Quality of machine-produced peanut crisps (*rempeyek*)
(Kualiti rempeyek yang dihasilkan menggunakan mesin)

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Keywords: rempeyek, machine, quality, performance

Abstract
A prototype machine for production of peanut crisps (*rempeyek*), a popular traditional snack of Malaysia, has been developed. The function of the machine was to carry out the filling processes of the slurry and peanuts followed by forming and frying of the peanut crisps. The production capacity of the machine and the product quality were evaluated. Results showed that the machine had a production capacity of 640 pieces of peanut crisps per hour. The end product had a round shape with diameter, weight and thickness of 59 mm, 3 g and 2.5 mm respectively. Acceptability of the product was comparable with traditionally prepared *rempeyek* especially in terms of texture, taste, aroma, colour and overall acceptability. The prototype machine can be scaled up to any desired capacity by increasing the number of depositors and moulding plates and enlarging the size of the frying tank.

Introduction
The establishment of the small and medium food industries especially *bumiputera*-owned (native-owned) relies greatly on traditional snacks such as *rempeyek*, *kuih ros*, *kerepek*, *keropok* and many more. These products are produced by an estimated 300 small and medium scale entrepreneurs (SME) throughout the country. They represent about 2.5% of 12,800 SMEs in the manufacturing of food and beverages sector in the country (SME 2006). The market value for snacks and chips in Malaysia in 2008 was recorded at RM599 million and expected to increase gradually at the rate of 4.4% per year (Abu Kasim and Noor Auni 2009). A major portion of the market was contributed by commonly available snacks such as potato crisps and extruded products which were produced by more than 10 big companies and only 20–30% was contributed by traditional snacks produced by the small food industry (Anon. 2003).

The marketing procedure and outlets for traditional snacks including *rempeyek* are similar to the conventional snacks. They are available atpopular outlets such as petrol kiosks, rest and rehabilitation (R&R) areas and grocery shops. The products are also distributed through hyper or supermarkets with the collaboration of the government marketing agency such as the Federal Agriculture and Marketing Authority (FAMA). Furthermore, they are exported especially to Singapore and the Middle East countries after active promotion by government agencies such as the Malaysian Industrial Development Authority (MIDA) and MATRADE and the food exporters.

*Rempeyek* is a nutritive product which contains 17% protein, 34% carbohydrate and a high source of energy (Tee et al. 1997).
It has been identified as one of the food products to be promoted under the one-village-one-product programme. Attempts have been made by various agencies, such as FAMA and the Department of Agriculture of Malaysia (DOA), to introduce rempeyek internationally. However, the inconsistency of product quality and specifications hampered the penetration into the international market. The traditional product, which is labour dependent, has inconsistent production methods which contributed to the low product quality. Rempeyek is an oily product which contains more than 40% fat (Tee et al. 1997). Higher fat content was observed if it was not properly fried and rinsed during processing. The product has a storage life of about 8 weeks in normal packing (PE and PP bags) and becomes rancid after 12 weeks of storage (Rosniyana et al. 2003).

Traditionally, rempeyek is prepared by frying the molded slurry in hot oil for a few minutes using a heated frying pan on a gas stove. Each worker is able to prepare about 100 pieces of rempeyek per hour. In order to facilitate the processing operation and to increase the production capacity, the rempeyek making machine was developed. The machine was designed with the objectives to increase production capacity, improve quality, and reduce dependency on human labour. Testing and evaluation of the machine were conducted to ensure that the machine is able to produce rempeyek with similar physical characteristics as the traditionally prepared product.

Materials and methods

The rempeyek making machine

The rempeyek making machine (Plate 1) has an overall dimension of 1.1 x 0.6 x 1.2 m (L,W,H). The main machine components are the filling hopper for slurry and peanuts, moulding tray for making the peanut crisps and fryer for frying the product. The slurry and peanut filling hopper has a dimension of 30 x 22 x 20 cm (L,W,H) with 12 small holes at the bottom for discharging the raw materials into the moulding tray placed underneath (Figure 1). The moulding tray is a rectangular stainless steel frame with dimensions of 26 x 22 cm (L,W)) and mounted on it are 12 small moulding plates of 5 cm diameter each. The tray is attached to a vertical handle that can be turned by an air piston cylinder. The moulding tray can be moved from the filling section to the frying section with the help of a mounting platform placed on the horizontal guiding shafts and air piston cylinder.

