KKU ENGINEERING JOURNAL 2016;43(S3):459-461 Research Article

KKU Engineering Journal

https://www.tci-thaijo.org/index.php/kkuenj/index

Effect of drying methods on property of Thai rice cracker

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Received April 2016
Accepted June 2016

Abstract

Fried glutinous rice cracker is a popular snack for local Thais. One of the production steps usually requires drying. Method of drying is an important process affecting products, shelf life and quality. In this research study, quality of rice cracker obtained from various drying methods (direct solar radiation, solar dome, and hot air drying oven) was investigated and compared. Properties of the rice cracker being analyzed were shrinkage ratio, expansion ratio, color, hardness and crispness. The rice cracker samples were in rectangular slap. Experimental results showed that the final moisture content of the rice cracker was in the range of about 8-10% wet basis. Direct solar drying gave minimum shrinkage ratio of 1.34 and maximum expansion ratio of 4.99. The color of dried rice cracker was given as L^* a^* b^* color space. The highest hardness of the rice cracker (2,200 g) can be reached by hot air drying, and the best crispness (18,000 g.s) was obtained by direct solar drying.

Keywords: Dehydration, Food processing, Food quality, Snack

1. Introduction

Fried glutinous rice cracker or "Khaotan" is a traditional snack of local Thai communities. Khaotan is popular in north of Thailand. From food preservation in small groups of housewives, khao tan is now an economically important product with export to the World. It helps generate significant extra income to local people. There are many shapes of rice cracker such as round, oval, rectangular or irregular shaped. In the production of rice cracker, drying is an essential step to preserve the rice cracker and prevent fungal spoilage. Subsequent step is frying. Fried rice cracker had moisture content about 8-10 % dry basis [1-2]. Drying process can be challenging due mainly to uncertainty and fluctuation in final moisture content of product, which in turns, depending on method of drying. Normally, drying by direct solar radiation is adopted to reduce moisture content of the steamed rice before frying. The energy is provided for free but the method has limitation regarding weather conditions. It can take long period of up to 2-3 days and risk contamination from insects, dust and others foreign materials that may damage the product [3-5]. Indirect solar drying using greenhouse dome dryer or drying with hot air from burning of fuel gas can offer alternative solution. However, these drying techniques can result in varying quality and property of the rice cracker.
Hence, in this work, we aimed to study property of dried rice cracker for each drying method and compare between them.

2. Materials and methods

2.1 Rice crack samples

The glutinous rice was obtained locally. Before experimentation, it was soaked in water overnight, after which it was washed and steamed. Then the cooked rice may be mixed with other ingredients, such as fruit syrup. The rice was then molded into shape with volume of about 12 cm^3. The moisture content was about 60-70 % dry basis.

2.2 Drying methods

Three methods of drying were used for removing moisture of the rice cracker. The configuration of the three dryers is shown in Figures 1, 2 and 3. For solar drying, it was operated between 9.00 am. – 17.00 pm. A hot air drying oven is a square room. It was operated at temperature of about 40-45^{o}C. Air distribution throughout the room was about 3-3.5 m^3/s. Hot air entered at the bottom of the room. Moist air exited at the top of the drying room. Moisture content was analyzed using a Mettler Toledo model MJ33. The final moisture content of rice cracker was about 8-10 % dry basis before storage. Temperature, humidity and intensity of solar irradiation were also monitored.

2.3 Property analysis

The following physical properties were considered; shrinkage ratio, expansion ratio, color, hardness and crispness. Shrinkage and expansion ratios were calculated from change in volume [6]. Color analysis was based on CIE system; lightness (L^*), redness (a^*) and yellowness (b^*). It was determined using Hunter Lab Color Flex [7]. Hardness and crispness were based on texture analysis using TAXT Plus. Three point bend, pre-test, test and post-test speeds of

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doi: 10.14456/kkuenj.2016.155

1, 2 and 10 mm/s, distance of 10 mm and trigger force of 5g were used.

