The Development of Tumbu Sugar Production Formed to Become Sugar Granules and Vacuum Packed to Meet Exports Demand

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Abstract—Tumbu sugar abstraction is an agriculture-based industrial products, conducted traditionally every cane harvest season. The result is formed in a tumbu, thus. it is called Tumbu sugar. The shape and size of brown sugar or sugar cane, both made from coconut sap, are considered less meet the demand of consumers who want practicality and convenience. Issues to be resolved in this research are improving quality, size and packaging to penetrate export markets. Sugar Tumbu currently form large chunks (100-125 kg), impractical to distribute, and not durable to be saved, easy to melt because it is hygroscopic. The purpose of this research is to produce or design a machine to generate sugar granules tapered cylindrical shape, diameter of 18 mm x height 16 mm = (18 x16) mm. The result of every production process is 10 x 10 = 100 grains. The method of generating mold unit of sugar granules comprising the steps: (1) determine the size of the products of sugar granules to be shaped, (2) designing and generating production machine according to the capacity of production, (3) designing the molding unit in accordance with the size of the shape of sugar granules, (4 ) test, repair and modification to obtain a good sugar granules. In initial test 10% of grains being produced are failed. It is solved by improving operator skill. On vacuum packaging test, Sugar granules were observed after 60 days seen no deformation compared with the unpackaged ones that become soft, and shrink. Sugar cane Products that molded into sugar granules and vacuum packed have the potential to become export products.

Keywords — Sugar mold, Tumbu sugar, sugar granules, appropriate technology

I. INTRODUCTION

Tumbu sugar is a sugar cane produced by some communities’ in Kudus regency. Tumbu sugar produced quality remains as the results of previous studies [1] i.e.: Quality II. Tumbu sugar quality improvement research has been conducted through methods sulfitation, and obtained the best method to produce Tumbu I sugar quality according to SNI 1-6237-2000 [2]. However, researches experienced problems in its development when the result applied in a small business Tumbu sugar, because sulphurous acid is not sold in the market. Therefore, it is necessary to study the quality improvement of Tumbu sugar Phosphatation methods, since phosphoric acid can be purchased at the chemical store.

This study applied the best method or chemical process technology from our previous study [3], and the use of appropriate technology equipment units which is used to improve the quality of Tumbu sugar. Previous research has produced Tumbu sugar quality I Indonesian National Standard (SNI 1-6237-2000) in the scale of micro enterprises. The results of this study further molded into sugar granules for easier packing and portability. Therefore, it needs to create a mold for generating sugar grain unit. It is expected to be disseminated as dedication to the community to foster new businesses in processing sugar cane into Tumbu scale micro enterprises.
Tumbu sugar small industrial is an agroindustry. It is processing sugarcane into Tumbu sugar that has been conducted by several communities in Kudus, Purwodadi, Pati and Rembang of Central Java, until now. The result is brown sugar cane, called Tumbu sugar. The process is conducted traditionally (hereditary), and the sugar quality produced is Tumbu II [4]. Tumbu sugar derived from sugar cane juice water treatment process called sap, which the water coming out of the mill sugarcane has matured; then, the juice is filtered and added lime to taste. Then, it is heated until boiling and stirred up into efflorescence. Furthermore, poured in a container called Tumbu, kept frozen, solidified and cooled.

Figure 1. Sugarcane and Tumbu sugar

Tumbu sugar packaging, previously has a large chunk weighing about 100 -125 kg, needs to be cut into smaller sizes before transported and further processed. The shape and physical size of sugar Tumbu does not meet the consumers’ demand who want convenience and easiness to store and consume directly. Therefore, it is necessary to design or manufacture a device that can produce Tumbu sugar into granulated sugar that are smaller and more practical to be consumed directly by consumers.

The problem of the research is how to design a molding machine that transform Tumbu sugar into granulated sugar cylinder, diameter of 18 millimeters by 16 millimeters high with capacity of 10 x 10 = 100 grain in a single molding process.

The long term goal of this research is to grow new businesses sugar cane household scale, and lend support on reducing sugar cane factories role. The impact is it will absorb a lot of labor in rural areas, increase revenue, boost the economy, strengthen food security and reduce urbanization. The specific objectives of this study are (1) to design and produce the machine that generate Tumbu granulated sugar and (2) designing the vacuum packaging for Tumbu sugar granules.

