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Changes of Petai during drying using freeze drying method

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Abstract. Petai (*Parkia speciosa*) is a plant of the type of legumes (Fabaceae). This plant is spread in Southeast Asian countries, especially in Indonesia, which is usually consumed as fresh food. Petai production increased from 2016 to 2017 by 9.45%, therefore petai is very abundant in Indonesia. Petai is known to contain sulfidic acid which is strong and easily damaged like other agricultural products. This causes a decrease in physical and chemical quality so that it can reduce consumer interest. One way to maintain the quality of agricultural products is frozen. This method is the most effective drying method. The purpose of this study was to study *freeze-drying* methods on the physical and chemical quality of petai seeds. The material used is petai pods that have been replaced from the skin of the aris. Petai pods are processed into dry petai. The freeze drying machine used has stainless steel with a total size of 0.7 m, width 0.5 m, and height 1 m. Drying was carried out by heating 60°C at a vacuum pressure of -73.5 cmHg. The initial air content (wet basis) produced by the thermogravimetric method with three samples averaged 83.61%, after drying the air content (wet basis) decreased by 9.868%. The study sample also showed physical changes using the color of three sample seeds. The mean values of colors L, a *, and b * before drying are 68.468; -24.123; and 35.167. After drying, the values of L, a *, and b * are 42.817; -21.76; and 18.977.

1. Introduction

Petai (*Parkia speciosa*) is a tropical annual tree from legumes (Fabaceae) types. This plant is widespread in Southeast Asia, especially in Indonesia. The seeds are consumed when young, both fresh and boiled first. Typical petai seeds can be consumed fresh or mixed into a number of food menus. Petai seeds are usually sold by including the skin.

The biggest increase in annual vegetable production occurred in petai commodities. Petai production in 2016 amounted to 194,936 tons, while in 2017 amounted to 213,361 tons or increased by 9.45% [1]. The data stated that petai production in Indonesia is very abundant because Indonesia is a tropical country which is a suitable place for petai cultivation.

From the research done by Tocmo [2], petai is known to contain strong sulfidic acid so that the petai has a distinctive odor. This reason makes foreign tourists visiting Indonesia interested in consuming petai. A delicious and distinctive taste also makes the interest of foreign tourists to petai soar up, so foreign tourists expect parties to produce petai with export quality. From the research conduct by



Pandeya (1972) in Gan and Latiff [3], petai (*Parkia speciosa*) contains thiazolidine-4-carboxylic acid which has anticancer activity, therefore it can prevent cancer.

Agricultural products are generally perishable or non-perishable, for example one of them is petai. The ripening process in petai decreases both physical and chemical qualities. Quality changes can be seen from the morphological properties of the product in terms of color value, size, and other physical properties. Events in the critical maturation process where the chemical composition of postharvest plants can affect physical qualities, so this is a major factor for consumers to buy a product. Some parameters that can be measured to determine the physical and chemical quality of petai are color value, chemical composition, and aroma characteristics of petai [4].

The best way to maintain a product is freeze-drying. Freeze drying is one of the drying methods that has advantages in maintaining product quality. According to research from Berk (2009) in Khampakool [5], the basic principle of freeze-drying is to eliminate the moisture content in a material by sublimation under vacuum condition with very low temperatures ($< -40^{\circ}\text{C}$), this characteristic has an impact on maintaining nutrition and taste from ingredients. The freeze drying method is very possible for perishable materials, for example banana fruit in the Khampakool [5] study. Used freeze-drying as the method for process banana results in the preserve of physical and chemical qualities. The study represents that local agricultural products can be treated with the freeze-drying method, such as petai products. At present, there are no studies that explain the effect of freeze-drying on the physical and chemical qualities of petai. Therefore, this study aims to produce quality-preserved petai for export quality so that Indonesian specialties can be famous throughout the country.

2. Methodology

This research was conducted at the Laboratory of Postharvest and Food Engineering, Faculty of Agricultural Technology, Universitas Gadjah Mada, in April 2019. The experiment was carried out with petai (*Parkia speciosa*) obtained from supermarkets, and the petai parts used were pods with initial moisture content an average of 83.61%.

