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Proximate Analysis: Content of Red Dragon Fruit Peel

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ABSTRACT

Background: The dragon fruits have the beneficial, including antioxidants, anti-inflammatory, antimicrobial, properties, blood sugar regulation, and can be used as an ingredient in cosmetics. The purpose of the study was to identify the active compunds contains in Dragon fruits peels using proximate analysis approach. **Method**: In this study, The proximate analysis was used to measure the contents of water, materials, protein, fat, carbohydrate, crude fiber, energy, Fe, vitamin C and E content, and beta carotene content in the laboratory process. **Results**: The proximate test results showed that the moisture content of dragon fruit peel flour was 6.3732% - 6.5158%, ash content was 4.8069% - 4.6173%, protein content was 9.2396% - 9.4276%, fat content was 0.4807% - 0.3646%, carbohydrate content was 28.5208% - 28.4530%, crude fiber content was 50, 5788% - 50.6217%, energy content 238.5314 cal/100g - 238.4489 cal/100g, mineral content 2.8993 mg/100g - 2.8747 mg/100g, vitamin C content 16.9835 mg/100g - 25.4752 mg/100g, beta carotene content 5.4672 µg/100g - 4.7922 µg/100g. **Conclusion**: Research shows that dragon fruit peelc contains various nutrients and bioactive compounds that are beneficial for health

Introduction

Dragon fruit is a cactus plant that belongs to the family Cactaceae and subfamily Hylocereanea. Dragon fruit is one of the plants from the cactaceae family originating from Mexico and developed in Indonesia in 2001. Dragon fruit is one of the fruits that can launch metabolism and body immunity, besides that the peel and fruit also contain beta catotene, betalain dyes that give red color to the fruit, fiber and antioxidants where the antioxidant content in dragon fruit functions as an antidote to free radicals red dragon fruit peel is often discarded as waste by the community, even though it actually contains many useful substances [1][2]. Some of the active compounds contained in dragon fruit peel are vitamin C, vitamin E, vitamin A, alkaloids, terpenoids, flavonoids, thiamine, niacin, pyridoxine, cobalamin, phenolics, carotene, and phytoalbumin, red dragon fruit peel (Hylocereus polyrhizus) can also be used as a natural colorant in noodles, with organoleptic test results showing a p-value of 0,000. The best noodle formulation is the blush noodle in T2, making this innovation a potential solution for healthy food [3].

Proximate analysis is a method used to identify the nutritional content of foods, including dragon fruit peels. This method categorizes food components based on their chemical content and function. In proximate analysis, the methods used include the Kjeldahl method for testing protein content, the soxhlet method for testing fat content, the oven method for testing moisture content, and the dry soaking method for testing ash content. The advantages of proximate analysis include that the technology needed is still relatively easy to reach or obtain, and this method can calculate the total nutritional content of food ingredients in units of percent. However, proximate analysis also has disadvantages, namely that it cannot explain the digestibility or texture of food in detail [4].

Proteins are an essential component of human and animal cells, as they are made up of amino acid monomers linked by peptide bonds. Protein is essential for every organism, both human and animal. Fat is the compound with the highest nutritional content in foodstuffs, including dragon fruit peel. Various sources of fat can be used to improve the quality of food and support optimal health, especially essential fats that have good quality. Moisture content indicates the percentage quantity of water contained in food ingredients, which affects appearance, texture and flavor. Meanwhile, ash content is the residue of inorganic components in food ingredients that are closely related to minerals. Based on these considerations, this study was conducted to determine the nutritional content of dragon fruit peels. The nutritional components contained in dragon fruit peel are expected to provide health benefits and potential use as raw materials in other food products [5][6].

