

## Effect of Drying Parameters on Moisture Content and Papain Enzyme Activity of Dried Papaya

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### ABSTRACT

Due to the importance of minimizing thermal stresses over drying and maintenance of relevant compounds, selection of proper drying condition is necessary to maintain the quality of the processed fruit. The aim of this project is to study the effect of drying parameters *i.e.* temperature, air velocity and geometry on moisture content and papain enzyme activity of dried papaya. Slices (0.5 x 1.5 x 1.5 cm) and cubes (1.0 cm<sup>3</sup>) of papaya were treated in tray drier at temperature (40, 50 and 60 °C) and air velocity (0.5, 1.0 and 1.5 m/s). Temperature was found to be significantly influencing the drying performance and quality retention for both slices and cubes. However, geometry was the most significant factor played as a controlling effect on moisture content, in which larger surface exposure helps temperature to take action strongly. Slices suffered higher water loss and enzyme degradation compared to cubes of papaya. Models obtained for moisture content and enzyme activity through response surface methodology were significant with  $R^2 = 0.93$  and  $0.80$  respectively.

Keywords: tray drying; papaya; moisture content; papain; enzyme activity; response surface methodology

### INTRODUCTION

Papaya (*Carica papaya* L.) has been regarded as one of the most valuable tropical fruits that contains vitamin C, beta carotene and papain enzyme. Dried papaya slices and cubes are expected to be a nutritious tea drink by maintaining the quality *i.e.* moisture content, original taste, color, aroma, nutrient and enzymatic concentration. In recent years, much attention has been given to the quality of dried products. Drying is a process in which water is removed to halt or slow down the growth of spoilage microorganisms, as well as the occurrence of chemical reactions (Vega-Mercado *et al.*, 2001). Tray drying application enhances the drying rate and improves the final product quality. The consumer demand has increased for processed products that keep more of their original characteristics (Torrington *et al.*, 2001). An important factor in improving dried fruits quality is the moisture content. Moisture content determines the water loss in dried products, in which lower moisture content provides higher quality in products preservation. Akanbi *et al.* (2005) reported on drying characteristics of tomato slices, including moisture content at different drying temperature. Another aspect to be considered is the retention of nutrients and biologically active ingredients such as enzymes. Papain, an enzyme found in papaya, is used for protein hydrolysis in medical application. The stability of papain enzyme is also influenced by drying process. Therefore, the aim of this project is to study the effect of various drying parameters *i.e.* temperature, air velocity and geometry on the quality of papaya based on moisture content and papain enzyme activity.

## MATERIALS AND METHODS

Mature selected papaya fruits (Hawaiian type) were supplied by MARDI, Pontian. The fruits were hand-peeled and cut into slices (0.1 x 1.5 x 1.5 cm) and cubes (1.0cm). The drying procedure followed Park *et al.* (2002) with slight modification. Drying was carried out using tray dryer (Armfield UOP8) at different temperature (40, 50 and 60 °C) and air velocity (0.5, 1.0 and 1.5 m/s). The tray dryer consists of horizontal air flow through trays and samples loaded on it. Sample weight was taken with time interval range of 15 – 120 minutes. Analysis of papain enzyme activity was then carried out after drying process completed. The drying kinetics and enzyme analysis were studied by observing the response surface using Statistica 5.0. (Statsoft Inc., USA).

The moisture content was expressed on a dry basis as kg of water per kg of free-moisture solid or kg H<sub>2</sub>O/kg dry solid. It was determined by an oven method, slightly modified from Funebo *et al.* (2000). Papaya slices were placed in oven (Memmert) at 100 °C for 24 hours to obtain the dry weight. Time-dependent moisture content of the samples was calculated as follows:

$$\text{MoistureContent} = \frac{\text{Wet weight} - \text{dry weight}}{\text{dry weight}}$$

For papain enzyme analysis, protein assay was used to measure amount protein hydrolyzed by the enzyme. Enzyme extraction from the dried papaya was carried out using acetone solution at ratio 5g sample : 10mL acetone. After 24 hours, 5mL casein substrate in test tube was soaked in 40 °C water bath for 15 minutes. Then, 2mL extracted enzyme solution was added into the test tube, followed by 3mL tetrachloroacetyl acid (TCA) to precipitate the hydrolyzed protein. After 60 minutes soaked in 40 °C water bath, the sample was centrifuged and optical density of collected supernatant was measured with spectrophotometer at 280nm. The enzyme activity of the samples was calculated as follows:

$$U/mg = \frac{A \times C \times 10}{W}$$

whereas; U = enzyme unit defined as an enzyme activity that releases 1g tyrosine at 40 °C for 60 minutes, A = standard activity of enzyme, C = concentration of enzyme, W = sample weight in mg and constant 10 represents the final mixture volume.