Figure 1 Direct solar drying on a tray

Figure 2 Indirect solar drying with greenhouse dome

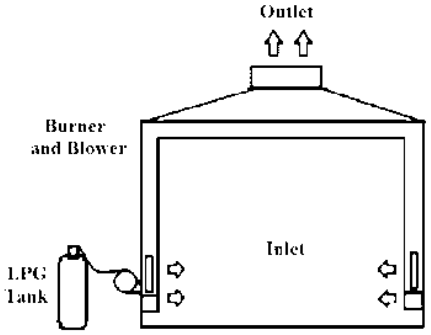

Figure 3 Hot air drying in an oven with LPG combustion

3. Results and discussion

For direct solar drying in ambient air, experiments on clear days showed average temperature and humidity of outdoor ambience at 41.5°C and 45% RH. Average solar power was 756 W/m^2 with maximum of 1,100 W/m^2. Drying time was 8 h or about one day of work. Final moisture content was about 8-9% dry basis. For indirect solar drying with greenhouse dome dryer, average temperature, air ventilation and dome solar power were found to be about 45-50°C, 1.0 m^3/s and 560 W/m^2, respectively. Average drying time was 13 h or about one and a half day of work. For hot air drying in the LPG fired oven, temperature was set at 40-45°C with air circulation of about 3-3.5 m^3/s. Average drying time was about 12 h, or about one night of work.

After frying of the dried rice crackers, their shrinkage and expansion ratios, color, hardness and crispness were analyzed and shown in Tables 1, 2 and 3, respectively. Physical appearance of the products after drying and frying was shown in Figures 4 and 5.

From the experimental results, it was clear that minimum drying time was obtained from direct solar drying (about 8 h). Maximum and minimum shrinkage of dried rice crackers were 35% from hot air drying oven and 26% from direct solar drying. Maximum expansion after frying was 400% from direct solar drying. Shrinkage of dried rice crackers and expansion after flying were found to depend on temperature and time in drying process. Dried rice crackers from direct solar drying was lighter, lower redness and yellowness than those obtained from other methods. Change in product colors was also dependent on drying time and temperature. Color of the fried rice cracker did not change significantly. For dried rice crackers, maximum hardness and crispness were 4,676.87 ± 582.43 g of force from hot air drying oven and 14,193 ± 1,180.32 g.s from direct solar drying. For solar dome dryer, hardness and crispness were quite low due to long drying time where evaporation of water occurred slowly and regularly. For fried crackers, maximum hardness and crispness were obtained from hot air drying oven and direct solar heating dryer, respectively.

Table 1 Shrinkage after drying and expansion after frying process

Drying methods	Shrinkage ratio	Percent shrinkage	S.D.	Expansion ratio	Percent expansion	S.D.
Direct solar drying	1.34	25.61	±0.91	4.99	399.85	±6.00
Solar dome dryer	1.41	28.95	±1.10	4.71	371.58	±4.27
Hot air drying oven	1.54	34.93	±0.50	4.68	368.37	±2.34

Direct solar drying Solar dome dryer Hot air drying oven

Figure 4 Color of rice crackers after drying

Table 2 Color of rice crackers

Rice cracker after drying process	Color			Rice cracker after frying process	Color		
	*L**	*a**	*b**		*L**	*a**	*b**
Direct solar drying	60.35	0.95	17.22	Direct solar drying	69.41	9.315	29.73
S.D. ±	0.220	0.064	0.330	S.D. ±	0.350	0.420	0.250
Solar dome dryer	62.39	3.74	22.45	Solar dome dryer	68.62	10.79	30.41
S.D. ±	0.610	0.098	0.200	S.D. ±	1.330	1.170	1.730
Hot air drying oven	58.91	5.95	22.35	Hot air drying oven	66.92	10.2	29.96
S.D. ±	0.310	0.077	0.130	S.D. ±	0.007	0.410	0.470

Direct solar drying Solar dome dryer Hot air drying oven

Figure 5 Color of rice crackers after frying

Table 3 Hardness and crispness of rice crackers

Rice cracker after drying process	Hardness (g)	Crispness (g.s)	Rice cracker after frying process	Hardness (g)	Crispness (g.s)
Direct solar drying	4,105.06	14,193.87	Direct solar drying	1,883.42	17,976.87
S.D. ±	517.32	1,180.32	S.D. ±	591.65	1,747.83
Solar dome dryer	2,840.39	10,787.31	Solar dome dryer	1,275.85	13,481.66
S.D. ±	423.32	958.56	S.D. ±	23.89	1,471.17
Hot air drying oven	4,676.87	13,780.66	Hot air drying oven	2,188.67	10,223.54
S.D. ±	582.43	1,125.43	S.D. ±	306.65	1,081.48

4. Conclusions

In this work, properties of rice crackers obtained from different drying methods (direct solar radiation, solar dome, and hot air drying oven) was analyzed and compared. It was shown that the highest quality of physical property of rice crackers may be obtained using direct solar drying. However, alternative dryers can be useful. Nonetheless, works on investigation of drying characteristics and quality of rice crackers should be carried out further in the future.

5. Acknowledgements

This work was supported by the National Research Council of Thailand, Uttaradit Rajabhat University and Chiang Mai University.

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