DESIGN OF BAJAKAH ROOT CHOPPING MACHINE INTO TEA POWDER

Muhammad Zainul Abdi[1], Saparin[1] , Yudi Setiawan[1], Eka Sari Wijianti[1]*

[1]Department of Mechanical Engineering, Faculty of Engineering, Universitas Bangka Belitung
Balunijuk, Bangka Regency, Bangka Belitung Islands Province, 33149
*Correspondence email: wijianti1903@gmail.com

ARTICLE INFORMATION

ABSTRACT

Tea (camellia sinensis) is one type of plant that is often found as a processed beverage. There are several raw materials for making tea that are often used including using leaves, shoots, flowers, and roots. One of the teas made from roots is bajakah root tea where the manufacturing process is still done in the traditional way, namely chopped using a machete. Therefore, in this study, a bajakah root chopping machine was designed with the aim of helping the bajakah root production process into tea powder. This bajakah root chopping machine into tea powder is designed using the France method with the demands of a sturdy frame and easy to move. This bajakah root chopping machine has dimensions of 340 mm long, 240 mm wide and 600 mm high. The engine is driven by an electric motor with a power of 0.5 Hp, a rotation of 1400 rpm using a pulley drive system with a ratio of 1: 1.5 and the rotation of the chopper shaft is 933 rpm. From the test results taken from a sample of 500 grams of raw material with 3 times testing, the resulting average is perfectly chopped as much as 389 grams, not perfectly chopped as much as 54 grams, with a time of 167.3 seconds. The production capacity of the machine is 8.37 kg/hour. The machine that has been made is able to chop bajakah roots with a machine production efficiency of 77.8%.

Keywords: bajakah root, tea, chopping machine.

1. Introduction

Tea (camellia sinensis) is one type of plant that is often found as a processed beverage. Tea is a drink that is familiar to Indonesian people. If there are guests at home, tea is one of the drinks that is used as a dish that almost every house provides. The price of tea is relatively cheap and the taste is delicious, so tea is favored from various circles. In general, based on the way or process of processing, tea can be classified into three types, namely green tea, oolong tea, and black tea (Rohdiana, 2009). There are so many benefits that we feel when consuming tea. Tea can provide a sense of freshness, restore health, and is proven not to cause negative impacts (Rohdiana and Widiantara, 2004).

One type of tea that exists is bajakah tea. Bajakah tea is a drink served by serving dried roots brewed with hot water. Bajakah tea is believed to have millions of benefits. Bajakah contains flavonoids, saponins, tannins and phenolic compounds, so it has potential as anti-cancer and anti-microbial (Saputra and Ayuchecaria, 2018). Bajakah has several other species including, S. acuminatus, S. apoensis, S. hirsutus. S. latibractea, S. latistipulus, S. pottingeri, and S. sanguineus (Ridder-Numan, 1992).

Bajakah tea as an herbal drink made from the roots of bajakah trees by going through stages including cutting, chopping, washing, drying to boiling. One of the craftsmen of bajakah roots into tea on the island of Bangka is Mr. Hasan, he is also a therapist for people who have pain in body areas such as back pain, veins, and other body parts. Usually after the therapy process Mr. Hasan gives tea from bajakah roots to his patients. The process of processing bajakah roots into tea is still done manually. Bajakah roots are cut using a machete with a length of 50 cm, after being cut along 50cm the roots are chopped using a machete with a size of 2 cm, then the roots are washed thoroughly after that the roots are immediately dried in the sun, the roots are dried for 7 hours in 1 day until completely dry, usually the roots are completely dry in 1 week depending on the weather during the drying process. After the drying process, bajakah root tea is ready for consumption. According to Mr. Hasan, this is less effective in addition to wasting labor and time, the chopped results are not perfect because they are still rough and do not resemble tea powder. The results of the manual process using a machete can be seen in Figure 1.

