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Taro Crushing Machine Design Using Aluminum Knife Disc

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Abstract

There are many agricultural communities, one of which is taro, because the season is suitable for the territory of Indonesia. With the development of appropriate technological advances, technological tools that can process agricultural products can be found, so thinking about how to improve and ease work or process crops or process taro products to increase the selling price even better. The purpose of the research in general is to make it easier to slice taro for chip entrepreneurs, especially taro chips, and can also be operated for cutting or slicing such as tempeh, potatoes, sweet potatoes, carrots, etc. The specific purpose for making this tool is to know the capacity of the taro chopper, to know the components in the taro chopper and to analyze the results of the taro chopper cut. From the manufacture of the tool, it can be concluded that this taro chopper is operated semi-automatically using an electric motor. This machine display method is a single display with 1 type of blade that cuts the taro continuously. The design of this taro chopper machine requires power from an electric motor of 0.54 HP with a rotation of 2800 rpm. The production capacity of the taro machine every 60 minutes is able to stretch as much as 1536 kg. By increasing production efficiency, it saves time and production costs, which has a positive impact on society.

Keywords: Taro, crushing machine, design, aluminum knife

INTRODUCTION

Taro tubers are native to Southeast Asia and are spread to China, Japan, and several islands in the Pacific Ocean.Taro tubers are often found almost throughout the Indonesian archipelago from coastal and mountainous areas. Taro (Colocasia esulenta L.Schoot) is a type of plant that belongs to the taro family or Araseae. Taro tubers are oval to slightly rounded, the skin is rough, there are traces of growth from the roots, and the color is brown. The flesh of the fruit is white or purple to slightly pink. In Indonesia, taro grows almost all of the archipelago and is spread from the coast to the mountains above 1000 m above sea level, both planted and wild. The productivity level of taro depends on the cultivar, the age of the plant and the environmental conditions in which the taro tubers are grown [1]. Like other agricultural products, taro has a limited shelf life. Taro that is not consumed until its shelf life will be wasted. So far, the common post-harvest handling of taro is to process it into chips.

The processing of taro chips today generally still uses the conventional frying method, namely frying using a regular pan. This fryer has many disadvantages, one of which is the very high oil temperature and is difficult to control. This can stimulate the formation of acrylamide compounds, which are carcinogenic compounds that can be formed due to the food processing process at high temperatures [1].

This taro chopper machine is used for taro choppers whose thickness can be adjusted, in addition to the taro chopper this machine can also be used for various other types of materials such as potatoes, cassava and others with the presence of a taro chopper machine the production process is faster and because this taro chopper machine can provide consistent chop results for the thickness of the chopsticks and the amount. Some previous studies that discussed taro chopper machines are: having a capacity of not too large of 186 kg/h and a large slicing power of 1/2 Hp [2-5]. The results of previous research still have many shortcomings in the machine that has been made, namely the results of slicing that vary for a long time, the power used is too large, so that the final result of the stretching is imperfect, and there are many other obstacles. Therefore, to maximize the above research, a Taro Chopper Machine was designed using an aluminum knife disc.

The purpose of this research is to be able to design a taro shredding machine, to be able to calculate the capacity of the taro shredding machine, and to be able to know the calculation process on the taro shredding machine.

