PROXIMATE COMPOSITION, MINERAL ANALYSIS AND PHYSICOCHEMICAL PROPERTIES OF DRAGON FRUIT *(Hylocereus undatus)*'S FLOWER

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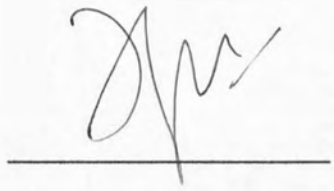

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ABSTRACT

This study was to determine proximate composition, mineral content and physicochemical properties of dragon fruit *(Hylocereus undatus)'s* flower using different treatment and storage temperature. Different treatments were store before blending (A) or blend before storing (B) and storage temperatures (25°C and –4°C) were used. Treament A with 25°C label as A25, treament A with –4°C label as A-4, treament B with 25°C label as B25, and treament B with –4°C label as B-4. The comparison of four samples using different treatments and storage temperatures showed that there were no significant differences in proximate composition, mineral content and physicochemical properties. In mineral analysis, potassium content in dragon fruit *(Hylocereus undatus)'s* flower was found to be high. Most mineral elements (i.e., sodium, calcium, magnesium, iron, copper and zinc) were found in small amount in this species. Sample A25 contained 78.02mg/g potassium, 7.26mg/g sodium, 19.72mg/g calcium, 11.87mg/g magnesium 0.2091mg/g iron, 0.0153mg/g copper and 0.1404mg/g zinc. Sample A-4 contained 52.44mg/g potassium, 5.40mg/g sodium, 7.56mg/g calcium, 8.27mg/g magnesium 0.1102mg/g iron, 0.0050mg/g copper and 0.0536mg/g zinc. Sample B25 contained 73.03mg/g potassium, 6.67mg/g sodium, 18.40mg/g calcium, 10.21mg/g magnesium 0.2042mg/g iron, 0.0101mg/g copper and 0.1134mg/g zinc. Sample B-4 contained 41.70mg/g potassium, 5.50mg/g sodium, 5.33mg/g calcium, 5.47mg/g magnesium 0.0843mg/g iron, 0.0021mg/g copper and 0.0392mg/g zinc. For the four treated samples, the range for water content was 90-92%. The values of crude fiber were within 6-7%. Ash, protein and crude fat showed the all values below 1%. And the values of carbohydrate were above 2% and below 1% for sample stored at room temperature and freeze temperature respectively. For physicochemical properties, soluble solid content of samples stored at 25°C and samples stored at –4°C were 6°Brix and 5°Brix respectively on the 7th day. The pH value for the four samples was fluctuating within pH value 4.4 and 5. The results of acidity showed the value between 0.13 and 0.25. In conclusion, dragon fruit (*Hylocereus undatus*)'s flower contained high water content in proximate composition and high content of potassium in mineral analysis.