One of the problems in processing the roots of the bajakah tree and made bajakah tea is the process of chopping bajakah roots into tea powder and the resulting size is not good enough to be

marketed. Previously, the process of processing bajakah roots into tea powder was processed manually, from the chopping process, washing to the drying process was done manually. But for businesses with middle-class capacity, it must be supported by technology so that the results obtained are faster and better (Hendriko et al, 2022).

**Figure 1**. *The results of the manual shredding process*

From the background of the above problems, a design of a bajakah root chopping machine into tea powder is needed with the aim of simplifying or shortening the production process so as to improve the quality and productivity of bajakah tea and can be useful for craftsmen and other communities.

2. MATERIALS AND METHODS

This research was conducted using the French method because there is a design process which can be understood, and is easier to do than other methods, as for the stages carried out, among others: 1) Problem analysis; 2) Conceptual design; 3) Process diagram; 4) Schematic realization; 5) Detailing. The problem analysis phase takes the problem statement and generates various solutions to the problem in the form of schematics. Conceptual design is the planning phase where in this stage the problem of the machine tool is outlined. Process diagram in this section contains an overview of the explanation of how this tool or machine works. The realization of the scheme in this phase the schemes are worked out in higher detail, if there is more than one, a final choice between is determined. Details where the quality of this workmanship must be good, otherwise delays and expenses or even failure will occur. The research flow can be seen in Figure 2.

The tools and materials used to make bajakah root chopping machines are as follows: 4 x 4 cm hollow steel, shaft, pulley, bolt and nut, stainless steel plate, bearing, belt, vice, grinding machine, welding machine, drilling machine and measuring tools. The power source used is an AC electric motor 0,5 HP. Although this motor heats up quickly using a heavy load, it can still move the chopping

blade. (Seprianto dkk, 2017). This research was carried out in the laboratory of the mechanical engineering the Universitas Bangka Belitung.
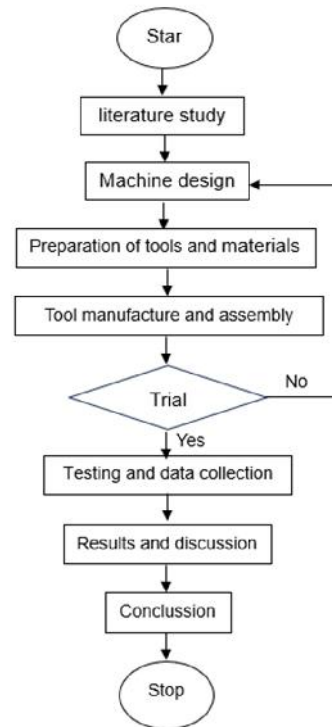
Figure 2. Research flow chart

2.1 Machine Testing Procedure

After making the bajakah root chopping machine, the next step is to test whether the bajakah root chopping machine can be used for research or not. If the machine has not been able to chop bajakah roots, it must return to the design stage to fix existing problems. If the machine has been able to chop bajakah roots, then the machine enters the testing stage. If the machine is not ready to be used to conduct trials with then the deficiencies in the machine must be corrected. The indicator of the success of the machine test is that the machine can chop bajakah roots into powder and can come out of a sieve with a diameter of 1 cm.

2.2 Retrieval of Testing Data

The steps of testing the bajakah root chopping machine into tea powder with test materials are as follows:
a. Prepare 500 grams of bajakah root as test material.
b. Prepare a bajakah root chopping machine.
c. Connect the electric motor to the plug.
d. Feed bajakah root through the input hopper.
e. The result of the test is the texture of bajakah roots in the form of powder that is chopped and filtered with a sieve found in the output hopper.

f. Switch off the machine when the chopped roots are no longer coming out.
g. Evaluate the condition of the machine after the chopping process, whether it still has problems or not.
h. If there are obstacles, then redesign it so that the machine can work optimally.

2.3 Testing Result Criteria

Research result grouping criteria
a. Perfectly chopped if the results of the chopping process can be chopped and filtered with a sieve hole with a diameter of 1 cm. For the size of the powder that is said to be perfectly chopped, the powder that makes it out through the sieve hole with a diameter of 1 cm.
b. Not perfectly chopped is the result of chopping that is not able to be filtered by a sieve on a hopper with a diameter of 1 cm.
c. Wasted (Out) the results of chopping that come out or are wasted from the hopper lid caused by hopper gaps that are less tight.

