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The Design of a Red Cracker (Kerupuk Merah) Dough Mixing Machine in the Development of the Small Industry in Lima Puluh Kota Regency

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Abstract. *Kerupuk merah* is a type of crackers made of flour, and it is red in color. It is a type of snacks used as complementary foods, and it can add more taste and aesthetic value on the main dish. It is a unique local product. In West Sumatra, a *kerupuk merah* industrial center can be found in Piladang, Akabiluru District, Lima Puluh Kota Regency. The production of this cracker is still performed manually, raising major concerns with production capacity and hygiene. The capacity of *kerupuk merah* production is determined by the dough mixing process (the first process). This process involves the use of a rectangular wooden box and man power from 3 to 4 people for kneading. The production capacity is 500 kg of dough/day or 56–63 kg/hour. The dough mixing process is performed 1–2 times/week. The data above reflect that the production process of *kerupuk merah* is energy- and time-consuming, thereby reducing the quantity and quality of the production. The design of a dough mixing machine is a solution to this problem. The dough mixer drum is designed in length, width, and height of 80 cm, 80 cm, and 60 cm, respectively. The optimum capacity of the dough mixer drum in each mixing process at the speed of 27.2 rpm and mixing rate of 906.34 kg/h is 150–200 kg. The mixing machine designed is food-safe because it is made of stainless steel. This invention may increase the industrial production capacity of *kerupuk merah*, save the kneading time, and improve the hygiene of the production, allowing the business to be developed.

Keywords: Kerupuk merah; hygienic; dough mixer; production capacity

1. Introduction

Kerupuk merah is a type of snacks that is familiar to the public. It is crispy and attractive in color. It is consumed as a food complement to enhance the flavor of or add an aesthetic value to the main dish. For example, it is added to *soto* Padang, fried rice, *pecel*, fried noodle or noodle soup, and *lontong/ketupat sayur*, among other dishes. *Kerupuk merah* is also known as Padang cracker (*kerupuk Padang*) because most Padang cuisines, especially those served with sauce, use it. In addition, it is also named so because its production mostly takes place in West Sumatra.

The industrial center of *kerupuk merah* in West Sumatra is in Jorong Piladang, Akabiluru District, Lima Puluh Kota Regency. It is a common thing that most villagers undertake the manufacture of *kerupuk merah* on the home industry scale as either a primary or a secondary source of income. The number of businesses in the Akabiluru District, especially those engaged in *kerupuk merah* production, continuously increases from year to year. In 2018, an increase of 14.16% from the number of businesses in 2016 was recorded in the district [1]. The increase in the total number of *kerupuk merah* businesses goes in line with the increase of demand for *kerupuk merah*, which comes not only from within West



Sumatra but also from Pekanbaru, Riau Islands, Jambi, Java, and Malaysia. However, the resource limitations in this industry have prevented maximum fulfilment of the whole *kerupuk merah* demand.

The processing of *kerupuk merah* that has been developing in the community and the industry, from upstream to downstream activities, such as raw ingredients mixing, cooking, molding, slicing, and drying all the way until the finished *kerupuk merah* product is produced and ready for packaging, is traditional (manual). The process of making *kerupuk merah* follows these steps: ingredients mixing, dough preparation, molding (cylindrical), steaming, cooling, slicing, drying, and frying [2]. This whole process certainly requires large amounts of man power, time, space, and fund. An absence of any of those requirements may lead to low productivity. In addition, the hygiene and quality of the resulting *kerupuk merah* may also be impacted. Hygiene in particular is highly considered.

Previous studies [3]–[5] reported the capacity of a designed *kerupuk* slicer tool to be 56.4–240 kg/hour, indicating that the problem with the capacity of *kerupuk merah* production must not be resolved in the slicing process, but from the beginning of the whole *kerupuk merah* production process, namely the ingredients mixing. Ingredients mixing is typically done using a can/wooden basin 500 kg in capacity 1–2 times a week, making the production reach only 500 kg/week on average. *Kerupuk merah* dough is kneaded using the power of 3–4 people because the dough is extremely sticky. This of course makes the job of mixing becomes tiring, energy- and time-consuming, and less hygienic. In addition, since it is the first process in the manufacturing of *kerupuk merah*, lengthy implementation of the process of mixing the ingredients will cause delay to the next processes. As a result, the production becomes limited and the consumers' demand cannot be wholly fulfilled. Therefore, it is considered necessary to design a *kerupuk merah* dough mixing machine. Based on the background above, this paper is entitled “The Design of a Red Cracker (Kerupuk Merah) Dough Mixing Machine in the Development of the Small Industry in Lima Puluh Kota Regency”.

The purposes of this research are as follows:

1. to design and to make a *kerupuk merah* dough mixing machine (mixer) and
2. to test the performance of the machine based on the work capacity of the kneader.

