rotation time of 59 seconds. The optimum slicing quality for cassava uses a pulley diameter of 7 inches with an optimum rotation time of 59 seconds. The conclusion is that the diameter of the pulley affects the thickness of the sample, the time and speed of the pulley rotation, and the quality of the chopping results.

Keywords:
Pulley diameter, pulley speed, spin time, sample thickness, sample size.

1 Introduction

Technological advancements are necessary to meet the demands of humans, particularly in the home industry, by facilitating business growth and enhancing efficiency. One of these enterprises involves the production of strips. Producing strips necessitates the use of a machine to cut them. An example of a machine is a multipurpose chopper used for processing semi-finished materials. Most multi-purpose stripping chopper machines continue to utilize traditional equipment throughout the chopping procedure[1][2].

The conventional chopping process can take quite a long time, so the production results are not optimal and can cause work accidents due to the use of manual labor [3][4][5]. Therefore, a multi-purpose chopper is needed that is hygienic, safe, and can increase production [6][7]. Making a multipurpose chopper machine uses an electric motor as its driving force [8][9]. A part from electric motors, other components such as pulleys and V-belts are things that must be considered. The pulley and V-belt function as a transmission system between the chopper blades and the drive motor and can change the rotational speed of the drive motor to the chopper blades [10][11].

In prior studies, a spring pusher equipped with four pulleys and a blade disk speed of 210 rpm was employed to provide a flow rate of 22 grams per second[12]. Meanwhile, the results of research on a cassava chopper machine use an electric motor with a power of 1 hp using a vertical blade that does not rotate stationary but moves forward and backward. The pulley used is 89 mm for the moving pulley, and 157 mm for the driven pulley. Produces a chopping capacity of 64 kg/hour [13]. The results of previous studies showed that they had not produced optimum test output, so a multi-purpose chopper machine design was carried out using a 1/2 hp electric motor with stationary moving horizontal blades.

The aim of this research was to assess the influence of speed and turning time pulley on the quantity and quality of output multipurpose chopper machine employed variations in the diameter of the driven pulley are 6, 7 and 10 inches. Fluctuations in the dimensions of the pulley impact both the rotational velocity of the pulley and the duration of operation of the machine. The correlation between the speed of the pulley and the operational duration of the machine is intended to achieve the optimal and efficient quantity and quality of production outcomes.

2 Materials and Methods

2.1 Materials

The ingredients used are cassava and bananas. The tools used are L-pipes, iron plates, stainless steel plates, cutting knives, shafts, bearings, pulleys, V-belts, electric motors, grinding machines, welding machines, calipers, tachometers and scales.

2.2 Design Research

The research was conducted at the IntidanInstrumentasi Laboratory of the Department of Physics, Faculty of Mathematics and Natural Sciences, JenderalSoedirman University. The research procedure includes three stages of design and one stage of testing. The design stages include the manufacture of the machine frame, the assembly of the chopper blades, and the assembly of the electric motor. The final stage is testing the multipurpose chopper[14].

2.2.1 Stages of Making Machine Framework

The process of constructing the machine framework involves several steps, including the preparation of L-pipes, iron plates, stainless steel plates, grinding machines, and welding machines. Subsequently, the L-pipe should be divided into multiple sections utilizing a cutting apparatus. Once the L-pipe has been severed, the subsequent action involves employing a cutting grinder to sever the iron plate, ensuring that both sides of the chopper frame are adequately covered. Subsequently, the L-pipes, iron plates, and stainless steel plates are shaped and joined together through the use of a welding apparatus. The infrastructure for the versatile chopper apparatus is complete.

2.2.2 Stages of Chopper Knife Assembly

The stages of assembling the chopper blades are preparing the cutting blades, bearings, shafts, and pulleys. Next is to combine the blade disc, shaft, and bearing. The last step is assembling the chopper blade components on the chopper machine framework.

2.2.3 Stages of Electric Motor Circuitry

The components required for manufacturing an electric motor include the electric motor itself, a pulley, and a V-belt. The pulley is mounted onto the electric motor. The electric motor is mounted at the rear of the chopper machine structure, and the V-belt is installed as a connecting transmission system between the electric motor and the chopper blade components. The versatile chopper machine is prepared for immediate usage.

2.2.4 Stages Fabrication of Testing Multipurpose Chopper Machine

The testing phase of the multipurpose chopper commences by energizing the chopper through the connection of the electric motor cable to the wall socket. The cassava or bananas are individually inserted into the input holes and tested. The speed change is achieved by altering the powered pulley, while the input hopper is used for placing cassava or bananas. The slicing time is determined by measuring it with a timer and tallying the outcomes of the slicing process. Next, they segregate the damaged and the satisfactory outcomes for subsequent re-evaluation.

