Modification of Palm Oil Brown Sugar Semi-Automatic Machine

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Abstract. Brown sugar semi-automatic machine is designed to improve production process of brown sugar. The problems of research are 1) Production process of palm oil brown sugar (evaporation and crystallization) is not optimal and need to be modified; 2) The speed of agitation system in evaporation is not optimal; and 3) Thermal suction system in crystallization is not optimal and causes caramelization process. This research aims to modify brown sugar semi-automatic machine by improving rotation speed in the agitation system of evaporation and thermal suction system in crystallization. This research is conducted by observing machine, analyzing system engine (specification and modification planning), designing of modified machine and evaluating of modified machine. The final targets of this research are modifying brown sugar semi-automatic machine in order to improve evaporation and crystallization process. The outputs are modification of brown sugar semi-automatic machine by adding agitator blades, installing inverter system as a speed regulator, and changing blower to thermal suction machine. However, performance test of modified machine will be tested in further research for comparing brown sugar quality due to improve the production process more effective and efficient.

1. Introduction

Oil palm plants are one of the most potential plantation products to be developed in Indonesia. In 2019, the total area reached 14,677,560 ha, production amounted to 42,869,429 tons, and productivity amounted to 3,702 kg/ha [1] (Directorat General of Plantations, 2019). According to Isroi [2], palm oil plants have a productive period ofapproximately 25 years, and then must be rejuvenated (replanting). The process of rejuvenation of palm oil plants produces waste and stems that are generally only burned and untapped. Palm oil stem waste if not managed properly will cause environmental problems because it is not easily degraded naturally and large in size so that it meets plantation areas. Based on the research of Agustira et al. [3], the utilization of palm oil stem waste by processing palm oil stems into brown sugar has considerable economic potential. The economic value of nira for 1 palm oil bar (unprocessed/ upright before being toppled) amounted to Rp. 15,813. or Rp. 1,897,500 per ha. But if processed into brown sugar has a potential income of Rp. 18,421,500 until Rp. 22,866,325 per ha.

Utilization of palm oil into brown sugar is considered more economically valuable compared to brown sugar. According to Mustaufik and Haryanti [4], brown sugar is one of the products that have high enough prospects to be developed and can be relied upon to be a substitute for sugar. Brown sugar has several advantages when compared to regular palm sugar for example longer shelf life, higher selling price, packer and transportation is easier, has a more distinctive taste and aroma, and practical to use. This is in line with Zuliana [5], brown sugar has a longer shelf life due to water content of less than 3%, distinctive aroma and taste, and more practical in its use.

Riyadi et al. [6] explaining about the process of making ant sugar is generally done in two ways, namely using raw materials and using printed sugar raw materials. In the process that uses nira raw materials, the initial tahap is done that is the cooking of nira using a frying pan at a temperature of 110-120 ^{o}C for about 4 hours until it produces a viscous liquid. Next is the crystal formation of a viscous sugar solution (crystallization). The process of rhythmization is traditionally done by rubbing thick sugar using coconut shells until it produces crystalline solid

sugar (see figure 1.). The final stage is drying until the moisture content reaches 2-5% by drying sunlight, roasted, or oven.

Figure 1. The process of crystallizing brown sugar traditionally uses coconut

Based on the description of the production process above, found the problem faced by ant sugar artisans is that the production process still uses traditional means so that the quality of the product is still low. Based on the research of Mustaufik et al. [7], brown sugar artisans have difficulty in determining the end point of cooking so that the stage ofcrystallization (granulation) is not optimal. Riyadi et al. explained that brown sugar artisans do production with limited skills and technology so that the product capacity is relatively small, which is about 8.5 kg /day. The brown sugar produced by artisans have high moisture content and granule sizes that are not uniform.

Nawansih et al. [8] explained that the production of ant sugar in the traditional way is considered less effective and efficient. This is because production consists of several stages (using several tools) namely cooking using a frying pan, drying using an oven, and granulation. In cooking, the low apasity of the pan results in the sugar crystals being thrown out during the stirring process. Therefore, it is needed the technology of semi-automatic cooking machine of brown sugar to optimize the production process.

In previous research has been done to build a semi-automatic cooking machine of palm brown sugar that has the function of cooking and crystal formation. The semi-automatic cooking machine of palm brown sugar in the previous study is expected to not only help utilize palm stem waste, but become an alternative production machine for brown sugar artisans (see Figure 2.) .

