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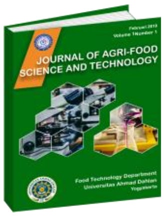

# Effect of Drying Time on Physicochemical Characteristics of Dragon Fruit Peels Powder *(Hylocereus polyrhizus)*

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**ABSTRACT**

*The increasing production and demand of dragon fruit (Hylocereus polyrhizus) in Indonesia produces a high amount of dragon fruit peel waste that can pollute the environment. As an alternative, dragon fruit peel could be applied as a functional food ingredient due to its high fiber content and antioxidant capacity. This study contributed to analyzing the effect of drying time on the physical and chemical characteristics of dragon fruit peel powder. To optimize the functional properties, dragon fruit peel was developed into a powder that was prepared by using a food dehydrator at 60 °C with drying times of 4, 5, and 6 h. The results showed that the longer drying time led to lower moisture and protein content, which reached the lowest at 9.73% and 13.07% with a drying time of 6 h, respectively. Meanwhile, drying time (4-6 h) did not significantly affect the ash (13.74-14.57%), fat (22.46-23.46%), and crude fiber content (29.13-31.75%) of dragon fruit peel powder. The drying time can affect antioxidant activity significantly, while the highest antioxidant activity was found in 6 h drying time (IC50 0.03 gram/mL). The L* value was measured between 29.68-30.23, a* value 9.61-10.34, and b* value 15.20-16.53. The drying time of 4 h could maintain the color of dragon fruit peel and produce the highest yield product at 4.52%. In general, drying dragon fruit peel powder for 4 hours gave the best results for high fiber content and high yield. Drying it for 6 hours was suggested to increase its antioxidant activity.*



## 1. INTRODUCTION

Indonesia is an agricultural country that provides vast land for farming. Generally, Indonesian people in rural areas depend on agricultural products (Simangunsong, 2014). One of the famous agricultural products that is produced in a high amount in Indonesia is dragon fruit. Indonesia was able to produce dragon fruit up to 6,696 tons per year in 2013, and it continued to increase to 82,544 tons in 2020 (Hasanah et al., 2022). The demand from the Indonesian community for dragon fruit reaches 200-400 tons per year (Jani et al., 2017). In general, dragon fruit is categorized based on the color of its flesh and skin, namely red skin and red flesh (*Hylocereus polyrhizus*), red skin and white flesh (*Hylocereus undatus*), and yellow skin and white flesh (*Hylocereus megalanthus*). Red dragon fruit (*Hylocereus polyrhizus*) is the most produced in Indonesia and is cultivated in areas such as Malang, Yogyakarta, Bogor, and Jember (Jani et al., 2017). Besides being consumed directly, dragon fruit can also be processed into juice, salad, or jam (Adelina, 2022). Dragon fruit is famous due to its beneficial effect on the body. It has a low glycemic index and is rich in vitamins, minerals, phytochemical compounds, and dietary fiber. In addition, the fruit has several biological properties, including antioxidant activity. The crude dietary fiber content in red dragon fruit was 10.1 grams per 100 grams (Rochmawati, 2019).

The increasing demand and production of dragon fruit in Indonesia results in dragon fruit peel waste that can pollute the environment. Dragon fruit peel, which is usually removed before consumption, contributes about 30% of the whole fruit (Apriliyanti et al., 2020). The high amount of dragon fruit consumption produces a considerable amount of peel waste and can contribute to environmental problems (Chumroenvidhayakul *et al*., 2022). Efforts can be made to realize zero waste listed in the Sustainable Development Goals (SDGs) by utilizing dragon fruit peel waste. The protein, fat, ash, and fiber contents of red dragon fruit peel were 8.98%, 2.60%, 18.76%, and 25.56%, respectively (Simangunsong et al., 2014). Previous research has also worked to develop some vegetable and fruit peel, such as apple, banana, kiwifruit, garlic, and mango, to be a functional food characterized by their chemical composition (Bhardway et al., 2022). Some studies also revealed that the nutritional composition of the skin or peel was higher than that of the kernel part (Adelina et al., 2021).

Previously, dragon fruit peel could be added to processed food products in the form of puree. Some studies added dragon fruit peel in puree form to make jam (Adelina, 2022), cendol (Hasanah, 2022), and marshmallows (Oktarina, 2021). The application of dragon fruit peel has been reported to improve the senses of processed food products such as noodles, bread, cakes, and cookies due to the content of anthocyanin and betacyanin pigment by developing the desirable color of the product (Palupi, 2021). Moreover, dragon fruit peel can also increase the nutritional content of processed products, such as fiber, vitamins, minerals, and phytochemical compounds that have antioxidant properties (Chumroenvidhayakul et al., 2022).