The results of chopping quality and quantity were determined by the thickness of the chopping randomly on each pulley variation and measured using a caliper. The relationship between pulley diameter and pulley speed uses Eq. 1 [15].

$$D_2 = \frac{n_1 \times D_1}{n_2} \quad (1)$$

whereD_1 is the drive pulley diameter (mm), D_2 is the diameter of the driven pulley (mm), n_1 is the drive pulley rotation (rpm), and n_2 is the rotation of the driven pulley (rpm).

The capacity of the chopper machine uses Eq. 2 [16].

$$K_A = \frac{B_B}{t} \quad (2)$$

whereK_A is tool capacity (kg/hour), B_B is the weight of the chopped material (kg), and t is the time needed to chop the material (hours). The percentage of impurities is the percentage by weight of material that is not perfectly chopped using the Eq. 3.

$$K = \frac{K_T}{B_B} \times 100\% \quad (3)$$

where$K$ is the percentage of impurities (%), K_T is the total weight of impurities (kg), and B_B is the weight of the chopped material (kg). The work efficiency of the chopper machine is the power effort released by the machine with power using the Eq. 4.

$$\eta_{work} = \frac{B_B - K_T}{B_B} \times 100\% \quad (4)$$

where$\eta_{work}$is the work efficiency of the chopper (%), B_B is the weight of the chopped material (kg), and K_T is the total weight (kg).

3 Results and Discussion

The multipurpose chopper uses an electric motor as its driving force with a power of ½ hp, and a speed of 1400 rpm. The components for making multipurpose chopper machines are electric motors, pulleys, V-belts, bearings, shafts, L-pipes, iron plates, stainless steel plates, knives and tachometers. The method used is the method of comparative analysis of pulley size variations. The research includes designing, manufacturing and testing multipurpose chopper machines. The multipurpose chopper machine can be seen in Fig. 1.

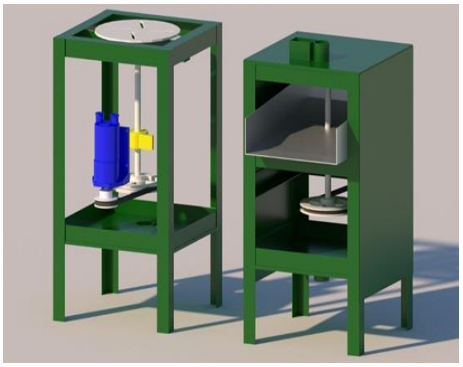

Fig. 1. Design of the multipurpose chopper machine.

Fig. 1 displays the design of the versatile chopper machine. The versatile chopper machine utilizes an electric motor with a ½ hp and a speed of 1400 revolutions per minute as its propelling force. The manufacturing process involves the use of many components such as electric motors, pulleys, V-belts, bearings, shafts, L-pipes, iron plates, stainless steel plates, cutting blades and tachometers. The employed approach is the way of comparing and analyzing differences in pulley sizes. This study entails the development, production, and evaluation of a versatile chopper. The multipurpose chopper machine is constructed using L-pipes, stainless steel plates and iron plates. Additional elements comprise of electric motors, pulleys, V-belts, shafts, bearings, cutting blades and tachometers. The driven pulley can be used with pulleys of varying sizes, specifically 6, 7 and 10 inches, while the drive pulley has a fixed size of 2 inches[17].

Characterization of the multipurpose chopper machine was carried out using 2 type samples, namely cassava and bananas. Material testing is carried out to obtain the best pulley quantity and quality results for use in multipurpose chopper machines. This modern chopper is a change from existing tools, as well as an alternative for chip manufacturers to get more efficient chopping results[12]. The quantity, quality and thickness of the multipurpose chopper machine used the Eq. 1, Eq. 2 and Eq. 3.Testing of the multipurpose chopper machine used the driven pulleys of 6, 7 and 10 inches, a moving pulley diameter of 2 inches, and rotational speed of the driven pulley of 467, 400 and 275 rpm.

The average capacity test conducted on cassava and banana materials will decide the cutting quantity. Fig. 2 displays the quantitative test results of the versatile chopper machine.