ABSTRAK

NILAI PEMAKANAN BUNGA BUAH NAGA (HYLOCEREUS UNDATUS) DENAGAN MENGGUNAKAN RAWATAN DAN SUHU PENYIMPANAN YANG BERLAINAN

Kajian atas komposisi proksimat, kandungan mineral dan ciri-ciri fizikokimianya bagi bunga buah naga (Hylocereus undatus) dengan menggunakan rawatan dan suhu penyimpanan yang berlainan telah dijalankan. Rawatan seperti penyimpanan sebelum dikisar (A) atau pengisaran sebelum penyimpanan (B) dan suhu penyimpanan (25°C dan –4°C) yang berlainkan telah digunakan. Rawatan A dengan 25°C dilabelkan A25, rawatan A dengan –4°C dilabelkan A-4, rawatan B dengan 25°C dilabelkan B25, dan rawatan B dengan –4°C dilabelkan B-4. Daripada perbandingan empat sampel dengan menggunakan rawatan dan suhu penyimpanan yang berlainan, keputusan membuktikan bahawa tiada perbezaan signifikan dalam komposisi proksimat, kandungan mineral dan ciri-ciri fizikokimia. Dalam analisis mineral, kandungan kalium dalam bunga buah naga (Hylocereus undatus) dijumpai tinggi. Kebanyakan mineral (iaitu natrium, kalsium, magnesium, besi, kuprum dan zink) adalah dijumpai dalam jumlah yang kecil di dalam spesies ini. Sampel A25 contained 78.02mg/g kalium, 7.26mg/g natrium, 19.72mg/g kalsium, 11.87mg/g magnesium 0.2091mg/g besi, 0.0153mg/g kuprum and 0.1404mg/g zink. Sampel A-4 contained 52.44mg/g kalium, 5.40mg/g natrium, 7.56mg/g kalsium, 8.27mg/g magnesium 0.1102mg/g besi, 0.0050mg/g kuprum and 0.0536mg/g zink. Sampel B25 contained 73.03mg/g kalium, 6.67mg/g natrium, 18.40mg/g kalsium, 10.21mg/g magnesium 0.2042mg/g besi, 0.0101mg/g kuprum and 0.1134mg/g zink. Sampel B-4 contained 41.70mg/g kalium, 5.50mg/g natrium, 5.33mg/g kalsium, 5.47mg/g magnesium 0.0843mg/g besi, 0.0021mg/g kuprum and 0.0392mg/g zink. Untuk keempat-empat sampel, julat untuk kandungan air adalah 90-92%. Nilai-nilai serabut kasar adalah dalam lingkungan 6-7%. Abu, protein dan lemak menunjukkan nilai-nilai kurang daripada 1%. Dan nilai-nilai karbohidrat adalah lebih 2% dan kurang daripada 1% untuk sampel menyimpan di suhu bilik dan suhu beku masing-masing. Untuk ciri-ciri fizikokimia, kandungan pepejal larut sampel yang menyimpan pada suhu 25°C dan –4°C adalah 6°Briks dan 5°Briks masing-masing pada hari ketujuh. Nilai pH keempat-empat sampel adalah naik turun di dalam lingkungan nilai ph 4.4 dan 5. Kajian-kajian keasidan menunjukkan nilai antara 0.13 dan 0.25. Kesimpulannya, bunga buah naga (Hylocereus undatus) mempunyai kandungan air yang tinggi dalam komposisi proksimat dan kalium yang tinggi dalam analisis mineral.

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LIST OF SYMBOLS

g	gram
mg	milligram
cm	centimeter
ml	milliliter
kg	kilogram
Kcal	kilocalorie
%	Percentage
<	less than
≥	more than or same
±	plus and minus with
°C	degree Celsius
°Brix	degree of soluble solid content
ppm	part per million
N	normality

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CHAPTER 1

INTRODUCTION

1.1 Research Background

Hylocereus undatus, locally known as Dragon Fruit or Pitaya, belongs to cactaceae family. Originally from Central & Northern South America, it is a new crop plant that is increasingly becoming popular due to its high economic returns & nutritional value. In Malaysia, most of the Red Pitaya fruits are exported to Canada although some varieties of white Pitaya fruit can be found in local markets.

There are many varieties of dragon fruits. The 'White Pitaya' has white flesh and less juicy; while the 'Red Pitaya' has dark red fleshy fruit and very juicy. The 'Yellow Pitaya' is covered by yellow scarlet skin on the outer layer of the fruit. When cut open, the fruit pulp has numerous impregnated seeds of sesame look (Nerd *et al.*, 1999). It is delicious fresh with mild sweet to slightly sour taste. The fruit is round, 13cm in diameter on the average, each weighing between 200-250g.

The pitaya plant normally flowers at night. It is categorized as ornamental plants due to its large, white flowers that only open for one night. Pitaya stems are of three-sided (triangular), four-sided or five–sided (Grant & Grant, 1979; Haber, 1983). The

night-blooming flower of the dragon fruit is a spectacular sight to behold, and has earned the name "Moonflower" or "Queen of the night". The flower is large, with waxy, white petals, and produces a sweet fragrance as it blooms, attracting bees and ants as pollinating agents. Since the flower is open for only one night, hand pollination may be necessary in some cases (Weiss *et al.*, 1994).

The flesh can also be used in fruit salads, set in jellies, mixed with milk, made into fruit juices, enzyme drink, sherbets or jams. The fresh flower can be used in vegetable salads, and the dried flower, in teas and soup. The extract of the young stem can be made into a nutritional drink, and the young stem can also be used fresh in vegetable salads. Pitaya is propagated by the seed and stem cutting. It grows best in dry, tropical to subtropical climates in soil supplemented with high amount of organic materials or soil that contain 10% to 30% of sand. Rainfall requirements are modest, between 600 to 1300mm. Excessive rain leads to cause flower drop and fruit rot. As a result, shading is needed to increase the fertility of the crop and avoid fruit rot (soft rot) during raining season (Jacob, 1999).