However, to facilitate handling and increase shelf life (Najjar et al., 2022), dragon fruit peel can be dried first and ground into powder. This drying process needs to be known for its effectiveness on physical and chemical properties that could meet the needs, and also time efficiency in the process, especially for the food industry. The selection of drying time for four h, five h, and six h was based on previous research (Fauzi et al., 2022), which states that the drying time range gives the best results for yield, chemical composition, and antioxidant activity. This study was conducted to determine the effect of drying time on the physical and chemical characteristics of dragon fruit peel (*Hylocereus polyrhizus*) powder. Furthermore, this research is expected to be used as a reference for handling dragon fruit peels for food industries that utilize the peels in powder for processed food products.

## 2. MATERIALS AND METHODS

### 2.1. Materials

The equipment needed are food dehydrator Gea RSA Getra ST-32 Volume 200 L, Philips HR2155-00 blender, 60 mesh sieve, Memmert UN 110 Universal Oven, Saftherm Muffle Furnace, UV-Vis spectrophotometer Thermo Scientific Genesys 110, soxhlet set, Kjeldahl set, vacuum pump, analytical balance, mohr pipette, volumetric pipette and other glassware. The materials used are hexane solvent, distilled water, methyl red indicator, NaOH, $H_2SO_4$, HCl, $CuSO_4$, $K_2SO_4$, Boric Acid, Ethanol, 2,2-diphenyl-1-picrylhydrazyl (DPPH) and $K_2SO_4$. Dragon fruit peels were collected from fruit juice and fruit salad vendors around IPB Vocational School, Malabar, and Bantarjati in Bogor City. The peels were first collected from several vendors and stored in the refrigerator (maximum of three days) before being handled (Indriani and Khairi, 2023).

## 2.2. Research Methods

### 2.2.1. Preparation of Dragon Fruit Peels Powder

Dragon fruit peels were prepared by separating the unfit parts, such as rotten and dark colored. The red-colored dragon fruit peels were selected and washed. Bleaching, as a pre-treatment, was carried out at 80°C for 1-2 minutes and then sliced into 3 mm in length. The drying process was performed with a food dehydrator at 60°C for 4, 5, and 6 hours (Puspita et al., 2021). During the drying process, samples were checked every 1 hour and weighed to see the percentage of weight loss. After the drying process, the dragon fruit peel was mashed using a blender and sieved using a 60-mesh sieve. The powder was weighed and then packaged using ziplock plastic.

### 2.2.2. Moisture Content

The aluminium crucibles were dried in an oven at 105°C for 15 minutes, cooled in a desiccator for 10 minutes, and then weighed. A total of 2 grams of sample was considered, and the cup was put in an oven at 105°C for 5 hours. After that, the crucible was cooled in a desiccator for 15 minutes until it reached room temperature and then weighed. The cup was dried again in the oven for 30 minutes, cooled in a desiccator, and then re-weighed (AOAC, 2005). Moisture content calculations can be done using equation (1).

$$Moisture\ content\ (\%db) = \frac{(\text{sample weight} - \text{dry weight})\ g}{(\text{dry weight})\ g} \times 100\% \qquad (1)$$

### 2.2.3. Ash Content

Analysis of total ash content by gravimetric method was carried out using a 550°C furnace based on the AOAC 2005 (Association of Official Analytical Chemists) standard method. The porcelain crucible was dried in an oven at 105°C for 15 minutes, cooled in a desiccator for 10 minutes, and then weighed the crucible with an analytical balance. A two-gram sample was weighed directly into the porcelain crucible. Burning was carried out on a porcelain triangle. After no longer smoked, the porcelain crucible was straightened, the cap was opened, and the flaming was resumed until a slight whitish color appeared on the lower wall of the cup. The porcelain cup was put into the furnace at 550°C until white ash was reached. The porcelain crucible was cooled in a desiccator for 15 minutes at room temperature and then weighed. Ash content calculations can be done using equation (2-3).

$$Ash\ content\ (\%wb) = \frac{(ash\ weight)\ g}{(\text{sample weight})\ g} \times 100\% \qquad (2)$$

$$\text{Ash content (\%db)} = \frac{(\text{\% wet base})\ g}{100 - \text{moisture Content (\%wb)}} \times 100\% \qquad (3)$$

