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# Dimensional Changes of Red Dragon Fruit (Hylocereus Polyrhizuz) Slices During the Drying Process

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**ABSTRACT** (10 PT)

Dragon fruit is one of the fruits with a fairly high water content which causes an increase in water activity and accelerates the growth rate of microorganisms. Research was conducted to determine the shrinkage that occurs in the fruit. Two different sample sizes were used in this study. Both were cylindrical in shape with a diameter of 2.5 cm and different lengths. 3 cm and 1.5 cm. The number of samples used for sample A and sample D was 5 pieces each. Measurements of weight and dimensions (sample length and diameter) were repeated every 15 minutes during the drying time at 45 ºC. Once the sample weight was constant, the material was put back into the oven at 105 ºC for 72 hours. After 72 hours, the sample was weighed and measured to determine the dry weight of the sample. Based on the study of the pattern of changes in the dimensions of red dragon fruit during the drying process, it can be concluded that the pattern of changes in volume ratio to KAbb is a linear pattern with an $R^2$ value of 0.9946. The pattern of changes in volume ratio to KAbb is polynomial degree 2 and 3, but the $R^2$ value is greater for degree 3, so degree 3 is more suitable for estimating the volume ratio of KAbb.values.



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## 1. INTRODUCTION

The high-water content of dragon fruit enhances water activity and speeds up microbial growth. Dragon fruit is composed of 90.2% water and 9.4 mg of vitamin C. If the same storage procedure is used, dragon fruit can be stored in temperature rooms for up to 10 days. As a result, suitable post-harvest handling and processing are required. One method is to dry dragon fruit to prevent damage and spoilage. Dragon fruit preparation can increase its life and keep it fresh for an extended period.

The shrinkage of dry materials owing to drying is a common phenomenon in post-harvest fruit processing. When a material shrinks, its volume drops and its hardness increases. Material heating and loss of water pressure on the material's cellular structure result in changes in material dimensions or deformation, as well as material shrinkage. As water vapour escapes from the material, shrinkage increases. Drying causes cavities that previously contained water in the material to shrink and even lose water, causing the substance's surface to dry and shrink. The purpose of this study was to determine how much the dragon fruit shrinks during the drying process.

## 2. MATERIALS AND METHODS

### 2.1 Material

For every 100 g of red dragon fruit, there are 0.7 to 0.9 g of fibre, 0.005 to 0.01 mg of carotene, 6.3 to 8.8 mg of calcium, 30.2 to 31.6 mg of phosphorus, 0.55 to 0.65 mg of iron, 13 to 18 Bx sugar content, 60.4 mg of magnesium, vitamin C, vitamins B1, B2, and B3 (Rohim et al., 2016). During its development, red-fleshed dragon fruit undergoes considerable physical and chemical changes, including an increase in soluble solids, pH, diameter, and mass, as well as a decrease in acidity in skin thickness. The colour and appearance of the dragon fruit skin are great indications of fruit development and can be used to predict when the fruit is mature enough for consumption and commerce (Magalhaes et al. 2019).

### 2.2. Methods

#### 2.2.1. Drying process

Muarif (2013) defines drying as the process or method of eliminating water from materials by evaporation. Oven drying is a simple and straightforward drying procedure. An electric oven is a mechanical drying device that can be employed since it is faster and easier to use (Mardiah, 2009). The drying principle states that due to the difference in the amount of water vapour in the air and the material to be dried, the water vapour in the substance to be dried evaporates. Material moisture content decreases are defined by changes in shape, such as volume and surface area, as well as cell injury (Kartika, 2016). After the sample has been produced, the drying process is carried out, and the temperature is set at 105 oC for 72 hours, allowing for effective moisture removal and the preservation of the material's structural integrity. This controlled drying interval guarantees that the material is properly and uniformly dried while minimizing structural damage or distortion.

#### 2.2.2. Moisture Content

Wet moisture content (bb) is represented as a percentage of water weight expressed in grams of water per 100 grams. The weight of dry material or a sample is the weight of the sample after it has been heated for a particular duration such that its weight remains constant or has reached a consistent weight.
The condition of a harvested material tends to have a high moisture content, making direct storage for a relatively long period of time impossible because the high moisture content of the material will facilitate the process of growing microorganisms, which will accelerate the process of causing damage to the food (Purwanti and colleagues, 2017). Moisture content is divided into two categories: dry basis and wet basis (KAbk and KAbb). Moisture content is calculated by multiplying the weight of the material by the weight of water lost during the drying process.

