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EFFECT OF MOISTURE CONTENT AND MICROWAVE POWER ON PUFFED YIELD AND EXPANSION VOLUME OF MALAYSIAN PADDY VARIETY MR297

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ABSTRACT

Puffed rice, is a popular ready-to-eat product especially in South-East Asia. In this study, an attempt is made to examine the effectiveness of puffing the Malaysia paddy variety MR297 using domestic microwave oven. The experiment was carried out based on two parameters, which are three levels of microwave power (600, 700 and 800 Watt) and three levels of moisture content (11, 14 and 17 % w.b.). The best condition for puffing the paddy was determined based on the puffed yield and expansion volume. The results show that adequate moisture content is required to generate sufficient internal pressure for puffing. The puffed yield and expansion volume were higher with an increase in microwave power. The best conditions to obtain highest puffing yield with the expansion volume of 2.22 mL/g were found to be at a moisture content of 14% w.b. with the microwave power level of 800 Watt. Further studies need to be carried out in order to improve the performance of microwave puffing process for Malaysia paddy variety MR297.

Key words: Paddy, puffing, microwave, puffed rice, MR297

INTRODUCTION

United Nations predicts that food demand must be increased by 70% to feed the projected world population by 2050. Therefore, if one can utilize food produced effectively; it would help in world food security. Paddy, also called as rice paddy is the whole rice grain covered by the hull and bran (Sivasankar, 2002). Rice paddy is a staple food for more than half of the world's population (Kamaraddi & Prakash, 2015). In 2016, the world production of rice paddy was about 741 million tonnes and China was the major rice paddy producer followed by India. In Malaysia, the paddy production in 2016 was about 2.25 million tonnes; which increased by 22% compared to 2015 (FAOSTAT, 2018). Rice paddy is commonly consumed as a dietary staple. However, it also can be developed as a value added food in the form of various products such as snacks, ready-to-eat breakfast cereal and infant food (Maisont & Narkrugsa, 2010).

Puffing is one of the potential methods that have been implemented in food industry for product development. High puffed yield and greater expansion are two major criteria for deciding the effectiveness of puffing (Bhatt & Joshi, 2014; Chanlat & Songsermpong, 2013; Joshi *et al*., 2014). However, there are several factors affecting the performance of puffing such as the variety of the grain, the physical characteristics, moisture content, the amylose content and also the puffing techniques (Mishra *et al*., 2014; Song *et al*., 2015; Wongsa *et al*., 2016).

Conventionally, puffed rice is produced by exposing the rice paddy to high temperature heat treatment, high strength extrusion and deep-frying (Devi & Das, 2017). Roasting has the risk of burning and producing defects, while frying in hot oil can cause over heating or charring because it depends on the skills of the operator. The alternative of puffing method is gun puffing. However, the

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construction of the pressure vessel and its operations is costly (Mishra, 2014; Nath *et al*., 2007).

Over the recent years, puffing in microwave oven has been reported and commercialized as it offers efficient and faster heating in reaching the puffing conditions (Das *et al*., 2015; Maisont, 2010; Swarnakar *et al*., 2014). Microwaves generate heat, exciting the molecules by alternating electromagnetic field resulting in rapid heating, which is known as volumetric heating from within the sample (Orsat *et al*., 2017). This rapid heating contributes to the minimization of temperature difference between the surface and interior of paddy grains. Microwave puffing has a lot of benefits over conventional processes such as quick start-up time, space saving, selective heating, and no need for pressure vessel and personal skills (Maisont, 2010).

The objectives of this study were to investigate the effects of moisture content and microwave power on the puffing performance of the Malaysia paddy variety MR297 in microwave oven and to determine the best conditions for puffing based on the puffed yield and expansion volume.

MATERIALS AND METHODS

Sample preparation

The paddy variety MR297 was procured from the paddy grower at Sungai Petani, Kedah, Malaysia. This sample paddy was cleaned removing the dirt and others particles before storage in aerated plastic bags. The initial moisture content of paddy was determined using standard procedure (AOAC, 2000). The paddy weighed 20 g and soaked in proper amount of distilled water for 24 hours to achieve the desired moisture content of 11, 14, and 17% wet basis (w.b.).

Puffing method

A standard domestic microwave oven of 20L volume (Samsung, model ME711K, China) at microwave frequency of 2450 MHz was used in this study. A total of 20 g paddy was put into a paper bag, then placed in the middle of the microwave oven with different microwave power levels which was 600, 700 and 800 Watt for 60 s, respectively. After the heating period was over, the oven was kept open for 2 min to cool down the chamber, then the whole sample was taken out from the paper bag.