Hylocereus undatus was chosen for this study because it is the most widely cultivated hemi epiphytic cactus. It occurs naturally in shaded habitats of tropical forests of Mexico, The West Indies, Central America, and northern South America, where it acquires water via roots in the ground and adventitious roots along its slender, three-flanged stems (Britton & Rose, 1963; Benzing, 1990; Barthlott & Hunt, 1993). It has various common names, including pitaya, red pitaya, strawberry pear, and increasingly pitahaya in Latin America, night-blooming cereus and queen of the night in North

America (the species is also cultivated for its large flowers), and red dragon fruit and fire dragon fruit in Asia. This species is currently grown for fruit in Australia, Cambodia, Colombia, Ecuador, Guatemala, Indonesia, Israel, Japan, New Zealand, Nicaragua, Mexico, Peru, the Philippines, Spain, Taiwan, Thailand, the United States, and Vietnam (Mizrahi & Nerd, 1999; Nerd *et al.*, 2002; Nobel & Barrera, 2002).

There are only a few researches on *Hylocereus undatus*'s flower. Most of previous studies focus their research on *Hylocereus undatus's* fruit but not on flower. However, this study explores the nutrient composition and physicochemical properties of *Hylocereus undatus's* flower.

1.2 Objective

1. Determine the proximate composition, mineral content and physicochemical properties of dragon fruit (*Hylocereus undatus*)'s flower with different treatment
2. Determine the proximate composition, mineral content and physicochemical properties of dragon fruit (*Hylocereus undatus*)'s flower with different storage temperature

CHAPTER 2

LITERATURE REVIEW

2.1 Dragon Fruit (*Hylocereus undatus*)

Dragon fruit or pitaya, have been grown in Vietnam for at least 100 years, following their introduction by the French (Mizrahi et al., 1997). Locally the fruit is known and sold as Thanh Long, or 'Green Dragon', a description associated with the green colour of the immature fruit, and the 'dragon-like' appearance of the 'scales' or bracts on the fruit surface. A member of the *Cactaceae*, the trailing cladodes stems modified to act as leaves bear spectacular ovoid fruit year-round which are a bright red colour when mature, and contain white, crimson, or pale-yellow flesh depending on the cultivar interspersed with small black seeds. There is currently much interest in developing this crop for fresh-fruit export beyond the 'local' Asian markets of Singapore, Hong Kong, Taiwan and Malaysia (Hoa *et. al.*, 2006). Dragon fruit has high economic value. It can be taken as fruit, flower, vegetable, health product and medicine as well, called "priceless treasure". Dragon fruit also called *Hylocereus undatus* is a red skinned climbing cactus that has received world-wide recognition as an ornamental plant for its large, scented, night-blooming flowers.

2.1.1 Fruit

The fruit comes in three types all with leathery, slightly leafy skin:

- *Hylocereus undatus*, white flesh with pink skin
- *Hylocereus polyrhizus*, red flesh with pink skin
- *Selenicereus megalanthus*, white flesh with yellow skin

Pulp colour in Hylocereus fruits varies from white to red and purple (Nerd, Gutman, & Mizrahi, 1999). The flesh, which is eaten raw, is mildly sweet and low in calories. The flavour is sometimes likened to that of the kiwifruit. The fruit may be converted into juice or wine; the flowers can be eaten or steeped as tea. Sesame seed-sized seeds are embedded throughout the flesh. Although the tiny pitaya seeds are eaten with the flesh, the seeds are indigestible. The fruit is popular eaten chilled, out of hand. It is also used to flavor drinks and pastries.