## RESULTS AND DISCUSSION

### Effect of process variables on moisture content

Average initial moisture content of fresh papaya was about 87.56%. From Fig. 1, it is shown that air velocity had no influence towards drying kinetics for either papaya slices or cubes. However, it can be clearly seen that increased in temperature from 40 °C to 60 °C caused the reduction of moisture content for both geometry of fruit cut. On the other hand, air velocity was only aiding the drying process. At the early stage of drying process, the moisture content was rapidly decrease but showed some convergence through the end as the equilibrium condition was reached. It shows that only at the beginning of drying process, both air velocity and air temperature strongly influenced the drying rate. However getting to the end, air temperature effect was stronger than the air velocity. This was due to higher internal resistance of fruits that air velocity insignificantly influencing the drying process. Fig. 2 shows that papaya slices had rapid drying process and suffered higher water loss compared to cubes. It can be explained that the wider diffusion directions and the lower thickness for slices contributed to the ease of water exits and furthermore affected by temperature, consequently, less moisture was retained. Fig. 3 shows the response surface methodology of moisture content, inferring the relation among air velocity, temperature and geometry of fruit cut to each other.

### Effect of process variables on papain enzyme activity

The standard curve of papain enzyme concentration shows inverse-relation between optical density reading and enzyme concentration. Fig. 4 shows the response surface methodology of papain enzyme activity, inferring the relation among air velocity, temperature and geometry of fruit cut to each other. Observing the response surface of papain enzyme activity, it can be inferred that temperature exhibits as tremendous effect compared to other independent variables. As shown in the figure, increase of temperature results in the degradation of enzyme concentration in samples. This was due to the sensitivity of papain enzyme to heat and high temperature. However, air velocity did not affect much on the retention of papain enzyme. The papaya slices and cubes shrank during drying, therefore less surface area was exposed to air flow. Comparing the geometry of fruit cut, slices suffered more papain enzyme loss than cubes, regarding the surface area of both geometries. Thin breadth surface of papaya slices provided larger surface area, thus more enzyme lost during drying.

## CONCLUSION

From the study, it can be concluded that drying air temperature was the most important factor affecting the drying rate and quality of dried papaya for each geometry of fruit cut. However, geometry was the most significant factor played as a controlling effect on moisture content and enzyme retention, in which larger surface exposure helps temperature to take action strongly. Papaya slices suffered higher water loss and enzyme degradation compared to cubes of papaya.

Model obtained for moisture content response through response surface methodology was significant ( $R^2 = 0.93$ ) and predictive, as shown below:

$$Z = 1.2212 \times 10^{-15} + 1.5890X_1 - 0.1619X_2 - 0.00324X_3 \\ + 0.0055X_1X_2 + 0.00378X_2X_3 - 0.0128X_1X_3 + 0.9831$$

Model obtained for papain enzyme activity response through response surface methodology was significant ( $R^2 = 0.80$ ) and predictive, as shown below:

$$Z = -1.2010 \times 10^{-18} - 6.4282 \times 10^{-4}X_1 + 0.0367X_1^2 \\ - 3.3918 \times 10^{-4}X_2 - 6.784 \times 10^{-6}X_3 - 0.00013X_1X_2 \\ - 9.233 \times 10^{-6}X_1X_3 + 7.9142 \times 10^{-6}X_2X_3 - 0.01374$$

