INJ INTERNATIONAL NEUROUROLOGY JOURNAL

A Review on Therapeutic Potential Study in Selenicereus undatus (Dragon Fruit)

Shubham Sharma[1], Yadvendra Singh Thenuan[2], Prottay Dutta[3], Abhishek Pandey[4], Bhupen Subba [5]
[1,2]Assistant Professor, School of Pharmacy, Mangalayatan University, Aligarh, UP, India
[3]Assistant Professor, Faculty of Pharmacy, Usha Martin University, Ranchi, Jharkhand
[4]Assistant Professor, Faculty of Pharmacy, Himalayan University, Itanagar, Arunachal Pradesh
[5]Assistant Professor, College of Pharmacy, Sikkim Professional University, Gangtok, Sikkim

Abstract

Because of its enormous curative potential, dragon fruit has attracted the interest of various scientists in recent years. Many phytochemical constituents with excellent pharmacological properties are present in the fruit. It is customarily used to make colors. Utilization as an antioxidant, antibacterial, antidiabetic, anticancer, and nutraceutical are a few of its discovered recently therapeutic applications. It is possible to extract the phytoconstituents from the fruit's skin, flesh, and seeds. Betacyanin, vitamin C, and lycopene are all recognized to be rich in fruit. The current review will focus on dragon fruit's pharmacological properties and phytochemical constituents. It also explains the fruit's security mechanisms. The review will clear the way for further studies into this amazing fruit.

Introduction

In addition to the advent of numerous new ailments over the past century, there have also been outbreaks of diseases including cancer and infectious disorders. The goal of the research is to win the war against such diseases. Numerous synthetic compounds that can be used as medications have been discovered as a consequence of extensive research and development. However, these compounds' negative impacts lead to a significant issue. A trend toward using natural goods is currently underway. Active ingredients with natural sources, such as plants, have been used since antiquity. Natural goods have been utilized in conjunction with allopathic treatments as first-line therapies, dietary supplements, or therapeutic adjuvants. The study of natural products' potential as therapies are now blossoming (1,2) "Dragon fruit" is one such natural fruit that has gained popularity in recent years. It is generally known that dragon fruit has both medicinal and dietary benefits. Natural products have bioactive phytoconstituents, which can be used as a nutraceutical formulation known as functional foods. Dragon fruit has been identified as a functional food. The present review focuses on dragon fruit's phytochemical and pharmacological properties to unveil its potential therapeutic applications. Three varieties of dragon fruit are cultivated, which show distinct colors of the skin and flesh. These include the following:

1. Hylocereus undatus 2. Hylocereus polyrhizus 3. Hylocereus megalanthus

The fruit, which is often referred to as pitaya fruit, is a member of the Selenicereus genus of climbing cacti. Many Asian nations, including Malaysia, the Philippines, Vietnam, Thailand, and Taiwan, eat it (3). Dragon fruit, dragon pearl fruit, pitahaya, strawberry pear, night-blooming cereus, and Cinderella plant are a few of the popular names for the plant. According to Morton (1987), it is also referred to locally as buah naga or buah mata naga (Malay/Indonesia), long Guo (China), and Thanh long (Vietnam). The plant is being grown more often as a result of studies emphasizing its potential for application in medicine (4,5). Fruits and blooms of the plant contain pharmacologically effective components (6,7). The major subject of this review is the Selenicereus fruit. According to Masyarakat Biodiversitas Indonesia and Universities' Sebelas Maret's Program Pascasarjana (2009), the fruit is oval in shape (Figure 1) and has a sweet and sour flavor. There are edible seeds embedded in the pulp that resembles kiwi fruit (8). The fruit can be consumed raw or added to beverages, sweets, etc. (9). Essential vitamins like vitamin C and minerals like calcium and phosphorus are found in the fruit's flesh (10). Both the flesh and peel of dragon fruit include pigments such as betacyanin (11). The current review compiles details on the pharmacological properties, phytochemical components, and safety of dragon fruit. To gather information regarding dragon fruit, a literature search was conducted in several databases between 1980 and 2019 including Science Direct, Google Scholar, PubMed, Scopus, ProQuest, and others.

