Effects of Chemical Composite, Puffing Temperature and Intermediate Moisture Content on Physical Properties of Potato and Apple Slices

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Abstract. Puffing technique is the process that can improve texture and volumetric of crisp fruit and vegetable. However, the effect of chemical composite in foods on puffing characteristics is still lack of study. Therefore, potato and apple slices were comparative study on their physical properties. Potato and apple were sliced into 2.5 mm thickness and 2.5 cm in diameter. Potato slices were treated by hot water for 2 min while apple slices were not treatment. After that, they were dried in 3 steps. First step, they were dried by hot air at temperature of 90^{o}C until their moisture content reached to 30, 40, and 50 % dry basis. Then they were puffed by hot air at temperature of 130, 150, and 170^{o}C for 2 min. Finally, they were dried again by hot air at temperature of 90^{o}C until their final moisture content reached to 4% dry basis. The experimental results showed that chemical composite of food affected on physical properties of puffed product. Puffed potato had higher volume ratio than those puffed apple because potato slices contains starch. The higher starch content provided more hard texture of potato than those apples. Puffing temperature and moisture content strongly affected on the color, volume ratio, and textural properties of puffed potato slices. In addition, the high drying rate of puffed product observed at high puffing temperature and higher moisture content.

Keywords: puffing; chemical composite; texture; volume ratio; drying rate.

1. Introduction

A conventional drying method, hot air drying, is the simple method which produces the low crispness fruit chips. Moreover, this method is used a low temperature and longer drying time which provide the high shrinkage and hardness dried product. The high temperature and short drying time, puffing technique, is an alternative method for producing healthy crispy snack and can be improve the quality of product [1]. The puffing technique was applied successfully in various fruits and vegetables such as banana, potato, apple, carrot and elephant yam [2-4]. A high temperature is applied for accelerating the moisture content inside the food sample and suddenly evaporated in very short time [5, 6] This phenomenon leads to a rapid evaporation from inside the material to drying medium. As a result, the food structure was rapidly expanded, then porous structure was created therefore its texture become more crispness and low hard texture [7]. However, different crop variety showed different physical properties and chemical composites which significantly affect the puffed product quality. Tabtiang et al. [8] studied the effects of banana varieties on the quality of puffed banana. The results showed that the varieties of banana significantly affected on the product quality. The puffed Homtong-banana gave a lower hardness puffed banana than those from Namwa-banana, but poor in its colour quality.
Therefore, the objective of this work was to study the effects of puffing temperature and intermediate moisture content on the drying kinetic and qualities of puffed potato and apple slices. The product quality was evaluated in terms of colour, volume ratio and texture properties. In addition, the drying characteristics is also determined.

2. Materials and methods

2.1 Raw materials

The raw materials for this experiment are potatoes and apples which were purchased from a local supermarket. They were washed and sliced to 2.5 mm thickness with 25 mm diameter. Potato slices were blanched by hot water at 95 ^{o}C for 2 min while apple slices were not treated. Moisture content of initial and dried samples was followed from the AOAC method (1995).

2.2 Puffing process

The puffing process consists of three drying steps. The first step, the sample slices were dried at a temperature of 90 ^{o}C, air velocity of 3 m/s and 80% recycled air until the moisture content reached to 30, 40 and 50 %d.b. Then, the sample slices were puffed at a temperature of 130, 150 and 170 ^{o}C for 2 min The last step, those samples were dried again at 90 ^{o}C to the final moisture content 4 % d.b.

2.3 Colour measurement

The colour of twenty puffed potato and apple slices were measured by a spectrophotometer (model ColorFlex, HunterLab Reston, VA, USA) with a D65 illuminate and observer angle of 10°. The colour of puffed samples were expressed in terms of L (lightness/darkness), a (redness/greenness) and b (yellowness/blueness).

2.4 Volume ratio measurement

The volumes of both initial and puffed sample were determined by a solid replacement method by using glass breads [4]. The volume ratio of puffed product was described by Tabtiang et al. (2012).

