

Research Paper

Effect of drying and frying time on textural and sensory characteristics of popped rice

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Abstract

The objective of this study was to investigate the effect of drying time and frying time on the textural and sensory characteristics of popped rice to be used as an ingredient base for snack bars. The broken sticky rice was steam-cooked before drying at 65°C for 2, 3 and 4 hours. The popped rice was then prepared by deep fat frying the dried rice at 210°C for 5, 10 and 15 seconds. The product quality was evaluated for moisture content, water activity, colour, texture and sensory perceptions. It was found that the drying time significantly affected the product colour ($p < 0.05$). However, the effect of frying time on final product quality was not significant at any given drying time ($p > 0.05$). The colour of the fried product obtained from cooked broken sticky rice dried for 2 hours was significantly lighter than that dried for 3 and 4 hours. The hardness of product measured as peak compression force increased with increasing drying time. Sensory evaluation indicated that the product obtained from drying cooked sticky rice for 3 hours, followed by deep fat frying for 10 seconds was the most acceptable.

Keywords: snack food, popped rice, drying, frying, textural characteristics, Thailand

Introduction

Sticky or glutinous rice is produced and widely consumed in Thailand. Its lack of amylase provides good properties for producing various porous textured products, such as popped, fried or baked snacks [1]. Nevertheless, the broken sticky rice has not been fully developed for value added products. Popped rice is one of the most well known puffed snacks in Thailand. It could be also used as an ingredient base for various snack bars, thus considered for this study. The main process of popped rice preparation includes steaming, drying and frying [2]. Initial moisture content of rice before frying is a major factor

influencing final product quality. With lower initial moisture content, the lower oil content is absorbed inside the fried product [3]. Thus, pre-fry drying is a significant process determining the final product quality [4]. Frying time and temperature also influence the product characteristics, especially texture and colour [5, 6, 7]. It has been reported that increasing frying time and temperature causes deep fried rice crackers to become harder [1].

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Materials and Methods

Materials

Broken sticky rice, Palm oil, Sucrose, Salt, Water

Equipment

Thermometer, Deep fat fryer, Tray dryer, Texture analyzer (TA-XT2i, New York, USA), Colour-view Spectrophotometer, Water activity meter (thermoconstanter), hot air oven.

Methods

For each treatment, sticky rice of 200 g was washed and soaked in water for 1 h, then drained before steaming at 100°C for 30 min. The steamed rice was dried in a tray dryer at 65°C followed by frying at 210°C. Two variables, drying time and frying time, were included in this study. Drying time was varied at 2, 3, and 4 h. Frying time was varied at 5, 10 and 15 s, respectively using 3² factorial design. Two replications were performed for each experiment. The fried popped rice was evaluated for moisture content, water activity, colour, texture (probe p/100, compression plate, loading speed of 1.5 mm/s, with a 25 kg load cell) and sensory perceptions. For sensory evaluation, popped rice bar was prepared using binding syrup comprising 2 g of salt, 175 g of sucrose and 175 g of glucose syrup with 650 g of popped rice. Out of six treatments, the top three samples were selected using a ranking test with 40 untrained panelists as tasters. Hedonic scale (from 1-extremely dislike to 9-extremely like) was also applied with 40 untrained panelists as tasters for product acceptance evaluation. The product colour, biting hardness, crispiness and overall liking were evaluated.

Results and Discussion

Rice Steaming and Drying Preparation

Steamed rice was prepared and dried before frying to obtain popped rice. During drying, samples were collected at 2, 3 and 4 hours for moisture content determination. The results are presented in Table 1. Rice moisture content decreased with increased drying time. The samples with varied levels of moisture content were then used for frying experiments.

Table 1. Moisture content of dried rice.