### 2.2.4. Fat Content

Fat content was analyzed using the soxhlet method based on AOAC 2005 (Association of Official Analytical Chemists). The fat flask was first dried in an oven at 105°C for 15 minutes, then cooled in a desiccator to room temperature. Five grams of sample was weighed and then put into hulls made with filter paper. Extraction in soxhlet was performed with hexane solvent for 3 hours. After the extraction was complete, the solvent from the fat was separated by distillation. The flask was placed in the oven for 15 minutes at 105°C. The fat flask was placed in a desiccator and then weighed to a fixed weight. Fat content calculations can be done using equation (4-5).

$$Fat\ content\ (\%\text{wb}) = \frac{(fat\ weight)\ g}{(\text{sample weight})\ g} \times 100\% \tag{4}$$

$$Fat\ content\ (\%\text{db}) = \frac{(\%\ \text{wet base})\ \text{g}}{100 - \text{moisture Content}\ (\%\text{wb})} \times 100\% \tag{5}$$

### 2.2.5. Protein Content

The method used to analyze the protein content of the sample was the AOAC 2005 (Association of Official Analytical Chemists) standard method, namely the Kjeldahl method. A sample of 0.1 grams was weighed and then transferred into the Kjeldahl flask. The catalyst protein, as much as 5 grams consisting of a mixture of $K_2SO_4$ and $CuSO_4$, was put into the flask, along with the addition of 5 mL of concentrated $H_2SO_4$. The flask was heated until the color of the liquid was a clear green. The flask was removed, and 50 mL of distilled water was added. After homogeneity, the solution was put into a distillation flask, and distilled water was added until half the flask was half full.

The distillate container was prepared with 10 mL of 4% boric acid in a 250 mL erlenmeyer, plus a methyl red indicator. Next, 25-30 mL of 30% NaOH was added and immediately covered with a distillation section. The heating mantle was ready to be turned on. The distillation process will be completed for approximately 45 minutes until the holding solution changes to a yellow color. The distillate collection erlenmeyer was removed, the end of the distillation pipe was rinsed using distilled water into the erlenmeyer, and the heating mantle was turned off. Titration was carried out with 0.02 N HCl with a change to red-orange color. Protein content calculations can be done using equation (6).

$$Protein\ content\ (\%db) = \frac{\%\ wet\ base}{100 - moisture\ Content\ (\%wb)} \times 100\% \tag{6}$$

### 2.2.6. Carbohydrate Content

Determination of carbohydrate content using the total by-difference method (Yunita, 2015). The calculation formula can be seen as equation (7).

$$\begin{aligned} &Carbohydrate\ (\%db) \\ &\quad = 100\% - (moisture\ contemt + ash\ content + protein\ content \\ &\quad + fat\ content) \end{aligned} \tag{7}$$

### 2.2.7. Crude Fiber

Crude fiber analysis was conducted using fat-free samples based on AOAC 2005 (Association of Official Analytical Chemists). A total of 2 grams of sample was placed into a 600 ml erlenmeyer, and then 200 ml of boiling $H_2SO_4$ solution was added. Next, the sample was simmered in the erlenmeyer for 30 minutes with occasional shaking. Then, the suspension was ready to be filtered. The residue left behind was washed with boiling water until it was no longer acid (tested with litmus paper). The remaining residue in the filter paper was washed with 200 ml of boiling NaOH solution. The suspension was simmered for 30 minutes and shaken occasionally. Filtering was carried out while washing with 10% $K_2SO_4$. The residue was washed with boiling water and 95% alcohol. It was dried in an oven at 105°C until constant (1-2 hours). The residue was then cooled in a desiccator and weighed, and the crude fiber content was calculated (equation (8)).

$$Crude\ fibre\ (\%db) = \frac{(\text{residual weight} - \text{filter paperweight})\ g}{(\text{sample weight})\ g} \times 100\% \qquad (8)$$