2.5 Texture measurement

The texture of puffed sample was evaluated by texture analyzer (TA-XT2i, Stable Micro Systems Texture, UK). The sample texture was evaluated in terms of hardness.

2.6 Statistical analysis

The data from an evaluation of puffed product quality were analysed by the Analysis of Variance by using SPSS software (Version 17). Differences mean values were established using Tukey's Multi Range Tests at a confidence level of 95% ($p<0.05$).

3. Results and discussion

3.1 Colour

Figure 1 shows the colour of puffed potato and apple slices under different experimental conditions. It can be seen that the puffing temperature significantly affected colors of puffed samples. The color change (ΔE) of both puffed products increase with increasing in the puffing temperature. This is because the high puffing temperature accelerated a non-enzymatic browning reaction [3, 10]. In addition, all cases of puffed potato slices gave more color change than that apple slices. However, the potato had lower amount of monosaccharide than apple slices as showed in Table 1. It may be because of enzymatic browning reaction in potato which more reactive faster than apple slices.

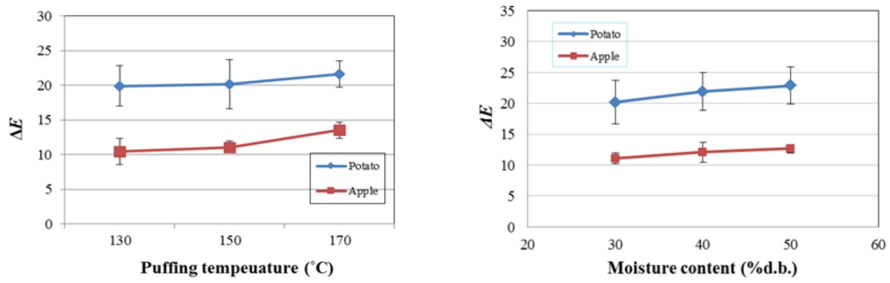
3.2 Volume ratio

Figure 2 shows the effects of puffing temperature and intermediate moisture content on volume ratio of puffed potato and apple slices. It was found that the puffing temperature and moisture content significantly affected on the volume ratio of puffed potato slices. An increasing in puffing temperature and moisture content resulted in increasing volume ratio of puffed potato slices [3, 6]. The puffed potato slices show the higher volume ratio than those apple slices in all conditions. This is because potato sample had higher starch content than apple sample as shown in Table 1, resulting in large volume expansion of product structure [1]. In case of apple sample, both factors are not significantly affected on the textural properties of puffed apple slices.

3.3 Texture

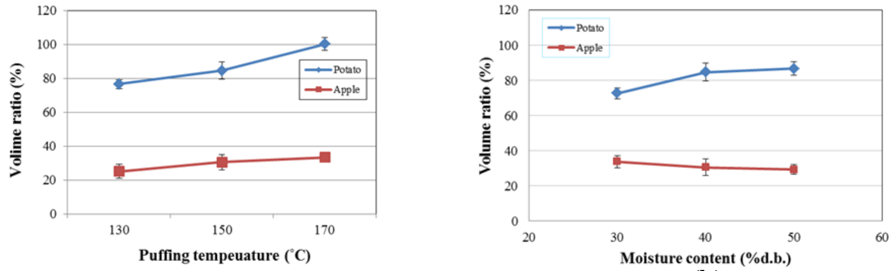
Figure 3 shows the effects of puffing temperature and intermediate moisture content on the hardness of puffed potato and apple slices. Increasing of puffing temperature and moisture content promoted lower hard texture of puffed potato. It is because the larger volume of potato sample as higher level of both factors provided more porous inside product structure therefore structural of puffed product become weaker [5, 7]. However, both factors were not significant effect on hardness of puffed apple slices. Considering between fruit variety, puffed potato slices had higher hardness than those apple slices.

This is because of their amount of chemical composition such as starch of potato, had higher than apple sample.



(a) (b)

Figure 1. Effects of puffing temperature at moisture content of 40% d.b. (a) and intermediate moisture content at temperature of 150 °C (b) on Δ*E* of the dried potato and apple slices.

