

Analysis of the Effect of Sieve Size on the Efficiency and Quality of Milling Results of Dried Shrimp

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Abstract

This study was conducted to investigate the operation of the dried shrimp grinding machine. This study was also undertaken to determine the differences in grinding results using three different sieve sizes. There are three sieve sizes used, namely, 5 mm, 7mm, and 9mm. This study was conducted to determine the results of grinding dried shrimp from fine to coarse, as the demand for ground shrimp in the market varies. Therefore, the researcher conducted this study with the aim of meeting market demand.

Keywords: Dried Shrimp Grinding Machine, Dried Shrimp, Fine Shrimp

I. INTRODUCTION

A grinding machine is a mechanical device used to change the physical form of a material into a smaller or finer form. Its purposes vary, such as grinding food ingredients, crushing grains for flour production, or refining chemicals in industrial processes (Anggriawan, 2021). Grinding machines typically use grinding mechanisms such as grinding wheels, grinding teeth, or sharp blades to achieve the desired results according to the specific application (Prasetyo & N., 2022). Most people still use the traditional method, which involves using a wooden pestle to pound the shrimp until smooth. This manual shrimp paste preparation process is inherently inefficient, requiring considerable time and effort, resulting in suboptimal results (Surya Dharma, 2019). Traditional grinding methods are less than satisfactory because they not only produce suboptimal results, but also require a long time and still require manual labor. The advancement of science and technology has had an impact and influence, with the ever-increasing need for various tools to simplify and expedite the work (Gurusinga et al., 2017). So this becomes a reference for the author for the results of the Analysis of the Effect of Sieve Size on the Efficiency and Quality of Dried Shrimp Grinding Results which can later produce ground shrimp which will be used as concentrate feed ingredients (Pengampu et al., 2020).

Basic Theory of Grinding Machines

A grinding machine is a mechanical device used to change the physical form of a material into a smaller or finer form. Its purposes vary, such as grinding food ingredients, crushing grains for flour production, or refining chemicals in industrial

processes. Grinding machines typically use grinding mechanisms such as grinding wheels, grinding teeth, or sharp blades to achieve the desired results according to the specific application (Lubis et al., 2016).

Types of Shrimp Grinding Machines

A shrimp grinding machine is a mechanical device used to change the physical form of shrimp into smaller or finer pieces. In this case, dried shrimp grinding machines are usually used in industry, but many still apply traditional shrimp grinding. Grinding with traditional methods is very time-consuming (Dermawan & Anshori, 2022). The types of dried shrimp grinding machines include the following:

1. Traditional shrimp grinder (manual)

Before the advancement of current technology, grinding dried shrimp still used human power entirely. In this case, human power is used entirely in grinding.

2. Modern shrimp grinder

With the rapid advancement of technology today, many machines are experiencing development, and this includes dried shrimp grinding machines. By using a system and cutting time significantly compared to using human power, in this case it has advantages in terms of time, cost and power (Saragi & A., 2021).

Shrimp Grinding Machine Design

The design of the dried shrimp grinding tool is as follows:

1. Engine Frame

2. Motor
3. Motor Pulley
4. V-belt
5. Gearbox Pulley
6. Gearbox
7. Clutch
8. Hopper
9. Outlet

This study uses a morphological machine matrix with the following variants:

1. The frame profile chosen is the first variation, namely the iron/iron L profile which is easy to assemble when making the machine frame.
2. The main driver is an electric motor with the reason to make work easier, reduce the amount of human power so that the machine can be operated by just one person.
3. By using a dimmer, the system usage will be easier to regulate.
4. The grinding shaft system uses a fan system because the grinding results for soft ingredients such as shrimp are considered more effective and even.
5. The cutting knife functions as a meat cutting tool, made from stainless steel.
6. The strainer serves as a place for the ground meat to come out.
7. The pulley functions as a rotation link from the electric motor which will be transmitted using a belt to the shrimp grinder.
8. The V belt functions as a connection from the driving source to the object to be moved via the pulley.