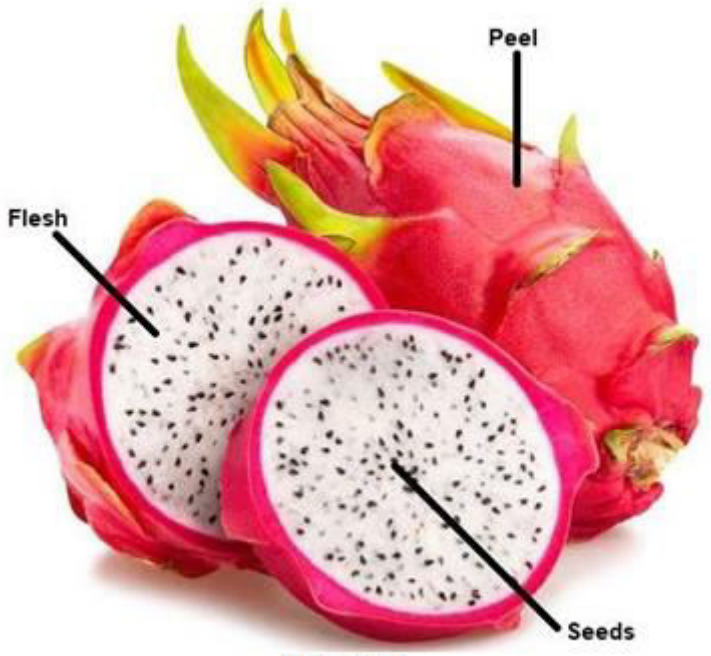

Figure: 1

Figure: 1

Table No. 1. Synonyms of Selenicereus undatus (Dragon fruit)

Sr. No.	Language	Synonyms
1	Indian	Dragon fruit
2	Chinese	huǒlóngguǒ
3	English	Strawberry Pear, Dragon fruit, Red pitaya
4	French	Cierge-metskaktus
5	German	Distelbirne
6	Indonesian	Buahnaga
7	Mexico	Junco, Flor de caliz, Pitajava
8	Vietnam	Dragon fruit, Thanh long
9	Spanish	Flor de caliz, Junco tapatio, Pitahaya orejona
10	Swedish	Dachenftskogskatus, Röd pitahaya

Table No. 2. Scientific classification of Selenicereus undatus (Dragon fruit)-

Sr. No.	Classification	Name
1	Kingdom	Plantae (Plants)
2	Sub-division	Trachebionta (Vascular plant)
3	Super division	Spermatophyta (Seed plants)
4	Division	Magnoliopsida (Flowering plants)

5	Class	Magnoliopsida (Dicotyledons)
6	Order	Caryophyllales
7	Family	Cactaceae
8	Sub-family	Cactoideae
9	Genus	Selenicereus
10	Species	*Selenicereus undatus*

Extraction.

Phytoconstituents from the Selenicereus plant may be isolated from the plant's fruit, flower, stem, and a variety of other components. This evaluation focuses on the plant's fruit. Hor et al. (2012), Phongtongpasuk, Poadang, and Yongvanich (2016), and Liaotrakoon, De Clercq, Van Hoed, and Dewettinck (2013) extract phytoconstituents from the fruit's meat, peel, and seeds. According to Liaotrakoon et al. (2013), pulp makes up 2/3 of the fruit's weight while seeds make up 8%. (Table 1) lists some of the known methods for obtaining phytoconstituents from dragon fruit as well as related data. Wichienchot et al. demonstrated that the technique of extraction, more specifically the solvent employed for extraction, had an impact on the yield and molecular weight of oligosaccharides isolated from dragon fruit. Traditional chromatographic and membrane filtering methods can be used to purify oligosaccharides, or new biological purification approaches utilizing yeast can be used (12). To improve extraction by lowering moisture content, Nurul Shazini Ramli et al. spray-dried the pieces of fruit flesh and peel that were previously kept in an 80°C freezer. The fruit's pigment loss might be decreased by limiting its exposure to light. The choice of extraction method is dependent on the fruit part being utilized for extraction, according to a comparison study of the traditional approach and the ultrasonic-assisted extraction method. Ultrasonic-assisted extraction was used to improve the extraction yield from the meat and the flavonoid content in the peel (13). Specific phytoconstituents can be extracted with the use of selected reagents and conditions. Norazelina Sah Mohd. Ismail et al. employed three different extraction methods: de-ionized water at 75°C for 1 hour, hydrochloric acid at 85°C for 1 hour, and ammonium oxalate at 0.25 percent, pH 4.6 ± 0.01. Using ammonium oxalate resulted in the highest production and purity of pectin from dragon fruit (14).

Table No. 03 Extraction of Active Constituents from Dragon fruit-

Fruit part	Method	Solvent	Extract
Fruit peel	Soxhlet extractor	Water /Ethanol	Flavonoids, Phenols, Reducing sugars, Proteins
Fruit flesh	Maceration	Water /Methanol	Fatty acids, Fatty acids esters
Fruit seeds	Soxhlet extractor	Water /Ethanol	oil

Phytochemical characterization and safety Aspects-

The main classes of phytochemicals present in dragon fruit are phenols, sterols, flavonoids, fatty acids, and tocopherols. A collection of phytoconstituents' of dragon fruit by category. Two species of pitaya, C. undatus were used to extract phytoconstituents, including n-hexadecanoic acid (1), 1-hexadecyne (2), 12-octadecadienoic acid (3), 2-chloroethyl linoleate (4), oleic acid (5), octacosane (6), 17-pentatriacontene (7), trichloroacetic acid, hexadecyl ester (8), 1-nonadecene (9), 6-tetradecane sulfonic acid, butyl ester (10), 1,2-benzene dicarboxylic acid, mono (2- Ethylhexyl) ester (11), phthalic acid, 6-ethyloct-3-yl 2-Ethylhexyl ester (12), eicosane (13), tetra tri acontane (14), 1-tetracosanol (15), hepta cosane (16), campesterol (17), stigmasterol (18), squalene (19), 11-hexacosyne (20), octadecanal (21), nonacosane (22), octadecane (23), γ- sitosterol (24), α-amyrin (25), hexadecyl oxirane (26), β-amyrin (27), ergosta-4,6,8(14),22-tetraen- 3- one (28), docosane

