

Proximate Analysis of Dragon Fruit (*Hylecereus polyhizus*)

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Abstract: Problem statement: Dragon fruit (*Hylecereus polyhizus*) is well known for the rich nutrient contents and it is commercially available worldwide for improving many health problems. Several studies show the proximity value of red pitaya fruits but the nutrient composition of the stem has not been extensively studied. **Approach:** This study was carried out to measure the proximate analysis of moisture content, water activity, ash, crude protein, crude fat, crude fiber, glucose and ascorbic acids content in premature and mature of dragon fruit. The dried powder was produced from the stem of dragon fruit and the proximate analysis of dragon fruit stem was compared between freeze drying process and drying oven process. **Results:** Results of this study showed that 96% moisture; 0.270 g of protein; 0.552 g L⁻¹ glucose and 132.95 mg L⁻¹ ascorbic acid of dragon fruit stem found higher than the fruit flesh of the dragon fruit. **Conclusion:** The premature stem had higher values than the mature stem of the dragon fruit which may helpful in preventing the risk factors of certain diseases.

Key words: Red pitaya, proximate analysis, Malaysia

INTRODUCTION

Dragon fruit or red pitaya belongs to the Cactaceae family from the subfamily Cactoidea of the tribe Cactea^[1]. In Malaysia, the red pitaya or dragon fruit is commonly called as “buah naga”. Among the red pitaya species *Hylcereus polyrhizus* (Red flesh) fruits are edible and it has a great source of vitamin C and water soluble fiber^[2]. *Hylcereus polyrhizus* is a small fruit climbing cactus that has received world-wide recognition as an ornamental plant for its large, scented, night-blooming flowers. The red skin fruit weighed up to 1kg has translucent dark-red flesh considered as a rich source of nutrients and minerals such as vitamin B1, vitamin B2, vitamin B3 and vitamin C, protein, fat, carbohydrate, crude fiber, flavonoid, thiamin, niacin, pyridoxine, kobalamin, glucose, phenolic, betacyanins, polyphenol, carotene, phosphorus, iron and phytoalbumin^[3]. It is also rich in phytoalbumins which are highly valued for their antioxidant properties^[4]. *Hylcereus polyrhizus* is rich in fibers, vitamin C, minerals and phytoalbumins which are highly valued for their antioxidant properties. The dragon fruit helps

the digestive process, prevent colon cancer and diabetes, neutralize toxic substances such as heavy metal, reduce cholesterol levels and high blood pressure and consumed regularly the dragon fruit can help against asthma and cough. It is also rich with potassium, protein, fiber, sodium and calcium which goods for health than other fruits^[5]. There are three techniques for foods drying are commonly used such as sun drying, drying oven and freeze drying. First, the drying process is heated high to force out the moisture from food. Secondly, dry air to absorb the released moisture and finally the air movement to carried out the moisture away from the food. The freeze dried product should be passing through all the three stages which are freezing process, primary and secondary drying process. Freeze-drying is a technique that results in high-quality dehydrated products due to the absence of liquid water and the low temperatures required in the process. The solid state of water during freeze-drying protects the primary structure and minimizes changes in the shape of the product, with minimal reduction of volume^[6]. The drying process may alter these properties, resulting in products with modified texture,

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optical, thermal and nutritional properties^[7]. The rehydration ratio can be considered as a measure of the injuries caused by the processing and drying to the material. It is generally accepted that the rehydration capacity is dependent on the degree of cellular and structural disruption. According to Jayaraman *et al.*^[8], during the drying process, irreversible cellular rupture and dislocation, results in loss of integrity and hence, in a dense structure of collapsed, greatly shrunken capillaries with reduced hydrophilic properties, which are reflected by the inability to imbibe sufficient water to fully rehydrate. Proximate analysis used to determine the proximate principles of any substance, as contrasted with an ultimate analysis. The proximate analysis of food refers to the analysis of the total content of a food component, not taking account of the individual compounds making up that food component. The macro components are generally analyzed for their proximate amounts^[9]. The main objectives of this study was to produce the dragon fruit stem in powder form using freeze drying process and to measure the proximate analysis parameter such as moisture content, water activity, crude protein, crude fat, crude fiber, ash, glucose and ascorbic acid between mature stem and premature stem and also comparing the proximate analysis of dragon fruit stem between freeze drying method and drying oven method.