Drying time at 65°C (h)	Moisture content (% dry basis) (mean±s.d.)
2	9.85±0.02
3	5.45±0.01
4	3.47±0.01

Rice Frying

Rice frying experiments were conducted to examine the effect of initial moisture content of rice before frying and frying time on popped-rice characteristics. After frying, the product's water activity varied between 0.3-0.4. It was found that the colour of popped-rice as indicated by L*, a*, and b* (Table 2) became a darker yellow when initial moisture content of rice was lower (longer drying time). However, only popped rice dried for 2 hours with the highest initial moisture content gave significantly different colour from that of rice dried for 3 and 4 hours ($p < 0.05$).

Table 2. Effect of drying and frying time on popped rice colour.

Drying time (h)	Frying time (S)	Colour ¹ (mean±s.d.)		
		L*	a*	b*
2	5	74.12 ± 4.21 ^a	2.49 ± 1.61 ^b	20.33 ± 2.10 ^c
	10	72.96 ± 2.00 ^a	2.96 ± 1.63 ^b	22.86 ± 2.58 ^c
	15	72.73 ± 3.52 ^a	3.94 ± 1.84 ^b	22.57 ± 2.02 ^{bc}
3	5	65.16 ± 0.26 ^b	8.51 ± 0.91 ^a	26.97 ± 0.22 ^a
	10	64.94 ± 1.59 ^b	7.29 ± 0.58 ^a	24.57 ± 0.61 ^{ab}
	15	64.44 ± 0.45 ^b	8.05 ± 0.87 ^a	26.79 ± 1.01 ^a
4	5	62.69 ± 0.56 ^b	8.47 ± 0.85 ^a	26.92 ± 0.98 ^a
	10	62.38 ± 0.04 ^b	7.96 ± 0.44 ^a	27.33 ± 0.69 ^a
	15	61.234 ± 0.58 ^b	8.04 ± 0.68 ^a	27.025 ± 1.02 ^a

Note: ¹Letters a, b, and c indicate significantly different mean values in the same column.

Texture of popped rice was measured as peak compression force as shown in Figure 1. The results indicated that at a given drying time, the peak compression force of fried product tended reach the maximum at 10 minutes of frying. However, the peak compression force increased with increasing drying time or when the initial rice moisture content was lower. This was in agreement with the results reported by Sukumar *et al* [8], that the hardness of fried chickpea flour-based snack increased at the lower moisture content of the pre-fried product.

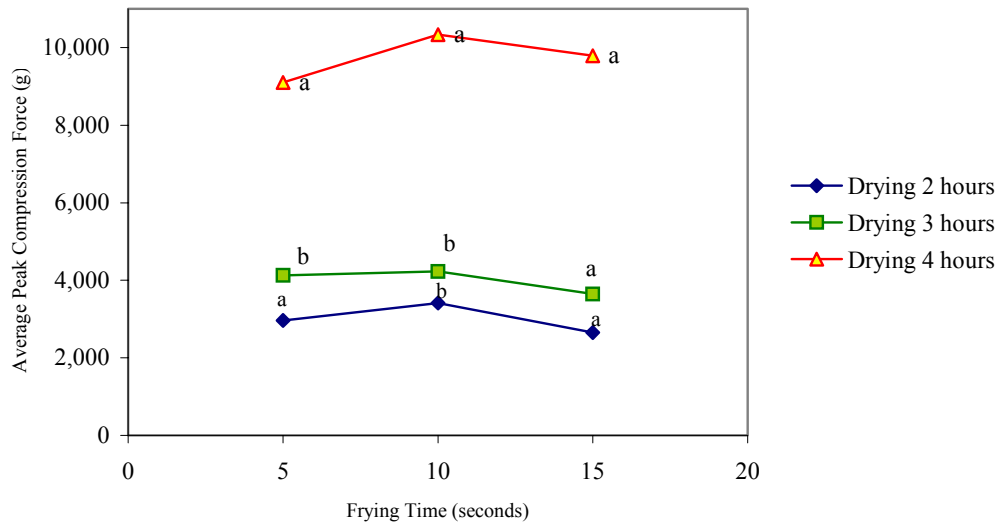


Figure 1. Effect of rice drying and frying time on popped rice hardness.

Note: Letters a and b indicate significant difference in mean values of the same line.