2.4 Design of bajakah root chopping machine

In planning the manufacture and assembly of machine construction, design drawings and calculations are made so that they have a clear direction in the process of working on the machine to be made. After the engine components are finished, the assembly process is carried out by combining the engine parts to become a complete machine in accordance with what has been drawn with the stages of the process that has been determined. The process of making and assembling the machine is as follows.

a. Construction of chopper.
Serves as a chopper of bajakah roots into tea powder. This chopper construction consists of two components, namely the shaft and the blade, the shaft is 450mm long with a diameter of 1-inch and the blade is rectangular with a blade length of 80mm, 8mm thick, and a blade angle of 40°. The construction of the chopper can be seen in Figure 3.
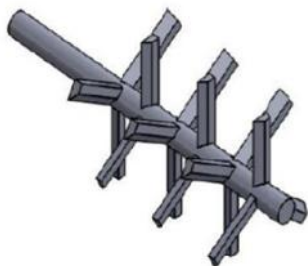

Figure 3. Construction of chopping blade.

b. Frame
The frame serves to support machine components with a height of 600mm and a width of 340mm, the detailed size can be seen in appendix 1. For the frame material itself, namely using 40 x 40 hollow iron. The frame design drawing can be seen in Figure 4.
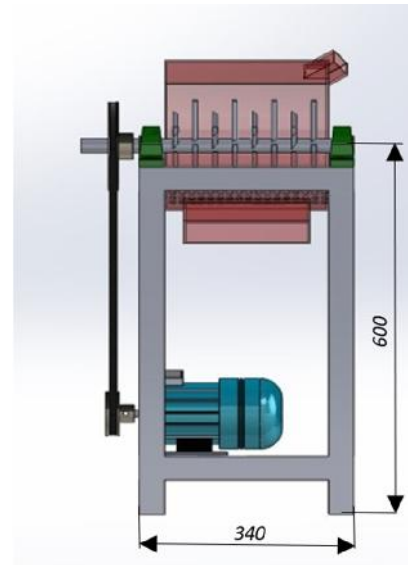

Figure 4. *Machine frame*

3.   RESULTS AND DISCUSSION

3.1   Design Calculation
Design calculations are carried out so that the components used in the machine are in accordance with the desired standards.
a. Motor output torque
In making this bajakah root chopping machine, the drive motor used has the following specifications:
N_{motor} = 1400 rpm
P_{motor} = 370 *watt*

From the above specifications the torque or T1 released by the motor will be calculated by the following formula (Sularso, 1997):

$$T_1 = 9{,}55.10^3.\frac{P\ motor}{N\ motor}$$
$$T_1 = 9{,}55.10^3.\frac{370\ watt}{1400\ rpm} = 2{,}523.10^3\ Nmm$$

From the above specifications, the torque released by the motor is 2523 Nmm.

b. Determining pulley rotation
From the output torque on the motor, equation 2.2 is used:
T_1 = 2523 Nmm
Round (n_1)   = 1400 rpm
Pulley diameter (d_1)   = 4 inch
Pulley diameter (d_2)   = 6 inch

Then the rotation of the driven pulley is as follows:

$$\frac{d_2}{d_1} = \frac{n_1}{n_2}$$

$$n_2 = \frac{n_1.d_1}{d_2}$$

$$n_2 = \frac{1400 \text{ rpm}.4}{6}$$

n_2 = 933 rpm.

So, the result of rotation on the pulley (n_2) is 933 rpm.

c. Pulley ratio

Calculation of pulley rotation with 4-inch drive diameter and 6 inches driven diameter. Calculating the ratio obtained can be calculated by the equation:

$$i = \frac{\text{n drive}}{\text{n driven}}$$

$$i = \frac{1400}{933} = 1.5$$

So, the ratio result obtained after the calculation is 1: 1.5.

