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Phytochemical composition, biological activities and nutritional aspects of *Hylocereus undatus*: A review

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Abstract

The most commonly cultivated vine cactus in the Cactaceae family is normally *Hylocereus undatus*, which would be native to Mexico and America. It is commonly referred to as "dragon fruit" or "pitaya." Additionally, it goes by the name "buahnaga," which means "dragon fruit." In addition to their attractive colour, *Hylocereus undatus* fruits are popular around the world due to its abundance in polyphenolic components and their antioxidant activity. Due to the characteristics, degree of production, and financial benefits of the pitahaya fruit, a member of the *Hylocereus* genus, more land has been planted in agriculture during the past two decades. Due to the characteristics, degree of production, and financial benefits of the pitahaya fruit, a member of the *Hylocereus* genus, more land has been planted in agriculture during the past two decades. Stalks, fruits, and flowers from the plant are used in food and film.

Keywords: *Hylocereus undatus*, antioxidant activity, antibacterial, toxicity, phytochemical content, wound healing

Introduction

Over a 100 years, the French introduced dragon fruit to Vietnam due to the most tropical fruit species have oval shapes and bright, red skin, it is known as thanh Long (Green Dragon). Having epidermis green foliaceous bracts or scales of a dragon. (Luu *et al.*, 2021) [34] Several *Hylocereus* and *Selenicereus* species, popularly known as strawberry pears, give medium- to large-sized fruit that the local community has long consumed. (J. Weiss *et al.*, 1994) [68]

One of the tropical fruits belong to the cactus family, Cactaceae is the dragon fruit or pitaya. Three major species of dragon fruit, particularly *Hylocereus undatus* (white flesh with pink skin), *Hylocereus polyrhizus* (red flesh with pink skin), and *Selenicereus megalanthus* (white flesh with yellow skin), are available for commercial cultivation. Because of the white flesh, *H. undatus* is often known as white pitaya. *Hylocereus undatus* was first observed in southern Mexico and has since moved to northern Australia, Taiwan, Malaysia, and other Asian nations. Pitaya raw flesh is kind of tasty and has little black seeds that are scattered throughout white flesh. (Sudha *et al.*, 2017) [57]. The most common method of propagating *undatus* is by cuttings, which are generated by detaching foot-long lateral branches at a stem segment. (Hitendraprasad & Hegde, 2020) [15] Fruits are a rich source of vital vitamins and minerals such alpha-carotene, vitamin E, vitamin C, lycopene, phosphorus, and calcium. Fatty acids are significantly important in industry and wellness. Importance, prospective economic advantage, and having a large market demand as a result. Therefore it is recognized as the fruit of the future. India has dragons Fruit cultivation and introduction are recent developments is being adopted in different regions. (Kakade *et al.*, 2021) [21]

Methodology of literature review

Several search engines and online databases, including SciFinder Scopus, PubMed, Google Scholar, Web of Science, and Science Direct, were used to perform an extensive literature survey from this review. The key words used were Antioxidant activity, Antibacterial toxicity, Phytochemical content, wound healing. On the subject of the review, both review papers and original research projects were included, with a focused on reports released during the last ten years.

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Papers with merely abstracts, unpublished manuscripts, conference proceedings, and publications in languages other than English were not taken into consideration. This is how the review is laid out:

The bioactive phytochemicals of the plant *Hylocereus undatus* are first exhibited in the leaves, fruits, roots, and seeds of the plant. These consist of their anti-inflammatory, antibacterial, and antioxidant properties.

Table 1: Taxonomy of *Hylocereus undatus*

Domain	Eukaryota
Kingdom	Plantae (Haeckel 1866)
Subkingdom	Tracheobionta
Super division	Spermatophyta (Seed Plant) (Willkomm 1854)
Division	Magnoliophyta (Flowering Plant) (Cronquist <i>et al.</i> 1966)
Class	Magnoliopsida (Dicotyledons) (Cronquist <i>et al.</i> 1966)
Subclass	Caryophyllidae (Takhtajan 1966)
Order	Caryophyllales (Jussieu 1789 ex Berchtold and Presl 1820)
Family	Cactaceae (Cactus family) (Jussieu 1789)
Subfamily	Cereoideae (Schumman 1898 published in Schumann 1899)
Tribe	Hylocereae (Buxbaum 1958)
Genus	Hylocereus (A. Berger) (Britton and Rose 1909)

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Morphology

The stems of dragon fruit have a habit of rising, spreading, and sprawling. They have lots of branching, too. There may be 4-7 fruits, each of which may measure up to 10 metres in length and 10-12 centimetres in diameter. Areoles are approximately 2 to 5 cm apart. Adult branches have spines that are 1-4 mm long and are from almost conical to acicular. Range in colour from blue-green to greyish-brown. The produce is Oval to oblong in shape. It is 3 to 8 cm thick and 4 to 10 cm long. This has a wide deep red frame and a bracteoles. These fruits have a white pulp with several little, black seeds dispersed throughout them it can be consumed. (Roy *et al.*, 2019) ^[50] The average shoot length showed significant differences (P0.05) seen between treatments