2. Methodology

This research was conducted in the workshop of Politeknik Pertanian Negeri Payakumbuh, argon workshop of Lima Puluh Kota Regency, and *kerupuk merah* industrial center in Payakumbuh City for four months. The tools and materials used in this research were as follows: 1 HP electric motor, scale, welding equipment and turning roll, stainless steel plate, stainless steel pipe, stainless steel strip, angle iron, steel strip, gear box, pulley, v-belt, and others. *Kerupuk merah* dough raw ingredients such as flour, water, and salt, among others, were obtained directly from the *kerupuk merah* industrial center.

A. Functional Design of the *Kerupuk Merah* Dough Mixing Machine

The *kerupuk merah* dough mixing machine was designed with the following functions:

- Mixer frame: the locus of the agitator tool
- Mixer drum: the container where a substance/mixture is to be kneaded, there is the agitator gear
- Kneader: kneading machine (mixing the dough until it reaches the desired structure and texture)
- Transmission system (pulley and v-belt): the system that transmits power from the motor to the shaft
- Motor: the source of energy to drive the tool through the transmission system

B. Structural Design of the *Kerupuk Merah* Dough Mixing Machine

- Mixer frame: made of angle iron 120 cm in height and 100 cm in width
- Mixer drum: made of stainless steel plate 2 mm in thickness, 100 cm in height, 80 cm in length, and 60 cm in width
- Kneader: made of stainless steel pipe 0.5 inch in thickness and 27.5 cm in length
- Motor: 1 HP electric motor
- Motor frame: made of angle iron and iron strips 50 cm in height and 30 cm in width

The design of the dough mixing machine can be seen in Figure 1.

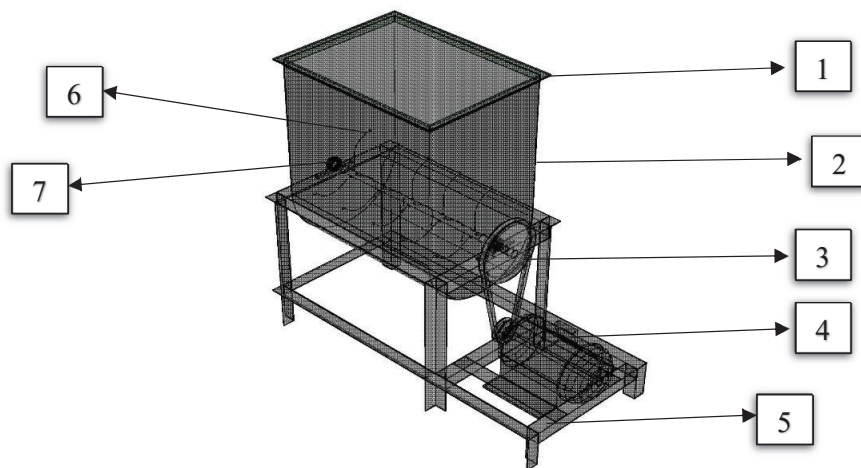


Figure 1. Design of the *kerupuk merah* dough mixing machine

Description:

1. Mixing drum cover
2. Mixing drum
3. Pulley and belt
4. Electric motor
5. Tool frame
6. Kneading gear
7. Axis

C. Performance Analysis

The performance of the *kerupuk merah* dough mixing machine in the form of capacity or mixing rate can be measured using the formula below [6]:

$$\text{Mixing machine capacity} = \frac{\text{Total amount of dough mixed (kg)}}{\text{Mixing time (hour)}}$$

3. Results and Discussion

Dough mixing is the first process in the manufacturing of *kerupuk merah*. Making a *kerupuk merah* dough mixing machine is a solution to the problems that arise from manual kneading. The manual kneading process and the *kerupuk merah* dough mixing machine produced in this study can be seen in Fig. 2 and 3.

The dough mixing machine is a machine which is driven by the mechanical motion of an electric motor. The machine can replace the human hand motion in *kerupuk merah* dough mixing. The advantages of *kerupuk merah* dough mixer are as follows:

- a. Faster kneading process than manual kneading,
- b. Automatic kneading system, thus saving energy,
- c. Better, homogeneous kneading result (softer texture) compared to the result of a manual mixing process, which can also be obtained from a single mixing process, and
- d. Greater hygiene of the result because of the use of food-safe material for the machine.

The use of the machine in the *kerupuk merah* dough mixing process allows for shorter kneading time. Typically, it takes 2.5 to 3 hours to manually knead up to 500 kg of dough, and this amount can be increased if the frequency of kneading is also increased 2–3 times a day. Men who do this labor may experience fatigue in the next mixing process; the first movement can be quick and irregular, but gradually it becomes slower. *Kerupuk merah* dough is made of tapioca flour, hence its stickiness/toughness. A manual kneading process will require hand strength and vigilance because the dough is kneaded when it is hot. Everything required in this manual process makes the mixing of

kerupuk merah dough difficult. Consequently, it is often difficult to hire kneaders, and thus the production capacity becomes impacted negatively.