Wet basis moisture content

$$M_{wet} = \frac{A-B}{A} \times 100\% \quad (1)$$

$M_{wet}$ = Wet basis moisture content (%)
A = Initial weight (g)
B = Weight of solids (g)

Dry basis moisture content

$$M_{dry} = \frac{A-B}{B} \times 100\% \quad (2)$$

$M_{dry}$ = Dry basis moisture content (%)
A = Initial weight (g)
B = Weight of solids (g)

### 2.2 Volume Depreciation Equation (Volumetric Shrinkage)

The shrinkage of dry materials owing to drying is a common phenomena in post-harvest fruit processing. When a material deforms, its volume drops and its hardness rises, this is referred to as shrinkage. As moisture evaporates from the material, shrinkage increases. The test employs three shrinkage models to detect the behaviour of the floor area ratio. (Kartika, 2016) The three models are exponential, linear, and polynomial. The volume shrinkage equation used to determine drying is determined by the relationship between the seed volume and the beginning volume for each moisture content.

$$\psi = V/Vo \quad (3)$$

where:
Ψ = Volumetric shrinkage index
V = Volume for Each Moisture Content ($mm^3$)
V0 = Initial Volume ($mm^3$)

### 2.3 Data Analysis

This study used a data analysis method by looking at the trend of the data after it was graphed. The graph was constructed to relate the shrinkage volume and moisture content of wet base to the moisture content of dry base. The determination of constants can be done using Microsoft Excel's Solver Tools. Data trends can be either linear or polynomial. The accuracy of the trend is based on the $R^2$ value of the trend equation obtained.

## 3. RESULTS AND DISCUSSION

### 3.1. Changes in wet basis moisture content and base moisture content dry.

In this study, the value of decreasing the wet basis moisture content ($KA_{bb}$) and decrease in dry basis moisture content ($M_{dry}$). You can see the change in water level on Figure 1 and Figure 2 :