Cuttings dipped in a 6000 ppm concentration of IBA had shoots with the largest lengths (9.5 cm) and the shortest lengths (4.3cm), respectively. (Seran & Thiresh, 2017) ^[52] Pitaya florescence should last about 5 days for one turn. (Islam *et al.*, 2012) ^[18] Under natural environmental conditions, *Hylocereus undatus* is subjected to dramatic alterations in photosynthetic photon flux (PPF). Numerous epiphytes, such as *Hylocereus undatus*, beneath a deciduous forest's canopy get 3-8 times more PPF when it's dry comparison to during the rainy season. (Ortiz-hernández & Carrillo-salazar, 2012) ^[40] For *Hylocereus undatus*, the effect of high elevations on net CO₂ uptake was transcendent. Tried to introduce as a crop in several Israeli localities, such as the valleys of the Jordan and Arava streams, where the daily average temperature is higher than 37 to 38 °C. This leads in apoptosis and injured stem tissue. (Ortiz-hernández & Carrillo-salazar, 2012) ^[40].

Hylocereus species' fruits can weigh up to 800 g, develop from both the ovary and the receptacle that surrounds the ovary, and show a positive relationship between fruit weight and seed count. (Valiente-Banuet *et al.*, 2007) ^[64] There has been no systematic variation in the grade of fruit produced throughout the year. (Rebecca *et al.*, 2010) ^[49] The connection between growth rates and climatic factors describes the vegetable's response to environmental conditions. (Thayamini & Thiresh, 2015) ^[59] The onset of flowering was correlated with an increase in temperature and relative humidity. (Thayamini & Thiresh, 2015) ^[59] entomofauna associated with yellow pitaya crops in three Inzá plantations that distinguish in agronomic and landscape attributes (González-trujillo *et al.*, 2019) ^[12].

Table 2: Region of different species of *Hylocereus undatus*

Species	Country	Reference
<i>Hylocereus undatus</i>	Southern Mexico, since moved to northern Australia, Taiwan, Malaysia, Other Asian nations, cultivated in the Indian states like Tamilnadu, Andhra Pradesh, Karnataka, Maharashtra, Panjab.	(Hitendraprasad & Hegde, 2020) ^[15]
<i>Hylocereus megalanthus</i>	United states, canary islands, Australia, Thailand, Vietnam, Southeast Asia.	(Hitendraprasad & Hegde, 2020) ^[15]
<i>Hylocereus polyrhizus</i>	Vietnam, US, Israel, China, Malaysia, Indonesia.	(Jaafar Sidek & Md Zemi, 2019) ^[19]

Pitahaya species

Yellow pitahaya (*Hylocereus triangularis*) and red pitahaya are the two most widely produced and consumed are the types of pitahaya (*Hylocereus ocamponis*). The most notable species from a commercial viewpoint is the yellow pitahaya.

View (the fruit resists to manipulation and transportation). Berries are available in a variety of sizes; some measure Average values are 10 and 6 cm respectively along center line (12 cm) and transverse plane (5-8 cm). Descriptions of plants.