The tool used is a freeze dryer with dimensions of $110 \times 60 \times 100 \text{ cm}^3$ of type SR91, the type of refrigerant R134a, and the type of heater is oil. This study observed the effect of freeze dryer on petai by analyzing final moisture content (wet basis/wb), hardness, drying rate, and color value (L, a^* , b^*). Moisture content (wb) was measured by the thermogravimetric method with the help of analytical scales and ovens. The determination of moisture content (wb) use equations (1).

$$M = \frac{m_o - m_1}{m_o - m_c} \times 100\% \quad (1)$$

Where :

M	= Moisture Content (wb) (%)
m_o	= initial mass of sample + cup (gr)
m_1	= final mass of sample + cup (gr)
m_c	= mass of cup (gr)

Color value measurement is done using TES-135 which is fired at several sample points. Hardness value was measured by the Brookfield CT-03 Texture Analyzer with TA-39 probes with a probe tip diameter of 2 mm with the depth of pressing in 20 mm.

3. Result and Discussion

3.1. Moisture Content

Changes in the moisture content of the material during 36-hour drying using a freeze dryer are shown in Figure 1. The final moisture content in the treatment time of drying for 36 hours is 9.868% or decreased by 73.742% from the initial value. The result was slightly different from the research by Klinkesorn [6], the study stated that ideal dry food products on an industrial scale have a maximum moisture content of 3 - 4 %. Another study was done by Pellicer [7] revealed that drying using freeze-dryer with strawberry fruit powder products result in the final moisture content of 3.9 - 4.1%. Lack of

drying time used by in the research was likely the reason for the high value of final moisture content. The physical and chemical properties of dried food can be influenced by the characteristics of the material microparticles, the condition of the dryer, and the conditions of the drying operation [8]. The final petai products at 36 hours drying time are slightly different to be used as industrial products.

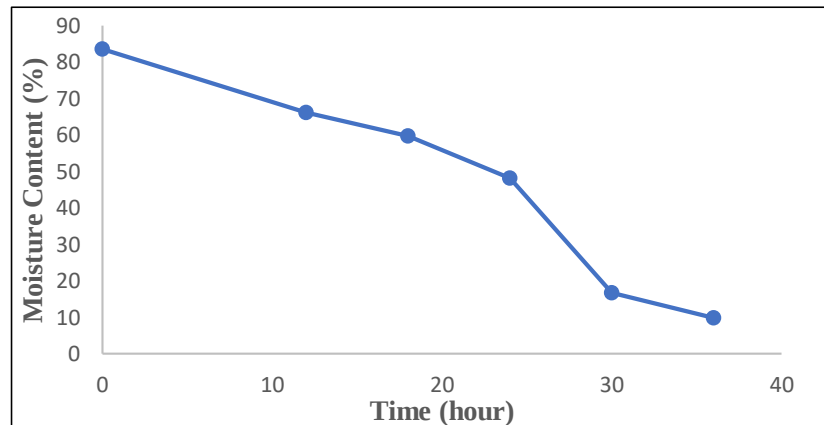


Figure 1. Moisture content of petai during freeze drying

3.2. Drying Rate

Figure 2. shows the value of the drying rate constant, which is 0.0499. This value is obtained from a regression analysis of first-order equations. The drying rate is estimated using an exponential model which is a first-order reaction equation [9]. The determination of drying rate use equations [10] (2).

$$\frac{M - M_e}{M_o - M_e} = \exp(-k \cdot t) \quad (2)$$

Where :

M	= Moisture content (%)
Me	= Equilibrium water content (%)
Mo	= Initial water content (%)
k	= drying rate constant (h ⁻¹)*
t	= drying time (h)

The drying rate constant obtained is 0,0499; in contrast to result found in research done by Ando [11] which uses MVD (microwave-vacuum drying) to dry apples with drying rate constants of 1,171-2,951. This is influenced by the design of drying tools and mechanisms. This freeze-drying method still requires time and energy, so that the dry ingredients obtained will be more suitable to be made into instant food.