Filter Hole Size Variable

The dried shrimp grinding machine was tested using several filter variations, namely the first filter with a hole size of 5mm, the second filter with a hole size of 7mm, and the third filter with a hole size of 9mm. Each parameter calculated in this experiment was tested 3 times to obtain an accurate average value. In each experiment, 1 kg of dried shrimp was used as the material to be processed into raw material for shrimp paste (Manurung & S., 2023). Thus, this testing process will provide consistent and reliable data to evaluate the performance of the dried shrimp grinding machine with various filter variations, and can provide important information to increase the efficiency and productivity of this machine in the dried shrimp grinding production process (Samosir & S., 2023). And the filter material is made of stainless steel. The hole size design that will be used in the dried shrimp grinding machine is as follows (Sianturi & N., 2024):

- a. Design hole size 5mm.
This hole size design has a very fine level of smoothness, so this diameter size is very often used to grind fine meat (Napitupulu & S., 2022).

- b. Design hole size 7mm
The design of this hole size has a slightly coarser level of fineness, so this diameter size is often used to grind slightly coarser meat.

- c. Design hole size 9mm
This hole size design has a very coarse level of fineness, so this diameter size is very often used to grind coarse meat.

II. RESEARCH METHODOLOGY

The duration of data creation and collection is estimated to be 1 month after the assignment proposal is approved. It is carried out in the workshop laboratory of the Mechanical Engineering Study Program, Faculty of Engineering and Water Resources Management, HKBP Nommensen University, Pematang Siantar., East Siantar District, Pematang Siantar City, North Sumatra. When designing a product, all information about the requirements or recruitment needs to be gathered. Therefore, a requirements list can be created to explain the product specifications in more detail before further development (Sinaga & S., 2022).

Tool sieve with a hole size of 5 mm, Sieve with a hole size of 5 mm is used to grind dried shrimp with fine results. Sieve with a hole size of 7 mm, Sieve with a hole size of 7 mm is used to grind dried shrimp with slightly coarse results Sieve with a hole size of 9 mm is used to grind dried shrimp with coarse results The material used in this study is dried shrimp. Dried shrimp is an ingredient that is often used for the daily kitchen needs of housewives. Dried shrimp can be included in all types of dishes cooked in the following ways: soup, dumpling filling, fried rice and many more (Simanjuntak & S., 2022). The design of the Sieve Hole and Blade Design that will be used in the process of grinding dried shrimp is as follows (Naibaho & N., 2022): The research stages carried out during the study are the preparation stage, the testing stage, the analysis stage, and the report preparation stage (Siahaan & M., 2023).

Preparation Stage

The preparatory stages carried out in this research are:

- a) Final assignment creation.
- b) Thesis outline seminar
- c) Literature study, this section discusses the theories and equations that support the analysis and are related to the dried shrimp grinding machine.
- d) Prepare the necessary materials and tools

Testing Phase. The testing phase was conducted in the Mechanical Engineering Laboratory at HKBP Nommensen University, Pematang Siantar. The testing methods were as follows:

Production efficiency test method

First stage: conducting a machine filter test with a filter hole diameter of 5 mm for a duration of 20 minutes.

Second stage: then testing was carried out with a sieve hole diameter of 7 mm for a duration of 20 minutes.

Third stage: then carry out testing with a sieve hole diameter of 9 mm for a duration of 20 minutes.

1. The analysis/analysis calculation stage used in the analysis research is 3 variations in the size of the sieve hole diameter which will affect the results of efficiency and final results.

2. Final drafting stage

The report preparation stage is the final stage of the writing activity, namely collecting test data, data analysis and data interpretation in the form of a final report that displays a literature study (Ruzek et al., 2019a).

Data collection techniques are activities that involve gathering data in the field to answer research questions. The data collection techniques used in this study are as follows:

Observation

Observation or direct observation is the activity of collecting data by conducting direct research on the research object so that one can clearly know the condition of the research object (Hambali & Doyan, 2021).

Engine test run

This test is carried out to ensure that the equipment or machine can function properly.