Various studies in the last five years have emphasized the antioxidant, antidiabetic, antimicrobial, and potential properties of dragon fruit peel pectin. These studies generally focus on secondary bioactive compounds and natural pigments, especially betacyanin, as well as the functional properties of pectin as a food additive. The results indicate that red dragon fruit peel has high antioxidant activity and can provide health benefits and broad industrial application potential [7]. Studies on the mineral content of dragon fruit peel are still very limited. Several studies have only mentioned the presence of macro minerals such as calcium, potassium, magnesium, and phosphorus, as well as micro minerals such as zinc, iron, and manganese, but comprehensive quantitative data are still rarely published [8][9]. In fact, minerals are important components that contribute to biological activity, nutritional value, and the potential use of dragon fruit peel as a functional food ingredient. The lack of research on mineral content means that the available information is still fragmentary, so it cannot yet be used as a strong basis for the development of dragon fruit peel-based food or pharmaceutical products. Based on this description, there appears to be a research gap, namely the limited scientific data on the mineral content profile in dragon fruit peel compared to research on other bioactive compounds. Therefore, this research is important to explore more information about the mineral content in red dragon fruit peel, so that it can complement the nutritional database, open up opportunities for wider utilization of dragon fruit waste, and support the development of functional food and pharmaceutical product innovations in the future.

Materials and Method

Time and Place

The research was conducted for six months, starting from August 2019 to February 2020. Samples of dried dragon fruit peel were obtained from dragon fruit farmers in Kulon Progo Yogyakarta. Previous research shows that adding 15% puree can increase the vitamin C content in dragon fruit products [10]. The dragon fruit peel was dried using a solar dome dryer technique. The dried dragon fruit peel was then blended into a powder form. Tests and analysis were carried out in a laboratory that is adequate for testing chemical and biochemical components.

Working Procedure

This research procedure includes moisture content testing, ash content testing, fat content determination, protein content determination, and carbohydrate content analysis.

Water Content Testing

A 5 gram sample of dried dragon fruit peel was weighed and then put into a porcelain cup of known weight and put into an oven at 100-105°C for 24 hours until the weight was constant. The cup containing the dried dragon fruit peel was removed from the oven and cooled in a desiccator. The calculation of water content is done with the following formula:

$$Water\ contain\ (\%) = \frac{B(g)-C(g)}{B\ (g)-A\ (g)} \times 100\%$$

A = Weight of empty cup (g)
B = Weight of cup with sample (g)
C = Weight of cup with dried sample (g)

Ash Content Testing

A total of 5 grams of dried dragon fruit peel samples are put into a porcelain cup that has been known by weight, nestled on a bunsen with a small flame until smoky, then in the furnace at 500-600 ° C until it becomes white ash. The ash obtained was cooled in a desiccator and weighed to a fixed weight. Calculation of ash content is done with the following formula:

$$Ash\ Content\ (\%) = \frac{C\ (g) - A(g)}{B\ (g) - A\ (g)} \times 100\%$$

A = Weight of empty cup (g)
B = Weight of cup with sample (g)
C = Weight of cup with dried sample (g)

Fat Content Testing

Dried dragon fruit peel samples were weighed as much as 2 grams, then extracted at 60 ° C for 8 hours and evaporated until dry. Then in the oven for 2 hours in an oven with a temperature of 150 ° C. Calculation of fat content is done with the following formula

$$Fat\ (\%) = \frac{C\ (gr) - A(gr)}{B\ (gr)} \times 100\%$$

A = Weight of empty round bottom flask (gr)
B = Weight of sample (gr)
C = Weight of round bottom flask and extracted fat (gr)

Protein Content Testing

The dried dragon fruit peel sample was weighed 2 grams and placed in a deconstruction flask. Added 15 ml of H_2SO_4 and 3 ml of H_2O_2 slowly and allowed to stand for 10 minutes. Deconstructed at 410 ° C for 2 hours until dissolved. Settled and added 50 ml of distilled water. Then distilled with 4% H_3BO_3 solution, sodium hydroxide, then distilled and collected distillate in erlenmeyer until the volume reached 150 ml. Titrated the distillate with 0.2 N HCl until the color changed from green to neutral gray. Calculation of protein content is done with the following formula

$$Protein\ (\%) = (VA - VB)\ HCL \times N\ HCL \times 14{,}007 \times 6{,}25 : W \times 1000 \times 100\%$$