Fig. 2 Manual kneading



(a)



(b)

Fig. 3 (a) The *kerupuk merah* dough mixing machine, (b) machine-kneading process

The spesification of the *kerupuk merah* dough mixing machine

- Mixer frame: made of angle iron 120 cm in height and 100 cm in width
- Mixer drum: made of stainless steel plate with a thickness of 2 mm
- Drum dimension (cm): 80 x 80 x 60
- Max electric power: 900 W
- Transmission: gear box, pulley, v-belt, 27.2 rpm
- Capacity: 906.34 kg/hour

In the *kerupuk merah* dough mixing machine, mechanical movement is enabled by an electric motor. This machine can work continuously without any fatigue factor. The mixer drum of the *kerupuk merah* dough mixing machine is designed in length, width, and height of 80 cm, 80 cm, and 60 cm, respectively. Although the content capacity of the mixing drum is 500 kg, the maximum capacity of the mixer drum that can be used for each mixing process at a speed of 27.2 rpm is 150–200 kg. This is influenced by the power source used and the length of the kneading gear. To obtain 150 kg of dough, the time required at a mixing rate of 906.34 kg/h is only 9.8–10 minutes. The same thing was also reported in [7], in which a 2-blade *kerupuk merah* dough kneader with a capacity of 75 kg was designed. Additionally, [8] designed a dough kneading device with a cylindrical dough molder, and [9] equipped the device with a conveyor belt to accommodate the cylindrical *kerupuk merah* dough molded.

The utilization of this mixing machine can also save man power, which usually takes the labor of 3 to 4 workers to only that of one operator. This greatly saves on human resources and helps overcome the difficulties of hiring workers for kneading. Moreover, it increases the *kerupuk merah* production capacity, allowing the industry to develop. The equipment or machinery used is not available at random as is desired. Rather, it is one that is able to save resources and improve productivity and it has gone through investigations technically, economically, and socially (e.g., [10], [11]). According to [12], using the *kerupuk merah* dough mixing machine is more economical than using the manual method (Rp42,112/kg vs Rp140,625/kg).

In addition, the *kerupuk merah* industry is continuously expanding its production capacity although there has been no literature regarding the nutritional content of *kerupuk merah*. Given that its main raw ingredient is starch, it is assumed that every 100 grams of *kerupuk merah* contains 362 calories, 0.5 gram of protein, 0.3 gram of fat, 86.9 grams of carbohydrate, 12 grams of water, and 100% edible part

(e.g., [13], [14]). Furthermore, [2] added that cracker crude protein content varies from 0.97 to 11:04 a.m.% wet weight

The *kerupuk merah* dough mixing machine is quite easy to operate. To operate the machine, the ingredients to be kneaded are first inserted into the mixer drum, then the operator should press the on button to turn the machine on and press the off button if the dough is mixed as desired. A completed homogenous mixing process is marked by the absence of loose flour outside or inside the dough as well as by a soft texture of the dough (Fig. 4). The quality of *kerupuk* is influenced by not only the raw and additional ingredients, but also the tools and means of processing used (e.g., [2], [15]). Mixing with the machine does not require any man power to homogenize the dough. It is different from the manual process, which requires a two-stage of kneading to obtain a homogeneous mixing result. Furthermore, this machine is made of a corrosion-resistant material and is not compounded with a solution. Therefore, the hygiene is maintained, and no harm is presented to health. It has also been proven by research results [16] that the *kerupuk merah* in Payakumbuh is safe for consumption because it does not contain the synthetic dye rhodamine B, which is commonly used as textile dye, paint, and paper dye.

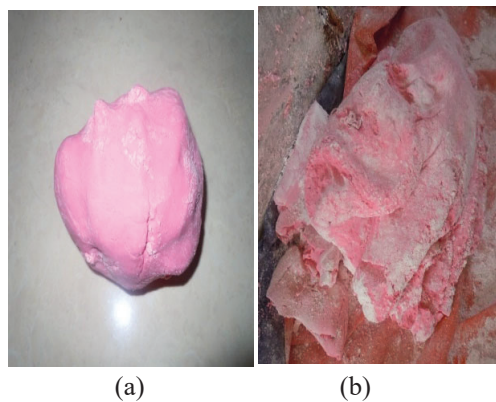


Fig.4. The results of mixing *kerupuk merah* dough with machine (a) and manually (b)

The use of the *kerupuk merah* dough mixing machine can increase the *kerupuk merah* production capacity, resulting in increased revenue that allows the *kerupuk merah* industry to expand. This will help the government realize its plan to develop the *kerupuk merah* industry in Lima Puluh Kota Regency.

4. Conclusions

From the research that has been performed it can be concluded as follows:

- The mixer drum of the *kerupuk merah* dough mixing machine is made in length, width, and height of 80 cm, 80 cm, and 60 cm, respectively, with a maximum capacity of 150 kg for each mixing process.
- The performance of the *kerupuk merah* dough mixing machine is seen from its mixing rate of 906.34 kg/hour, which reflects a greater effectiveness and efficiency than manual kneading.
- The use of this mixing machine can increase the capacity, quality, and hygiene of *kerupuk merah* production.
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