RESEARCH METHODS

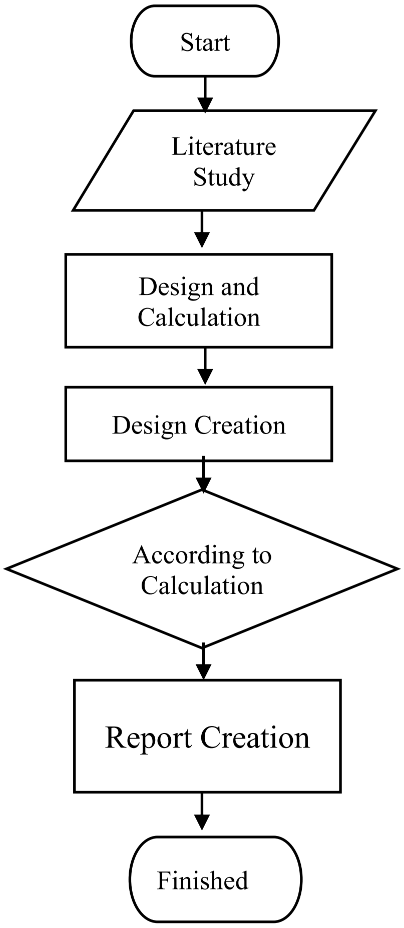

Fig. 1. Flowchart

Fig. 1. is a flow diagram of the process of making this research starting with a literature study. The literature study aims to find and collect references or materials related to the Taro Cutting Machine. The references collected come from journals, books and sources from the internet. The next step is the design and calculation

process. In this process, the purpose of calculating how much motor power is used, rpm used, length of V-Belt used, length between shafts, the result of pulley speed, and designing the shape of the tool. The next step is to create a tool design which in this step uses the solidworks 2020 application to make an image design according to the size that has been set, this design process includes the tool design process. After completing the process of making the tool design, it will be observed whether the size of the tool design is in accordance with the calculations in the design above, if it is not suitable, calculation and redesign will be carried out and remake the design in accordance with the size. But if it is in accordance with the calculation and design, the next step can be done, namely writing a report properly and correctly.

RESULTS AND DISCUSSION.

Pictures of Taro Chopper Machine Using Knife Disc **Fig. 2**

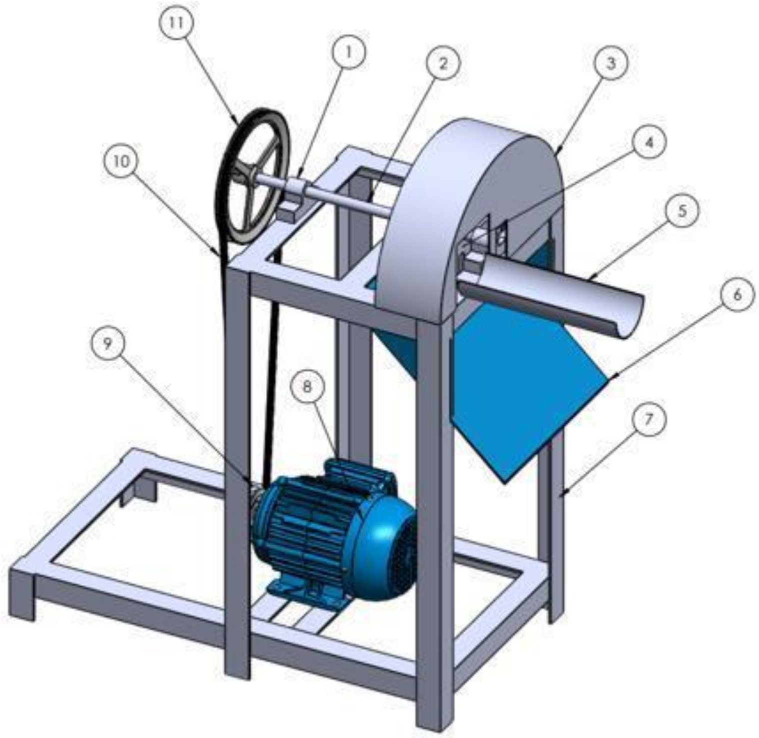

Fig. 2. Taro Chopper Machine Design

Image caption:

1. Bearing
2. Shaft
3. Blade Cover
4. Knife Disc
5. Funnel Entry
6. Outbound Funnel
7. Skeleton
8. Motor
9. Pulley Motor
10. V-belt
11. Pulley Poros

Working principle of taro chopper machine

This taro chopper machine is designed to chop taro using the drive power of an electric motor with a rotation of 2800 rpm. The electric motor will rotate the blade disc connected to the shaft by transmitting power to the shaft through pulleys and belts. On the knife disc there are 4 knives attached to the disc. The knife disc used is a vertical knife disc. The peeled taro is inserted through the hopper to the slicing chamber. The result of taro cracking falls through the production funnel. The knife plate will slice the taro vertically. The peeled taro is inserted through a hopper to the slicing room. The resulting taro slices fall through the production funnel.