Figure 2. Brown sugar semi-automatic cooking machine

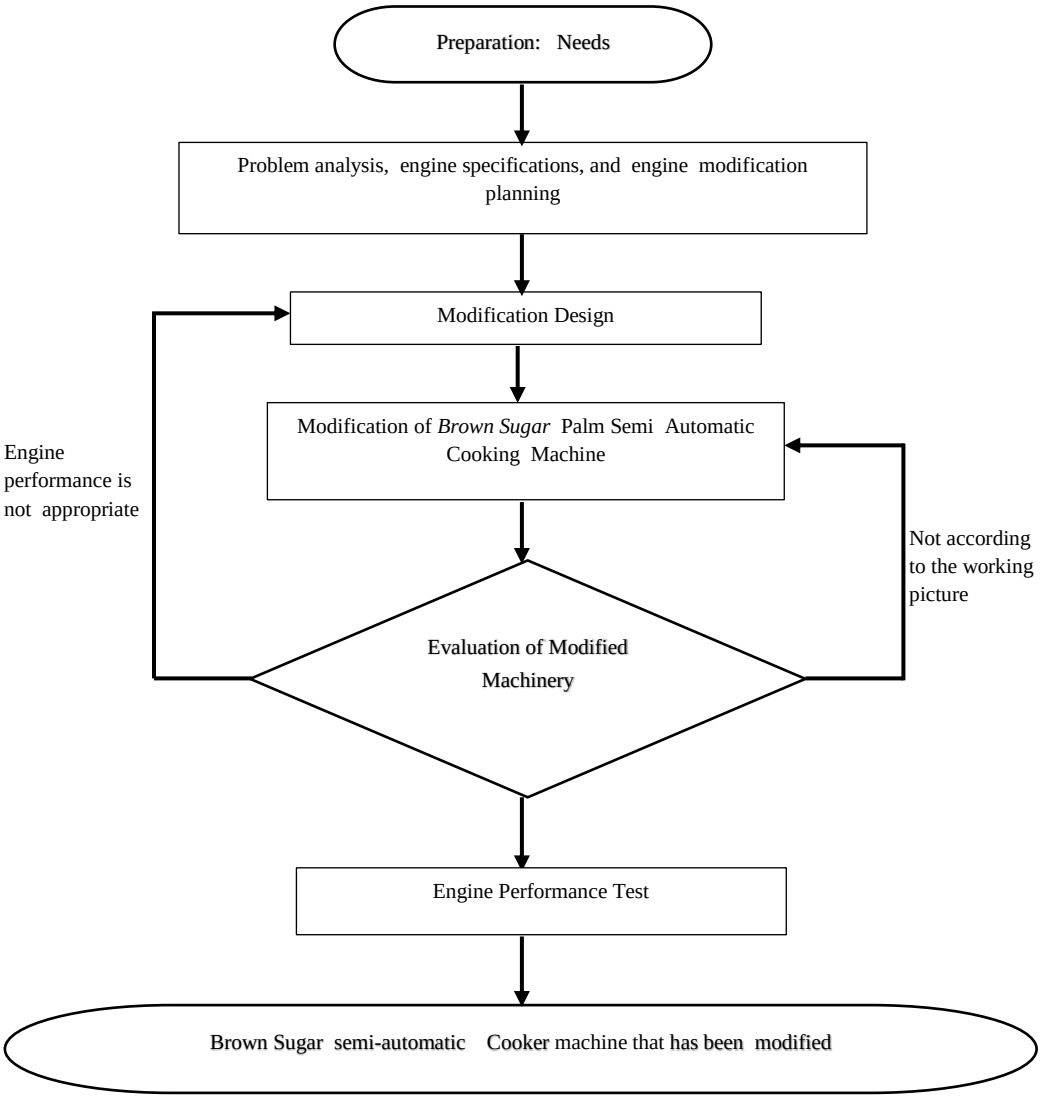
But in previous studies, the cooking machine still has shortcomings, especially stirring in the evaporation and crystallization process. The stirrer blade consisting of 2 blades, namely wood and metal material is still not optimal in the cooking of nira and gives rise to crust (caramelization). In addition, the rotary speed on the existing machine cannot be set so that at the time of crystallization of sugar are thrown out of the machine. Disadvantages in other crystallization processes are that heat cannot be eliminated optimally using mini fans on the machine.

This research aims to modify brown sugar semi-automatic machine by improving rotation speed in the agitation system of evaporation and thermal suction system in crystallization.