3.2 Test Result Data

From testing and making this bajakah root chopping machine, test results were obtained from a sample of 500gr bajakah root raw material with 3 tests. The test results can be seen in Table 1 and the image of the chopping result can be seen in Figure 5.

Table 1. Test results data.

No	Initial Weight (Gram)	Process Time (Second)	Perfectly Chopped (Gram)	Imperfectly Chopped (Gram)	Waste (Gram)
1	500	141.0	409 (81.8%)	50 (10%)	41 (8.2%)
2	500	172.0	401 (80.2%)	50 (10%)	49 (9.8%)
3	500	189.0	357 (71,4%)	62 (12,4%)	81 (16.2%)
Average		167.3	389 (77.8%)	54 (10.8%)	57 (11.4%)

Figure 5. The result of the chopping

The following is the test result data with a raw material weight of 500 gr with 3 tests. For the first test the machine can chop the roots perfectly as much as 409 gr, not chopped perfectly as much as 50 gr and wasted / out of the tube as much as 41 gr

with a time of 141 seconds. For the second test the machine can chop the roots perfectly as much as 401 grams, not chopped perfectly as much as 50 grams and wasted / out of the tube as much as 49 grams with a time of 172 seconds. For the third test the machine can chop the roots perfectly as much as 389 gr, not chopped perfectly as much as 54 gr and wasted / out of the tube as much as 57 gr with a time of 189 seconds.

a. Calculation of machine production capacity

The average mass of output is 389-grams with an average time of 167.3 seconds.

Output capacity

$$= \frac{\text{average output period}}{\text{average process time}} = \frac{389 \text{ gram}}{167,3}$$

$$= \frac{389kg}{167,3 hours} \times \frac{3600kg}{1000 hours}$$

$$= 8,37 kg/hours$$

b. Production efficiency calculation

The average mass of output is 389 grams, the mass of input is 500 grams.

Efficiency of machine product

$$= \frac{\text{average output mass}}{\text{input mass}} \times 100$$

$$= \frac{389 \text{ gram}}{500 \text{ gram}} \times 100\%$$

$$= \frac{389 \text{ kilogram}}{0.50 \text{ kilogram}} = 77.8\%$$

From the above results, the machine output capacity is 8.37 kg/hour, and the production capacity efficiency is 77.8%.

3.2 Analysis of discussion results

The following are some analyses of the results and discussion of the research that has been done.

a. The machine can work well, although there are still around 22.2% of bajakah roots that have not been chopped properly. However, this percentage shows that more than 75% of the chopping results can be used.

b. The root stuck in the tube wall is caused by the first separation eye with the side wall of the tube is too far away.

c. The occurrence of powder coming out of the gaps of the machine, which causes dust from the powder to scatter. This occurs because the gap from the hopper is not tight during the welding process.

d. In the test results, it is known that the efficiency level of the bajakah root chopping machine is 77.8%, the reason is because the distance between the blades is too far, and the gap between the blades and the tube wall is too far.

4. CONCLUSION

From the results of planning and designing bajakah root chopping machine into tea powder that has been done, it can be concluded that the Bajakah root chopping machine uses 0.5 Hp motor power using pully and belt drive. This machine has a blade system with a vertical position and a zigzag disusan with a total of 18 rotating blades, each row filled with 3 dividing blades mounted in a vertical position. The hopper is modified to be more effective and a sieve is placed at the bottom of the hopper. This machine can accommodate an output capacity of 8.37 kg/hour. Also results test of the production capacity of this bajakah root chopping machine is 8.37 kg / hour with an average time of 167.3 seconds, with an average of 77.8% chopped powder and powder that is not chopped / left in the tube as much as 10.8% within machine production efficiency level to 77.8%.