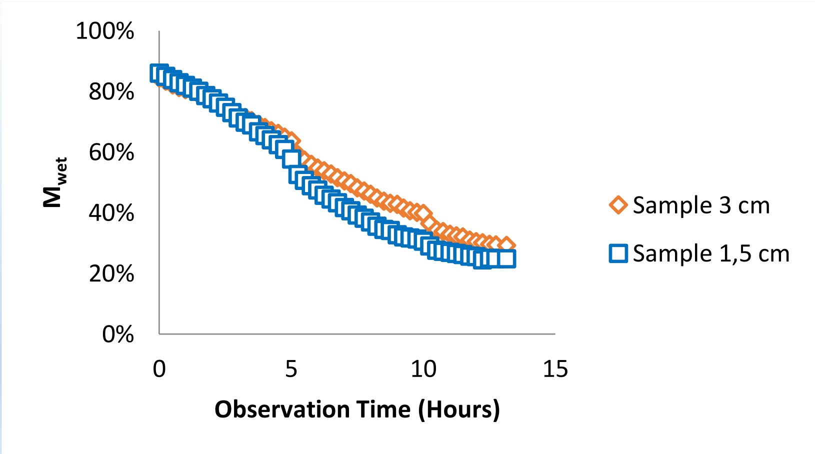


Figure 1. Comparison chart of $M_{wet}$ with observation time

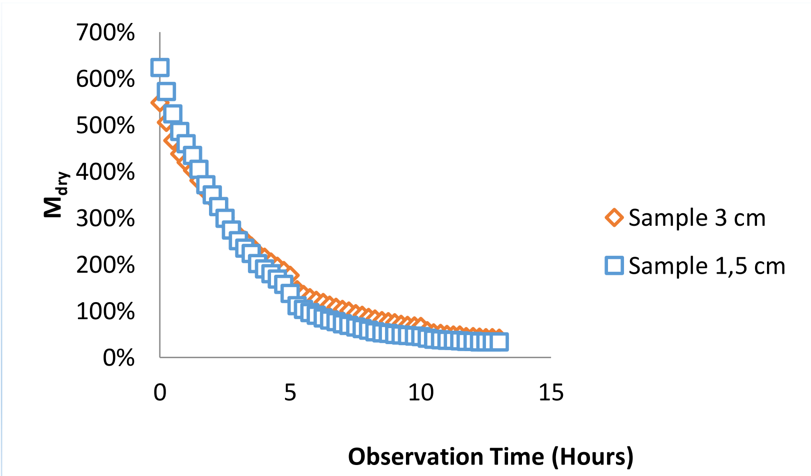


Figure 2. Graph of comparison of $M_{dry}$ with observation time

Analysis of changes in wet basis moisture content (Mwet) and dry basis moisture content (Mdry) during the drying process establish data with graphs that could be seen in Figures 1 and 2, which are shown to be experiencing considerable decreases in graphic patterns. Variations in sample size with different temperatures can significantly change the drying rate, which is consistent with Hasyim (2011)'s conclusion that the method works. the duration of drying is determined by the surface area being dried; the faster the drying time, the thinner the dried material.

Figure 1 and Figure 2 show changes in the pattern of decreasing water content, that there is a difference to achieve a constant moisture content. In figure 6, ie change in moisture content on a wet basis, with a temperature of 45 ºC on a sample of 3 cm with the water level first 84,47% experienced a decrease until it reached the water level about 29.28% lasted for 13 hours. In the 1.5 cm sample with water content first 86.07% experienced a decrease in water content which reached around 24.08% lasted 13 hours.

Figure 2 shows an increase in dry basis moisture content. three centimetre sample with an initial water content of 547.16% witnessed a decline in water content to around 41.47% after 13 hours, while a 1.5 cm sample with an initial water content of 623.57% experienced a decrease in water levels to around 32.98%. According to Ratnasari (2014), depreciation is one of the physical changes that occur in drying as a result of the existence of evaporation of water from the material and changes in the internal structure. This, in turn, causes variances in the ultimate water content in each sample, even when treated at the same temperature and in the same size.

### 3.2. Changes in Volume Ratio During the Drying Process

The results of observations of red dragon fruit during drying have changed volume ratio during the drying process on a sample of 3 cm and a sample of 1.5 cm with a drying temperature of 45 ºC is presented in Figure 3, as follows:

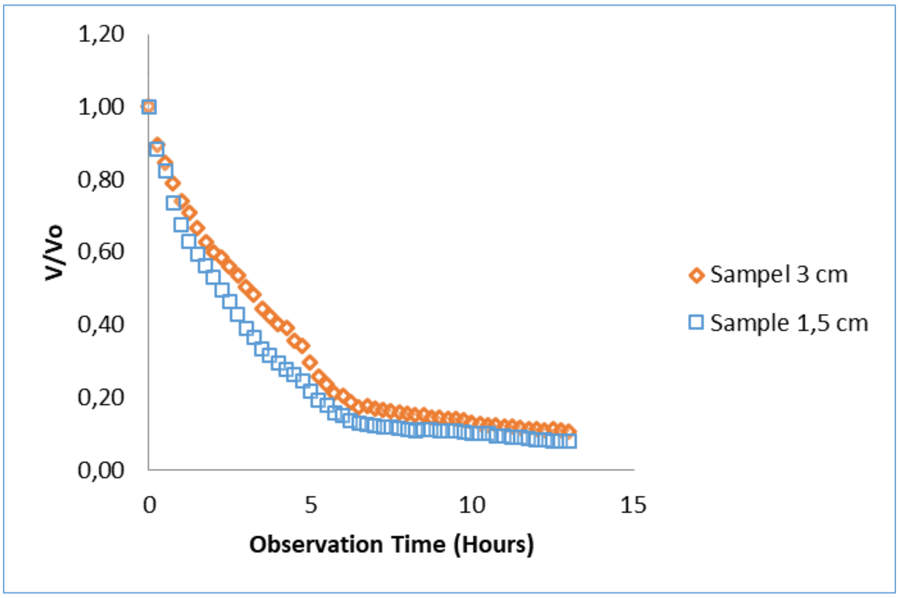


Figure 3. Graph of ratio changes during drying

There are various examples of data processing that have been completed. The temperature and area surface of the dried material are two factors that influence the drying process. Figure 3, which depicts the change in the ratio during the drying process, indicates that in the sample 3 cm, the average volume ratio at the start of the experiment, namely 1, then the volume ratio fell gradually slowly and continuously so that the volume ratio reaches 10.70% and lasts for 13 hours. In the sample 1.5 cm with an average volume ratio at the start of the experiment, i.e., 1 with the observation time of 13 hours, the volume ratio gradually dropped until it reached 7.96%. The surface area of dried dragon fruit has a large influence on the volume ratio and water content, as drying observations on 1.5 cm samples change faster than drying observations on 3 cm samples. Based on Megalhaes (2019), the length of the drying process (achieving a constant condition) depends on the temperature, the surface of the dried material, and various other elements.