Documentation

Documentation is carried out to support the truth of the information obtained, either in the form of photos, notes during the research, and recordings during the trial process during the research process.

The data used in this study was obtained by grinding dried shrimp. This data was used to determine the efficiency and quality of dried shrimp grinding production, including time efficiency and production yield. The following table shows the results of the analysis:

Problem identification is the first step in tool design. Several challenges have been identified with the dried shrimp grinder, including its heavy weight and high manufacturing costs (Suganya et al., 2022).

Problem Analysis

After knowing the existing problems in the existing dried shrimp grinder, a problem analysis is carried out. At this stage, an analysis is carried out to get a solution to the problem that suits the expected needs. Drawing a tool technically is the process of pouring out ideas and concepts based on basic theories that support this process can be done by studying the characteristics and physical data, making a schematic circuit by looking at the functions of the components studied, so that a tool can be made that meets the expected specifications of the tool drawing results equipped with sketch images using *AutoCAD software*.

III. RESULTS AND DISCUSSION

Research result

The results of the research that has been conducted are in the form of a modified design of a shrimp grinding machine product, product trial results, product validation results, product advantages and disadvantages. The shrimp grinding machine designed and built in this study has several main components that support its work operation, namely a drive motor, gearbox, pulley, v-belt and shrimp grinder (Ruzek et al., 2019b).

The screw has a function as a pusher/presser for meat towards the chopping knife, made of ST 37 iron. The chopping knife functions to chop shrimp when the shrimp is pressed by the pusher *screw*, this material is made of *food grade iron* type 307 (Arta et al., 2020).

The function of the elements in the modified grinding machine design is the drive motor, which acts as the main drive, using an electric motor. The engine used has a power of 1 hp and an engine speed of 1500 rpm. In testing, the drive motor was able to operate. The machine operates well at various speeds and has no functional issues. The transmission system uses a V-belt and pulley system, which transfers power from the drive motor to the shrimp grinder (Espinel et al., 2021). The pulleys used are 3 inches and 5 inches in diameter. The designed drive transmission consists of the final rotation of the rotary blade used for cutting shrimp.

Pulley speed ratio calculation

It is known:

motor pully diameter (D1) = 76.2 mm

Gearbox pully diameter (D2) = 127 mm

motor rotation speed (n1) 1500 rpm

Asked: n2 (rotational speed of the pulley)?

Gear Box Ratio = 1 : 5

Answer:

$$n_1 \cdot d_1 = n_2 \cdot d_2$$

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

$$n_2 = \frac{1500 \cdot 76,2}{127}$$

$$n_2 = 900 \text{ rpm}$$

$$n_2 = \frac{900}{50}$$

$$n_2 = 18 \text{ rpm}$$

a) Power (P) = 1 HP (745.7 Watt) = (0.7457 Kw)

b) Electric motor shaft rotation n1 = 1500 rpm

c) Stirring shaft rotation n2 = 250 rpm

d) Motor shaft diameter d1 = 12.5 mm

e) Gearbox pully shaft diameter = 24 mm

f) Distance between pulley axes (x) = mm

g) Comparison of turns (i)

h) Design power (kW)

i) Design moment (Kg.mm)

j) V-belt speed (m/s)

1. Rotation ratio (i)

It is known:

$$P = 0.7457$$

$$n_1 = 1500 \text{ rpm}$$

$$n_2 = 18 \text{ rpm}$$

Asked: i (rotation ratio)?

$$\text{Answer: } i = \frac{n_1}{n_2}$$

$$i = \frac{1500}{18}$$

$$i = 83.33$$

So the power value that will be transmitted is

4

2. Design power (kW)

It is known:

$$f_c = 1.2$$

$$P = 0.75 \text{ kW}$$

Question: Design Power P_d (kW)?

$$\text{Answer: } P_d = f_c \cdot P$$

$$P_d = 1.2 \cdot 0.75$$

$$P_d = 0.9 \text{ kW}$$

So the planned power value obtained is 0.9

kW

3. Design moment (kg.mm)

It is known that:

$$P_d = 0.9 \text{ kW}$$

$$n_1 = 1500 \text{ rpm}$$

Question: design moment T_1, T_2 (kg.mm)?

