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Design of Knife Profile and Hopper Position of Banana Chopper Machine

Achmad Arifin [a], Muhammad Taufik Amri [b,*]

[a]*Department of Mechanical Engineering Education, Universitas Negeri Yogyakarta, Indonesia*
[b]*Department of Mechanical and Automotive Engineering, Universitas Negeri Yogyakarta, Indonesia*

**Corresponding author: taufikamri50@gmail.com*

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ABSTRACT

Banana chopper machine is a machine used to cut bananas to be processed into banana chips. In its use, banana chopper machines often experience problems in cutting bananas. Obstacles in cutting bananas affect pieces that are damaged or deformed and the size of the pieces is still not wide and the thickness is still above 2 mm. The aim of this study was to produce banana slices with an elongated oval shape and the slices remained intact with an average thickness of 2 mm. This study used the R&D method and direct trials on banana percussion machines. The collection and presentation of data uses ten samples of banana cutting results with three tests and will measure the thickness of the banana and observe the results of the banana slices visually. The results of this study were in the form of banana slices that were tried on a banana chopper machine and modifications were made to the parts hopper and blade profile. Modification hopper beveled at the ends hopper and the blade profile is made curved

1 Introduction

AL-FA Tech is a business engaged in the production of appropriate technology tools aimed at agriculture, livestock, and small and medium enterprises located in the Giri Peni area of Wates. AL-FA Tech employs 4 to 5 workers in the manufacturing of these tools. The Appropriate Technology Tools (TTG) produced by AL-FA Tech come in various shapes and types, and their numerous features are widely used in society to facilitate daily tasks and activities [1]. The local community often faces difficulties in completing tasks. One of the appropriate technologies developed by AL-FA Tech is the banana slicing machine.

The banana slicing machine is a device used to cut bananas into uniform sizes and thicknesses, eliminating the need for manual labor [2]. This research addresses issues faced by one of the SMEs collaborating with AL-FA Tech, specifically regarding the banana slicing machine used for making banana chips. The current banana slicing machine has several issues, such as frequent damage at the initial stage of banana cutting, resulting in broken slices. The maintenance of the cutting blades is also time-consuming as it uses four blades. The shape of the cutting blades also results in slices that are too thick, which reduces the quality of the banana chips. This issue is crucial as it is important for the banana slices to be of consistent thickness, ideally around ±2 mm.

The current design of the hopper affects the resulting small, circular-shaped banana slices. The small size of the slices has become an issue because the banana chip producers desire wider

slices that are more oval-shaped and elongated. This is done to attract consumers, as larger banana slices give the impression of a more substantial product. To address this issue, a study was conducted to modify the blades and hopper of the banana slicing machine. The goal of the modification is to adjust the banana slicing machine, specifically by altering the blade profile, its placement, and the hopper position, in order to produce elongated oval-shaped slices while maintaining the integrity of the slices (i.e., preventing breakage) with an average thickness of ±2 mm.

2 Method

The development research of the banana slicing tool was conducted at the AL-FA Tech Workshop, located in Giri Peni, Sentolo, Wates, Kulon Progo. The design process took place at RT.40/RW.18, Sideman, Giri Peni, Wates District, Kulon Progo Regency, Special Region of Yogyakarta.The method used in the study to modify the banana slicing machine is Research and Development (R&D). This method is chosen because it focuses on the development of the hopper, blade shape, and blade holder to produce elongated oval-shaped banana slices [3]. Research and Development (R&D) is an in-depth research approach that collects data on user needs (user needs analysis), followed by a product development program to produce a product and evaluate its effectiveness [4]. It involves basic research activities that gather information about user needs (needs analysis), followed by product development activities to create a product and assess its effectiveness. This type of research is experimental, involving the redesign of the hopper position and blade profile.

2.1 The subject of study

The subject of this study is the development of the hopper and the modification of the blade shape. The research sample consists of the banana slices produced, which meet the buyers' specifications: elongated oval-shaped, intact (not broken), and with an average thickness of ±2 mm.

2.2 Research procedure

The procedure is described according to the type of research conducted. This section outlines how the research was carried out and how data will be collected, including:

a. Design of the Hopper and Blade

The design of the modification begins by creating simulation drawings using SolidWorks or Inventor software. During the simulation, the blade movement is tested within the software to ensure that it can cut all parts of the banana inside the hopper. Once the simulation shows that the blade can effectively slice the entire banana in the hopper, the process can proceed to the next stage.

b. Fabrication and Installation of the Hopper and Blade

In this stage, the fabrication of the hopper and blade is carried out using the tools and materials previously listed. Once the blade and hopper are completed, the old hopper and blade on the banana slicing machine are removed. The new blade, once finished, must be installed carefully and in accordance with the design specifications. After installation, the blade should be tested to ensure it rotates smoothly and without any friction. The new hopper must also be installed according to the design specifications. It should be securely attached to ensure it is stable and does not detach or shift during operation.

c. Preparation of Supporting Equipment

Before conducting the testing, the necessary supporting equipment was prepared, including Raja Nangka bananas, calipers (vernier or digital) for measuring the thickness of the banana slices, and a dynamo to drive the blade. The dynamo used has a specification of 180 watts and a speed of 1400 rpm, ensuring the proper operation of the slicing mechanism.

d. Data Collection and Validation

Data collection is conducted by performing several trials of banana slicing and taking samples of the resulting banana slices. Data validation must be carried out to ensure that the collected data aligns with the objectives of this study.