REFERENCES

Bandarta Ras, B. R. 2012. Mesin Pencetak Bakso Otomatis. Batam State Polytechnic. https://docplayer.info/72166960-Mesin-pencetak-bakso-otomatis-tugas-akhir.html

Dicky Seprianto, Iskandar, Romi Wilza, Novia Faradilla, Radika Permana Putra, Zikri Zal Fauzan. 2017. Alat Bantu Penggulung Benang Songket Palembang Pada Lungsen Dengan Sistem Otomatisasi Transverse Roll. *AUSTENIT*. Vol. 9 No1. 17-24. https://doi.org/10.5281/zenodo.4547614

Franata, F.A., 2021. Rancang Bangun Mesin Pencacah daun Pelawan Portable dengan Kemiringan Sudut Mata Pisau. *AUSTENIT*. Vol.13 No2. 38-46. https://doi.org/10.5281/zenodo.5703830

Hafidin, B., Setiawan, Y., Saparin, S., 2021. Rancang bangun mesin pencacah Daun Pelawan Menjadi Serbuk Teh, Proceedings of National Colloqium Research and Community Service. Vol5 (2021). https://doi.org/10.33019/snppm.v5i0.2696

Kaharudin and bambang 2021. Rancang Bangun Mesin Pencacah Pakan Ternak Kapasitas 50Kg /Hour. SIGMAT, Teknik Mesin Unsika. Vol1 No2 1-8. https://doi.org/10.35261/sigmat.v1i2.5555

Hendriko, Menti Diana Hura, Jajang Jaenudin, Made Rahmawaty, Nur Khamdi, 2022. Rancang Bangun Mesin Pengiris Tempe Otomatis dengan Pengaturan Ketebalan. *AUSTENIT*. 14.1; 24-31. https://doi.org/10.5281/zenodo.6499808

Lulu zakia hasanah. 2021Akar Kayu Bajakah dan Manfaatnya untuk Kesehatan, Banten-indonesia. https://www.academia.edu/88344873/Review_Akar_Kayu_Bajakah_dan_Manfaatnya_untuk_Kesehatan

Margono, Nugroho Tri Atmoko, Bambang HariPriyambodo, Suhartoyo, Sang Alang Awan. 2021. Rancang Bangun Mesin Pencacah Rumput untuk PeningkatanEfektifitas Konsumsi Pakan Ternak di Sukoharjo. DOI: 10.52561/abma.v1i2.132

Natal Thailatua Sitanggang. 2021. The Effect of Variation of the Number of Blades on the Fineness of Coffee Beverage Powder on the kepok banana peel grinding machine. Universitas Bangka Belitung. https://repository.ubb.ac.id/4985/

Ratna Dewi, 2021. Design of a cattle grass chopping machine using a strip knife. https://repository.ummat.ac.id/2390/

Ridder-Numan, J. 1992. Spatholobus (Leguminosae-Papilionoideae): a new species and some taxonomic notes. Blumea - Biodiversity, Evolution and Biogeography of Plants, 37(1), 63-71. https://repository.naturalis.nl/pub/525773

Rohdiana, D. 2009, This Tea is Healthy, a Popular Scientific Review, First Print. Alfabeta Publisher, Bandung. https://opac.perpusnas.go.id/DetailOpac.aspx?id=709576

Rohdiana, D., and Widiantara, T. 2004. Antioxidant Activity of Some Superior Tea Clones, Proceedings of the National Seminar and Congress of the Indonesian Food Technologists Association (PATPI), Jakarta. https://patpi.or.id/en/topics/seminars/

Saputera, M. M. A., & Ayuchecaria, N. 2018. Uji Efektivitas Ekstrak Etanolik Batang Bajakah Tampala (spatholobus littoralis Hassk) Terhadap Penyembuhan Luka, 53(9), 1689-1699. https://doi.org/10.36387/jiis.v3i2.185

Sularso and Kiyokatsu Suga. 1997. Buku Basic Planning and Selection of Machine Elements, PT Pradya Paramita.

Suprianto. 2015. AC MOTORS: AC Motor Theory and Types of AC Motors. Retrieved 23 June 2019. https://www.orientalmotor.com/ac-motors-gear-motors/technology/pdf/AC%20Motor%20Fundamentals.pdf