Answer :

$$T_1 = 9.74 \times 10^5 \frac{P_d}{n_1}$$

$$= 9.74 \times 10^5 \left(\frac{0.9}{1500} \right)$$

Table 1. Production results of dried shrimp grinding that have been carried out.

Sieve Size (mm)	Rotation (rpm)	Raw Materials (kg)	The final result	
			Final Weight (kg)	Time (seconds)
5	18	1	0.6	80
			0.7	83
			0.8	86
			0.9	90

From the dried shrimp grinding test table above, a sieve hole size of 5 mm produces a time of longer grinding. The test was carried out 4 times. The first experiment used 1 kg of raw material to produce a final weight of 0.6 kg with a grinding time of 80 seconds using an 18 rpm screw (Hazaar et al., 2024). The second experiment was carried out with a raw material weight of 1 kg to produce a final weight of 0.7 kg, and a grinding time of 83 seconds, using an 18 rpm screw (Godara et al., 2022). The third experiment was carried out using 1 kg of raw material and produced a final weight of 0.8 kg, with a grinding time of 86 seconds, using an 18 rpm screw (Urbano-Peña et al., 2024). The fourth experiment was carried out using 1 kg of raw material to produce a final weight of 0.9 kg, with a grinding time of 90 seconds using an 18 rpm screw. To determine the number of sieve mesh holes with a size of 5 mm and a sieve diameter of 5 inches, the following is done:

$$= 584.4 \text{ kg.mm}$$

$$T_2 = 9.74 \times 10^5 \frac{P_d}{n_2}$$

$$= 9.74 \times 10^5 \left(\frac{0.9}{250} \right)$$

$$= 3,506.4 \text{ kg.mm}$$

So the design moment values obtained are $T_1 = 584.4 \text{ kg.mm}$ and $T_2 = 3,506.4 \text{ kg.mm}$

4. V-belt speed (m/s)

It is known that:

$$D_1 = 76.2 \text{ mm}$$

$$n_1 = 1500 \text{ rpm}$$

Asked: V_p (peripheral speed)

Answer :

$$V_p = \frac{\pi \cdot d_1 \cdot n_1}{60}$$

$$= \frac{3,14 \cdot 76,2 \cdot 1500}{60}$$

$$= 5.9 \text{ m/s}$$

So the value of the peripheral speed based on the calculation is 5.9 m/s.

Discussion

The process involved a yield/comparison between the weight after grinding and the initial weight. This study conducted three tests, each involving 1 kg of dried shrimp. (Himanshi et al., 2023) The yield for this tool can be seen in the table 1. below:

Convert sieve diameter to mm:

$$1 \text{ inch} = 25.4 \text{ mm}$$

$$\text{Filter diameter} = 5 \text{ inch} \cdot 25,4 \text{ mm/inch} = 127 \text{ mm}$$

Surface area of the filter

$$\text{Area} = \pi \cdot r^2$$

$$r = \text{diameter} / 2$$

$$= 127 \text{ mm} / 2$$

$$= 63.5 \text{ mm}$$

$$\text{Area} = 3,14 \cdot (63,5 \text{ mm})^2$$

$$= 3,14 \cdot 4032,5 \text{ mm}^2$$

$$= 12.665 \text{ mm}^2$$

1. Number of mesh holes in the filter

$$\text{Number of holes} = \frac{(\text{Luas Permukaan Saringan})}{(\text{Ukuran Mesh})^2}$$