2.3 Data Collection Technique

The data collection technique in this study uses an experimental method and direct trials, conducting three separate experiments. The treatments in these experiments focus on the hopper and the slicing blade. During the trials, the researcher observes and measures 10 banana slices. The sliced banana samples are measured to achieve a thickness with an average of ±2 mm, which is presented in a table. The physical appearance of the banana slices is also documented through images.

3 Result and discussion

The results of the banana slicing machine research were conducted in accordance with the procedures outlined in the research methodology. The method used is research and development (R&D) based on testing and experimentation.

3.1 Hopper Position

The hopper was redesigned to achieve banana slices with the desired results. The hopper design is shown in Figure 1. The placement of the new hopper is different from the previous one; the new hopper is positioned at an angle, with the end of the hopper also angled to produce elongated oval-shaped banana slices. This design modification ensures the desired slicing outcome.

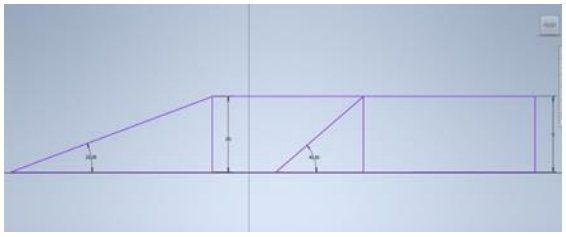

Figure 1. Hopper sketch

Figure 1 shows two right triangles with different angles. The first triangle has an angle of 20º, and the second triangle has an angle of 40º. Both triangles have the same height of 8 mm. The calculated lengths of the hypotenuses are 23.39 mm for the 20º angle and 12.46 mm for the 40º angle. From these calculations, it can be observed that the length of the hypotenuse is influenced by the angle. As the angle decreases, the hypotenuse becomes longer. After determining the slope of the hopper, the hopper and feeder designs were created, as shown in Figure 2 and Figure 3.

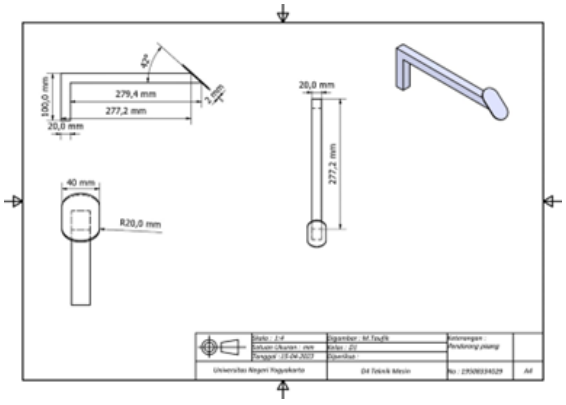

Figure 2. Hopper feeder design

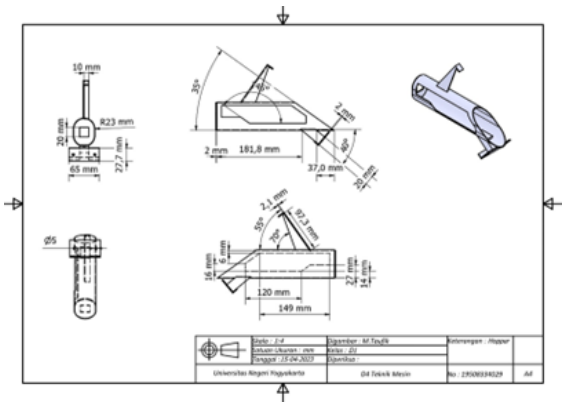

Figure 3. Hopper design

3.2 Blade Profile

The blade is made of aluminum because this material is lightweight and comfortable to use as a tool that comes into contact with food. Aluminum does not introduce toxic contamination and is rust-resistant, making it an ideal choice for food-related equipment [5]. In this study, the blade design is curved to reduce the risk of the banana being crushed or damaged during the slicing process. Essentially, when the blade is curved, the sharp edge of the entire blade can make contact with the banana being sliced. Previously, the blade was designed straight, which did not allow the sharp edge to contact the entire surface of the banana, resulting in damaged or imperfect slices. The results of the design can be seen in Figures 4 and 5.