### 2.2.8. Antioxidant

Antioxidant analysis of the DPPH IC50 method (Adelina, 2022) was carried out by measuring the absorbance of the control. As much as 1 mL of 70% ethanol was put into a test tube. Furthermore, 4 mL of 50 µM DPPH solution that has been prepared is added to the test tube that has been coated with aluminium foil. The solution was mixed until homogeneous and left for 30 minutes in a dark place. The sample was measured with a UV-Vis spectrophotometer with a wavelength of 514 nm. Measurement of sample absorbance was carried out by making 5 grams of sample mixed with 50 mL of 70% ethanol until homogeneous. The mixture was centrifuged at 500 rpm for 5 minutes. A total of 1 mL of sample was put into a test tube that was coated with aluminium foil, and then 4 mL of 50 µM DPPH solution was prepared and left for 30 minutes in a dark place. The sample was measured with a UV-VIS spectrophotometer with a wavelength of 514 nm. If a high absorbance is obtained, then make four dilution concentrations below and measure the absorbance (use a total of 5 concentrations). Finally, the %inhibition calculation formula can be seen on equation (9).

$$\%\ \text{Inhibition} = \frac{\text{Abs control} - \text{Abs sample}}{\text{Abs control}} \times 100\% \qquad (9)$$

### 2.2.9. Color

Color measurements were made by using a chromameter (Widiyani et al., 2023). The result of the reading is L = lightness, a = redness, and b = yellowness. The chromameter results will be translated into the value of L = lightness, which has a range of 0, which means the color is getting blacker, to a value of 100, which means the color is getting whiter. The color dimension is also expressed by the symbol a = redness, where a positive value indicates a redder color, and a negative value indicates a greener color. The next dimension is b = yellowness, where a positive value indicates a yellow color and a negative value means a blue color.

### 2.2.10. Yield

Calculation of the final yield (Paramita, 2023) was carried out by comparing the weight of the initial sample before drying with the weight of the final sample as dragon fruit peel powder. The result calculation formula can be seen on equation (10).

$$\text{Yield}\ (\%) = \frac{\text{final sample weight}}{\text{initial sample weight}} \times 100\% \qquad (10)$$

### 2.2.11. Data Analysis

The data obtained were analyzed for variability with Analysis of Variance (ANOVA) at a significance level of $\alpha = 0.05$ using SPSS Statistics V25.0 and Duncan's Multiple Range Test (DMRT) at a significance level of $\alpha = 0.05$.

## 3. RESULT AND DISCUSSION

### 3.1. Preparation of Dragon Fruit Peels Powder

The drying of dragon fruit peel was carried out using a food dehydrator at a temperature of 60°C for three drying times. The weight loss was observed as the drying time increased, and constant weight was obtained after drying for five hours. The weight loss in dragon fruit peel during drying can be seen in Figure 1. The difference in drying results for the three samples can be seen in Figure 2. When drying was carried out, we experienced a continuous decrease in weight in the initial 4 hours. In the span of 5 to 6 hours, the weight of dragon fruit peel powder stabilized. Drying is influenced by relative humidity (RH), which is the percentage of water vapour content in the air at a specific temperature relative to the total water vapor at saturation. RH is the ratio between the partial pressure of water vapor and the partial pressure of saturated water vapor in air at a certain temperature. Food dehydrators have a smaller RH value than ovens, so the resulting water content is also smaller than that of ovens (Chandra & Witono 2018).

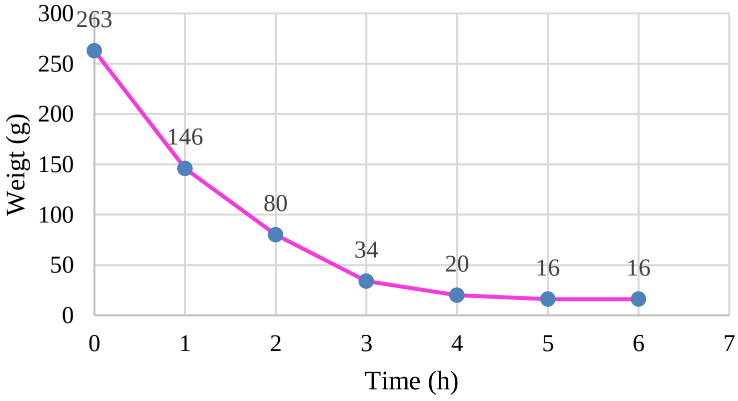


Figure 1. Weight Loss Chart of Dragon Fruit Peel Powder

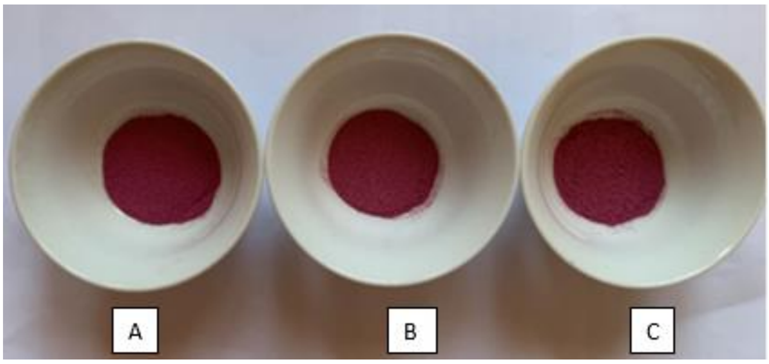


Figure 2. Sample A (Drying for 4 h) Sample B (Drying for 5 h) Sample C (Drying for 6 h)

