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*Research Article*

# Application of Gravity Force on Banana Cutting Machines

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**Abstract:** Indonesian people love to consume bananas as fruit. Many sources of nutrients, including minerals and carbohydrates, are contained in this fruit. Various UMKM (Usaha Mikro, Kecil dan Menengah) have grown by developing processed banana foods such as sale and banana chips. An important step in making processed banana dishes is cutting the bananas. In general UMKM still process bananas using conventional techniques, namely cutting using manual human power. The purpose of this study is to utilize gravity to design a banana cutting machine. Gravity will cause the banana pieces to fall into the storage container. The dimensions of the cutting machine are designed with a small size to facilitate mobility. The results showed that the use of a cutting machine increased the efficiency of banana cutting. A more uniform cutting thickness was achieved.

**Keywords:** Banana; cutting; efficiency; gravitation

## 1. Introduction

The most popular commodity in Indonesia is bananas. Bananas are a fruit that is high in nutrients and has many sources of vitamins, including minerals and carbohydrates. Bananas have many elements that are important that are important for human healt, including vitamin C, sugar, and supply of vitamins, minerals and energy at affordable prices. This fruit is usually consumed as is. If processed properly after harvest, this fruit can be used as food. Bananas can be processed into various dishes, including juice, fried bananas, and banana nuggets. Utilizing banana processing to diversify food sources. In addition to being a food source, this fruit can be used to make banana chips and other processed banana products, as well as being a sales center for the industry.

Almost types of soil can support the growth of banana plants. One of them is the Magelang area which is located on the main road to Semarang, Yogyakarta and is located on the slopes of Mount Merapi. This area is fertile enough to support the cultivation of agricultural products such as bananas, cassava and rice. This city has witnessed the growth and development of various UMKM, one of which is UMKM that grow and sell bananas. In general, UMKM still processed bananas using conventional techniques. For business owners, slicing bananas with a knife or hand peeler is a big challenge. When compared to the use of technology in the slicing process, conventional methods are considered quite capable of reducing production costs. The cause of the limited production capacity of banana chips is that human labor is still needed in the cutting process which still uses manual procedures [4]. Therefore, to boost the productivity of banana sales, mechanical slicing is needed with a banana slicing machine.

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## 2. Literature Review

Several studies of banana slicing machines or cutting machines have been conducted, including. The productivity of the bananachips depend on how fast the banana slices can be sliced. Slicing using manual technique required more human energy and take a long time. The result of the analysis shows that the machine can produce 64.8kg slices of banana in one hour. Theoverall dimension of the banana slicing machine is 700mm x 600mm x 755mm with the weight of 57kilogram.

Meanwhile studied that A Technology Impact Assessment (TIA) was carried out in Catbalogan City's neighborhood New Mahayag. The Mahayagnon Women's Association Daan sa Pag-asenso (Path to Progress) association took part in the assessment. The utilization of fruit slicing machines to cut fresh, peeled bananas into banana chips was the main emphasis of the TIA. The association's production of banana chips has increased from one "kabolig" per day using a human stripper to four "kabolig" per day using a slicing machine. With each profit sharing, the association's revenue rises from PhP 100 to PhP 1,000. The group also produced other goods, such as cassava chips, sweet potato chips, and calamansi puree. Because women produce more banana chips to sell in their designated marketplaces, the machine works well. The machine's user-friendliness makes it easy for women to operate and slice bananas. The time saved by the person slicing bananas can already be used for other productive tasks and activities related to processing banana chips.

Machine with a motorized also studied by. This research focused on design and fabrication of motorized / power operated plantain slicer to meet the raising demands for plantain chips in Nigeria. The objectives of this research was met as the machine has the capacity to produce plantain chips of uniform size in shorter time and a greater slicing efficiency of up to 96.84% while keeping the cost of the machine at an affordable price.