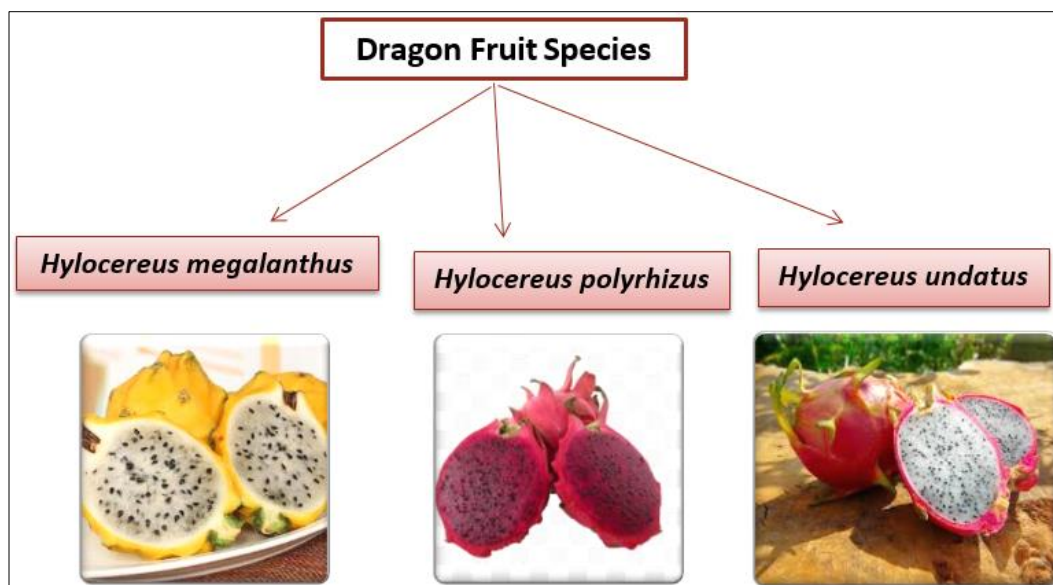


Fig 1: Shows the different dragon fruit species

***Hylocereus undatus*'s phytochemical composition**

The body benefits from the nutrition and phytochemicals discovered in dragon fruit. Several studies have found that dragon fruit having the capacity to prevent human illness. (Safira *et al.*, 2021) ^[51] The fruits of *Hylocereus* cactus have risen in value recently. It's tremendously increasing global popularity as a result of pretty colors, a sweet, juicy taste, and been considered as the Cactaceae family's most gorgeous. Besides being reddish-purple, *Hylocereus* fruits are also Because of this, cacti are being highlighted by global producers. Due to its abundant supply of polyphenolic components and their antioxidant activity. (Cheah *et al.*, 2016) ^[7].

Carbohydrates, proteins, saponin phenolic compounds, terpenoids, oils, flavonoids, tannins, phenols, coumarin, and steroids are among the phytochemicals detected in dragon fruit or pitaya. The fruit includes all the nutrients needed for a balanced diet, including vitamins, fat, crude fibre, and minerals, according to nutritional analyses. (Safira *et al.*, 2021) ^[51].

Cold plasma treatment improved the cutting-induced accumulation of phenolics and thus improved the antioxidant activity of fruit pitaya, freshly cut by inducing the consumption of main sugars, increasing energy supply, amplifying signal role of ROS, and activating phenylpropanoid metabolism in fresh-cut pitaya fruit. This treatment also significantly reduced the increase in total numbers of aerobic bacteria while maintaining the fresh-cut pitaya fruit's safety. (Li *et al.*, 2019) ^[26] Without seeds, juice yield is much lower, accounting for only 55% in some pitahaya varieties. (Le Bellec *et al.*, 2006) ^[25] The antioxidant properties were examined using the total polyphenol assay expresses gallic acid as equivalent, and there were 86.10 mg of total polyphenolic compound in 0.50 g of dried dragon fruit extract. (Rebecca *et al.*, 2010) ^[49].

Anti-inflammatory activity

Dragon fruit has antioxidant and anti-inflammatory properties due to its composition, which consists compounds such as betalains and squalene. Betalains are unstable and sensitive to degradative factors such as temperature, pH, oxygen, or light, but their bioactivity can be extended by encapsulation by introducing additional a protective and

impermeable layer. The anti-inflammatory activity of betalains derived from *Hylocereus polyrhizus* peels may be attributed to their high antioxidant activity. Free radicals may be the primary pro-inflammatory mediators; thus, reducing the mediators decrease the inflammatory response. (Luu *et al.*, 2021) ^[21].

Antioxidant activity

The availability of electrons to neutralise free radicals is the essential point of *in vitro* antioxidant activity. (Luo *et al.*, 2014) ^[33] The DPPH (1, 1-diphenyl-2-picrylhydrazyl) method was used to determine the total antioxidant activity of fruit extract. (Sudha *et al.*, 2017) ^[57] Several research were conducted on both the red and white pitaya samples, including antioxidant activity tests (DPPH, ABTS, and FRAP), TPC, TFC, and TBC. (Safira *et al.*, 2021) ^[51].

The total antioxidant content of *Hylocereus undatus* seeds water extract was determined to be 0.08 mg/ml. The FRAP assay measures antioxidants' ability to diminish the free radical effect of reactive oxygen species. Total antioxidant power is synonymous with total reducing power. The extract's radical scavenging and inhibition of lipid peroxidation was due to the quenching of free radicals or reduction of Fe³⁺ to Fe²⁺, which could be attributed to the presence of polyphenolics such as flavonoids, anthocyanins, and others. (Roy *et al.*, 2019) ^[50].

Antimicrobial activity

To determine whether antibacterial activity was present, the Agar well diffusion technique for bactericidal susceptibility was used in Aqueous Dragon fruit extract using *Escherichia coli*, *Klebsiella* sp, *Staphylococcus epidermidis*, *Staphylococcus aureus*, and one fungus (*Candida albicans*). The dragon fruit was juiced with blinder, and the crude was used directly. The remaining juice was dried in an oven at 45 degree celcius, and different solvents been brought to use with this dried extract. Methanol (with 5% DMSO and ethanol). The extractions were effective. carried out in an Innova 4000 incubator shaker at 40 °C for 2 hours before filtering with filter paper The medium was autoclave sterilised at 120 °C. The medium was then transferred to sterilised Petri plates and kept at 37 °C to solidify. Using a loop, the bacterial strains were distributed on Petri plates. A single 4 mm diameter well was made on each plate using a

gel pierce. The wells were packed with 5l of Dragon extract. The plates were incubated for 24 hours at 37 °C. The experiments were conducted in triplicate, and the zone of inhibition was determined. (Mahdi *et al.*, 2018) ^[35].