### 3.2. Moisture Content

Moisture content is a very important component in determining the stability and durability of a product (Rismaya et al., 2018). Moisture content is the amount of water present in food ingredients, usually determined in percent. The free water content in food will affect the appearance, texture, freshness, flavour, and shelf life of food products. In addition, the water content will also affect the growth of moulds, yeasts, and bacteria, which will cause changes in the quality of food ingredients (Agustin et al., 2022). The moisture content of dragon fruit peel powder is shown in Table 1.

Table 1. The moisture content of dragon fruit peel powder

| Sample | Moisture Content (%dk) |
|---|---|
| A | 13.30±6.59$^{b}$ |
| B | 10.65±1.99$^{a}$ |
| C | 9.73±6.76$^{a}$ |

Sample A (drying for 4 h), sample B (drying for 5 h), sample C (drying 6 h). the results that show different lower-case letters indicate significant differences at a significance level of α = 0.05.

Based on the analysis that has been done, the results showed that variations in drying time affect reducing the moisture content of dragon fruit peel powder. The results of the variance test showed that the water content in the three variations of drying time was significantly different ($P<0.05$). The lowest moisture content was achieved by the drying time of 6 h (9.73%). The results of the water content obtained meet the requirements of SNI-3751-2018 regarding wheat flour, with a maximum water content limit of 14.50%.

This result was similar to the research conducted by Puspita (2021), where the moisture content of dragon fruit peel flour was 9.73%-13.30% when oven-drying for 20 hours at 60°C. However, these results were higher compared to the research conducted by Chumroenvidhayakul (2022), which obtained a moisture content in dragon fruit peel flour of 5.81% after drying for 12 hours at 60°C using an oven. The decrease in water content in the increase of drying time variation is caused by the heat given, which causes evaporation of water, and the longer time leads to more water evaporating.

### 3.3. Ash Content

Ash content is the residue produced after burning organic matter at high temperatures. Heat the sample material at a high temperature of more than 450 °C or decompose the organic components (C, H, O) with strong acids. This residue consists of various minerals whose composition and amount depend on the type of food and the analytical method used. Ash content is also related to the mineral content of the material. Ash content testing can be done by determining total ash content, water-soluble ash content, and acid-soluble ash content (Agustin et al., 2022). The ash content of dragon fruit peel powder is shown in Table 2.

Table 2. The ash content of dragon fruit peel powder

| Sample | Ash Content (%db) |
|---|---|
| A | 13.74±0.67$^{a}$ |
| B | 14.52±1.56$^{a}$ |
| C | 14.27±3.32$^{a}$ |

Sample A (drying for 4 h), sample B (drying for 5 h), sample C (drying 6 h). the results that show different lower-case letters indicate significant differences at a significance level of α = 0.05.

The results of the variance test showed that the ash content in the three variations of drying time was not significantly different ($P>0.05$). It was known that the average ash content obtained ranged from 13.74% to 14.27%. The results of the ash content obtained did not meet the requirements of SNI-3751-2018 regarding wheat flour, with a maximum ash content limit of 0.70%. The high ash content test results are caused by the high mineral content in food ingredients (Riansyah et al., 2013). Dragon fruit skin contains minerals such as calcium and phosphorus (Puspita et al., 2021). Therefore, the higher ash content could be associated with the higher mineral content of the product. These results were much higher compared to the other peel powder, such as mango peel powder 3.6% (Weshah and Al-Hafud, 2023) and banana peel powder 6.45% (Akram et al., 2022).

### 3.4. Fat Content

Fats are categorized chemically as a group of ester organic compounds formed from the reaction of alcohols and organic acids. Fat-forming components generally consist of glycerol molecules that bind to three fatty acid molecules or mixed triglycerides. Fat in food components is a heterogeneous component, causing the analysis of fat constituent components to be very complex. The fat content in flour should be small because fat can cause rancidity in flour when it is at high levels (Darmawati et al., 2022). The fat content of dragon fruit peel powder is shown in Table 3.