The machine is also equipped with a flat-bottom fryer with dimensions of 80 x 35 x 16 cm (L,W,H) and provided with a 4 kW heating coil to heat the cooking oil to a temperature of about 180 °C which is controlled automatically by the digital type thermostat.

The machine runs automatically when the starter button is switched on. The operating mechanism is represented by the movement of the moulding tray from filling of slurry, followed by filling of peanuts, dipping in hot oil, removing the product from the tray, tilting the tray to remove excess oil and going back to the initial position under the slurry hopper. The operating mechanism takes 70 s to complete
the cycle and the operation will be repeated continuously until the stop button is pushed.

**Raw materials preparation**

Basically two raw materials are required to prepare the peanut crisps, namely the slurry which is prepared from rice flour, coconut milk, anchovies and several types of spices as the product base and the peanuts as a topping to the product (Noor 2005). For evaluation of the machine operation, the slurry was prepared using one kg of rice flour, 400 ml of instant coconut milk, 70 g powdered spices, 60 g ground anchovies, 4 eggs and little bit of salt and calcium carbonate. Water was added at 1.50, 1.75 and 2.0 litres to prepare 2.0–2.5 litres of slurry with a viscosity of 70, 60 and 50 centipoise (cP) respectively.

Peanuts used were washed and re-dried in an oven at a temperature of 70 °C for 2 h so as to reduce the moisture content from 15% to about 7–8%. About one kg peanuts was required to process 3 litres of slurry.

About 15 kg of cooking oil was required to fry rempeyek using two frying tanks. The fryer attached to the machine was filled with 7 kg cooking oil while a second additional fryer was filled with 8 kg cooking oil. Both fryers were heated to a temperature of about 180 °C before the frying process was carried out. The first frying was done in 30 s to form the product before it was transferred to the second fryer to complete the frying process within 3–4 min to produce rempeyek with even brown colour. The two step frying process was able to facilitate the forming and frying processes and prevented mixing of uncooked and cooked products.

**Rempeyek processing**

Manual processing was conducted by filling 6 ml of the slurry into each mouldling plate in a handheld moulding tray using a measuring spoon. This was followed by addition of 4–5 peanuts on each plate. Moulds filled with slurry and peanuts were placed on the surface of the hot oil for 10 s before being dipped in the oil and fried within 2–3 min. Sufficient amount of samples were prepared before the products were cooled in a container layered with paper towels and packed for quality determination.
For mechanical processing of rempeyek, the slurry was filled into the hopper and the machine automatically filled the 12 moulding plates with the slurry and peanuts before being fried in the fryer attached to the machine. Partially cooked rempeyek were collected and transferred to another fryer to fully fry the product. The end products were then cooled in a container layered with paper towels and packed for quality evaluation. The products were labelled and kept in storage containers before evaluation for physical appearance and sensory quality such as weight, thickness, diameter, colour and product acceptability.

**Quality evaluation of rempeyek**

Evaluations were carried out to compare the quality of the product from the machine with the manually prepared product (control). Both production methods were carried out using prepared slurry with a viscosity of 50, 60 and 70 cP and the experiment was repeated three times.

Product appearance for each treatment was evaluated based on 30 pieces of samples (10 pieces per replicate) and another 30 pieces were used for sensory evaluation. The samples were packed in 10 small plastic bags (3 pieces/bag), labelled and kept in airtight containers while waiting for the sensory evaluation to be carried out at the same time.

Sensory evaluation was carried out by presenting the products to 10 experienced panellists who will rate the texture, aroma, taste, colour and overall acceptability using a 9-point hedonic scale where 1 = dislike extremely and 9 = like extremely.

Data collected were subjected to one-way analysis of variance (one-way ANOVA) to determine differences in the product according to the slurry viscosity and sensory attributes. Differences among means were separated using the Duncan Multiple Range Test (DMRT) at $p < 0.05$ level.