## ACKNOWLEDGEMENT

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## FIGURES

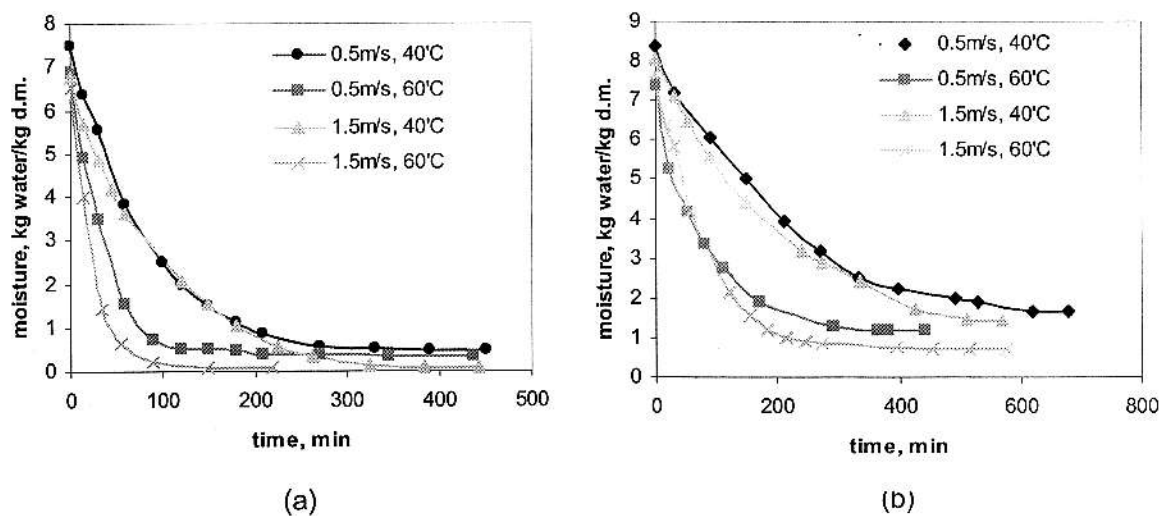


Fig. 1. Effect of temperature and air velocity on moisture content for papaya (a) slices, and (b) cubes

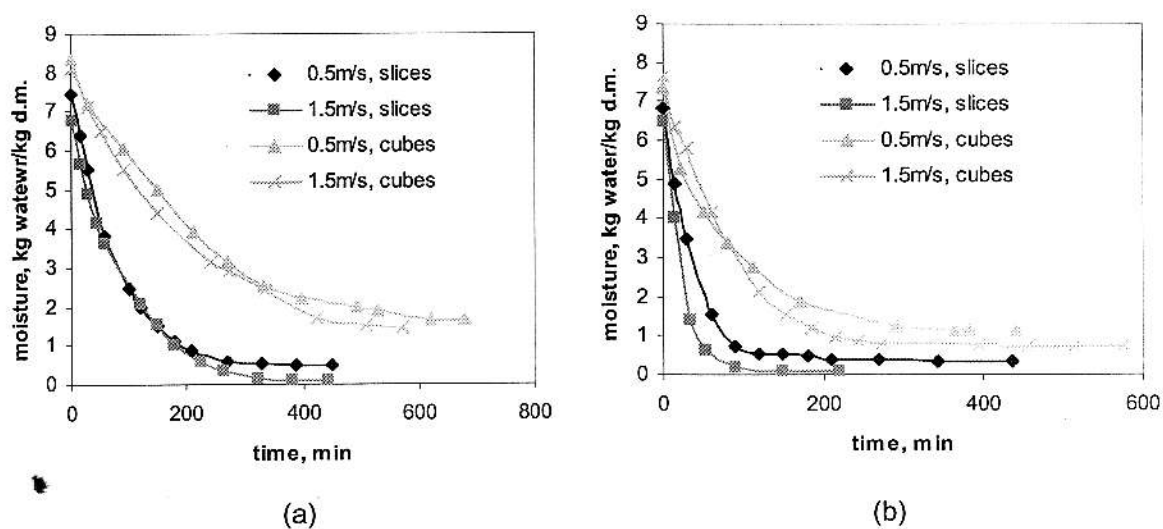


Fig. 2. Effect of geometry and air velocity on moisture content at drying temperature (a) 40 °C and (b) 60 °C