Table 3. The fat content of dragon fruit peel powder

| Sample | Fat Content (%db) |
|---|---|
| A | $22.81 \pm 1.64^{ab}$ |
| B | $22.46 \pm 1.98^{a}$ |
| C | $23.46 \pm 6.42^{b}$ |

Sample A (drying for 4 h), sample B (drying for 5 h), sample C (drying 6 h). the results that show different lower-case letters indicate significant differences at a significance level of $\alpha = 0.05$.

The results of the variance test showed that the fat content in the three variations of drying time was not significantly different (P>0.05). The average fat content obtained ranged from 22.13% to 23.46%. These results were in contrast to the research conducted by Simangunsong (2014), which found fat content in dragon fruit peel flour at 2.26% to 2.60%. The study conducted by Mukminah (2019) also reported that the fat content of red dragon fruit peel flour ranged from 12.03% to 14.30%. High-fat content occurs due to the destruction of fat due to high temperatures. Fat is a compound formed as an esterification reaction between glycerol and fatty acids. The heat used for drying results in the breaking of double bonds in fat so that the fat will be decomposed into glycerol and fatty acids (Darmawati et al., 2022).

### 3.5. Protein Content

Protein is a macro component that is very important for the body because it functions as a building substance in the formation of damaged cells and as a source of energy because it contains carbon. The protein component in food is essential (Agustin et al., 2022). The protein content of dragon fruit peel powder is shown in Table 4.

The results of the variance test showed that the protein content in the three variations of drying time was significantly different (P<0.05). After Duncan's post-test, the results of sample B (5 hours) were the same as sample C (6 hours), but sample A (4 hours) was different from the other two samples. The average protein content obtained ranged from 13.07% to 15.18%. The results of the protein content obtained meet the requirements of SNI-3751-2018 regarding wheat flour, with a minimum protein content limit of 7.0%.

However, the result was different from the research conducted by Chumroenvidhayakul

(2022), who obtained a lower protein content in dragon fruit peel flour, which was 6.37%. Similarly, in a study conducted by Simangunsong (2014), the protein content obtained ranged from 7.0% to 9.0%. In addition, research conducted by Arsyad (2021) also reported that the protein content of dragon fruit peel flour was 0.40% to 0.79%. The drying process results in lower moisture content loss compared to other cooking methods, so the proportion of protein content could increase (Nguju et al., 2018). However, the longer drying time could result in a decrease in protein content due to protein denaturation in food products.

Table 4. The protein content of dragon fruit peel powder

| Sample | Protein Content (%db) |
|---|---|
| A | 15.18±1.14$^{b}$ |
| B | 13.76±1.80$^{a}$ |
| C | 13.07±2.71$^{a}$ |

Sample A (drying for 4 h), sample B (drying for 5 h), sample C (drying 6 h). the results that show different lower-case letters indicate significant differences at a significance level of $\alpha = 0.05$.

### 3.6. Carbohydrate Content

Another macronutrient component is carbohydrates, which function as energy producers for the human body. Carbohydrates are broadly divided into two groups: simple carbohydrates and complex carbohydrates. Simple carbohydrates are divided into monosaccharides, disaccharides, and oligosaccharides. In comparison, complex carbohydrates are divided into polysaccharides and non-starch polysaccharides or fiber. Carbohydrate components in dragon fruit peel are generally dominated by fiber. The carbohydrate content of dragon fruit peel powder is shown in Table 5.

The results of the variance test showed that the carbohydrate content in the 3 variations of drying time was not significantly different (P>0.05). After Duncan's post-test, the results of sample A (4 hours) were the same as sample C (6 hours), but sample B (5 hours) was the same as the other two samples. The average carbohydrate content obtained ranged from 34.99% to 39.49%.

Table 5. The carbohydrate content of dragon fruit peels powder

| Sample | Carbohydrate Content (%db) |
|---|---|
| A | 34.99±3.25$^{a}$ |
| B | 38.94±1.62$^{ab}$ |
| C | 39.49±4.60$^{b}$ |

Sample A (drying for 4 h), sample B (drying for 5 h), sample C (drying 6 h). the results that show different lower-case letters indicate significant differences at a significance level of $\alpha = 0.05$.