MATERIALS AND METHODS

Sample preparation: The dragon stem was cleaned and drained off before used. Nearly 200 g of stem was cut into small pieces using Warring blender (Warring Commercial, Laboratory Blender) for 2 min and was homogenized using homogenizer (Heidolph DIAX 900) with ratio 1:3 w/v and filtered using Muslin Cloth. The filtrate was transferred into freeze dryer bottle in and kept at -18°C for four days or at -80°C for two days in freezer before freeze-drying at -45°C, pressure 86×10^{-3} M bar for 4 days. Then the frozen sample was freeze dried using freeze dryer (LABCONCO, Freeze Dry System/ FREEZONE 4.5). The freeze dried sample was kept into a tight container before further analysis. Moisture, ash, fat, protein content, water activity and fiber in the sample were determined using method by AOAC International^[10].

Moisture content: The crucible was placed inside drying oven for 105°C for 2 h. After that, the crucible was placed in the desiccators for allowing cooling. The beaker was weighed and 2 g of the powder was placed in the beaker. The sample was drying in drying oven (Memmert 600, Germany) for 3 h at temperature

105°C. Then the dried sample was weighed for percent of dry weight and percent of moisture content in sample.

Ash: The preparation of ash was same as preparing crucible in moisture content. Two gram of sample was put into crucible and weight was recorded and placed in muffle oven (Furnace Nabertherm, Germany) at 550°C for 8 h.

Fat: The fat content was determined directly extracting the dried ground pitaya fruit with petroleum ether in an intermittent Soxhlet extractor (Soxhlet Extractor Darmstadt, Germany) and extracted the sample for 4 h. The residue in round bottom flask after solvent removal represents the fat content of the sample. The residue was weight and checks the Reflective Index (RI) using reflxtrometer (Merck KGaA, 64271 Darmstadt, Germany).

Crude protein: Nitrogen was determined using micro-Kjeldahl method. About 2 g of dried sample was transferred into digestion tube by adding 2 tablets of catalyst and 20 mL of sulfuric acid to digestion in 30 min using Kjeldahl digester (Tecator Kjeltac System, Germany) at minimum temperature 400°C. After that, 50 mL distilled water was added for distillation using Kjeldahl distillation. Then, the sample was titrated with hydrochloric acid (0.20 N) to calculate the amount of HCL present in NaOH solution (40%). The boric acid solution (4%) was used for the catalyst reagent. The percentages of nitrogen were converted to protein by multiplying by 6.25.

Water activity: The powder was placed inside the plastic placing sample. It was measured using A_w sprint (Swiss made NOVASINA TH-500) water activity equipment.

Crude fiber: Two gram of sample was put into 250 mL conical flask and 1.25% Sulfuric acid solution was added. The sample was heated about 30 min and was filtered using vacuum filter (today's vacuum filtration VF 100) and washed until traces of acid was undetected using pH paper. The Whatman paper 5B which pore size 125 micrometer was placed in the Buchner flask. After that the acid extracted was transferred into 250 mL conical flask and 1.25% NaOH solution was added. The sample was heated again for 30 min and was filtered using vacuum filter and washed with water until base was undetected. The whole material was transferred into crucible and dried for 12 h at 120°C. After that the crucible was placed into muffle oven at 550°C for 12 h and weight of crucible was recorded.

Ascorbic acid: Five gram of fresh pitaya stem was cut and homogenized using warring blender. The sample was filtrated using Muslin cloth. The filtrate will used to determine the ascorbic acid content using reflectometer (Merck KGaA, 64271 Darmstadt, Germany).