## 3. Method

The slicing machine is made with the following manufacturing stages following the flow diagram:

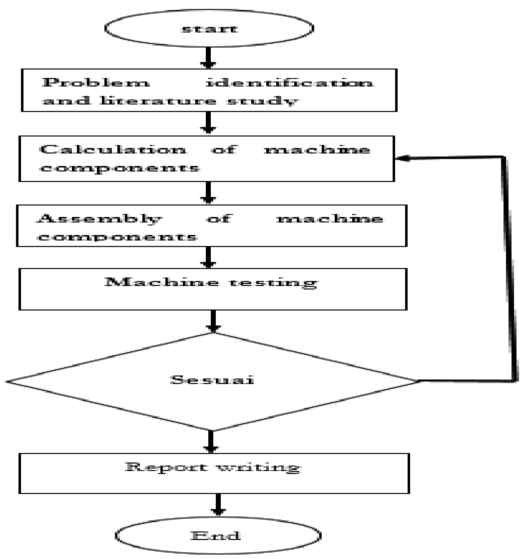

**Figure 1**. Banana cutting machine manufacturing flow chart

The research began by identifying existing problems. This stage was carried out by conducting a literature study related to various cutting machines. In addition, field observations were also conducted to sale producers in Magelang regarding cutting bananas for sale and chips production. From this identification, it was concluded that most of the cutting process was still done manually. After identifying the problem, a solution was found, namely making a banana slicing machine. Before making the machine, calculations were made for the machine components, that is:

a. Electric motor

Electric motor as the driver of the slicing machine with ¼ HP power.

$\boldsymbol{F} =$ rotating style

$$\boldsymbol{F = 0,1\ kg\ x\ 10\ \frac{m}{s^2} = 1\ N}$$

$$\boldsymbol{r = 0,2\ m}$$

Obtained

$$\boldsymbol{T = (1N)(0,2m) = 0,2\ Nm}$$

Engine power (P) is calculated using the equation

$$\boldsymbol{P = \omega.T}$$

With

$$\boldsymbol{P = \textbf{Engine power}\ (kW)}$$

$$\boldsymbol{T = Torsion\ (Nm)}$$

$$\boldsymbol{\omega = Angular\ speed\ \left(\frac{rad}{s}\right)}$$

$$\boldsymbol{\omega = \frac{2\pi n}{60}}$$

$$\boldsymbol{\omega = \frac{2\pi.667}{60}}$$

$$\boldsymbol{\omega = 69,8\frac{rad}{s}\ (planned)}$$

Obtained :

$$\boldsymbol{P = \left(69,8\frac{rad}{s}\right)(1Nm)}$$

$$\boldsymbol{P = 69,8\ W}$$

So the planning power required is:

$$\boldsymbol{P_d = f_c.P}.$$

$$\boldsymbol{P_d = (1,2)(69,8\ W)}$$

$$P_d = 83,76\ W$$

The planned power is 83.76 W. In order for the machine to work optimally and for the availability of electric motors on the market, an electric motor with a power of ¼ HP with a rotation of 1000 rpm is used.

b. Strength of the axle material

Transmitted power

$$P = \frac{1}{4} HP = 186,425W$$

Planned twisting moment

$$T = 9,74x10^5 \frac{P_d}{n}$$

$$T = 9,74x10^5 \frac{186,425}{1200}$$

$$T = 4,35\ kg.mm$$

Shear stress $\tau_a$

The shaft material selected is JIS G 4501 carbon steel type SS 55 C. The tensile strength of the shaft is $66 \frac{kg}{mm^2}$ with safety factor $sf_1 = 6,0$ **and** $sf_2 = 2,0$

So the shear stress is obtained

$$\tau_a = \frac{\tau_b}{sf_1.sf_2}$$

**Where**

$\tau_b =$ tensile strength of the material

$sf_1$= safety factor for the mass effect of the material S-C value is taken 6,0

$sf_1$= the second safety factor due to the influence of stress concentration, value is taken 2,0

$$\tau_a = \frac{66}{(6,0)(2,0)}$$

$$\tau_a = 5,5\ \frac{kg}{mm^2}$$

Shaft diameter

$$D_s = \left[\frac{5,1}{\tau_a} K_t.C_b.T\right]^{1/3}$$

$D_s$=shaft diameter (mm)

$K_t$= torsional moment correction factor (1,0-1,5)

$C_b$= bending load correction factor (1,2-2,3)

$$D_s = \left[\frac{5,1}{5,5}(1)(2)(4,35)\right]^{1/3}$$

$$D_s = 9,30\ mm$$

$D_s$ is the minimum diameter for the shaft. The shaft is an important component in a machine as a transmission of motion and power. So a shaft with a diameter of 28mm is chosen to keep the shaft working optimally.

c. Drive pulley

Diameter of the pulley used $d_p$= 4 inch and the driven shaft pulley is planned to be of diameter $D_p$ = 6 inch.