Component Design and Calculation this Table of Design Calculation Results for Taro Slicing Machine **Table 1.**

Table 1. Design Calculation Results for Taro Slicing Machine

No	Calculation Description	Result	Unit
1	Machine Capacity	25.6	kg/min
2	Machine Capacity	1536	kg/h
3	Cutting Force	72.88	N
4	Mass of Aluminum Disc	0.027	kg
5	Force Due to Disc Mass	0.2646	N
6	Total Force (Cutting + Disc)	146.02	N
7	Required Power	339.3	Watt
8	Planned Power (with correction)	407.16	Watt
9	Motor Power Used	0.54	HP
10	Motor Speed	2800	rpm
11	Motor Pulley Diameter	76.2	mm
12	Shaft Pulley Diameter	177.8	mm

a. Machine Capacity
The machine is capable of slicing 25.6 kg of taro per minute, or approximately 1,536 kg per hour, which reflects high productivity and efficiency. This capacity is significantly greater than in previous studies, where the maximum capacity reached only around 60 kg/h.

b. Force and Power Calculations
The required cutting force is 72.88 N per slice.
An additional 0.26 N is contributed by the rotating disc's mass.
The total working force is approximately 146 N.
The minimum power required for operation is 339.3 Watts, which, after applying a safety correction factor of 1.2, increases to 407.16 Watts.

c. Motor Specification
Based on power demand, a motor with at least 0.54 HP (Horsepower) is recommended. Therefore, a 0.5 to 1 HP electric motor is suitable for optimal performance.

d. Pulley and Transmission System
The pulley system consists of a 76.2 mm motor pulley and a 177.8 mm shaft pulley, effectively reducing the motor's speed from 2800 rpm to around 1110 rpm. This reduction is aligned with the cutting requirements. The belt transmission system is simple, cost-effective, and provides sufficient mechanical efficiency.

The taro slicing machine demonstrates excellent performance for household and small-to-medium enterprise (SME) applications. Its high capacity, moderate energy consumption, and simple construction make it a practical solution for efficient taro processing.

Belt Selection

Some belt transmission systems use V belts because they are easy to handle and relatively cheap. Based on the belt selection diagram with a power of 3/4 HP and a rotation of 2800 rpm, a type A belt with the following size was **Fig. 3**.

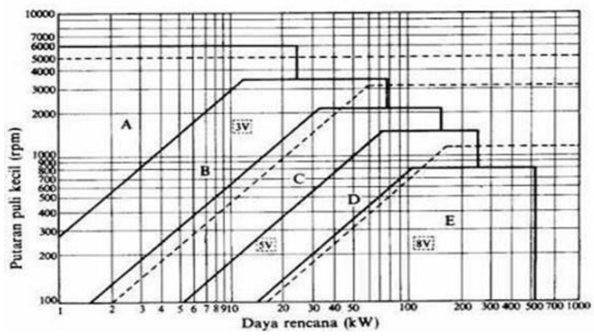

Fig. 3. Belt Selection Diagram [6]

So, the pulley driven used is type A size 7 inches with Aluminum material.
Based on the belt selection diagram above, the type A belt has the following specifications **Fig. 4**

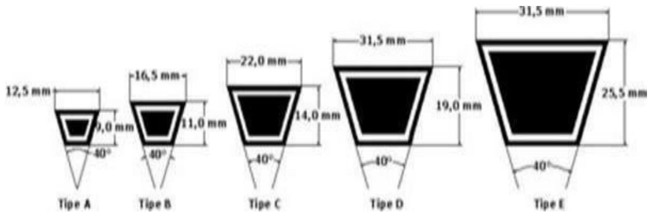

Fig. 4. Belt Type [7]