Glucose concentration: The glucose concentration was determined using 2 g of fresh pitaya stem. The sample was cut into small particles and homogenized using warring blender. Then, the sample was filtrated using Muslin cloth and centrifuged with speed of 15000 rpm for 15 min. The emulsion was analyzed using glucose analyzer to measure the glucose concentration.

RESULTS

In this study, we determined the method of production of *Hylocereus polyrhizus* stem powder using freeze drying method and the proximate analysis parameter was carried out using dried sample from freeze dryer and drying oven. For proximate analysis, we determined the moisture content, water activity, ash, crude protein, crude fiber, crude fat determination, glucose and ascorbic acid. All the analysis was done through Standard Operation Procedure (SOP) in the food analysis lab. Table 1 shows the comparison between the operating system of freeze dryer and drying oven. The data shows that drying oven was used at 50°C to dry the sample rather than freeze dryer system was used at -45°C. About 184.02 g initial weight of sample stem was homogenized using homogenizer with water ratio 1:3 w/v and dried using freeze dryer at temperature -45°C and vacuum pressure 89×10^{-3} M bar. The final weight was 5.93 g and the weight of moisture lost was 178.09 g due to high amount of water contained in the pre mature stem.

Table 2 shows the proximity analysis in dragon fruit stem. For freeze dried product, the percentage of moisture content in mature stem was 96.04% and for pre-mature stem was 97.62%. While, for drying oven method, the percentages of mature stem was 96.11 and 96.42% for pre-mature stem. Water activity analysis relies on measuring the amount of moisture in the equilibrated headspace above the sample, which correlates directly with sample A_w . A sample for water activity was placed in a small closed chamber at constant temperature and a relative humidity sensor was used to measure the Equilibrium Relative Humidity surrounding the product (ERH) of the sample atmosphere after equilibration. A simple and accurate variation of this approach is the chilled mirror technique in which the water vapor in the headspace condenses on the surface of a mirror that was

cooled in a controlled manner. Water activity plays a main role where it controls the microbial activity and it keeps the key for the shelf life of the dragon fruit product especially in stem. The higher moisture content (high water activity, A_w) will thus decrease the keeping quality and the shelf life also shorter. The result shows the water activities of the mature stem for freeze drying and drying oven result was in range 0.545-0.563 A_w . While, for the pre-mature stem show that the result in range 0.836-0.865 A_w . There is a possibility for the growth of halophilic organisms and xerophilic organisms for minimum temperature at 25°C in the stem of dragon fruit.

In this experiment, the percentage of nitrogen was also calculated using the standard procedure of Kjeldahl methods and the conversion factor was 6.25. The result of this analysis showed that 7.18% of mature stem and 14.7% of pre-mature stem using freeze drying product. While, the percentage by without using freeze drying product are 6.3% for mature stem and 11.9% for pre-mature stem. Nitrogen was the most distinguishing element present in proteins. Figure 1 shows that percentage of crude protein in pre-mature stem was higher than the mature stem because, the pre-mature stem has more nitrogen presented rather than mature stem.

To determine the crude fat, the Soxhlet method was applied which involved a direct solvent extraction.

Table 1: Comparison of operating system of freeze dryer and drying oven

Measurement	Freeze dryer	Drying oven
Temperature	-45°C	50°C
Air condition	vacuum, cold	Fresh air inlet,
Pressure	86×10^{-3} M bar	hot normal air
Equipment brand	LABCONCO, Freeze dry system	Memmert 600, Germany
Duration time	4 days	1 day

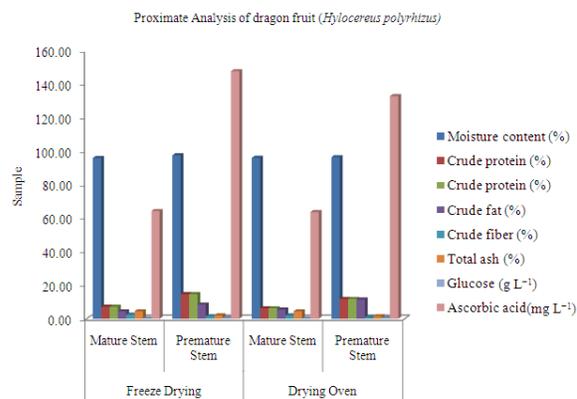


Fig. 1: Comparison between mature stem and pre-mature stem using freeze drying and drying oven

