Design and Development of Stirring and Cooking Machines for Palm sugar

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Abstract. The production process of palm sugar is carried out by farmers or craftsmen with very simple equipment, namely cauldrons, stirrers and firewood stoves. Products were produced using this method are not good, short durability, require a long time, so it is inefficient and effective. The purpose of this study was to overcome worker fatigue, minimize work accidents and increase the production capacity of printed palm sugar and palm sugar. The research method that will be carried out is designing and making a stirrer and cooking machine for palm sugar palm, an electric motor drive system with several stages, namely the preparation stage in the form of a field survey of the conditions and production capacity of palm sugar, and preparation of materials and equipment required, the assembly phase of equipment components that have been made or purchased, and the Testing phase of the assembled equipment are tested. This testing phase will be repeated over and over until the data about the correct rotation is obtained to get the optimal amount of production. Specifications of the stirrer and cooking sugar ants are 155 cm high, 80 cm long, and 65 cm wide, stirring shaft diameter 1 inch and the power of the motor drive 1/2 hp, and a capacity of 29 kg per day.

1. Introduction
South Sulawesi, especially Enrekang and Pangkep districts, is one of the largest palm sugar producers in Eastern Indonesia. Palm sugar production in South Sulawesi from 2007 to 2011 experienced a significant increase, which is an average of 5% annually. The latest data collected shows the production of palm sugar in South Sulawesi for the year 20011 alone at 357,972 tons (BPS South Sulawesi, 2011). Generally, sugar production is marketed to urban areas, such as the city of Makassar and Ambon City.

The palm sugar industry or business as the location and object of research is located in Maiwa, Enrekang Regency, South Sulawesi Province. The industry is classified as a small industry and managed in a familial manner. Palm sugar has been known by the people of Indonesia as one of the sweeteners of food and beverages that can be substituted for sugar. Palm sugar is obtained from the tapping process of palm juice which is then reduced in water content until it becomes solid. This palm sugar product is in the form of printed sugar and ant sugar. Print sugar is obtained by cooking palm juice until it becomes thick like a cotton candy then printing it in a semicircular mold. As for the palm sugar of ant, the cooking process is longer that is until the palm sugar crystallizes, then dried until the water content is below 3%. This type of palm sugar has the advantage of palm sugar, which is longer durability, more hygienic and practical to use.

Based on the results of surveys and interviews with farmers and palm sugar craftsmen, they generally suggested that the quantity of production and the low quality of palm sugar caused by the
processing of palm sugar that had been done so far had not been optimal. This is because the palm sugar processing equipment and systems carried out by farmers or craftsmen of palm sugar have been very simple.

The process of producing palm sugar at the farmer or craftsman level is carried out with very simple equipment, namely using cauldrons, stirrers and firewood stoves. The products produced in this way are not good, besides the short durability also requires a long time, so it is not efficient and effective.

Another problem experienced by artisans is the lack of market certainty from the sugar product of the ant. The palm sugar they produce is mostly made on order and the amount is not much. So that most of the palm sugar crafters prefer to produce brown sugar as their main livelihood, because it is considered more promising and has market certainty in this case it was bought by the brown sugar collectors. To overcome the shortcomings and weaknesses described above, it is necessary to apply a mixing machine and a machine for cooking palm sugar ants that are driven by motorcycles. The machine intended is that which is easy to operate and can be made by a local welding workshop with the cost of making machines that can be reached by farmers or craftsmen of palm sugar.

![Figure 1. Design of stirring and cooking palm sugar machine](image)

2. **Research Method**

2.1. **Place and Time of Research**

This research was carried out in Mechanical Workshop in Mein Engineering and Food Technology Laboratory in Chemical Engineering at Ujung Pandang State Polytechnic in May - October 2018.
2.2. Sourcing data
Data sources used in the study are primary and secondary data. Primary data is obtained based on the results of direct interviews in the field and dissemination of information in the form of structured questions to respondents. Secondary data is obtained from library data as well as various data relating to palm sugar, data extraction in related departments such as agriculture, plantation services, and industry and trade services.

2.3. Collecting Data
Data collection method is done by interviewing with structured questions. Interviews are conducted in the form of deep interviews with the aim to explore hidden data that may be reluctant to be revealed by respondents.