II. METHOD

A. The location and time of the study
The location field research is in micro-scale enterprises Tumbu sugar at UD. MUSTIKA BUMI belongs to Mr. Nurhadi, Gribig village RT 2 RW 2 Gebog Subdistrict, Kudus, Central Java Province. The timing of the field research is September - October 2015, on sugar cane milling season.

B. Research Materials and Devices
1). The main ingredient research: sugarcane milled to taken its sap and sieved, lime, and water, technical phosphoric acid, litmus paper (pH paper). 2). Research tools: a container of juice vessel of stainless steel materials, juice purification vessel (mixing with lime juice), mixer, stainless steel wok, litmus paper, furnace and gas stoves. Tools and machines for creating components of granular sugar mold unit, among others: milling machines, lathes, drilling machines, grinding machines and others. 3). Stationery (ATK)

C. Design of Sugar Granules Molding Machine
The steps in the design are: 1) it needs recognition and identification: identification of needs, starting with studying the literature i.e.: scientific journals about the equipment or machines that already exist. Designers identify shortcomings and weaknesses of the machines that have been there and trying to find solutions. Thus, equipment created to obtain optimal results tailored to the needs of community; 2) formulate problems, include all the planned specifications. Such problems may include details of inputs and outputs, the nature and dimensions, required fees, the amount made, estimated useful life, and the various obstacles that will be faced by these activities; 3) synthesis and analysis, which is looking for the best alternative out of several proposed engine design alternatives and analyze the weaknesses and advantages of each alternative design;
4) evaluation of machine specifications defined and created a model or prototype; 5) presentation, in the form of drafting the outcome document of planning in the form of a complete picture, parts list, material specifications and others to complete the manufacturing process. Here is presented a flow chart will clarify the course of planning activities or the overall planning process [5].

The method of creating unit mold sugar granules comprising some steps: 1) determine the size of the products of sugar granules to be produced; 2) designing and creating molding machine according to the capacity of production; 3) designing the molding unit to meet the size of the expected product shape; 4) test, repair and modification, to obtain a good sugar granules. To create Tumbu sugar granule, hot sugar dough that still mushy inserted into the mold with diameter of 18 millimeters and a height of 16 millimeters. Then it is allowed to stand until cool.

![Diagram of Tumbu sugar granules production machine]

Caption:
1. Frame 19. Nut
2. Shaft 20. Mould support
3. Top cam 21. Ejector support
4. Lower cam 22. Screw 2
5. Coupling 1 23. Tension spring
6. Handle 24. Pressure spring
7. Guide pin 1 25. Spring pin
9. Nut 1 27. Absorber
11. Ejector 1 29. V-belt
12. Mould 30. Pulley
13. Ejector pin 1 31. Drawer
14. Ejector pin 2 32. Screw 3
15. Coupling 2 33. Support
16. Cam support 34. Screw 4
17. Pillow block 35. Cover
18. Screw 1

Figure 2: The design of Tumbu sugar granules production machine

D. The design of vacuum packaging

Basically, all of the sugar is hygroscopic, thus, it is easily suck and release water vapor. Due to the hygroscopic properties Tumbu sugar will melt slowly and become soft, thus, deformation happened. To prevent it, the sugar cane needs to be isolated from the influence of the surrounding air environment by vacuum packaging. In addition, vacuum packaging will also make sugar to be sterile and durable.

III. RESULT AND DISCUSSION

The results are physically obtained from this study include: 1) creating Tumbu sugar granules machine with capacity of 100 grains each press, shown in Figure 2; 2) granulated Tumbu sugar with diameter of 18 millimeters and a height of 16 millimeters in vacuum packs shown in figure 3.
The main parts of the machine consist of a construction device, mold, and the motor. How it works: sugar molds filled with sap that has hardened prepared at the position in the midst of the mold. Suppressor moved up and down through the encouragement cam connected shaft-driven electric motor. Transmission pulley wheel from the electric motor to the cam shaft using the clutch is connected with stirrups pedal. Each set foot on the pedal will press the mold that will generate 100 grainssugar granules. The success rate of moulding up to 90% of the value can be increased by more skilled operator.