### 3.3 Changes in Volume Ratio Due to Changes in KABB and KABK

The results of observations of red dragon fruit during the drying process, changes in volume ratio due to changes in $M_{wet}$ and $M_{dry}$ in the 3 cm sample and 1.5 cm sample with drying temperature of 45 ºC seen in Figure 4 and Figure 5, as follows :

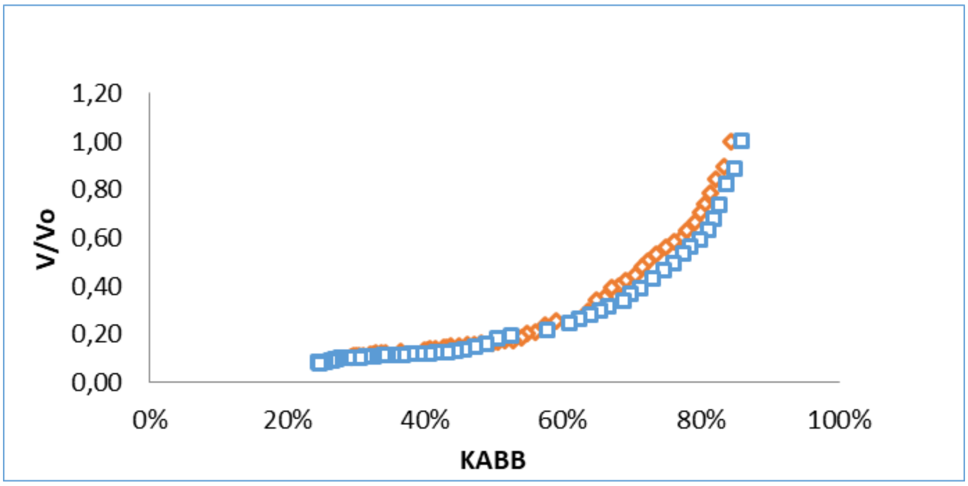


Figure 4. Graph of changes in volume ratio due to changes in moisture content on a wet basis

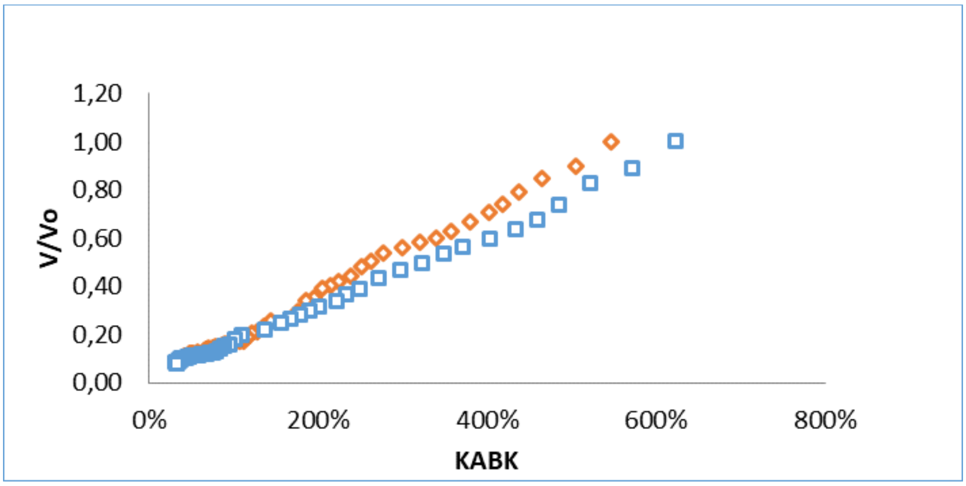


Figure 5. Graph of changes in volume ratio due to changes in moisture content on a dry basis