The planned pulley rotation is :

$$\frac{n_1}{n_2} = \frac{d_p}{D_p}$$

$$\frac{n_1}{1000} = \frac{4}{6}$$

$n_1$ =667 rpm

**4.** Belt

The belt is used as a rotational forwarder from the motor to the driven shaft. The speed and length of the belt are calculated as follows:

Belt speed

$$v = \frac{D_2.n}{60.1000}$$

Where

$v$= speed around the pulley (m/s)

$d_p$= drive pulley diameter (m)

Obtained

$$v = \frac{(0,153)(1000)}{60.1000}$$

$$v = 0,00255\ m/s$$

Length of belt circumference

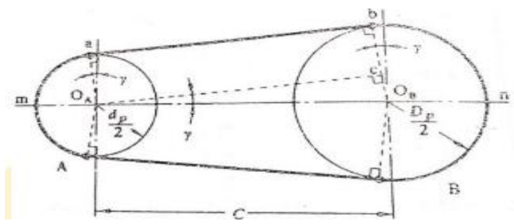


**Figure 2.** Calculation of the length of the belt circumference

Information

C= distance between the two pulley axles (550 mm)

$\boldsymbol{D_p}$= driven pulley diameter (152,4 mm)

$\boldsymbol{d_p}$= drive pulley diameter (101,6 mm)

The circumference of the belt is determined by the following formula:

$$L = 2C + \frac{1}{C}\left(D_p + d_p\right) + \frac{1}{4C}\left(D_p - d_p\right)^2$$

$$L = 2(550) + \frac{\pi}{2}(152,4 + 101,6) + \frac{1}{4(550)}(152,4 - 101,6)^2$$

$$L = 1517,95\ mm$$

Based on the calculation results above, the belt length is 1517.95 mm. The belt type is determined from the planned power and rpm of the motor, obtained type A. The belt sold on the market is a belt with a length of 60 inches or 1524 mm so that the type A60 belt is used. Some of the slicing machine parts that we produce are as follows:

**Figure 3.** Frame part slicing machine components

**Figure 4.** Slicing machine components cutting blade part

Next, the machine components are assembled into a banana cutting machine.

## 4. Results and Discussion

The banana slicing machine is designed semi-automatically so that it has a greater production capacity than the manual method. The engine power is obtained from the rotation of the electric motor, which is distributed by a v-belt and pulley in a transmission. This transmission mechanism is chosen because the rotation power of the electric motor is much greater than the material to be sliced. To ensure that the bananas move down due to gravity, a hopper or banana container is installed at the front of the machine

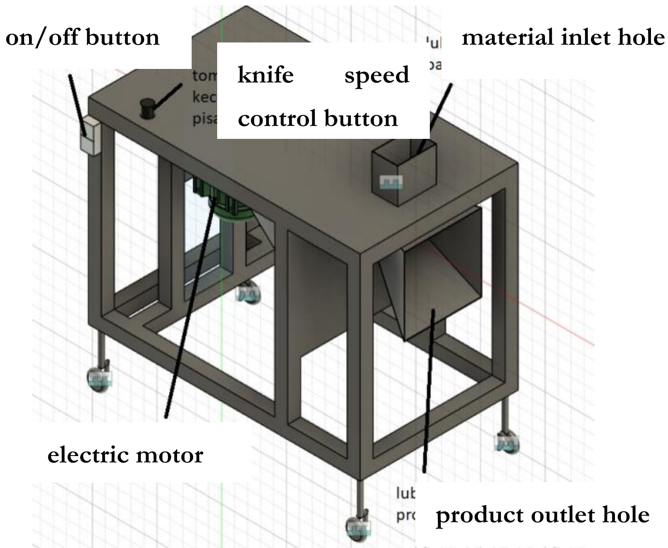


**Figure 5.** Banana slicing machine

The specifications of this slicing machine are as follows:

a. Machine frame

The machine's iron frame measures 100 mm x 50 mm x 60 mm. To facilitate the movement of the machine, three-inch diameter wheels are installed at the bottom of the machine.

b. Material inlet hole

The hole is made to direct the banana towards the slicing knife. The hole is equipped with a pusher to facilitate the entry of the banana into the slicing knife. In addition, this box-shaped hole can be adjusted for transverse or parallel cuts.