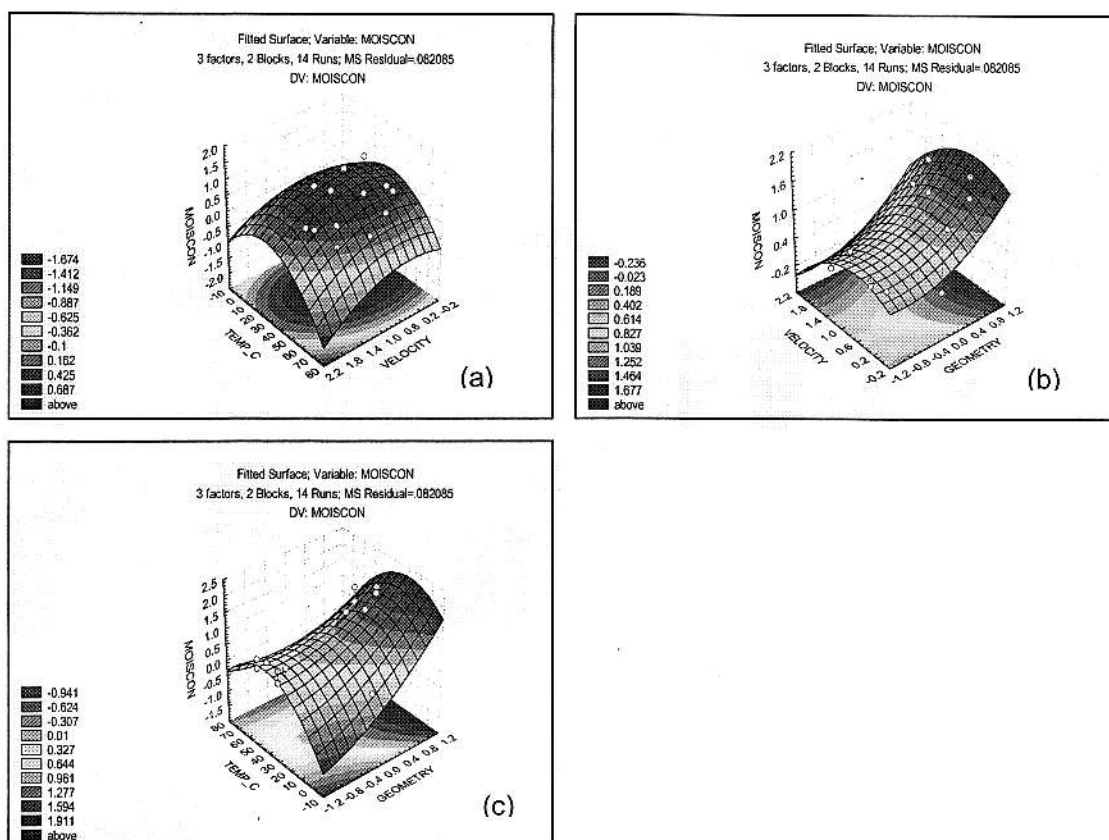


Fig. 3. Response surface methodology for moisture content analysis with process variables (a) air velocity and temperature, (b) geometry and temperature, and (c) geometry and air velocity

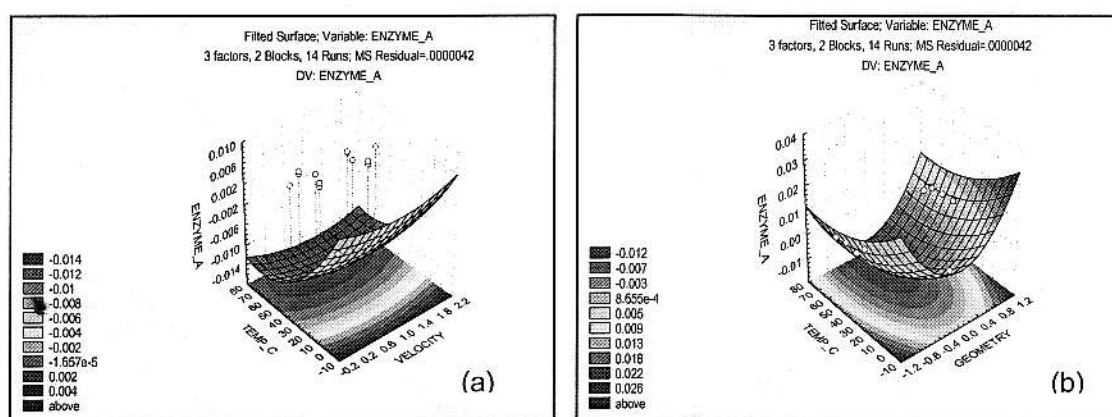


Fig. 4. Response surface methodology for papain enzyme analysis with process variables (a) air velocity and temperature, and (b) geometry and temperature