The increasing trend of carbohydrates could be due to the breaking down of the bonding part of the water molecule ($H_2O$) during the drying process, which can affect the carbohydrate content. This could happen due to water molecules forming hydrates with other molecules containing O and N atoms, such as carbohydrates. In addition, an increase in carbohydrate content increases total soluble solids because sugars, as part of carbohydrates, dissolve further with heating, so total soluble solids could also increase (Yunita, 2015). Another researcher also revealed that the increasing temperature of drying did not significantly affect the carbohydrate content in winged beans (Asgar et al., 2022).

### 3.7. Crude Fiber

Crude fibre is a component that is present in food but cannot be digested by the human body. Dietary fibre is generally sourced from plant foods such as fruits, vegetables, grains, and legumes. Dietary fibre plays an essential role in maintaining digestive health, helping to reduce cholesterol, and maintaining body weight. Food fibre is divided into two groups: insoluble dietary fibre and soluble fibre. One of the benefits of fibre in dragon fruit skin is that it lowers cholesterol through the mechanism of inhibiting fatty acid synthesis. The crude fiber content of dragon fruit peel powder is shown in Table 6.

Table 6. The crude fiber of dragon fruit peel powder

| Sample | Crude Fiber (%db) |
|---|---|
| A | 31.75±2.23$^{a}$ |
| B | 30.50±1.16$^{ab}$ |
| C | 29.13±0.61$^{a}$ |

Sample A (drying for 4 h), sample B (drying for 5 h), sample C (drying 6 h). the results that show different lower-case letters indicate significant differences at a significance level of α = 0.05.

The results of the variance test showed that the crude fiber in the three variations of drying time was not significantly different (P>0.05). After Duncan's post-test, the results of sample A (4 hours) were different from sample C (6 hours), but sample B (5 hours) was the same as the other two samples. The average crude fiber content obtained ranged from 29.13% to 31.75%. This decrease is caused by the cell walls of the material breaking down during the processing process and the time of drying, causing the crude fibre content of the material to decrease (Yunita, 2015). These results were also in line with the previous research, which stated that the longer time and the higher temperature of drying did not affect the fiber content of leave powder, which in detail has an increasing trend for the soluble dietary fiber and a decreasing trend for the insoluble dietary fiber (González-Jiméne et al., 2022). According to research conducted by Puspita (2021), the food fiber content contained in red dragon fruit skin was 46.7%. This fiber content value was higher than the fiber content value in wheat flour by 5.12% (SNI 2018).

### 3.8. Antioxidant Activity

Antioxidants are electron-donating chemical compounds and can stop chain reactions caused by free radicals in the body. In general, the human body will be exposed to free radicals from air pollution during outdoor activities. Plants contain antioxidants that function as radical scavengers and can convert free radicals to less reactive ones. Carotenoids, vitamins, flavonoids, and phenols are examples of natural antioxidants found in plants. Some of the ways that antioxidants can be used to stop oxidation reactions are as proton donors and inhibition with enzymes. The antioxidant activity of dragon fruit peel powder is shown in Table 7.

Based on the results of the variance test it showed that antioxidant activity in 3 variations of drying time was significantly different (P<0.05). The results were performed in IC50, which is the concentration of extract that could eliminate 50% of free radicals (Adelina et al., 2021). The lower IC50 value is associated with higher antioxidant activity. The results obtained for sample A was 0.11 g/mL, sample B was 0.07 g/mL, and sample C was 0.03 g/mL. Based on these results, it can be seen that the longer drying time could increase the antioxidant ability. The Maillard reaction that occurs during the drying process can produce non-phenolic compounds such as malonaldehyde and can contribute to the antioxidant content made. In addition, the processing process can break down covalently bound phenolic compounds into free forms that can increase their antioxidant activity. The same results were obtained by increasing the time and temperature of the drying process, which could increase the antioxidant activity of pine nut skin and shell (Adelina et al., 2021). However, these results were lower compared to the antioxidant performance of jackfruit peel in methanol extract with IC50 1.25 mg/mL and garlic peel in ethanol extract with IC50 0.20 mg/mL (Bhardwaj et al., 2022). The different results could also be affected by the various methods of analysis.

Table 7. Antioxidant activity of dragon fruit peel powder

| Sample | IC50 (g/mL) |
|---|---|
| A | 0.11±0.00[c] |
| B | 0.07±0.00[b] |
| C | 0.03±0.03[a] |

Sample A (drying for 4 h), sample B (drying for 5 h), sample C (drying 6 h). the results that show different lower-case letters indicate significant differences at a significance level of α = 0.05.