Megalhaes (2019) states that the dimensions of the material, when drying, extensively affect the volume ratio and water content—based on the results. Observations on the 1.5 cm sample changed more quickly than drying on a sample of 3 cm. Figure 4 shows that sample 3 cm with a drying temperature of 45 ºC the average volume ratio at the start of the experiment, i.e., 1 with a wet basis moisture content at the start of 84.47% after it dried, the volume ratio decreases slowly and constantly so that the volume ratio reaches 0.010. In the sample, the 1.5 cm average volume ratio at the start of the experiment, namely 1 with a wet basis moisture content at the start of 86.07% after drying, decreased significantly slowly and constantly so that the volume ratio reached 0.079. Temperature and drying time dramatically affect the volume ratio and water content.
From Figure 5, on a 3 cm sample with an average drying temperature of 45 ºC, the volume ratio at the start of the experiment, which is 1 with the moisture content of the dry basis at baseline of 547.16%, after drying for 13 hours, the volume ratio decreased slowly and constantly, so that the volume ratio reached 0.107. In the 1.5 cm sample temperature of 45 ºC, the average volume ratio at the start of the experiment, namely 1 with the initial dry base moisture content of 623.57%, after drying for 13 hours, the volume ratio decreased to 0.079.

### 3.4 Recapitulation of the V/V0 Change Pattern Model of $M_{wet}$ and $M_{dry}$

The drying model, which included third order polynomial models, second order polynomial models, and linear polynomial models, was used to investigate the behaviour of the volume ratio. The model's calculation output is then tested by checking the termination coefficient. Several models performed the termination coefficient test to determine the applicability of a model to the value of the original data (Aulia et al, 2013). The following table shows the test results in the coefficients are terminated in third order polynomial models, second order polynomial models, and linear response to red dragon fruit at a drying temperature of 45 oC can be seen in following table:

Table 1. Coefficient of Determination

| Sample | Pattern | | Equality | $R^2$ |
|---|---|---|---|---|
| A | Mwet | Polynomial orde-3 | $y = 7.273x^3 - 8.4918x^2 + 3.5475x - 0.3872$ | 0.9956 |
| | | Polynomial orde-2 | $y = 3.665x^2 - 2.8485x + 0.6628$ | 0.9842 |
| | Mdry | Linear | $y = 0.1755x + 0.0163$ | 0.9946 |
| D | Mwet | Polynomial orde-3 | $y = 7.817x^3 - 9.6889x^2 + 4.1516x - 0.4794$ | 0.9904 |
| | | Polynomial orde-2 | y = 2.9634x2 - 2.1573x + 0.4732 | 0.963 |
| | Mdry | Linear | $y = 0.1466x + 0.0267$ | 0.9962 |

Table 1 data show that the $r^2$ value for the 3 cm sample at 45 oC is 0.9956 in the third order polynomial model, 0.9842 in the second order polynomial model, and 0.9946 in the linear model. $r^2$ value on a 1.5 cm sample with a drying temperature of 45 oC, $r^2$ value in the 3rd order polynomial model, namely 0.9904, $r^2$ value in the second order polynomial model, namely 0.963, and $r^2$ value on the linear, which is 0.9962.

The 3rd order Polynomial model employed in the test has a value of R2 that is high and falls into the category of extremely strong relationship level. This matter demonstrates that the polynomial model is the best model for representing the change in dimensions of red dragon fruit during the drying process, because the 3rd order polynomial model has variables that cause a change in another variable, namely the volume ratio in the model 3rd order polynomial has an effect on the water content in red dragon fruit, and the 3rd order polynomial model has the most regression coefficients than the other models, It performs a significant role in the significant change in the value of the independent variable. The higher the regression coefficient value, the larger the change contribution, the larger the ratio of the red dragon fruit's volume dimensions, and the higher the sample's water content. This is consistent with studies conducted by Nurhawa (2016) and Malengsang (2012), which found that the optimal model is the third order polynomial model.

## CONCLUSION

Research on changes in red dragon fruit dimensions during processing and drying has led to the following conclusions: the pattern V/V0 against Mwet is linear, with an $R^2$ value of 0.9946; the pattern V/V0 with respect to Mwet is a polynomial of order 2 and order 3, but order 3 is better at estimating V/V0 based on Mwet because order 3 has a larger $R^2$ value.

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