$$= \frac{(12.665 \text{ mm}^2)}{(5 \text{ mm})^2}$$

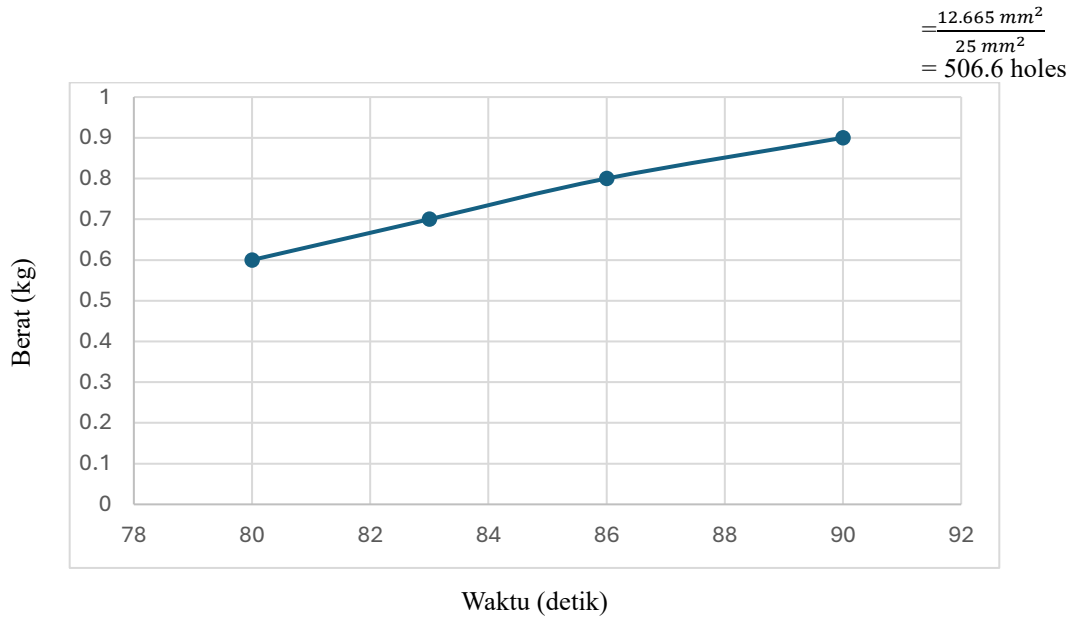


Figure 1. Graph of Weight Change Using 5 mm Size



Figure 2. Results of grinding using a 5 mm sieve

Table 2. Results of grinding dried shrimp that have been carried out.

o	Filter Size	Rotat ion (rpm)	Raw Materials (kg)	The final result Final Weight (kg)	Time (seconds)
	7	18	1	0.6	70
				0.7	72
				0.8	75
				0.9	78

From the dried shrimp grinding test table above using a 7 mm sieve hole size, it produces a slightly slower grinding time (Fatmawati et al., 2022). This test was carried out 4 times, the first experiment used 1 kg of raw material and produced a final weight of 0.6 kg with a grinding time of 70 seconds, using a screw of 18 rpm. The second experiment was carried out using 1 kg of raw material and produced a final weight of 0.7 kg, with a grinding

time of 72 seconds using a screw of 18 rpm (Yosua, 2024). The third experiment was carried out using 1 kg of raw material, and produced a final weight of 0.8 kg with a grinding time of 75 seconds, using a screw of 18 rpm (Ahluriza & Sinaga, 2021). The fourth experiment was carried out using 1 kg of raw material, and produced a final weight of 0.9 kg, using a screw of 18 rpm (Butar Butar et al., 2021).

The size determines the number of mesh holes in the filter with a hole size of 7 mm and a filter diameter of 5 inches, you need to do some calculations:

Convert sieve diameter to mm:

$$1 \text{ inch} = 25.4 \text{ mm}$$

$$\text{Filter diameter} = 5 \text{ inch} * 25,4 \text{ mm/inch} = 127 \text{ mm}$$