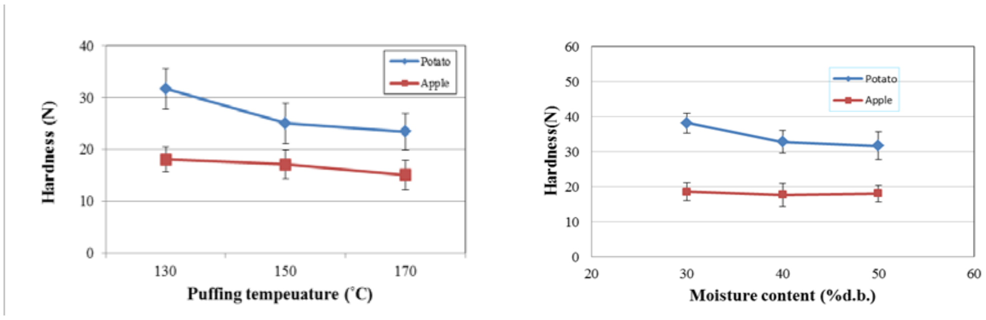


(a) (b)

Figure 2. Effects of puffing temperature at moisture content of 40% d.b. *(a)* and intermediate moisture content at temperature of 150 °C (b) on volume ratio of the dried potato and apple slices.

Table 1 Starch, some sugar and pectin content of fresh potato and apple.

Fruits	Starch (% dry mass)	Fructose (% dry mass)	Glucose (% dry mass)	Pectin (% dry mass)
Potato	17.50	0.20	0.20	0.7-1.5
Apple	0.05	6.00	2.00	0.78



(a) (b)

Figure 3. Effects of puffing temperature at moisture content of 40% d.b. (a) and intermediate moisture content at temperature of 150 °C (b) on hardness of the dried potato and apple slices.

3.4 Drying characteristics.

The drying rates of potato and apple slice at different puffing temperature and intermediate moisture content is shown in Figure 4. The high puffing temperature and high moisture content of puffed potato products provided higher drying rate, resulting in a shorter drying time. This is because the puffed potato had higher volume then its moisture easy movement to its surface [1]. It should be note that, the drying rate of puffed apple slices was lower than puffed potato slices in all cases. It is due to the lower volume of apple than potato. In addition, higher amount of sugar content in apple can be react with moisture and then the moisture difficult to remove from inside apple tissue to its surface [8].

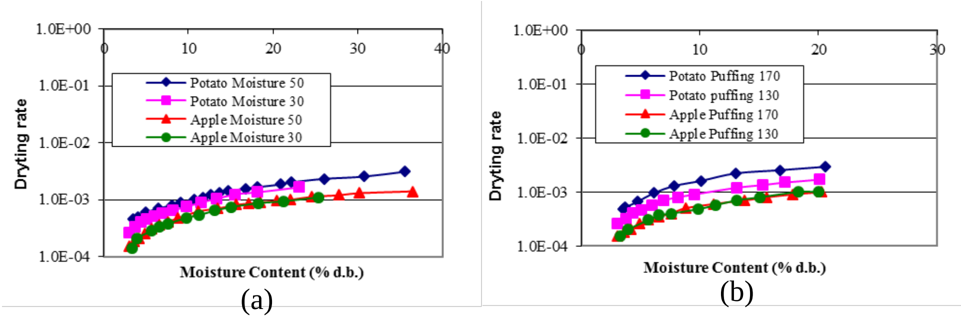


Figure 4. Effects of (a) puffing temperature at 40% d.b. and (b) intermediate moisture content at 150 ^{o}C on the initial slope of the potato and apple slices.

4. Conclusion

Fruit variety affected on qualities of dried product. Potato could be puffed after processing therefore it had higher volume expansion than apple. However, the higher of starch content in potato provided harder texture and initial slope than apple. Moreover, higher puffing temperature and moisture content provided more color change, larger volume ratio, lower hardness of puffed potato slices. However, the effects of puffing temperature and intermediate moisture content had not significant effect on quality of puffed apple slices.

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