Antidiabetic activity

The functional properties of various concentrations of fruit samples differ significantly (P 0.01). The anti-diabetic activity of dragon fruit extracts ranged from 1.033 to 32.436 percent at various concentrations. As the concentration of dragon fruit extract increased, so did its functional properties. Red pitaya considerably enhanced insulin resistance, and consuming 600 g of red pitaya fruit everyday decreased blood glucose levels in type II diabetics. (Sudha *et al.*, 2017) ^[57].

Medicinal uses

Fruits from the genus *Hylocereus* and *Selenicereus* are very nourishing and significant in calcium, phosphorus, potassium, vitamins A and C, and vitamin C. In 26% of Mayan home orchards, *Hylocereus undatus* was conventionally produced for food and medication. (Livera *et al.*, 2012) ^[29].

Relevance of its industrial and medical applications. The effects of water-based extracts of the shoot, fruit peel, pulp, and flowers of *Hylocereus undatus* on the healing of wounds of streptozotocin diabetic rats were examined by Pérez *et al.* (2005) ^[44].

Industrial uses

Dragon fruit juice, sherbets, jam, syrup, yoghurt, jelly, preserve, candy, and pastries are just a few of the industrial products that can be produced using it. Pulp is now and then mixed into pizzas. Dragon fruit wine industry is a relatively prosperous industry in Malaysia. As a raw material for the food colouring industry, the red and pink pulp of dragon fruit can be used as a food colouring agent. Dragon fruit flower buds are used in soups and salads, and they can be consumed as vegetables. Tea is sometimes made with flowers. (Gunaseena *et al.*, 2006) ^[14].

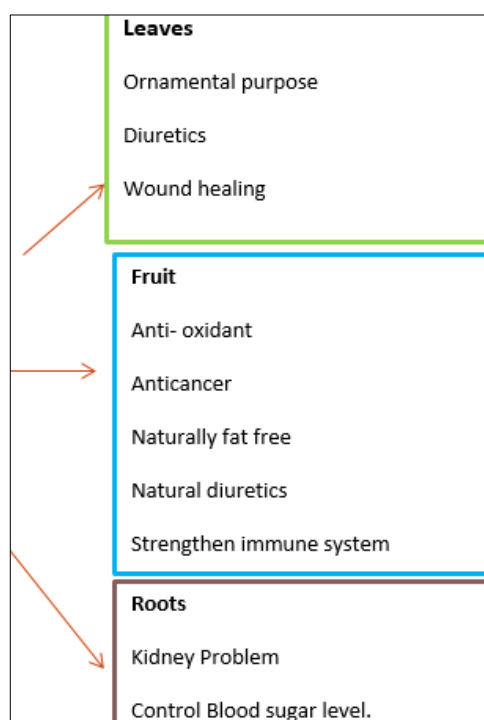


Fig 2: *Hylocereus undatus* plant part uses and its associated food matrice

Conflict of interest

The authors declare that there is no conflict of interest.

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Conclusion

Among the freshest fruits, popularly referred to as pitaya or dragon fruit or *Hylocereus* spp., is enjoyed widely throughout the world. Dry regions like those in Southeast Asia, America, Vietnam, Canary Island, and Thailand are ideal for dragon fruit cultivation. The body benefits from the minerals and phytochemicals found in dragon fruit. According to numerous research findings, dragon fruit offers potential as a human illness preventive for a number of ailments. Accordingly, dragon fruit can be categorised as a fruit that can be categorized as a medical plant and utilised as an alternative to the usage of medicinal treatments that are based on chemicals.

It has been exhibited that the ethanolic extract of *s. undatus* lowers blood sugar levels, which may be related to an increase in insulin production brought on by pancreatic cell regeneration. In addition, it has been shown that *S. undatus* contains flavonoids and alkaloids that can be used to treat diabetes and other disorders. The ethanolic extract of *S. undatus* was found to have anti-diabetic qualities, suggesting it may be beneficial in the treatment of diabetes. The results demonstrate that the dragon was an excellent source of antioxidant activity. Furthermore, it had the capacity to heal wounds when applied with an extract cream, which shown an incredible capacity to do so and had a greater activity than the water extract alone. This could have a variety of applications in the pharmaceutical and biomedical industries as well as in industrial equipment.

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