Puffing performance evaluation

The yield of puffed paddy was calculated using the following equation (1) as determined by Kapoor (2013):

$$Puffed\ Yield\ (\%) = \frac{w_p}{w_p + w_{up}} \times 100\% \qquad (1)$$

Where,
w_p = weight of puffed paddy (g)
w_{up} = weight of un-puffed paddy (g)

The volume of puffed paddy was determined using volume displacement method as described by Segnini *et al*. (2004). Expansion volume was calculated using equation (2):

$$Expansion\ Volume\ \left(\frac{mL}{g}\right) = \frac{v_p}{w_s} \qquad (2)$$

Where,
v_p = volume of puffed paddy (mL)
w_s = weight of paddy sample (g)

Statistical analysis

All experiments were conducted in three replicates and the respective means were analyzed using analysis of variance (ANOVA). Duncan's multiple range was used to identify a difference between means at 95% significant level.

RESULTS AND DISCUSSION

Puffed yield

The initial moisture content of the paddy variety MR-297 was found to be 11% (w.b.). Puffed yield shows the puffing ability of the paddy under different processing conditions. In this study, the percentage of puffed yield varied from 2.15% to 23.33% at different moisture contents and microwave power level as shown in Figure 1. It is apparent from this figure that paddy rice puffed at moisture content of 14% (w.b.) had the greatest puffed yield compared to 11% and 17% (w.b.). This result indicates the requirement of moisture conditioning of the raw paddy sample in order to gelationise the starch. On the other hand, paddy sample at moisture content of 17% (w.b.) gave the lowest total puffed yield (w.b.). This may have been due to the higher moisture in the grains loosening the interlocking in the husk which resulted in insufficient internal pressure being maintained to cause puffing (Murugesan & Bhattacharya, 1991). It also can be seen that the puffed yield increased as the microwave power level increased for all moisture contents. The effects of microwave power level on the puffing performance of 14% (w.b.) moisture content on total puffed yield is shown

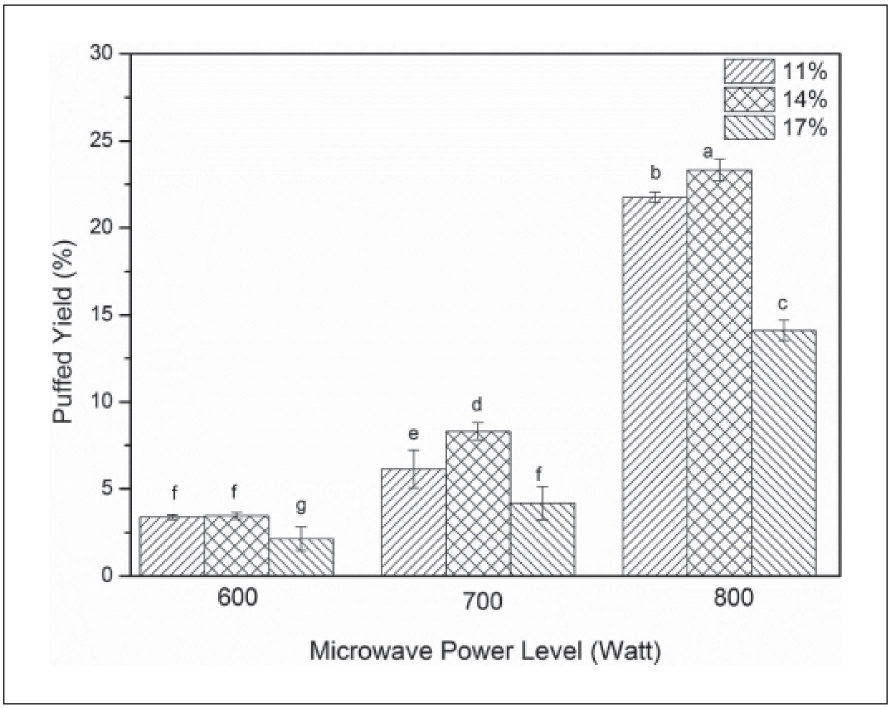

Fig. 1. Puffed yield at different moisture content and microwave power level. (Values with the same letter are not significantly different)