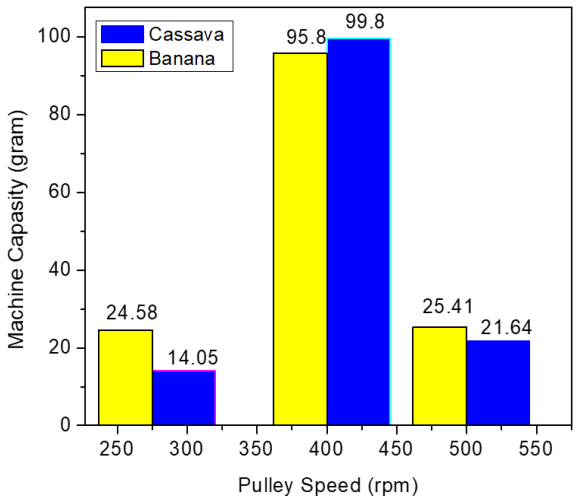

Fig. 2. Quantity of multipurpose chopper machine.

The average weight of the good slicing obtained for casava using pulleys with diameters of 6, 7 and 10 inches was 817, 896 and 704 grams, respectively. The mean damage caused by slicing casava was 166.6, 99.8 and 118.8 grams, respectively. The maximum capacity was 7 inches, while the minimum capacity was 10 inches. Achieving a pulley rotation speed of 300 rpm resulted in obtaining a mass of 850 grams within a time period of 2.20 minutes. The efficiency of this pulley for slicing cassava is suboptimal due to its slower rotational speed compared to the 6-inch pulley. The variation in the outcome of capacity slicing at each pulley is determined by the specific characteristics and dimensions of the cassava being chopped. As the duration of exposure to open space increases, the consistency of the cassava becomes firmer, so becoming it more challenging to cut. The current multipurpose chopper machine still relies on user input to perform the chopping procedure. The size of the cassava, being larger than the aperture of the chopper, hinders the slicing procedure[18].

The chopping results of a multipurpose chopper machine for bananas of diameter pulley were 6, 7 and 10 inches, respectively can be seen in Table 1. It obtains an average yield of 573.2, 863.6 and 863.6 grams with an average time of 22.6, 58.8 and 35.2 seconds. The average quality of good chopping by this pulley is 488.4 and 804 grams with an average damage chopping of 84.6, 67.6 and 59.6 grams, respectively. The highest experimental capacity of chopping produced was 95.8 grams/second for 7 inches, and the lowest experimental capacity was 24.58 grams/second for 6 inchi.

Table 1. Diameter and rotational speed pulley of themultipurpose chopper machine

Diameter pulley (inch)	Rotational speed of pulley (rpm)	Quantity		Quality		Thickness (mm)	
		Casava	Banana	Casava	Banana	Casava	Banana
6	467	21.64	25.41	804	704	0.17	0.16
7	400	17.91	24.92	804	704	0.17	0.16
10	275	14.05	24.58	488	817	0.16	0.17

The rotation speed that results from using this six-inch pulley is too quick to slice soft materials like bananas, thus it is not a viable choice for this purpose. Furthermore, choosing the right bananas can have an impact on how well they chop in a multifunctional chopper. There is less slicing when the bananas are sliced more ripely. Because the 7-inch pulley rotates at a slower pace than the 6-inch and 10-inch pulleys, it is ideal for chopping bananas. On the other hand, research employing an electric motor running at 1400 rpm and a pulley variation that moves 80 mm apart[6]. The moving 100 mm and 55 mm pulleys obtain a cutting capacity of 2.9 kg/min for the 80 mm pulley and 2.4 kg/min for the 100 mm pulley. The quantity of the chopper capacity is the number of choppers that can be produced by the chopper at a certain time. The quantity of cassava is determined by the form of chopping, where there are good and bad chopping results [19]. The quantity results of the multipurpose chopper machine for cassava and bananas are as shown in Fig. 2.

The pulleys' respective diameters are 6, 7 and 10 inches. The pulley's rotating speeds are 467, 400 and 275 rpm, in that order. For cassava, the capacity chopping results are 21.64, 99.8 and 14.05 grams/second. Additionally, for bananas, it is 25.4, 95.8 and 24.58 grams/second. The maximum speed for cutting is 400 rpm for cassava and 275 rpm for bananas. The machine's capacity increases with the amount of chop results it achieves and the speed at which it chops. The machine's cutting results and the amount of time it takes to chop the material are the reasons for the variations in the machine capacity results. The machine's capacity increases with the amount of chop results it achieves and the speed at which it chops. The maximum quantity in this test was produced using a 6-inch pulley rotating at 467 revolutions per minute. Fig. 3 displays the outcomes of the multipurpose chopper machine's quality test.