VA = ml HCL titration sample
VB = ml HCL titration blank
N = Normality of standard HCL
14.007 = Atomic weight of nitrogen
6.25 = Protein conversion factor
W = Weight of sample

Carbohydrate Content Testing

Carbohydrate analysis is carried out by difference, which is the result of subtraction from 100% with water content, ash content, protein content, and fat content, so that the carbohydrate content depends on the reduction factor.

$$Karbohidrat\ (\%) = 100\% - (abu + air + lemak + protein)$$

Fiber Content Testing

Dried dragon fruit peel flour samples were weighed (2-3 grams) and extracted fat using a Soxhlet device with ether or petroleum ether, then the samples were dried in an oven until constant weight. The fat-extracted samples were then hydrolyzed with 0.255 N sulfuric acid solution for 30 minutes, filtered, and washed with hot water. Next, the samples were hydrolyzed with 0.313 N sodium hydroxide solution, filtered, and washed again with hot water and ethanol or acetone. After the washing process, the residue was dried in an oven at 105°C until constant weight, then burned in a furnace at 550°C to remove organic matter. Crude fiber content was calculated using the formula:

$$Crude\ fiber\ content\ (\%) = \frac{(Initial\ sample\ weight(g)}{Residue\ after\ burning(g)} \times 100\%$$

Energy Content Testing

Method: Energy content testing was carried out using the calorimetric method. A sample of dried dragon fruit peel that has been mashed is weighed as much as 1 gram. The sample was put into a bomb calorimeter, and the combustion process was carried out in high-pressure oxygen. After the combustion is complete, the temperature rise of the water in the calorimeter is measured, and the calorific value is calculated using the equation:

$$Energy(kal/100g) = \frac{\Delta T \times W \times C}{sample\ weight(g)} \times 100$$

ΔT = increase in water temperature
W = weight of water in calorimeter
C = calorific capacity of the calorimeter.

Phosphorus (P) Level Testing
Phosphorus levels were determined by spectrophotometric method. A 2 gram sample of dried dragon fruit peel was decomposed using concentrated HCl, then filtered and diluted to a certain volume. The decomposed solution was added to the reagents ammonium molybdate and stannous chloride, then the absorbance was measured at a wavelength of 690 nm. Phosphorus levels were calculated based on a standard curve made using phosphate standard solution.

Iron (Fe) Content Testing
Iron (Fe) content testing was carried out by atomic absorption spectrophotometry (AAS) method. A 2 gram sample of dried dragon fruit peel was decomposed using a mixture of HNO_3 and concentrated HCl. The decomposed solution was filtered and diluted, then analyzed using an atomic absorption spectrophotometer at a specific wavelength for iron. Iron content was calculated using an iron standard curve.

Vitamin E Content Testing
Vitamin E content testing was conducted using the High-Performance Liquid Chromatography (HPLC) method. Dried dragon fruit peel samples were extracted with an organic solvent, such as hexane, then the extraction results were injected into an HPLC system with a UV detector at a wavelength of 292 nm. Vitamin E levels were calculated by comparing the chromatogram results with vitamin E standards.

Vitamin C Content Testing
Vitamin C content testing was carried out using the titration method. A sample of dried dragon fruit peel was weighed as much as 1 gram, pulverized, and extracted with oxalic acid. The extract was titrated with 2,6-dichlorophenolindophenol (DCPIP) solution until color change occurred. Vitamin C content was calculated using the formula:

$$\mathrm{vitaminC}\left(\frac{\mathrm{mg}}{200\mathrm{g}}\right) = \frac{(VX\ FX\ NX\ M)\mathrm{X}\ 100}{sample\ weight(g)}$$

V = volume of DCPIP used
F = DCPIP factor
N = normality of DCPIP
M = equivalent weight of vitamin C.