c. Slicing knife

Aluminum is used to make the blade. To make banana cutting faster, two 40 cm diameter knives are available. The thickness of the banana slices and the rotation speed can be adjusted as needed.

d. Product outlet hole

This hole functions to drain the sliced banana pieces. A hopper or banana container is installed at the bottom of the hole so that the banana can move down due to the pull of gravity.

e. Source and transmission of rotation

An electric motor with a power of ¼ HP is used as the engine drive. The transmission system uses an A60 type V belt with a ratio of 1: 2. Electric motors were chosen to reduce noise and air pollution (9)

The working principle of this banana slicing machine utilizes the force of gravity. The power source from the electric motor will move pulley 1 and the v-belt rotates to move pulley 2. This power is transferred to the shaft connected to the banana slicing knife. Furthermore, the kinetic energy is channeled to the reducer to reduce the rotation generated by the electric motor. The blade rotates and will slice the bananas that have been put in the container. The results of the slicing will fall into the container that has been provided due to the pull of gravity. The steps for operating the machine are as follows:

a. Prepare the tools and materials, namely bananas and banana cutting machines.
b. Turn on the machine
c. Set the speed of the knife rotation, wait until the rotation is stable
d. Insert the banana into the material input hole
e. Prepare a container, place it under the product output hole
f. When finished, turn off the knife rotation and turn off the machine.

Kepok banana is a banana with a slightly flat shape and is often called a flat banana. The size of the fruit is small, with a length of 10-12 cm and an average weight of 80-120 g. The skin of the fruit is very thick with a greenish yellow color and sometimes brown spots. This banana has a delicious taste and high nutritional content [10]. The average time required to cut a banana using a manual knife with a thickness of 2 mm is 10 seconds. The manual cutting capacity is 36 kg / hour. By using a cutting machine, the cutting time can be shortened, namely the average cutting of 1 banana with a thickness of 2 mm is 3 seconds. The cutting capacity increases 3 times to 108 kg / hour. The following is a picture of the results of cutting with a cutting machine.

**Figure 6.** Cross section results with a thickness of 2 mm.

In the picture above, it can be seen that the cutting results with the cutting machine provide satisfactory results. The cutting thickness and size are more uniform.

## 5. Conclusions

Based on the results obtained, it can be concluded that the banana cutting machine with the application of gravity increases cutting efficiency. The cutting thickness is more uniform.

## References


[1] E. D. T. RIZKA HASANAH□, "The analysis of nutrient and fiber content of banana (Musa paradisiaca) sold in Pontianak, Indonesia," B I O F A R M A S I J N A T P R O D B I O C H E M, vol. 15, pp. 21-25, 2017.
[2] M. W. D. S. N.-N. T. L. M. S. Keulemans, "Sampling Strategies and Variability in Fruit Pulp Micronutrient Contents of West and Central African Bananas and Plantains (Musa Species)," Journal of Agricultural and Food Chemistry, vol. 55, p. 2633–2644, 2007.
[3] H. S. M. Dr, "Banana plant as a source of valuable antimicrobial compounds and its current applications in the food sector," Journal of Food Science, vol. 86, no. 9, pp. 3755-4243, 2021.

[4] O. S. L. C. C. S. S. S. O. K. Kimsron Srieng, "From Bananas to Chips: A STEM Journey to Explore Food Processing Concept," Journal of Innovation, Advancement, and Methodology in STEM Education, vol. 2, no. 2, pp. 98-104, 2025.
[5] A. K. A. R. M. A. H. M. Mohd Afiq Danial Khairull Azhar1, "Design of Banana Slicing Machine," RESEARCH PROGRESS IN MECHANICAL AND MANUFACTURING ENGINEERING, vol. 3, no. 1, pp. 26-36, 2022.
[6] E. H. C. Marcos E. Bollido1, "Technology Impact Assessment of Banana Slicing," Journal of the Austrian Society of Agricultural Economics (JASAE), vol. 16, no. 06, pp. 159-167, 2020.
[7] C. A. Ezugwu, "Design and fabrication of a motorized/power operated plantain slicer for optimum chips production," International Journal of Mechanical Engineering and Technology, vol. 10, no. 1, p. 485–1495, 2019.
[8] K. S. &. Suga, "Dasar perencanaan dan pemilihan elemen mesin," Pradya Paramita, 2004.