Table 2: Moisture content analysis of *Hylocereus polyrhizus*

Sample	Freeze drying		Drying oven	
	Mature stem	Premature stem	Mature stem	Premature stem
Moisture:				
Weigh of aluminum dish (g)	54.800	55.160	53.980	54.960
Weigh of aluminum dish with sample before drying (g)	60.350	60.200	58.610	54.960
Weigh of aluminum dish with sample after drying (g)	55.020	55.280	54.160	55.150
Dry Metter (%)	3.960	2.380	3.890	3.580
Moisture content (%)	96.040	97.620	96.110	96.420
Water:				
Water Activity (A_w)	0.563	0.836	0.545	0.865
Temperature (T)	25.3°C	25.5°C	25.7°C	25.2°C
Time (t)	11 min 32 sec	5 min		
41 sec	16 min 08 sec	5 min 52 sec		
Crude protein				
Amount of HCL required to titrate (mL)	10.000	18.600	9.000	15.000
Nitrogen (%)	1.480	2.350	1.010	1.900
Weight of protein (g)	0.144	0.294	0.126	0.238
Protein (%)	7.180	14.700	6.300	11.900
Crude fat:				
Thimble + dry sample (g)	46.890	47.050	47.420	47.580
Weight of thimble after extraction (g)	46.800	46.880	47.310	47.350
Weight of fat (g)	0.090	0.170	0.110	0.230
Crude fat (%)	4.500	8.500	5.500	11.500
Reflective index (Brix%)	10.800	28.400	12.500	33.100
Crude fiber				
Weight of crucible (g)	17.300	17.000	16.870	17.460
Weight of crucible + fiber (g):	17.350	17.030	16.910	17.480
Weight of fiber (g)	0.050	0.030	0.040	0.020
Crude fiber (%)	2.500	1.500	2.000	1.000
Ash:				
Weight of crucible (g)	16.910	17.440	17.010	17.920
Weight of crucible + ash (g)	17.000	17.480	17.100	17.950
Total ash (g)	0.090	0.040	0.090	0.030
Total ash (%)	4.500	2.000	4.500	1.500

The free lipid content consists of neutral fats (triglycerides) and free fatty acids was determined by extracting the dried and ground material with light petroleum or diethyl ether in a continuous extraction apparatus such as a Soxhlet extractor. The result for the fat weight in the mature stem and premature stem for freeze drying method was 0.09 and 0.17 g with reflective index 8.0 and 28.4% Brix. For without freeze drying result, weight of the mature stem and premature stem was 0.11 and 0.23 g with reflective index 12.5 and 33.1% Brix.

Table 2 shows the crude fiber analysis for mature stem and premature stem in dragon fruit. The result shows that the percentage of fiber was low in dragon fruit stem compared to the dietary standard of dragon fruit flesh. The crude fiber percentage of mature stem and premature stem using freeze drying are 2.5 and 1.5% while 2.0 and 1.0% for using drying oven. The standard of high-fiber in food was above 40% or above 0.75 g. The percentage of fiber in mature stem and premature stem are 4.5 and 2.0% respectively using freeze drying process and 4.5 and 1.5% respectively for drying oven process. The result shows that there was a

small amount of minerals left out in the stem. It was because the content of starches of the stem contains fiber, phosphate and calcium. Crucible selection was critical to accurate results but each type of crucible has its limitations. While platinum crucibles are the best, they are prohibitively expensive. In Table 2, majority of premature stem have higher value than mature stem. The higher parameters for premature stem are moisture content, water activity, crude protein crude fat, glucose concentration and ascorbic acid. The higher parameters for mature stem are crude fiber and total ash because of little fiber in premature stem of dragon fruit. But the Dragon fruit stem gets more fiber while growing up into a mature stem. Figure 1 shows that comparison between mature stem and premature stem using freeze drying process and drying oven process.