Three product treatments including drying 2 hours, frying 10 seconds, drying 2 hours, frying 15 seconds and drying 3 hours, frying 10 seconds were chosen by ranking preference test. To evaluate the consumer’s preference of the popped rice, plain rice snack bar was prepared. Hedonic score was employed.

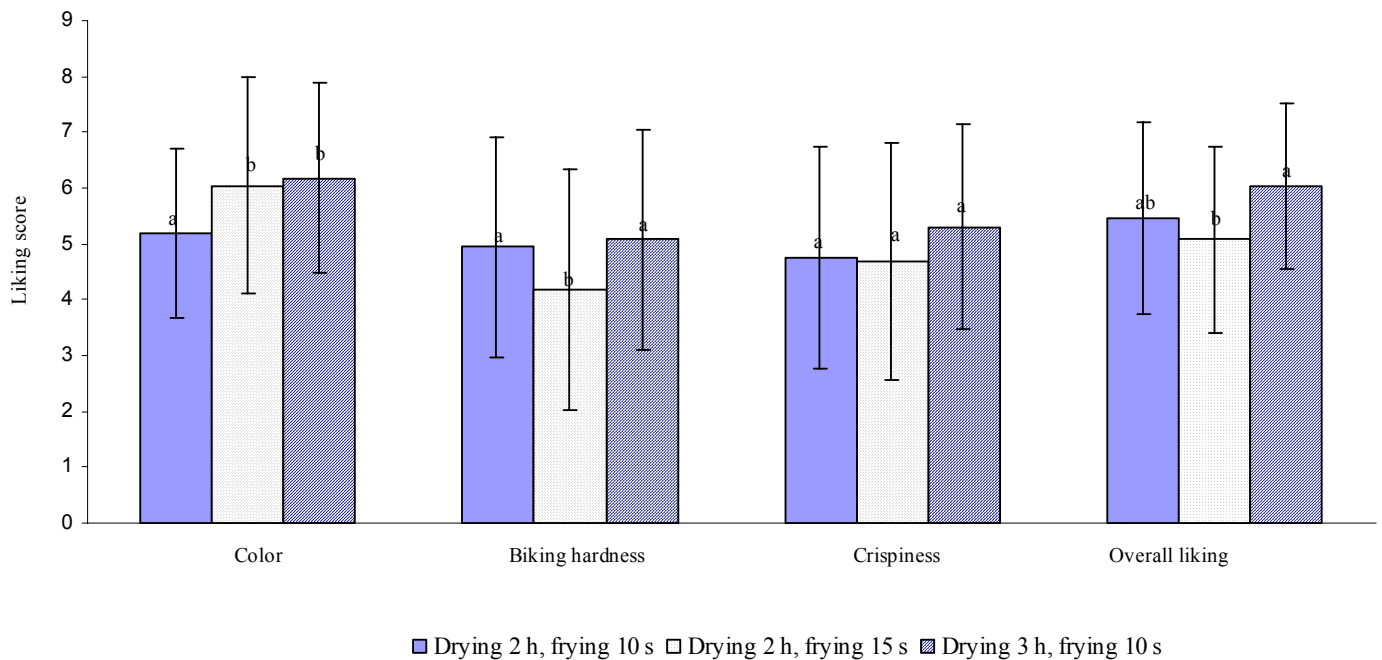


Figure 3. Preference score of popped rice snack bar.

The results shown in Figure 2 indicate that the product prepared from 3 hours of drying, followed by 10 seconds of frying, received the highest overall liking score ($p < 0.05$). It was noticed that the most acceptable product also provided the highest colour and texture liking scores. Nevertheless, the crispiness liking scores of all samples were not significantly different ($p > 0.05$).

Conclusions

The experimental results showed that popped rice characteristics were associated with the initial moisture content prior to frying and frying time. According to this study, drying cooked rice for 3 hours (moisture content of about 3.47% d.b.) followed by 10 seconds of deep-fat frying was the best condition for popped rice preparation.

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