β-Carotene Content Testing
Testing of β-carotene content was carried out using the spectrophotometric method. Dried dragon fruit peel samples were extracted with an organic solvent, such as n-hexane, and then the absorbance was measured at a wavelength of 450 nm using a UV-Vis spectrophotometer. The β-carotene content was calculated by comparing the absorbance results of the samples with the β-carotene standard curve.

Results and Discussion
Results
Based on the tests carried out on dried dragon fruit peel flour samples at Chem-Mix Pratama Laboratory, the proximate analysis results are presented in Table 1.

Table 1. Proximate Test Results of dragon fruit peel flour replicates 1 and 2

No	Parameter (Unit)	Content		Difference
		1st Test	2nd Test	
1	Water (%)	6,3732	6,5158	0,1426
2	Ash (%)	4,8069	4,6173	0,1896
3	Fat (%)	0,4807	0,3646	0,1161
4	Protein (%)	9,2396	9,4276	0,188
5	Karbohidrat (%)	50,5788	50,6217	0,0429
6	Fiber (%)	28,5208	28,4530	0,0678

7	Energy (kal/100g)	238,5314	238,4489	0,0825
8	Fosfor (mg/100g)	2,8993	2,8747	0,0246
9	Fe (mg/100g)	3,8502	3,7256	0,1246
10	Vitamin E (mg/100g)	12,4678	11,9257	0,5421
11	Vitamin C (mg/100g)	16,9835	25,4752	8,4917
12	β-Karoten (ug/100g)	5,4672	4,7922	0,675

Discussion

Based on Table 1, it can be seen that the test results between the first and second replicates show insignificant differences. Therefore, the test results from the second replicate will be used in this study. The results of this study show that the moisture content of dried dragon fruit peel flour is 6.5158%, the moisture content of dragon fruit peel flour was 10%. Previous studies have shown that the water fraction content in dragon fruit peel is 73.038 ± 4.077 μg/ml. The difference in moisture content in this study and the research of Aprilia and Rakhmawati (2021) may be due to changes in environmental humidity during the measurement process or differences in the way samples are handled. If the samples are not stored under the same conditions the moisture content may differ. In addition, drying techniques, drying time, differences in where the dragon fruit grows and differences in fruit fertility can also affect test results[11][12].

The ash content in this study was 4.6173%, this result is much lower than the research of Aprilia and Rakhmawati (2021) which was 21.35%, the difference in ash content in this study can be caused by differences in the combustion process or heating accuracy. Differences in sample mass or combustion techniques can also affect the ash content measurement results. The higher ash content is related to the high mineral content in dragon fruit peels [12], [13]. The ash content in dragon fruit peel is an important parameter in proximate analysis that reflects the total amount of inorganic minerals. Ash remains after organic matter is burned at high temperatures, so ash content can be used to estimate the mineral content in food. Several studies have reported that dragon fruit skin has a higher ash content than the flesh. According to Yustini, (2020), the ash content of red dragon fruit skin reaches 8.75%, while a study by Wiyono, dkk (2023) reported an ash content ranging from 6–10% on a dry basis. These values indicate that dragon fruit skin has the potential to be a source of natural minerals [14].