Basically, the result that has been taken from the experiment cannot be determined as same as the standard value of dragon fruit flesh. Half of nutrient in stem has higher value and another half has lower value. The higher values for proximate analysis parameter are moisture content and ascorbic acid. The lower values for proximate analysis parameter are crude protein,

Table 3: Comparison between stem and flesh of dragon fruit

Nutritional contents	Flesh	Stem
Moisture	82.5-83 g	96.0-98.0 g
Protein	0.159-0.229 g	0.120-0.270 g
Fat	0.21-0.61 g	0.09-0.23 g
Crude fiber	0.7-0.9 g	0.02-0.05 g
Ascorbic acid (vitamin C)	8-9 mg	63.71-132.95 mg L ⁻¹
Ash	-	0.03-0.09 g
Water activity (A _w)	-	0.545-0.865 A _w
Glucose	-	0.263-0.552 g L ⁻¹

crude fat, crude fiber and analysis. The other parameter such as glucose, ash and water activity cannot be determined as a lower or higher because the reference data cannot find. Table 3 shows comparison between stem and flesh of dragon fruit. The result shows that a small different value between freeze drying process and drying oven process. In this experiment, there are some different between freeze drying and drying oven. The differentiation of this process has been shown in Table 3, which was freeze drying process are used at -45°C and vacuum pressure at 86×10^{-3} M bar. For drying oven process, it was used at high temperature 50°C and pressure at normal air. In this case, the value of ascorbic acid has more affected to the others parameter because, ascorbic acid has a biological role as a reducing agent in hydroxylation reactions in the body, easily oxidized by air and easily destroyed by during food processing with high temperature. The results of this study were similar to the study done by Khalili *et al.*^[5].

DISCUSSION

Pitaya is commercially cultivated in many parts of Asia^[11] and cultivation in Malaysia is more concerned^[12]. The pitaya fruit has medicinal value and increases the excretion of heavy metal toxins and lowers cholesterol and blood pressure. The peel of dragon fruit has a high potential to be used as a natural dye^[13]. However, ingestion of significant amounts of red-fleshed dragon fruit may result in pseudo-hematuria^[14].

This research was carried out from the production powder from dragon fruit stem using freeze drying method and the proximate analysis parameters such as moisture content, water activity, crude protein, crude fat, crude fiber, ash, glucose and ascorbic acid was measured using freeze drying product (powder) and without using freeze drying product (dried with drying oven). Freeze dried products at lower temperatures extends their shelf life. The shelf life of a freeze dried product can be predicted by measuring the rate of degradation of the product at an elevated temperature. The drying oven process is used at 50°C and can make

an effect of proximate analysis parameter such as glucose and ascorbic acid. Based on the result of sample preparation by production of powder, to ensure the powder process was success, several parameters must be controlled such as cooling chamber, temperature and vacuum pressure. The temperature and the vacuum pressure must be in low temperature to get perfect powder. In the manifold method, flasks, impulse or vials are individually attached to the ports of a manifold or drying chamber. The product is either frozen in a freezer, by direct submersion in a low temperature bath, or by shell freezing, depending on the nature of the product and the volume to be freeze dried. The pre-frozen product was quickly attached to the drying chamber or manifold to prevent warming. The vacuum must be created in the product container quickly and the operator relies on evaporative cooling to maintain the low temperature of the product. This procedure can only be used for relatively small volumes and products with high eutectic and collapse temperatures.

CONCLUSION

A well rich nutrient content has the possibility to prevent various diseases. This study provides that premature stem of dragon fruit has more nutritional value than the mature stem. This selection of nutrients from the premature stem has an important nutritional quality to improve the benefit for health and therapeutic potential by targeting the compounds present in the premature stem. Red pitaya could be considered as a valuable economic product.

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