2. Materials and Method

The research was conducted at Rizky Putra Perkasa Workshop, Tanjung Sari Village of Natar District of South Lampung Regency by modifying the semi-automatic cooking machine of palm ant sugar that has been made in previous research with capacity of 20 liters, electric motor with power 1 HP, voltage 220 volts, and drive motor speed 1450 rpm.

The research was conducted based on the following flowchart :



3. Result and Discussion

3.1 Modification of Agitator Blades

The agitator blades in the previous study amounted to 2 pieces consisting of two types of materials. The first type is made of stainless plates and the second type is made of wood. The two types of agitator blades are combined so that when used both types of stirrers will work in accordance with their function. Stainless agitator serve to stir and erode palm oil. This blade can be lowered to the base of the cooking cauldron, so as to prevent

caramelization when the nira boils until it becomes ant sugar. The next blade made of wood serves as a stirrer and grinder of palm nira on the edge of the cooking cauldron. Both types of stirrer blades were chosen because they have the property of not reacting with nira during the cooking process and are not too sticky so that they are easy to clean (see figure 3a).). Based on the results of trials in previous studies, the process of grinding brown sugar is still not optimal, especially when palm oil is boiling and getting thicker. The process of grinding takes a long time and there is still a caramelization process. This is due to the lack of number of agitator blades and has only one stainless agitator blade. Therefore, in this study was modified into three agitator blades by adding one stainless agitator blade (see figure 3b.)

Figure 3a. Agitator blade before modification

Figure 3b. Agitator blade after modification

According to McCabe [9], the process of stirring and mixing to overcome three main types of problems, namely (1) to produce static or dynamic uniformity in multicomponent multiphase systems, (2) to facilitate the transfer of mass or energy between non-uniform parts of the system and (3) to indicate phase changes in multicomponent systems with or without changes in composition. Stirring is the main key in mixing a material either in the same phase or in different phases but has one purpose. so that materials can interact with each other until they reach a certain homogeneity at a certain time. In this study the stirring process is very important in the ripening of palm oil, which functions in homogenization and prevents caramelization.

3.2 Modification of Speed Regulator

In previous research, the engine was equipped with gear modules measuring 18 and 36, as well as an electric motor powered by 1 HP with a voltage of 220 volts and a speed of 1450 rpm (see figure 4a.) . Gear installation is done by drilling and speeding the mixer ad hole adjusted to the size of the mixer ad hole with the drive motor ad then diskrap to make a spi hole then transmission from the motor to the gear box using a fan belt and connected by using pully. Gear box is installed with the aim of regulating the stirring ad rotation so that the stirring movement can be regular. The gear box rotation ratio is 1: 60. But in the previous engine only had one speed, namely 1450 rpm which was channeled to the mixer to 20 rpm. The disadvantage in previous research is that the speed of the stirrer cannot be regulated (added and reduced), so that by the time the nira has started to thicken, the mixer is not able to spin nira.

Modifications were made to this study by adding an inverter so that the speed can be set at a range of 10 rpm to 50 rpm. This modification is done because in the process of making sugar ants the speed of stirring used changes- ubah. When the ant sugar dough is in liquid form, the speed of stirring used is a fast speed while when the sugar the ants begin to form kristal the speed of stirring is in use a slow speed so that the ant sugar is not thrown outside the cooking machine. The inverter comes with an *on-off* button to power the stirrer, as

that converts DC voltage into AC voltage with voltage and frequency values can be set. Inverter installation aims to

regulate the speed of the AC motor by changing the input frequency.

Figure 4a. *Gear box* before modification

Figure 4b. *Gear box* added inverter

3.3 Modification of Cooling Fan into Thermal Suction Machine

In previous research, cooling fan were installed on skeletal poles using iron plates that were welded and grated on the iron plate. The installed fan is a fan with a mini type of AC fan 220 volts / 50 watt (see figure 5a.). The installation of cooling fans aims to remove heat during the evaporation and crystallization process to prevent caramelization. However the cooling fan does not work effectively in removing heat so in the process of evaporation and crystallization of sugar ants still form caramel. Therefore, in this study modifications were made by turning the mini fan into a sucker blower (see figure 5b.) According to Bantacut [11], in the process of making sugar required a cooling process to lower the boiling point after the cooking of nira so that there is no caramel formation.

Figure 5a. Cooling fan before modification

Figure 5b. Modifications using a thermal suction

4. CONCLUSIONS

Modification of brown sugar semi-automatic machine by adding agitator blades, installing inverter system as a speed regulator, and changing blower to thermal suction machine. However, performance test of modified machine will be tested in further research for comparing brown sugar quality due to improve the production process more effective and efficient.

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