The results in this study show that the fat content of dried dragon fruit peel flour is 0.3646%, this result is much lower than the research of Aprilia and Rakhmawati (2021) where in that study the fat content of dried dragon fruit peel flour was 4.80%. The difference in the results of fat content between this study and the research of Aprilia and Rakhmawati (2021) may be due to differences in the quality of the fruit or samples tested, or differences in terms of extraction techniques and treatments that are not uniform, causing differences in the results obtained [12][15]. Red dragon fruit skin contains only about 1.2% fat, much lower than the seeds, which have a fairly high essential fatty acid composition. The fat in dragon fruit skin generally consists of small amounts of unsaturated fatty acids, such as linoleic acid and oleic acid, which are beneficial for maintaining cardiovascular health. Another study identified that the lipid fraction in dragon fruit skin contains minor components such as phytosterols, tocopherols, and lipophilic pigments that can provide antioxidant effects. Although the levels are not significant, the presence of these compounds supports the potential of dragon fruit skin as a functional food additive. The low fat content makes red dragon fruit skin relatively low in energy, making it suitable for use as a low-fat food ingredient. On the other hand, the low fat content also reinforces the benefits of dragon fruit skin in the formulation of health products such as fiber-rich flour, functional beverages, or feed ingredients [16][17].

The protein content in this study was 9.4276%, this result is much higher than the results of Aprilia and Rakhmawati's (2021) research, which amounted to 5.08%. This difference in results can be caused by several factors, such as differences in the quality of the materials or samples tested, or also different environmental conditions and processing processes between the two studies. Variations in these factors can affect the chemical composition of the sample, including the measured protein content [12],[5]. The study by Biswas et al. (2022) reported dragon fruit peel powder with ~6.03% protein (peel powder, dry basis). Dragon fruit peel generally contains moderate to low amounts of protein compared to other parts that are more nutrient-dense; however, when converted into peel powder or peel flour (dry basis), the protein content may appear higher. Research reports from 2020-2025 show a fairly wide range of values from ~0.4 g/100 g (fresh basis) to ~6–7 g/100 g (dry/powder basis) depending on the species, the part analyzed, and the processing/reporting method [9].

The carbohydrate content in this study was 50.6217%, this result was slightly low when compared to the research of Aprilia and Rakhmawati (2021) which amounted to 50.76%. Other studies have reported that the carbohydrate content in dragon fruit peel is higher than that found in this study. A study by Biswas et al. (2022) reported that dragon fruit peel powder contains 77% carbohydrates (dry basis). Reyes-García et al. (2024) found that the carbohydrate content of dragon fruit peel was around 72.5 g/100 g (peel flour, dry basis), higher than that of the flesh. Nur et al. (2023) reported that the carbohydrate content of H. polyrhizus peel was 68% (basis reported in proximate analysis). The difference in the results of carbohydrate content between this study and the research of Aprilia and Rakhmawati (2021) could be due to several factors such as differences in the quality of dragon fruit peels used, differences in the drying process, or differences in laboratory conditions when testing can cause slightly different results. However, this difference was not significant and showed good consistency between the two studies.

The crude fiber content of dried dragon fruit peel flour in this study was 28.4530%. In Aprilia and Rakhmawati's research (2021), the crude fiber content of dragon fruit peel flour was 26.22%. The difference in crude fiber content in this study and the research of Aprilia and Rakhmawati (2021) could be due to differences in the variability and quality of the samples tested, differences in sample processing or fiber extraction techniques, or due to differences in the processing and drying methods of dragon fruit peels that can affect the crude fiber content. If there is a difference in the drying method or the length of drying, this may lead to differences in the final results. Dragon fruit peel contains very high levels of fiber, especially when analyzed in peel powder/peel flour (dry basis). Study reports show that the total fiber content in peel/powder ranges from 50% to 79% (dry weight) depending on the processing method and definition (total dietary fiber vs. crude fiber) [18][19].