**Production capacity and product consistency**

Based on initial processing trial, slurry with 60 cP was the most suitable mixture to be used for verification trials of the machine. For that purpose, four trials using 5.0 litres slurry with 60 cP viscosity were conducted for determination of machine performance. Twelve pieces of semi-cooked product were taken during processing at intervals of 5, 15, 30, 45, 60 and 75 min. They were then fried using another fryer, cooled and packed separately for quality evaluation. The finish product was sorted into three groups, namely, full complete round, more than three quarter round and less than three quarter round. Each portion was weighed separately. Time taken to process 5.0 litres of slurry to finish product was recorded. The weight of the end product was measured prior to packing and storage.

**Results and discussion**

**Filling rate and the shape of end product**

Manual filling of slurry using a spoon (6 ml) at different viscosities resulted in three different weights of slurry in the moulding plate (*Table 1*). As the slurry becomes thinner (50 cP), the quantity of flour particles in the slurry becomes less and the product recovered after frying becomes lighter and can be differentiated significantly when it was compared with the thicker slurry with a viscosity of 60 and 70 cP. The opposite trend was observed when the filling process was carried out using the machine. Each filling hole was discharging slurry at a rate of 6.8 g for thinner slurry which reduced to 5.7 g as the viscosity increased to 70 cP (*Table 1*). This phenomenon is basically due to the viscous slurry which is thick and sticky and resisting the flow of material through holes made in the filling tray (Stanley 1981).

The viscosity and quantity of slurry in the moulding plate determined the weight and size of the end product. Slurry with 70 cP, had a filling rate of 7.35 g, resulting in a heavier and thicker product with an
Table 1. Filling and forming of *rempeyek* using slurry at different viscosities

<table>
<thead>
<tr>
<th>Slurry viscosity (cP)</th>
<th>Filling method</th>
<th>Weight of slurry (g) per plate</th>
<th>Product quality (average for each piece)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Weight (g)</td>
</tr>
<tr>
<td>70</td>
<td>Manual</td>
<td>7.35a</td>
<td>3.38a</td>
</tr>
<tr>
<td></td>
<td>Machine</td>
<td>5.74d</td>
<td>3.17a</td>
</tr>
<tr>
<td>60</td>
<td>Manual</td>
<td>7.12a</td>
<td>3.24a</td>
</tr>
<tr>
<td></td>
<td>Machine</td>
<td>6.50c</td>
<td>2.94b</td>
</tr>
<tr>
<td>50</td>
<td>Manual</td>
<td>6.85b</td>
<td>3.13a</td>
</tr>
<tr>
<td></td>
<td>Machine</td>
<td>6.80b</td>
<td>2.88b</td>
</tr>
</tbody>
</table>

Values with different letters in each column are significantly different (*p* < 0.05) based on DMRT.

Table 2. Sensory scores for manually and mechanically prepared *rempeyek*

<table>
<thead>
<tr>
<th>Slurry viscosity (cP)</th>
<th>Filling method</th>
<th>Hedonic rating test scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Texture</td>
</tr>
<tr>
<td>70</td>
<td>Machine</td>
<td>7.8a</td>
</tr>
<tr>
<td>60</td>
<td>Machine</td>
<td>7.4a</td>
</tr>
<tr>
<td>50</td>
<td>Machine</td>
<td>7.6a</td>
</tr>
<tr>
<td>60</td>
<td>Manual (control)</td>
<td>7.7a</td>
</tr>
</tbody>
</table>

Values with different letters in each column are significantly different (*p* < 0.05) based on DMRT.

average weight and thickness of 3.4 g and 3.13 mm respectively (*Table 1*). Slurry at 50 cP produced a product with less weight and thickness. However, it was not a good end product because the peanut crisps became too light, thin, brittle and were easily broken during handling and packing.

The acceptable mixture for mechanical production of *rempeyek* was using slurry with a viscosity of about 60 cP. The filling rate was about 6 g per moulding plate and the resulting product, each weighing about 3 g, was relatively consistent in diameter and thickness. The product also had a similar shape and size when compared to manually prepare *rempeyek* (*Table 1*). The lowest rating was given to the sample prepared using machine with the slurry mixture at a viscosity of 50 cP. This product obtained a score of 7.6 for texture while the scores for the other categories were all below 7 (like moderately) (*Table 2*). The overall acceptability of this product was found to be significantly lower compared to the other products prepared at higher viscosity. The slurry at 50 cP contained a higher amount of water and thus was less viscous and found to be difficult during forming and frying process, resulting in deformation of products which were not well accepted by panellists.