A. Functional Testing

Functional testing on the machine is conducted by order of the following steps:

1. Hot Nira that begins to thicken poured, leveled, and compressed using a planner in the mold. Production must be conducted before the sap being cold, hard and frozen. This process should be performed at Tumbu sugar production location. After, a fairly dry and harden, the mold that has been filled can be taken to another location to be issued.

2. Install the mold. Before installation conducted, the mold cleaned from traces of sugar that sticks on it. Once the mold cleaned and leveled the surface, then the mold is mounted on the machine and ready pressed to produce Tumbu sugar granule.

3. Turn on the electric motor that clutch mounted, thus, it can set the time of pressing and when not by pressing the pedal. Once the mold is installed in the right position, the sugar can be generated by pressing the pedal. At the time of the ejector cam rotates pressing the ejector pin pushing out and falling sugar granules enter the sump.

4. Produce is collected and observed further.

5. To examine the functional units of the mold that has been created, an analysis conducted based on the form of the product (figure 2).

B. Vacuum packaging test

The order of the test follows these steps:

1. Tumbu sugar grain mold inserted into a special vacuum bag. There are two types of bags used forms: the regular form and shape up;

2. The bags that have been filled Tumbu sugar mold inserted in the machine to conduct the vacuum process;

3. The test of product durability conducted by observing the deformation of the product based on time. Most sugar product is stored in regular plastic bags without vacuum and partly in vacuum bag. After being left for two months we can see if there is any change on the shape;

C. Analysis on the results of the sugar

The study was conducted by producing the sugar from the same location at different times. After the sugar product issued, then observations is conducted to analyze the shape perfection and compare the amount of product intact and non-intact. The amount of non-intact sugar is less than 10% after the trial. Based on this data, an analysis conducted to identify the causes of non-intact product. The causes can be divided two groups, i.e.: the human factor and appliance factor.
Human factors: the hot sugar dough ready to produce must be poured before it hardens. Skills for someone to pour, hot compress and flatten the dough into each mold hole in the limited time needs some exercises. Tools factor: the non-intact occurs because there are some holes where the surface wall is rough. Therefore, when squeezed out residual of sugar stuck to the walls of the hole. After the pit wall surface smoothed, the percentage of intact product increase. Corrective measure that has to be conducted is smoothing the surface wall of each hole and train skilled personnel of Tumbu sugar producers.

D. Vacuum packaging,

After functional testing and unit mold analysis, further testing of vacuum packaging conducted to recognize any deformation indication of the product as the time change. The results of observations on various deformations of sugar products with different treatment were observed after 60 days can be seen in the following figure.

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<tr>
<th>1</th>
<th>2</th>
<th>3</th>
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<tbody>
<tr>
<td>Deformation</td>
<td>melt</td>
<td>softens</td>
<td>shrinking</td>
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<tr>
<td>Packaging storage</td>
<td>Opening</td>
<td>closed</td>
<td>sealed</td>
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**Figure 5** Sugar shape deformation results after 60 days
Figure 5 shows clearly how the relationship between: hygroscopic nature, a way of packaging, and the deformation as time change. Previously, sugar is left open, the hygroscopic properties of the suck and release water vapor will deformed the sugar to become soft and liquid. Thus, it is evident that the vacuum packaging can prevent the influence of the external environment on deformation process at the same time also increase the durability of the product.

IV. CONCLUSIONS

It can be concluded that it has successfully created or realized: the pressing machine unit to create sugar granule or Tumbu sugar granules cylindrical shape products with diameter 18 millimeters, a height of 16 millimeters. The production capacity of each press totaled 100 grains (1.0 kg). The main mover is an electric motor of 0.5 HP with a working rotation of 100 rpm. Each stamping on the pedal will release 100 grains of sugar granules. The success rate of moulding up to 90% of the value can be increased by more skilled operator. The researches team has been successful for 60 days storing sugar granules in plastic vacuum packaging without any shape change. Therefore, Tumbu sugar granules in vacuum package have potential as an export product. Recomendation, Tumbu sugar with vacuum packaging has longer shelf durability, not easy soft or melts even though it is hygroscopic. The results of this research should be disseminated to the public, thus, the Tumbu sugar micro scale business through Phosphatation methods developed in some areas and absorb labors, and increase revenue.

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