Belt Linear Velocity

The linear velocity of the belt is calculated based on the diameter of the driving pulley and the motor's rotational speed. In this case, a pulley with a diameter of 76.2 mm is driven by a motor running at 2800 rpm. The result shows that the belt's linear velocity reaches 11.1 meters per second. This is considered a high value, indicating that the transmission system can transfer power quickly and efficiently. It is particularly suitable for light to medium industrial machines that require fast rotational response.

Distance Between Pulleys and Belt Length

The center distance between the pulleys is calculated based on a standard ratio between the diameters of the smaller and larger pulleys. The calculation results in a center distance of 508 mm, which complies with the standard stating that the center distance (C) should be between the larger diameter (d2) and three times the sum of both diameters. Based on this, the required belt length is approximately 1430 mm, corresponding to a standard A-type belt size of 54 or 56.3 inches. This indicates that the chosen belt length is appropriate and can be fitted without excessive tension or slack.

Belt Cross-Sectional Area and Tension Forces

The belt's trapezoidal cross-section is calculated to determine its effective area in withstanding tension. The resulting cross-sectional area is 0.837 cm². Based on the rubber belt material's maximum tensile stress of 25 kg/cm², the belt's maximum allowable tension is calculated to be 20.92 kg. After subtracting the centrifugal force (0.08 kg), the tension on the tight side (T1) is 20.84 kg or 204.37 Newtons, while the slack side (T2) is 17.06 Newtons. These values indicate that the belt operates within a safe range and will not fail under normal working conditions.

Transmitted Power

The power transmitted by the belt is determined by the difference in tension between the tight and slack sides, multiplied by the belt's velocity. With T1 and T2 values previously calculated and a belt speed of 7.7 m/s, the transmitted power is found to be 1448.3 Watts, or approximately 1.45 kW. This is a substantial amount of power, suitable for driving medium-scale industrial equipment such as conveyors, blowers, or light manufacturing machinery.

Shaft Load and Reaction Force Calculations

Shaft calculations are carried out to verify whether the shaft can withstand the forces exerted by the belt and additional loads such as a disk. The total force acting on the shaft is 222.218 N, consisting of the belt forces (T1 + T2) and a minor force from the disk. The reactions at supports A and B are calculated to be 279.8 N and 57.3 N respectively. The maximum bending moment occurs at point D, with a value of 38.99 Nm. This bending moment becomes the reference in determining the shaft's minimum required diameter to ensure structural integrity.

Shaft Material Selection

The shaft material is analyzed based on its Brinell Hardness (HB), with an average value of 106.756 kg/mm². Using the correlation between hardness and tensile strength, the material's tensile strength is found to be 36.83 kg/mm². This suggests that the shaft is made of ST 37, a low-carbon steel known for its strength, toughness, weldability, and machinability. ST 37 is commonly used in shaft applications due to its excellent balance of mechanical properties and cost-efficiency.

Shaft Diameter Based on Guest and Rankine Theories

Considering the combined bending and torsional loads on the shaft, both Guest and Rankine theories are applied. These approaches yield a minimum required shaft diameter of approximately 22.94 mm. However, to accommodate safety factors and compatibility with standard components (such as bearings), the diameter is increased to 25 mm. This is a common practice in mechanical design to mitigate unexpected dynamic loads and ensure long-term reliability.

From all the calculations and analysis, it can be concluded that the designed belt and shaft transmission system meets both technical requirements and safety standards. All components—from the belt, shaft, to the bearing—have been thoroughly analyzed based on mechanical theory and empirical material data. The system is not only efficient in power transmission but also reliable enough for use in small to medium industrial applications. This design approach also ensures an adequate safety margin in terms of both dimensions and material strength.