### Acceptability of *rempeyek*

Product prepared manually obtained the highest score for almost all categories when compared with mechanically produced products. It was an expected result as the prototype machine needs to be improved by proper adjustment of the machine operating system. However, statistical analysis on the texture, taste, aroma and colour indicated they were not significantly different. The

### Machine performance and production capacity

The production capacity of the machine is very much dependent on the time taken for the machine to convert the slurry mixture into moulded product after completion of the first frying process. The operating sequence of the machine started from filling of slurry into the moulding tray followed by topping with peanuts, dipping in hot oil, pushing of floated product, draining of excess oil.
Machine-produced peanut crisps (rempeyek) and back to filling position. The operating process was repeated 66–68 times in 75 min to process 5 liters of slurry (Table 3). A total of 800 pieces of rempeyek were collected at the end of processing with a total weight of about 2.4 kg.

The machine showed relatively constant rate of production capacity. However, the quality of the end product varies depending on processing time. During the depositing process, there was an incident where the discharging of slurry was not complete resulting with end products with deformed shape of less than ¾ round. This was observed at the initial stage of the production process. The amount of deformed products was recorded at 17% at the initial stage and gradually reduced to 3–6% towards the end of the processing stage (Table 3). High percentage of full size products (75% and above) were obtained when the machine was running for 15 minutes and reached the maximum percentage after one hour operation.

### Conclusion

The prototype machine was developed with the intention of improving the traditional practice of producing rempeyek. The production capacity was recorded at 640 pieces per hour, three to four times faster than manual processing. The automatic mechanism of the machine was able to replace human labour and can be continuously operated for a long period of time. The machine was found best suited to process slurry with a viscosity of 60 cP. The end product has a round shape with 59 mm diameter, 2.5 mm thick and about 3 g in weight. The size of the product was significantly changed if more water was added to the slurry and the viscosity reduced to 50 cP. Sensory evaluation indicated that product prepared using slurry at 60 cP has a hedonic rating score of above 7 (like moderately) for colour, aroma, taste, texture, overall acceptability and was not significantly different from manually prepared rempeyek.

### References


<table>
<thead>
<tr>
<th>Processing stage (minutes)</th>
<th>Quality of product (%)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Full size</td>
<td>3/4</td>
<td>&lt;3/4</td>
</tr>
<tr>
<td>5</td>
<td>58.3</td>
<td>25.0</td>
<td>16.7</td>
</tr>
<tr>
<td>15</td>
<td>75.0</td>
<td>16.7</td>
<td>8.3</td>
</tr>
<tr>
<td>30</td>
<td>79.2</td>
<td>15.8</td>
<td>5.0</td>
</tr>
<tr>
<td>45</td>
<td>83.3</td>
<td>12.0</td>
<td>4.7</td>
</tr>
<tr>
<td>60</td>
<td>90.0</td>
<td>6.8</td>
<td>3.2</td>
</tr>
<tr>
<td>75</td>
<td>86.5</td>
<td>7.8</td>
<td>5.7</td>
</tr>
</tbody>
</table>

*5.0 litres slurry; 75 min processing time; 800 pieces of rempeyek produced
Abstrak
Sebuah mesin prototaip menghasilkan rempeyek, snek tradisional yang popular di Malaysia, telah dibina. Mesin ini berfungsi untuk mengisi bancuhan tepung dan kacang tanah diikuti dengan membentuk dan menggoreng rempeyek. Kapasiti pengeluaran mesin dan kualiti produk yang dihasilkan telah dinilai. Keputusan menunjukkan mesin berupaya menghasilkan 640 keping rempeyak sejam. Produk yang dihasilkan berbentuk bulat bergaris pusat 59 mm, berat 3 g dan dan tebal 2.5 mm. Penerimaan produk setanding dengan rempeyek yang dihasilkan secara tradisional terutama dari aspek tekstur, rasa, aroma, warna dan penerimaan keseluruhan. Mesin prototaip ini boleh dipertingkatkan kepada kapasiti yang dikehendaki dengan menambah bilangan lubang pengisian, piring membentuk dan membesarkan saiz takung menggoreng.