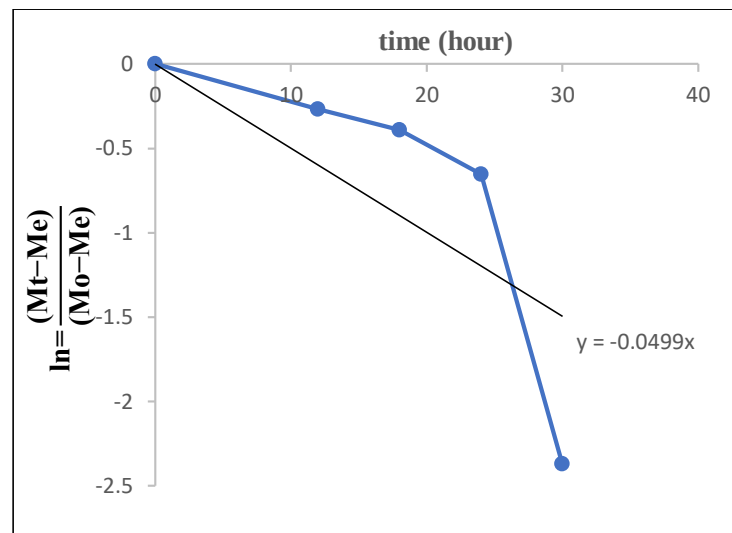


Figure 2. Drying rate

3.3. Colour

Color is one of the characteristics of agricultural products that are valued by consumers to determine their quality [12]. Figure 3 shows changes in color quality (L, a*, b*) in petai when drying for 36 hours. The L value indicates the lightness of the product, the research showed a decreased of the value by 37.47%. The high brightness value (L) in the product indicated that the product has a large porosity in the structure of the product [13]. The decrease in brightness value due to porosity in petai decreases during the freeze-drying process.

The value of a* expresses the level of green/red value of the product, indicates that there is an enzymatic browning reaction on agricultural materials [14]. Figure 3 shows changes in the value of a* in petai when drying for 36 hours. The value of a* tends to rise. However, at the time of 30th hour, the value was declined as the result of increasing in green color on petai pods. This phenomenon expresses that the enzymatic browning reaction by the petai has stopped at the 30th-hour drying. Therefore, the freeze-drying method can stop the enzymatic browning reaction in petai, so it can maintain the color quality of the products. The b* value indicates the level of the yellow/blue value. Figure 3 shows that the value of b* in petai has decreased by 46%. The yellowish level of the petai is due to the increase in green color which can be indicated as the enzymatic browning reaction stops.

3.4. Hardness

The hardness value is obtained as the peak of the deformation graph curve [5]. In Figure 4 shown changes in the value of petai hardness during drying for 36 hours tended to increase by 1.661 kg. As a result of the freeze-drying process, the water content of the product decreased. When water content shortens from the product it will cause the product to harden. The porosity would drop and affect the increasing hardness value of the product [12].