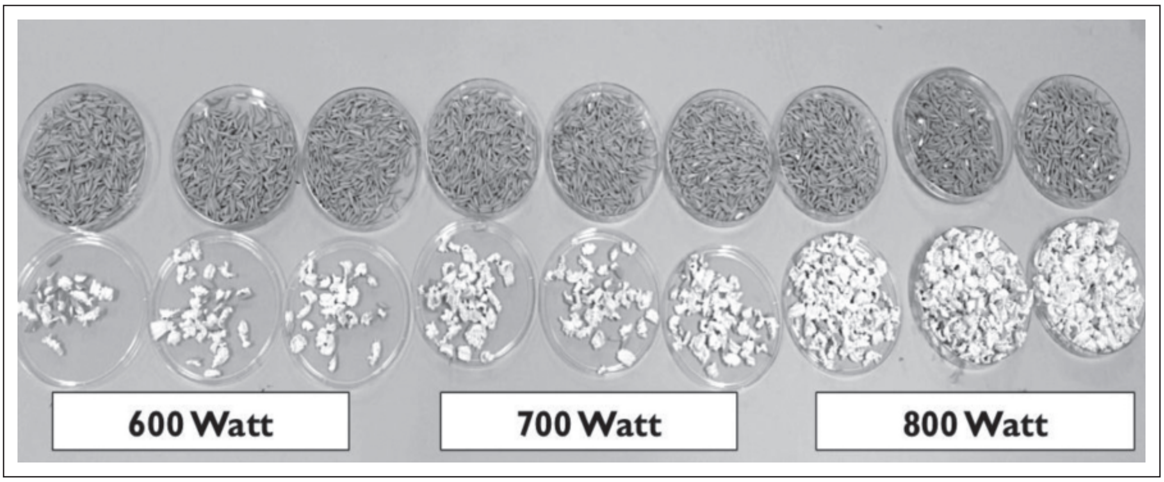

Fig. 2. Puffed paddy of 14% (w.b.) moisture content at the difference microwave power level.

in Figure 2. This finding suggests that further investigation is needed to achieve maximum rate of puffing. Maison & Narkrugsa (2010) reported that paddy rice samples soaked in the salt solution results in higher puffed yields than samples soaked in water. The presence of salt will cause a change in the dielectric properties of the material and thus facilitated the absorption of the microwave energy and converted it to heat faster than water. Previous work done by Singh & Singh (1999) shows that coating applied over the grain kernels can also enhanced the puffing performance.

Expansion volume

A puffing process involves the expansion of a gas within a product either to create an internal structure or to expand the existing structure (Payne *et al.*, 1989). Figure 3 represents the expansion volume of puffed paddy at different moisture content and microwave power level. The results show that the expansion volume of puffed paddy varied from 0.12 mL/g to 2.22 mL/g. The increase of expansion volume was quite apparent with the increase in microwave power level. The highest expansion volume was observed at moisture content

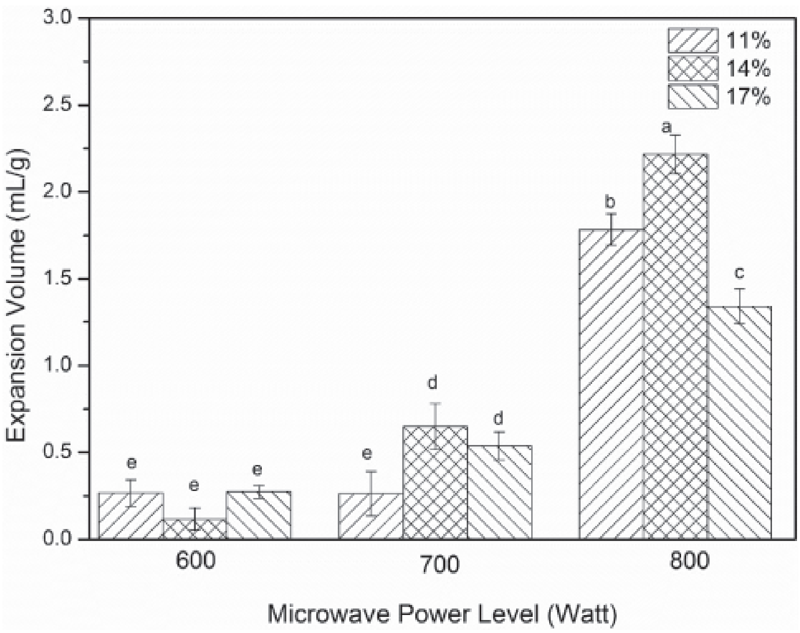

Fig. 3. Expansion volume at different moisture content and microwave power level.
(Values with the same letter are not significantly different).

of 14% (w.b.) with microwave power level of 800 Watt. No significant change in volume expansion was observed with different moisture content of the paddy puffed at power level of 600 Watt. Maisont & Narkrugsa (2010) also reported that puffing at 800 Watt produced higher expansion volume when compared to 600 Watt and 700 Watt.

CONCLUSIONS

Promotion of value-added products from paddy can help to increase our local producer's profitability, which in turn would attract the young generation to get more involved in this sector. Therefore, in this study an attempt was made for puffing the Malaysia paddy variety MR297 using domestic microwave oven. The moisture content and microwave power had high significant effects on puffed yield and expansion volume. The highest puffed yield and expansion volume obtained in this study was 23% and 2.22 mL/g, respectively. Taken together, this results suggest that further study needs to be conducted to improve the performance of micro-wave puffing of Malaysia paddy variety MR297.

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