Development of Keropok Keping Drying Machine for Small & Medium Enterprises (SMEs)

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Abstract. Keropok is a traditional cracker product in Southeast Asia. Keropok is made from fish, squid or shrimp mixed with starch or sago flour and eggs. In Malaysia, keropok industry is widely operated at the coastal areas where the fish/seafood supply can be easily accessed. Keropok need to be dried before the packaging process. At the moment, conventional method was used where the keropok is arranged under the sunlight on a board called pemidai. The method is considered less hygienic since it exposed to the dirt and dust and less practical especially during the raining season. This research is focusing on a new automation technique to solve the problems. Rotary drum with internal holder was developed as the drying machine. Keropok keping (types of keropok) was selected to be experimented using the machine with three different rotating speeds. Preliminary experiment result shows that the broken rate of the keropok keping was around 27% of the total weight. The development of new automation system is hoped to improve the small medium enterprises (SMEs) in Malaysia.

1. Introduction

Fish cracker is a traditional product for the countries in Southeast Asia. The cracker is known as kaogrieb in Thailand; krupuk, kerupuk or kroepoek in Indonesia; bánh phồng tôm in Vietnam and keropok in Malaysia [1]. Keropok is usually made from fish, squid or shrimp which mixed with starch or sago flour, and egg. Salt, sugar, garlic and monosodium glutamate (MSG) is added as a flavour ingredient. In Malaysia, the keropok industry is widely operated in the coastal areas of Kelantan, Terengganu, Pahang, Johor and Kedah. This is due to the high fish/seafood supply, high temperature and windy area that contributed to the sustainability of the industry. The demand for this industry is constantly increased. According to [2], one of the keropok entrepreneur in Kedah managed to achieve a production value of RM100,000 per month. Keropok losong and keropok keping is the most popular and highest in demand compared to other types of keropok.

In keropok industry, most of the production process is conducted by semi-automated machine such as mixing and grinding. However, the drying process is still conducted manually. In conventional method, the keropok is arranged and dried on a board called pemidai. As shown in Figure 1, the keropok is placed on the pemidai under the sunlight so that the keropok is exposed to the heat and wind to be dried. At the moment, the method is considered the most convenient and practical. Besides, the operating cost is considered cheap. However, this method is exposed to the low level of hygiene.
and bad weather that can limit the potential of the keropok to be manufactured in high volume and exported to the other countries.

Figure 1. Keropok drying process using pemidai

By using the pemidai, the keropok is contaminated by dust and dirt from air pollution. Besides, the keropok is exposed to the animals and insects such as birds, mice, flies, etc. During the raining season especially at the east coast area in Malaysia, more time is needed to dry the keropok. In order to meet the market demand, new method for the drying process need to be invented. However, in general the research on food drying machine is considered limited.

Dryer is example of technique that widely used to dry the food product. Combined microwave-vacuum-rotary drum dryer for example was used by [3] to dry the chili products. The vacuum drying system was used for sensitive material to avoid damage or decomposed at high temperature. The rotary technique has been adopted for dying the products to eliminate the dead zone effect. Dead zone is a place or time in which there is nothing happen or little activity performed [3]. The accumulated latent heat entrapped in the dead zones can damage the product. Moving tray dryer is another example of technique used to dry the apricot products [4]. Moving tray technique was developed to overcome the poor drying air distribution in the stationary tray system. The drying technique increased the drying rate and produces the uniform quality of products.

Both technique and approach is considered complex in design and expensive. It is not applicable for the small & medium enterprises (SMEs) that require a simple and low price machine. Therefore, in this research new keropok keping drying machine was developed. The objective is to come out with simple and low price machine to improve the hygienic and production rate of the keropok keping. In this paper, the development of the machine and preliminary experiment conducted will be discussed.

2. Method

2.1. Develop the drying machine
The new keropok keping drying machine design is shown in Figure 2. The machine consist of rotary drum, exhaust fan, gear motor, roller chain rubber tires and holder. The drum is made from stainless steel and coloured with black to increase the heat absorption. The drum is 100cm in length and 76 cm in diameter. The exhaust fan is placed at the end of the drum. The fan made from plastic and the air flow generated from the fan is used to dry/heat the keropok keping in the drum. In general concept, drum rotation and fan air flow vaporized the water from the keropok keping. The process is continuously performed until the moisture level in the keropok keping is considered low and suitable for packaging.
The gear motor is used to generate power to rotate the chain. The applied gear motor is a DC, 24V with anti-clockwise rotation. There are four rubber tires used for the machine. The rubber tires are attached at the shaft to hold and maintain the rotation of the drum. Lastly, the drying machine consists of special holder to hold the keropok keping during the rotation process. Besides, the holder avoids the dead zone from occurred within the drum. The holder is made from zinc plate and forming to the desired shape. The fabricated keropok keping machine is shown in Figure 3.

2.2. Conduct the preliminary experiment
The preliminary experiment was conducted to analyse the efficiency of the machine to dry the keropok keping based on different rotation speed. The experiment was conducted in the laboratory (indoor) under undirected sunlight condition. The experiment was conducted to manipulate the condition where drying process cannot be conducted during the raining season. The experiment was conducted for four hours (between 10am to 2pm) and the reading of temperature, humidity and weight of the keropok keping was taken every hours.