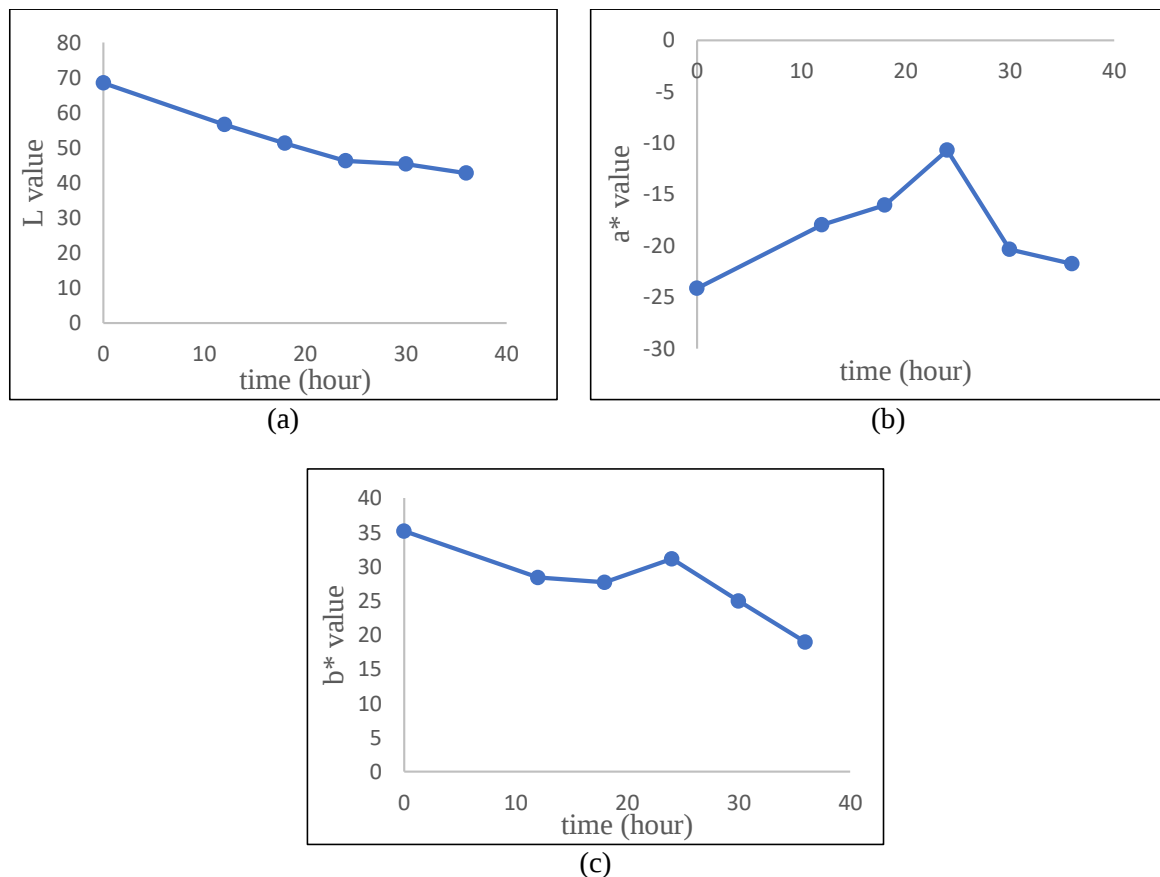


Figure 3. Color value of petai (a) L value (b) a* value (c) b* value during freeze drying

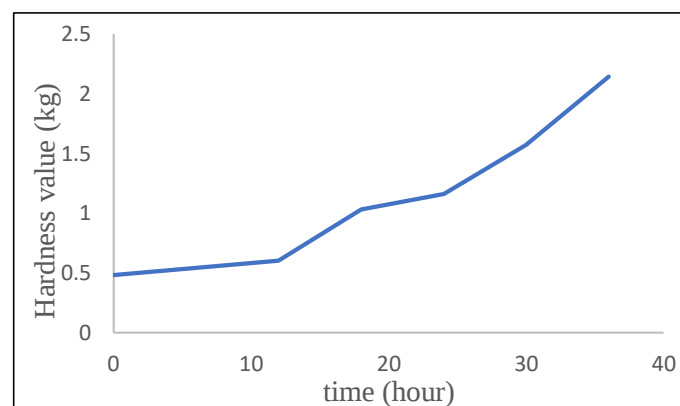


Figure 4. Hardness value (kg) of petai during freeze drying

4. Conclusions

Petai (*Parkia speciosa*) was dried by freeze-drying method with drying time of 36 hours. The freeze drying method can affect the quality of the petai in terms of water content, color value, and hardness value. The value of water content decreased by 73.742%, the drying rate measured is 0.0499% / hour. The brightness (L) value and b* value also decreased by 37.47% and 46%. The value of hardness has increased by 1.661 kg from the value of initial hardness.

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