### 3.9. Color

Color parameters are determined using the International Commission on Illumination (CIE) L*a*b* system. The L* (lightness) value indicates the level of brightness or reflected light that produces the achromatic colors of white, grey, and black [L* = 0 (black) and L* = 100 (white)]. The a* value represents a red-green mixed color consisting of a* representing a red value between 0 and 60, while -a* denotes a green color with a value between 0 and -60. The b* value represents the blue-yellow mixed chromatic color, which consists of b* representing the yellow color with a value of 0-60, and the -b* value representing the blue color with a value of 0 to 60 (Widiyani et al., 2023). Color is one of the most important physical characteristics of the food ingredient. Therefore, the effect of drying on color should be evaluated. The color analysis of dragon fruit peel powder is shown in Table 8.

Table 8. The color of dragon fruit peel powder

| Sample | L* | a* | b* |
|---|---|---|---|
| A | 29.68±0.00[a] | 9.61±0.44[a] | 16.53±0.04[a] |
| B | 30.09±0.02[b] | 10.18±0.42[b] | 15.55±0.36[b] |
| C | 30.23±0.00[c] | 10.34±0.14[c] | 15.20±0.37[c] |

Sample A (drying for 4 h), sample B (drying for 5 h), sample C (drying 6 h). the results that show different lower-case letters indicate significant differences at a significance level of α = 0.05.

The L*, a*, and b* values were significantly different among samples ($P<0.05$). The L* and a* values increased significantly, while the b* value decreased with the increasing drying time. All the samples have a* value positive (9.61-10.34), which indicates the samples tend to have red color, and the highest intensity of red color was obtained in sample C. The increasing of a* value could also relate to the formation of melanoidin, which is produced during the drying process. Meanwhile, all samples have the positive b* value (15.20-16.53), which is associated with a yellow color while decreasing during the drying process. The decrease of b* value with the increasing drying time was also observed in flaxseed (Suri et al., 2020). Meanwhile, the rising L* value (29.68-30.23), which resulted in brighter color as drying time increased, was not a common phenomenon that happened during the drying process. However, the degradation of pigment, such as anthocyanin and betacyanin, in dragon fruit peel powder during the drying process can explain the result obtained. The same results were also observed with the *buni* fruit sample that contained a high amount of anthocyanin pigment (Permatasari and Defsila, 2021). Therefore, the increasing drying time could lead to a brighter color of dragon fruit peel powder.

### 3.10. Yield

The results of the variance test show that the yield at three variations of drying time is not significantly different (P>0.05). The results (Table 9) of sample A (4 hours) showed the highest yield of 4.52%, followed by sample B (5 hours), which showed 4.47%. The lowest yield was obtained in sample C (6 hours), which is 4.42%. Based on these results, it can be concluded that the longer drying time led to a smaller yield.

Table 9. The yield of dragon fruit peel powder

| Sample | Yield (%) |
|---|---|
| A | $4.52 \pm 1.50^{a}$ |
| B | $4.47 \pm 2.93^{a}$ |
| C | $4.42 \pm 5.93^{a}$ |

Sample A (drying for 4 h), sample B (drying for 5 h), sample C (drying 6 h). the results that show different lower-case letters indicate significant differences at a significance level of $\alpha = 0.05$.

The results were in accordance with research conducted by Santi (2021) on dragon fruit, which stated that a longer drying time could produce a smaller yield of product (12-15%). Other research also reported that increasing drying time could decrease product yield. This could happen due to the water contained undergoing evaporation during the longer drying process. However, the moisture content of dragon fruit peel powder drying for four hours (13.30% in Table 1) has met the requirement of SNI-3751-2018, which has a maximum water content of 14.50%. Therefore, drying for four hours could be a reliable condition for drying dragon fruit peel.

## 4. CONCLUSIONS

The physicochemical characteristics of dragon fruit peel powder were affected by the drying time using a food dehydrator at 60 °C. The results showed that a drying time of 4 to 6 h had no significant effect on the ash, fat, and crude fiber content of dragon fruit peel powder. Longer drying time caused lower moisture and protein content, which reached the lowest point at 6 hours of drying time. The highest antioxidant capacity was found in the sample drying for six hours. A drying time of four hours was recommended to produce higher crude fiber, yield, and retain the color of dragon fruit peel, while a drying time of six hours was recommended to increase the antioxidant activity of dragon fruit peel powder.

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