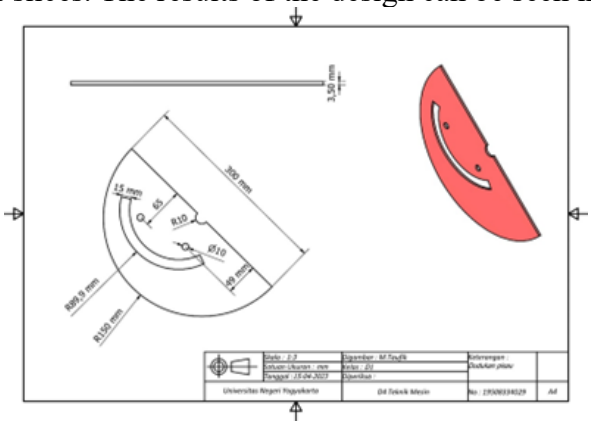

Figure 4. Blade holder design

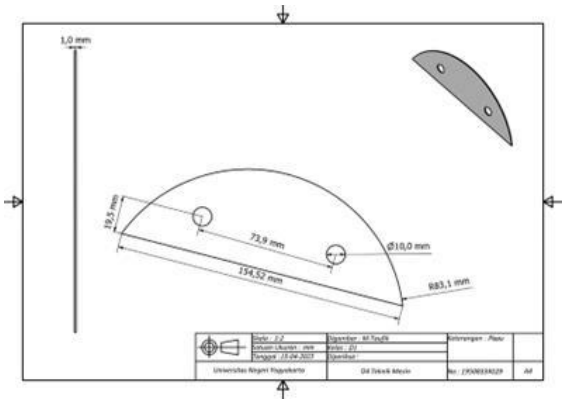

Figure 5. Blade design

3.3 Data collection

After the design, fabrication, and assembly stages of the banana slicing machine were completed, machine testing was conducted using available bananas, and data was collected from the sliced results. Figure 6 illustrates the difference between the machine before and after modification, ready for testing. During the testing, three trials were performed, and 10 banana

samples were taken. The thickness of each sample was measured and averaged to evaluate the results

(a) (b)

Figure 6. Machine modification (a) before and (b) after

After conducting the tests, the results of the banana slices were obtained, as shown in Figure 7. The sample data of banana slices can be seen in Tables 1, 2, and 3.

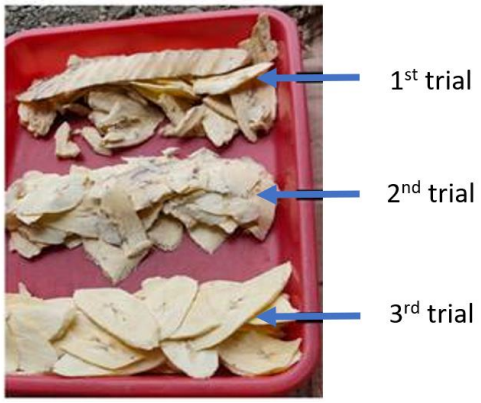

Figure 7. Banana slice on the 1st, 2nd, and 3rd trial

Table 1. Sample collection of experiment 1

No.	Sample	Banana Thickness
1	Sample 1	3.2
2	Sample 2	3
3	Sample 3	3.1
4	Sample 4	2.8
5	Sample 5	2.9
6	Sample 6	2.9
7	Sample 7	2.8
8	Sample 8	2.9
9	Sample 9	2.9
10	Sample 10	2.9
Mean		**2.93**

Table 2. Sample collection of experiment 2

No.	Sample	Banana Thickness
1	Sample 1	2.2
2	Sample 2	2.3
3	Sample 3	2.1
4	Sample 4	2.2
5	Sample 5	2.3
6	Sample 6	2.1
7	Sample 7	2.1
8	Sample 8	2.2
9	Sample 9	2
10	Sample 10	2
Mean		**2.15**

Table 3. Sample collection of experiment 3

No.	Sample	Banana Thickness
1	Sample 1	2.1
2	Sample 2	2.1
3	Sample 3	2
4	Sample 4	2
5	Sample 5	2
6	Sample 6	2
7	Sample 7	2.1
8	Sample 8	2
9	Sample 9	2.
10	Sample 10	2
Mean		**2.03**

From the results of Experiment 1, the thickness and shape of the banana slices were obtained and are presented in Table 1 and Figure 7. Upon direct observation, the banana slices could not yet be considered satisfactory due to the presence of scratches on the slices and remnants of banana left on the blade. The average thickness of the banana slices was measured at 2.93 mm.

After conducting Experiment 1 and analyzing the results of the banana slices, an observation was made to identify the causes of the issues. The changes implemented before conducting Experiment 2 included replacing the ring plate holder between the blade and the disc with a thinner one, with a thickness of 1 mm. Additionally, the tip of the hopper was adjusted to be closer to the blade holder, and the bolts were tightened to ensure they did not come into contact with the bananas during slicing. After completing these modifications, Experiment 2 was conducted, but the results showed that the banana slices were still not neat.

4 Conclusion

The conclusion of this study indicates that the objectives of the research have been achieved, namely to produce elongated oval-shaped banana slices that remain intact with an average thickness of ±2 mm. Several modifications were made during each trial to the hopper and blade, such as bringing the hopper closer to the blade holder, adding a spacer between the blade and the holder, and adjusting the bolts to prevent them from scratching the bananas. The third experiment produced the best results compared to the previous trials, which can be observed visually and measured for thickness, averaging ±2 mm.

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Conflicts of Interest

The authors no conflict of interest.

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