Fig. 3 depicts that the quality results of the multipurpose chopper machine. It uses the same pulley and speed as the quantity test. The results obtained from the rotation speed pulley for cassava of 467, 400 and 275 rpm of the good chopping are 817, 704 and 704 grams, respectively. For bananas, they are 488, 804 and 804 grams, respectively. The good chopping for cassava is 467 rpm pulley rotation, which is 817 grams and 804 grams for banana.

It is evident from Fig. 3 that using a 6-inch pulley with a rotation speed of 467 rpm will yield satisfactory results when chopping cassava plants. You can use a 10-inch pulley that rotates at 275 rpm for bananas. Compared to bananas, cassava has a tougher physical form. Using a 6-inch pulley, this study's efficient chopping outcomes were 81.4% for cassava slicing and 85.8% for banana slicing. The outcome of consistent thickness requires the use of a mechanical chopping machine[17]. The average thickness of each slice is shown in Fig. 4.

Fig. 4 shows that result of the thickness of the chopping which was carried out using a conventional tool obtained different slicing results, so it is necessary to make a mechanical chopping machine that can obtain uniform thickness results [19]. The thickness of the slicing results in this study was measured by taking ten randomly selected samples. Furthermore, the samples that have been taken are measured using a vernier caliper to obtain thickness results. The average thickness of each slice is shown in Fig. 4. Results of the average thickness are obtained using a pulley rotation speed of 467, 400 and 275 rpm, respectively for cassava, and bananas are 0.17 and 0.16 mm, respectively. The thickness results from each pulley variation are different due to the emphasis placed on it by human errors. The more human errors press the material being tested, the thicker the results obtained [20].

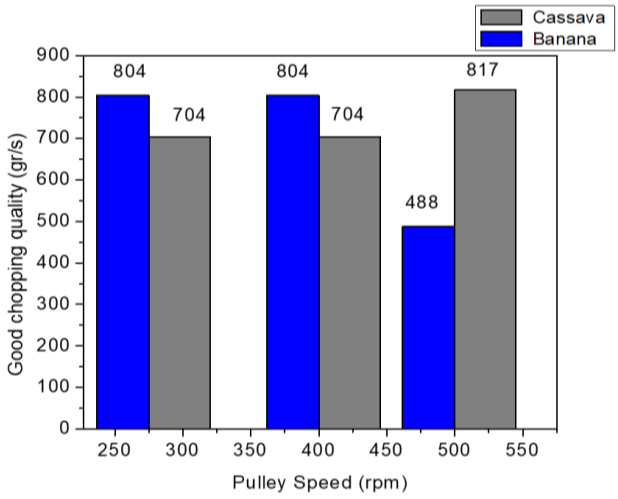

Fig. 3. Quality of multipurpose chopper machine.

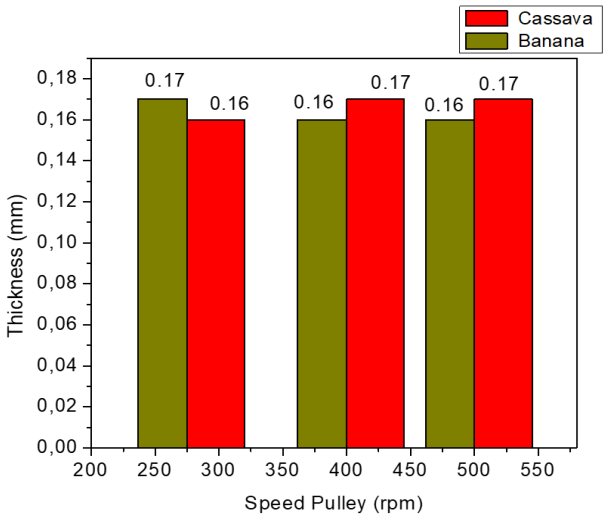

Fig. 4. Thicknessresult of multipurpose chopper machine.

4 Conclusion

It can be concluded that the multipurpose chopper machine is made up of several main components, including a machine frame, an inlet hole, an outlet hole, a cutting knife, a power source and a transmission, based on the results of research on the effects of speed and turning time pulley on the quantity and quality of output. The resulting pulley's speed decreases with increasing

pulley diameter. The pulley's speed has an impact on both how long it rotates for and how much output the multipurpose chopper produces. The thickness does not diminish as the pulley speed rises. The material type is to blame for this, however production is produced at a higher pace due to the pulley rotation time.

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