Table 2.1 Nutrition facts of Pitaya

Food value per 100g serving for Red Pitaya	
Moisture	82.5 – 83.0 g
Protein	0.159 – 0.229 g
Fat	0.21 – 0.61 g
Crude Fibre	0.7 – 0.9 g
Carotene	0.005 – 0.012 mg
Calcium	6.3 – 8.8 g
Phosphorus	30.2 – 36.1 mg
Iron	0.55 – 0.65 mg
Vit B1	0.28 – 0.43 mg
Vit B2	0.043 – 0.045 mg
Vit B3	0.297 - 0.430 mg
Vit C	8 – 9 mg
Other	0.54 – 0.68 g

Source: Taiwan Food Industry Development and Research Authorities, Report Code 85-2537. (Figure show may be vary from country to country due to climate, ways of cultivation and type of pitaya)

2.1.2 Flower

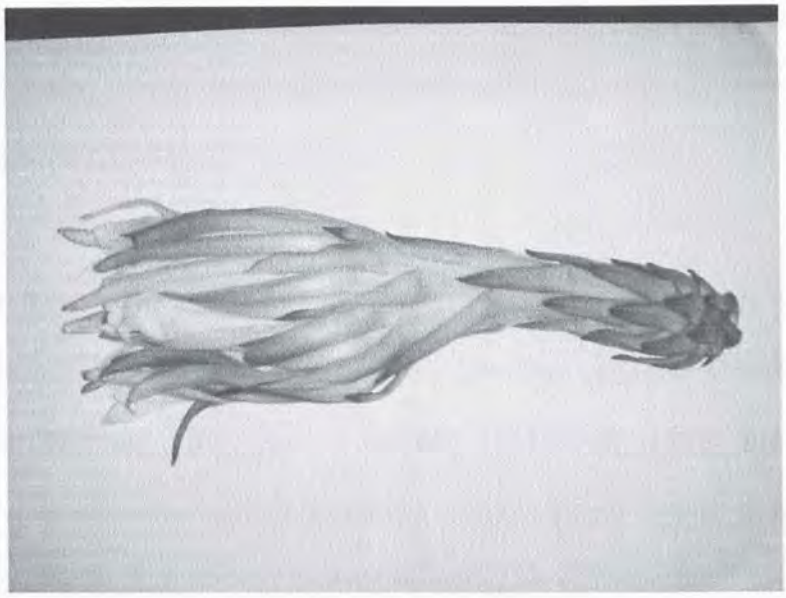

Figure 2.1 Dragon Fruit (*Hylocereus Undatus*)'s flower

Pitaya flowers at night. The large white flowers render them popular as ornamentals, being referred to as Moonflower, Lady of the Night or Queen of the Night (Jacobs, 1999). Research on the environmental factors which influence the induction of buds in pitaya would be useful for the understanding of variability in fruit set between seasons, between varieties and between sites. Flowering is initiated at the end of the dry season in Central America and continues throughout the wet season. Flowering in pitaya is a response to day length (Barbeau, 1990).

The night-blooming flower of the dragon fruit is a spectacular sight to behold. Since the flower is open for only one night, hand pollination may be necessary in some cases. Cross pollinating by hand of different species can encourage more prolific fruit set, and the fruit may also be larger in size. The oval to oblong fruit with overlapping scales

fill out quickly, and about 40 days after flowering, the fruit (8-15cm long) ripens, and is ready for picking. The fresh flower can be used in vegetable salads, and the dried flower, in teas and soup (www.itfnet.org/newsletter.content.fm?ID=231&NewsletterTitle= Newsletter%20Jan%202004).

Flowers are ornate and beautiful, and many related species are propagated as ornamentals. In the northern hemisphere, flower initiation occurs in several flushes from May to October (Barbeau, 1990; Nerd & Mizrahi, 1997; Ortiz, 1999), and seems to be induced by long days (Feng-Ru & Chung-Ruey, 1997; Luders, 1999). In full production, pitaya plants can have up to 4-6 fruiting cycles per year.

2.2 Description

Sprawling terrestrial or epiphytic vines; stems 3-winged, the wings 2-3 cm wide, thin, crenate with calloused margins. Areoles with 1-4 conical spines 1-3 mm long. Flowers nocturnal, 25-30 cm long, 15-25 cm in diameter; sepaloid perianth parts greenish white, linear to linear-lanceolate, 10-15 cm long, 1-1.5 cm wide, inner perianth parts white, oblanceolate, 10-15 cm long, ca 2.5 cm wide; staminal filaments cream-colored; style cream-colored, 17.5-20 cm long; stigma lobes up to 24, cream-colored. Berries red, fleshy, splitting, oblong, 5-12.5 cm long, 4-9 cm in diameter. (Wagner *et al.*, 1999)

2.3 Scientific Classification

Table 2.2 showed the scientific classification of Hylocereus undatus. The classification divided into seven group that are kingdom, division, class, order, family, genus and species. The scientific name for each classification from kingdom to species are Plantae, Magnoliophyta, Magnoliopsida, Caryophyllales, Cactaceae, *Hylocereus* and *H. undatus* respectively.