The taro chopper machine was designed with the aim of maximizing cutting efficiency while maintaining mechanical simplicity and reliability. Central to its operation is an electric motor with a speed of 2800 rpm, which drives the cutting disc through a belt and pulley system. The use of a V-belt was selected based on its proven reliability and cost-effectiveness for power transmission, particularly in small- to medium-scale applications [8]. The high linear belt velocity of 11.1 m/s indicates a well-optimized transmission system, supporting fast rotational response—a feature crucial for agricultural processing machinery.

The calculated cutting capacity, which reaches 1536 kg per hour, exceeds conventional household slicers by more than 20 times. This demonstrates the design's scalability for small industries and farmer cooperatives. The required motor power, estimated at 407 watts with safety correction, fits well within the standard 0.5 HP range, confirming energy efficiency [9].

In terms of mechanical strength, the shaft is designed using material identified as ST 37, known for its toughness, weldability, and ease of machining [10]. The final shaft diameter of 25 mm was chosen not only based on stress analysis but also for compatibility with standard bearing sizes, such as the 6304 bearing. This design decision increases both reliability and ease of maintenance. Overall, the integration of standard engineering practices with validated material data ensures that the machine meets industrial reliability standards while remaining accessible in terms of cost and manufacturability.

CONCLUSIONS.

Based on the design and analysis carried out, it can be concluded that the designed taro chopper machine demonstrates excellent and efficient performance for small to medium-scale production needs. The machine is capable of reaching a production capacity of approximately ±1536 kg per hour, which is significantly higher than manual methods or conventional equipment commonly used in household or MSME sectors. By utilizing a 0.54 HP electric motor with a rotation speed of 2800 rpm, the transmission system—relying on a combination of pulleys and an A-type belt—successfully transfers power optimally, maintaining the speed and stability of the cutting blades. The design also considers ergonomic aspects and operational ease, which greatly assist users in improving time efficiency and production volume of taro slicing. Overall, the implementation of this simple mechanical technology has proven effective in increasing productivity, reducing dependence on manual labor, and contributing to innovation in appropriate technology-based agricultural tools

REFERENCES

[1] S. Koswara, "Teknologi pengolahan umbi-umbian," Bogor Res. Community Serv. Inst. IPB, 2013.

[2] Wardianto, D., Hafni, H., & Perkasa, M. H. Pembuatan Dan Pengujian Mesin Perajang Talas. Jurnal Teknologi dan Vokasi, 1(1), 31-37. 2023

[3] Andi, R. A., Arif, G., & Cici, A. *RANCANG BANGUN MESIN PERAJANG DAUN TALAS BENENG* (Doctoral dissertation, Politeknik Manufaktur Negeri Bangka Belitung), 2021.

[4] Mulyaningsih, N., & Choirul, C. Upaya Peningkatan Produksi Keripik Talas Melalui Penerapan Mesin Perajang Di Desa Balesari. Jurnal ABDINUS: Jurnal Pengabdian Nusantara, 4(2), 329-338. 2021.

[5] Husman, H., & Ariyono, S. Rancang Bangun Mesin Pengiris Singkong. *Manutech: Jurnal Teknologi Manufaktur*, *10*(02), 31-34. 2018.

[6] Sularso and Kiyokatsu Suga. Dsar Planning and Selection of Engine Elements. PT. Pradnya Paramita, 2008

[7] Khurmi, R. S., & Gupta, J. K. (2005). A Textbook of Machine Design. In Eurasia Publishing House. Eurasia Publishing House

[8] M. Foley, "Design Guide on Pulleys and Belt Drives," *CMTco Engineering*, 2022.

[9] Engineering Toolbox, "Belt Transmission – Power and Speed," *The Engineering ToolBox*, 2024. [Online]. Available: https://www.engineeringtoolbox.com

[10] W. D. Callister, *Materials Science and Engineering: An Introduction*, 7th ed., John Wiley & Sons, 2007.