The energy (calories) in dragon fruit skin is calculated based on its carbohydrate, protein, and fat content. Since dragon fruit skin is very rich in carbohydrates (fiber & pectin), low in fat, and has moderate protein, most of the energy comes from the carbohydrate fraction [16][20]. The results of this study also showed energy levels of 238.5314 cal/100g in the first replication and 238.4489 cal/100g in the second replication with a difference of 0.0825 cal/100g. Phosphorus levels were 2.8993 mg/100g in the first replication and 2.8747 mg/100g in the second replication with a difference of 0.0246 mg/100g. Iron content was 3.8502 mg/100g in the first replication and 3.7256 mg/100g in the second replication with a difference of 0.1246 mg/100g. Vitamin E content was 12.4678 mg/100g in the first replication and 11.9257 mg/100g in the second replication with a difference of 0.5421 mg/100g. Vitamin C content was 16.9835 mg/100g in the first replication and 25.4752 mg/100g in the second replication with a difference of 8.4917 mg/100g. The β-Carotene content was 5.4672 ug/100g in the first replication and 4.7922 ug/100g with a difference of 0.675 ug/100g.

In general, the results of replicate 1 and replicate 2 showed good consistency for most of the parameters measured. However, there are some parameters that show significant differences, namely in the content of vitamin C and vitamin E. Significant differences in vitamin C and E content are likely caused by several external factors such as exposure to light, oxidation processes, or less than optimal extraction methods. Vitamin C itself is known as a vitamin that is prone to degradation or damage when exposed to high temperatures or light, while vitamin E can be easily oxidized if not stored properly. Proximate test results on dried dragon fruit peel flour showed good consistency between the first and second replicates [15] However, to get a more complete picture of the nutritional content of dragon fruit peels, further research is needed to compare the proximate test results between dragon fruit peels that have been dried into flour with fresh dragon fruit peels. The drying process can significantly affect the nutritional content of dragon fruit peel, especially in terms of moisture content. Fresh dragon fruit peel has a much higher moisture content compared to dried dragon fruit peel. This difference can affect the concentration of other nutritional components such as carbohydrates, protein and fat. In addition, important compounds such as vitamin C and β-Carotene may be decreased or altered during drying, which may reduce the nutritional value of the dragon fruit peels [5][21][22].

Therefore, it is important to conduct further research comparing fresh and dried dragon fruit peels. This is done to understand how the drying process affects the nutritional quality. This research will help determine how much nutritional value can be retained in the final consumed product, as well as provide guidance for optimizing the processing process so that the health benefits of the original ingredients can be maintained. In addition, this research will also provide valuable information on the utilization of dried dragon fruit peel in various food products and compare its nutritional quality with fresh dragon fruit peel. For example, research by Nia Rochmawati (2019) explored the use of dragon fruit peel flour as a base for making cookies, while research by Nizori, Sihombing, and Surhaini (2020) discussed the use of dragon fruit peel as a natural food coloring. These studies show the practical application of dried dragon fruit peels. However, further research still needs to be done to compare the nutritional quality between fresh dragon fruit peels and dried dragon fruit peels [11][21]. Dragon fruit peel is not just waste, but a source of antioxidants, fiber, pectin, natural pigments, and bioactive compounds that are beneficial to health (antioxidants, antidiabetic, hypocholesterolemic, prebiotic) as well as being highly valuable in the food, pharmaceutical, and cosmetics industries. This potential makes dragon fruit peel a strong candidate for the development of functional foods and sustainable value-added products [23][24][25].

Conclusion

Based on the results of the study, it can be concluded that the proximate levels of dried dragon fruit peel flour showed good consistency between the first and second replicates. However, for this study, the proximate test results that will be used are from the second replicate, which includes moisture content of 6.5158%, ash content of 4.6173%, protein content of 9.4276%, fat 0.3646%, carbohydrate 28.4530%, crude fiber 50.6217%, energy 238.4489 cal/100g, mineral 2.8747 mg/100g, vitamin 25.4752 mg/100g, and β-Carotene 4.7922 μg/100g. The second replicate was chosen because it provided more accurate and stable data. Although there was a significant difference in vitamin C and E content, which is most likely due to external factors such as exposure to light or oxidation, the second replicate test results are still considered more representative for further analysis, especially considering the difference in water content between fresh and dried dragon fruit peels which may affect the concentration of other nutrients.

Declaration

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Conflicts of Interest: There is no conflict of interest in this research

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