Surface area of the filter

$$\text{Area} = \pi * r^2$$

$$r = \text{diameter} / 2$$

$$= 127 \text{ mm} / 2$$

$$= 258.5 \text{ holes}$$

$$= 63.5 \text{ mm}$$

$$\text{Area} = 3,14 * (63,5 \text{ mm})^2$$

$$= 3,14 * 4032,5 \text{ mm}^2$$

$$= 12.665 \text{ mm}^2$$

Number of mesh holes in the filter

$$\text{Number of holes} = \frac{(\text{Luas Permukaan Saringan})}{(\text{Ukuran Mesh})^2} = \frac{(12.665 \text{ mm}^2)}{(7 \text{ mm})^2} = \frac{12.665 \text{ mm}^2}{49 \text{ mm}^2}$$

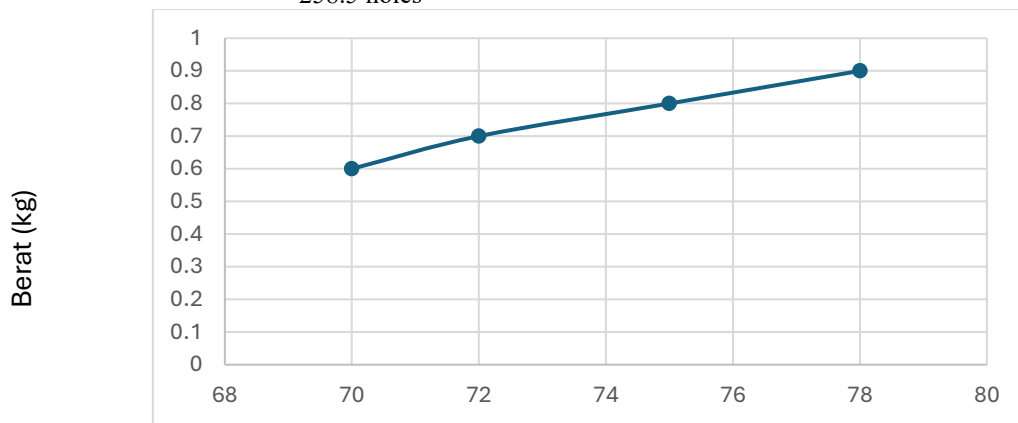


Figure 3. Per u material weight graph using a size of 7 mm



Figure 4. Results of grinding using a 7 mm sieve

Table 3. Results of grinding dried shrimp after being carried out.

o	Filter Size	Rotation (rpm)	Raw Materials (kg)	The final result	
				Fine (kg)	Shrimp Time (seconds)
9	18	1	1	0.6	60
				0.7	64
				0.7	67
				0.8	70

From the dried shrimp grinding test table above , the 9 mm sieve hole size produces a faster grinding time . The test was carried out 4 times, the

first experiment was carried out using 1 kg of raw material, and produced a final weight of 0.6 kg, with a grinding time of 60 seconds, using a screw of 18

rpm. The second experiment was carried out with 1 kg of raw material and produced a final weight of 0.7 kg, with a grinding time of 64 seconds, using a screw of 18 rpm. The third experiment was carried out with 1 kg of raw material, and produced a final weight of 0.7 kg, with a grinding time of 67 seconds, using a screw of 18 rpm. The fourth experiment was carried out with a raw material weight of 1 kg, and produced a final weight of 0.8 kg with a grinding time of 70 seconds, using a screw of 18 rpm (Firman Manahan Panjaitan & Putra, 2025).

To determine the number of mesh holes for a filter with a hole size of 9 mm and a filter diameter of 5 inches, you need to do several calculations:

Convert sieve diameter to mm:

$$1 \text{ inch} = 25.4 \text{ mm}$$

$$\text{Filter diameter} = 5 \text{ inch} * 25,4 \text{ mm/inch} \\ = 127 \text{ mm}$$