The weight of the keropok keping was taken out to measure the moisture content. In total, between 223g to 226g of keropok keping was used for the experiment. Two important outputs were measured.
from the experiment which is the drying rate and broken rate of the keropok keping. The outputs were calculated based on equation (1) and (2) below;

\[
\text{Drying rate} = \frac{\text{initial weight} - \text{final weight}}{\text{time interval}}
\]

\[
\% \text{ of broken} = \frac{\text{weight of broken}}{\text{total weight}} \times 100\%
\]

3. Results and Discussion

The result from the indoor experiment is shown in Table 1 and Figure 4. Three different speeds were used for the experiment namely high (125 rpm), medium (102 rpm) and low (60 rpm).

| Speed       | Time (hour) | Temperature (ºC) | Weather Condition | Humidity (%RH) | Weight (g) |
|-------------|-------------|------------------|-------------------|----------------|------------|
| 125 rpm (High) | 0           | 30.7             | Clear             | 72.4           | 225.6      |
|             | 1           | 31.4             | Clear             | 71.7           | 222.8      |
|             | 2           | 32.1             | Clear             | 71.2           | 219.0      |
|             | 3           | 31.0             | Clear             | 69.4           | 217.3      |
|             | 4           | 30.2             | Clear             | 70.3           | 212.0      |
| 102 rpm (Medium) | 0           | 29.4             | Clear             | 73.8           | 223.4      |
|             | 1           | 30.5             | Clear             | 72.3           | 221.9      |
|             | 2           | 30.8             | Clear             | 71.7           | 221.0      |
|             | 3           | 29.9             | Mostly cloudy     | 74.2           | 220.4      |
|             | 4           | 28.0             | Raining           | 76.9           | 195.7      |
| 60 rpm (Low)   | 0           | 31.0             | Mostly cloudy     | 74.5           | 225.5      |
|             | 1           | 31.7             | Clear             | 71.9           | 213.5      |
|             | 2           | 30.7             | Mostly cloudy     | 74.4           | 194.5      |
|             | 3           | 28.8             | Raining           | 80.0           | 189.9      |
|             | 4           | 27.5             | Raining           | 84.8           | 181.0      |

The result shows that the average temperature for high, medium and low speed was around 31ºC, 30ºC and 30ºC. The temperature in three different days was nearly the same and can be classified as the constant variable. The reading of humidity was taken around the food cell (keropok keping). Humidity is the value of moisture content in the air during the experiment. Based on the result, average humidity for low speed was recorded with the highest reading with 77.1%RH (relative humidity), followed by medium speed (73.2%RH) and high speed (71.0%RH). The humidity of the keropok keping cell surrounding was increased due to the vapour content which needs to be carried out during the process.

Based on the principle of drying, the dry air comes into contact with the keropok keping and absorbs some of the moisture from the food before the air was blown away. Therefore, if the dry air flow was used with a low RH, it slowly become saturated and pick up the water vapour from the keropok keping. However, if the wet air flow was used with a high RH, it quickly becomes saturated and cannot pick up further water vapour from the keropok keping.
The temperature of the air affects the humidity of the air surrounding the keropok keping cell. The ambient temperature plays an important role in helping to speed up the drying process. This is because the higher temperature can reduce the humidity of the air flow and allow the air to carry out more water vapour from the keropok keping. The low speed of rotation recorded the highest reading of humidity for the indoor experiment means the keropok keping cell in static position was supported by smooth evaporation process.

High value of humidity reading means more absorption of water vapour from the keropok keping cell during the process. The process of extracting the moisture from the keropok keping can continue until the keropok keping is dried and suitable for packaging. The weight of keropok keping will decrease due to the loss of water content. However, the drying process for the experiment was only limited to four hours. The result in Figure 4 shows that the weight of keropok keping was reduced significantly using low speed of rotation following with medium and high speed. The weight change using high speed of rotation was considered too small.

Based on equation (1) and (2), the drying rate for each speed per hours and broken rate for each speed in four hours were calculated and shown in Figure 5 and 6. The result in Figure 5 shows that the rate of drying for low speed of rotation was the highest with 11.13g/h, followed by medium (6.93g/h) and high (3.40g/h) speed of rotation. In this experiment, the drying rate was depends on the humidity value. The result in Figure 6 shows that the keropok keping was broke easily in high speed of rotation with 36.84%, followed by the medium (33.49%) and low (27.4%) speed of rotation. The result indicated that the low speed of rotation is more efficient to dry the keropok keping. The keropok keping can be dried faster with less broken rate.

**Figure 4.** The graph of weight versus time for three different speed
4. Conclusions
This paper presents the development of keropok keping drying machine for small & medium enterprises (SMEs). The drying method is based on the rotating drum and air flow from the fan. Special holders were developed for the drum in order to avoid the dead zone effect and hold the keropok keping. Indoor experiment was conducted with three different rotating speeds for four hours respectively. The result showed that low speed of rotation dried the keropok keping faster with lower broken rate compared to the medium and high speed of rotation. However, the 27.4% of the broken rate is still considered as high percentage and improvement need to be performed to support the keropok keping industry.

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