Table 2.2 Scientific classification of *Hylocereus undatus* (Anderson, 2001)

Classification	Scientific name
Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Caryophyllales
Family	Cactaceae
Genus	*Hylocereus*
Species	*H. undatus*

2.4 Variety of Dragon Fruit

There are many named varieties of dragon fruit. More than 60 have been identified in California alone. Some certainly were started from seed, but most were undoubtedly brought in from Asia and South America as cuttings. Importation of cuttings from outside of the country is difficult because the plants are protected under CITIS regulations, even though the majority of the *Hylocereus* species are not endangered. Quality of the fruit does vary between varieties, but harvest time has a much greater effect on quality than varietal differences. As mentioned previously, there are self-

compatible and self-incompatible varieties. The majorities of the varieties from Asia are self-compatible and are autogamous, as well. Except for a few varieties from Guatemala, the red-fleshed varieties are self-incompatible. There is considerable variation in fruit size and shape between the varieties. Fruit shape ranges from nearly round to an oblong shape that is typical of the white-fleshed varieties from Vietnam. Much work remains to be done in evaluating existing varieties and in selecting and developing new varieties based on fruit quality, shelf life, and productivity. Table 2.1 shows the Botanical and common names for cacti known as Pitaya or Pithaya (Dr. Fletcher, 1997).

Table 2.3 Botanical and common names for cacti known as Pitaya or Pithaya (Dr. Fletcher, 1997)

Botanical Names	Common Names
Acanthocereus occidentalis	pitaya
Acanthocereus pentagonus	pitahaya, naranjada
Acanthocereus tetragonus	pitaya, acanthocereus
Cereus peruvianus	pitaya, apple cactus
Cereus thruberi	pithaya
Echinocereus conglomerates	pithaya de agosto
Echinocereus stramineus	Mexican strawberry, pitahaya
Escontria chiotilla	pitaya, jiotilla
Hylocereus costaricensis	pitaya, pitahaya
Hylocereus guatemalensis	pitaya, pitahaya
Hylocereus ocamponis	pitaya roja
Hylocereus polyrhizus	pitaya, pitahaya
Hylocereus undatus	pitahaya oregona, red pitaya, strawberry pear, dragon fruit, dragon pearl fruit, thang loy, pitaya roja
Myrtillocactus geometrizans	pitaya
Selenicereus megalanthus	pitaya amarilla, yellow pitaya
Stenocereus griseus	pitaya de mayo
Stenocereus gummosus	pitaya agria
Stenocereus queretaroensis	pitaya de queretaro
Stenocereus stellaatus	pitaya de augusto
Stenocereus thurberi	pitaya dulce
Stenocereus thurberi var litoralis	pitaya dulce

2.5 Plant Cultivation

A veining, terrestrial or epiphytic cactus, with fleshy stems reaching from a few inches up to 20ft long (in mature plants). The plant may grow out of, and over the ground or climb onto trees using aerial roots. It grows best in dry, tropical or subtropical climates where annual rainfall ranges from 20-50" per year. In wet, tropical zones, plants may grow well but sometimes have problems setting fruit reliably. Will tolerate temperatures to 104F, and short periods of frost, but prolonged cold will damage or kill the plant. The plants aren't usually too picky as to soil type, but because of their epiphytic nature, it is recommended to grow them in soil that is supplemented with high amounts of organic material. The plant has been grown successfully in sandy soils. Shade is sometimes provided in hot climates.

2.6 Factors Influencing Flower Quality

The plants are sensitive to extremes in temperature. Flower production was found to be only 15% to 20% of levels in areas where average summer temperatures were just 7 degrees cooler(Mizrahi & Nerd, 1999). The main problem with too much shade is that flowering will be severely reduced and, consequently, production will be drastically reduced. To maximize production it is recommended that a minimum amount of shade be used to prevent bleaching out (Thomson, 2002; Raveh *et al.*, 1997). Although these plants are cacti, they take more water than expected for a typical desert cactus. The optimal amount of water still needs to be worked out and it will vary by location, depending on climactic factors as well as soil type. Heavy rains (greater than 1300 mm)

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