Surface area of the filter

$$\text{Area} = \pi * r^2$$

$$r = \text{diameter} / 2$$

$$= 127 \text{ mm} / 2$$

$$= 63.5 \text{ mm}$$

$$\text{Area} = 3,14 * (63,5 \text{ mm})^2$$

$$= 3,14 * 4032,5 \text{ mm}^2$$

$$= 12.665 \text{ mm}^2$$

Number of mesh holes in the filter

$$\text{Number of holes} = \frac{(\text{Luas Permukaan Saringan})}{(\text{Ukuran Mesh})^2}$$

$$= \frac{12.665 \text{ mm}^2}{(9 \text{ mm})^2}$$

$$= \frac{12.665 \text{ mm}^2}{81 \text{ mm}^2}$$

$$= 157 \text{ holes}$$

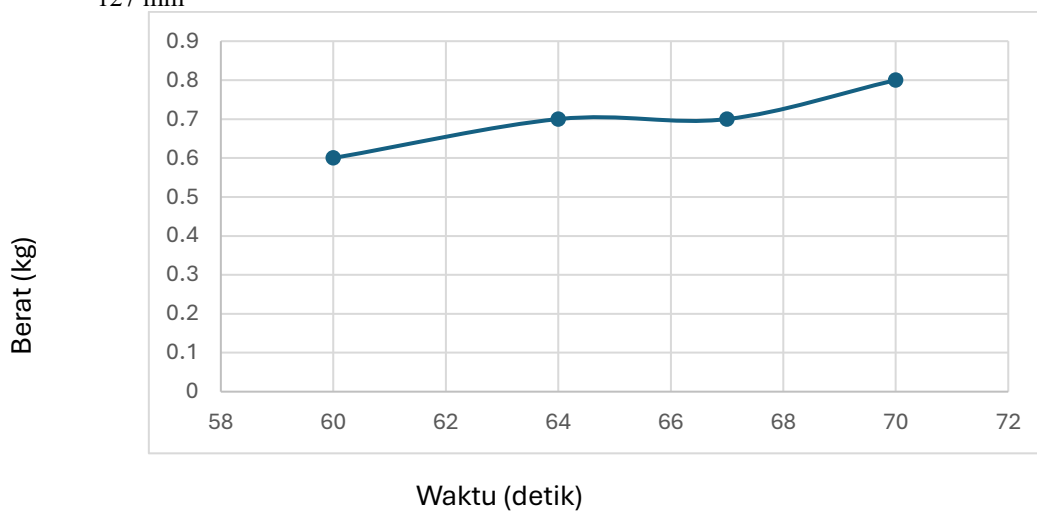


Figure 5. Graph of Weight Change Using 9 mm Size



Figure 6. Results of grinding using a 9 mm sieve

The screw has a function as a pusher / presser of meat towards the chopping knife, made of ST 37 iron. The chopping knife functions to chop shrimp when the shrimp is pressed by the pusher screw, this

material is made of food grade iron type 307. The grinder housing as a place for the shrimp grinding process, this material is made of cast iron. While the filter functions as a regulator of the level of fineness

of the meat depending on the filter holes, this material is made of *stainless steel*. The results of the shrimp grinding machine trial are to test whether the machine is in accordance with the expected goals or not. The machine tests that will be tested are selecting a smooth shrimp output hole diameter for raw shrimp paste and comparing the length of the automatic shrimp grinding process with manual shrimp grinding. This is done to facilitate the grinding process. The output is observed by changing the output hole diameter from 5 mm, 7 mm, and 9 mm. These results are recorded in the following table:

IV. CONCLUSION

Based on the results of the research conducted, we can know the working principle of the dried shrimp grinding machine, which is by utilizing rotation to grind dried shrimp. Based on the research that has been done, valid dried shrimp grinding results were obtained. Experiments Using a 5 mm sieve can produce very fine ground shrimp, and take longer due to the smaller sieve hole size. Tests were carried out 4 times with raw materials for one experiment of 1 kg of dried shrimp, and produced an average of 0.75 kg of fine shrimp. Based on this study, it was also found that using a driving power of 18 rpm is very efficient in grinding fine shrimp.

V. RECOMMENDATIONS

In the process of analyzing the influence of sieve size on the efficiency and quality of the results of grinding dried shrimp, there are things that must be considered in the process of grinding dried shrimp, namely the distance between the screw blade and the bearing wall must be tight so that the shrimp to be ground can be ground completely, without having to open the grinding sieve which can increase the grinding time.

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