Figure 2. Manufacturing process of stirring and cooking palm sugar machine
2.4. Designing
In the introduction, it has been stated that the purpose of this paper is to plan and embody a stirring machine and a machine for cooking palm sugar, which is driven by a different motor than the previous stirring machine and palm sugar cooking machine. Hopefully the mixing machine and sugar cooking machine, which is driven by a motor which is made later, will have better and more efficient mixing and mixing results in the process. The design stages are as follows. Make a design (sketch drawing) of the components to be made. Designing is done by drawing on a computer using Autocad software as shown below:

2.5. Assembling
After all components are finished, the next stage is the assembly stage. The assembly process is the process of assembling or combining each component into a mutually supportive form so that a working mechanism is formed that matches what is desired. The assembly steps are as follows:

- The frame that has been made is placed on a flat floor.
- Attach the stove mount rail path to the top of the stove holder. In order for the rail to be strong, welding is needed with 90 A electric welding and 2.6 mm electrodes.
- Insert the stove holder on the rail that has been installed in the frame.
- Install the bearing holder, motor holder, and reducer holder in the place that has been prepared in the drive chamber by welding 90 A electric welding and 2.6 mm electrodes.
- Install the pads on the stand that has been installed in the frame.
- Attach the shaft to bearing 1, simultaneously connecting the shaft to the gear between the bearings 1 and 2. Then press the shaft until it enters the bearing 2. 2. Tighten the bearing bolt.
• Connect the shaft with the stirring shaft by using a sheath and bolt 12.
• Paint parts of the stand frame and stove protector in black using spray-gun and orange supporting poles, home and motorbike protectors using spray-gun.
• Install the hard installation from the motor to the reducer through the pulley and belt on the drive chamber.
• Install the installation current from the motor to the socket.
• Install the cover of the drive chamber using a bolt.
• Install the stove on the stove holder on the stove holder on the frame.
• The tool is ready to be tested.

2.6. Testing Machine
To determine the performance of the palm sugar palm cooking and stirring machines, it was need to test the machine. The testing procedures of this machine are as follows:
• Put the juice in the tube while filtering to remove impurities. Turn on the stove on the cooking machine and stirrer of palm sugar.
• Cook the juice of the juice until it boils and produce yellow bubbles. Lift the yellow foam using a filter.
• Install the stirrer on the fixed shaft then tighten it with a bolt that has been prepared.
• After the juice of the juice is cooked marked by changing the color of the sugar to brown, add the pecan seeds that have been mashed, and then stir constantly when large bubbles appear turn off the stove.
• The juice concentration is left for ± 10 minutes.
• After silence, turn on the stirrer by pressing the ON button on the switch. Stir the sugar with a stirrer until it becomes sugar crystals or granules of raw material for palm sugar.
• After becoming a crystal, weigh the results using a scale.
• Clean the remnants of the raw material for palm sugar which is attached to the tube wall.

The results of the tests that have been carried out are as follows:

| No | Materials | Cooking Time | Time of Stirring | Results |
|----|-----------|--------------|-----------------|---------|
|    | Palm sugar| Candlenut | Traditional | Machine |    |
| 1  | 50 litres | 4 pieces | 5 Jam | - | 60 minutes | 8,5 kg |
| 2  | 50 litres | 4 pieces | - | 3 jam | 15 minutes | 8,5 kg |

3. Results and Discussion
In traditional experiments the juice needed is 50 liters to produce 8.5 kg of raw material for palm sugar. This traditional method takes 5 hours to cook and 1 hour for the stirring process. So the total time taken is 6 hours. But sometimes it takes longer than that. This is caused by the uneven heat produced by firewood.

The stirring process also still uses human power so that the stirring process can cause work accidents in the form of fatigue and the palms of the workers sprained. In the traditional process can only be produced once a day so that it can only produce 8.5 kg / day.

In the experiment using a machine, the juice needed 50 liters produces 8.5 kg of raw material for ant palm sugar for 3 ¼ hours where, the cooking process uses a 3-hour machine, and the stirring process is 15 minutes.

At the time of cooking faster because the heat produced by the stove is more evenly distributed. In the second experiment the stirring process was easier, faster, and workers' work safety was guaranteed.
This is because they no longer use human power when mixing sugar to powder. Raw materials for palm sugar, which can be produced once is 14.5 kg because the capacity of the tube in this machine is 100 liters of juice. In production using machines can produce 2 times a day. So what can be produced in a day can reach 29 kg of raw material for palm sugar.

4. Conclusion
From the experimental data above, it can be concluded that:
- The mixing machine and cooking sugar of the ants are 155 cm high, 80 cm long, and 65 cm wide, the stirrer shaft diameter is 1 inc and the motor power is 1/2 hp.
- In the process of making raw materials for palm sugar using this machine, the results are more effective and efficient. Where in this process no longer use human power when stirring is replaced by mechanical power from an electric motor so that the safety of workers is guaranteed.
- With this tool can increase production capacity every day with a faster time. There was an increase in production compared to the traditional method from 8.5 kg to 29 kg per day due to the larger cooker tube capacity and production twice a day.

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