DOI: 10.5123/inj.2023.4.in115
ISSN:2093-4777 | E-ISSN:2093-6931
Vol. 27 Iss. 4 (2023)

(29), stigmast-4-en-3-one (30), β-sitosterol (31) (15). Cholesterol (32), gallicacid (33), vanillic acid (34), syringic acid (35), protocatechuic acid (36), p-hydroxybenzoic acid (37), p-coumaric acid (38), and caffeic acid (39). The chromatographic analysis revealed that among α, β, γ, and δ-tocopherol, C. undatus, and H. polyrhizus contained α-tocopherol (40) and γ- tocopherol (41) (16). Stearic acid (42), a saturated fatty acid is found to be present in dragon fruit seeds (17). Rebecca et al. have successfully isolated Myo-inositol (43) crystals in significant quantities from H. polyrhizus (18), which can be used for hormonal diseases. Dragon fruit flesh contains monosaccharides like glucose (44) and fructose (45), and some oligosaccharides (19). Dragon fruit also contains lycopene (46), β-carotene (47), and vitamin E (40) (20). Betacyanin (48), a red-colored pigment, can be isolated from dragon fruit (21). The fruit is also a rich source of vitamin C (49) (22).

Therapeutic activity of Selenicereus undatus (Dragon fruit) in Health care management-

Numerous phytoconstituents in dragon fruit have a wide range of pharmacological effects. Although it has a few well-known traditional uses, there is currently active research investigating the fruit's potential therapeutic advantages. shows the link between the phytoconstituents of dragon fruit and their pharmacological activities. This section discusses the therapeutic uses of dragon fruit and related phytoconstituents.

Anti-microbiological action.

Infectious disease rates are rising in the twenty-first century, and concern over antimicrobial resistance is rising. a few contagious Almost no or very few of the available medications can treat some disorders (23). This issue can be solved by the creation of novel antibacterial substances. Considering treatment resistance and the cost of synthetic medications, antimicrobial agents of natural origin can be quite important. Silver nanoparticles were created by Siriporn Phongtongpasuk et al. using dragon fruit peel extract. The smallest and most stable nanoparticles

were created at pH 5.35 when compared to 3.35, 4.35, and 5.35. The analysis of antibacterial activity using the disc diffusion technique. The produced nanoparticles were efficient against both gram-positive bacteria like Staphylococcus aureus and gram-negative bacteria like Escherichia coli and Pseudomonas aeruginosa. The antibacterial activity of nanoparticles was comparable to that of the positive control drug, gentamycin. Nanoparticles demonstrated superior antibacterial efficacy against gram-positive bacteria when compared to action against gram-negative bacteria. There have been reports of phytoconstituents in dragon fruit extract stabilizing silver nanoparticles. The reduction of Ag+ to Ag0 was also attributed to the phytochemicals of dragon fruit. The presence of Ag2O in the final product was confirmed by XRD and EDX analysis, which also contributed to the antibacterial activity along with silver nanoparticles (24). Yi Yi Yong et al. have studied the effect of refrigeration on phytochemical constituents and antimicrobial activity of dragon fruit. After 6 days of storage at 4°C, there was a 57.2% increase in the betacyanin content of dragon fruit.

Anticancer activity.

Cancer is one of the leading causes of death worldwide that need attention. Anticancer activity of constituents from natural origin can be of great use in the treatment of cancer. Several studies have proved the cytotoxic effect of phytoconstituents from dragon fruit. Hui Luo et al. analyzed the cytotoxic activity of dragon fruit peel extract using an MTT assay. The extracts showed cytotoxic effects against PC3 (human prostate cancer cell line), Bcap-37 (human breast cancer cell line), and MGC-803 (human gastric cancer cell line) in a dose-dependent manner. The IC50 value ranged from 0.61 to 0.73 mg/ml. H. polyrhizus showed a better cytotoxic effect than S. undatus on MGC- 803 cells. Cytotoxic activity of individual phytoconstituents namely α-amyrin, β-amyrin, β- sitosterol, and stigmas-4-en-3-one were also analyzed in the three cell lines mentioned. Amyrin, sitosterol, and stigmas-4-en-3-one were tested for their cytotoxic effects on cell lines. These results suggest that these phytoconstituents may have anticancer properties (25). The MTT assay was used in research by Rajarajeswaran Jayakumar et al. to demonstrate the effectiveness of a methanolic dragon fruit extract against growing MCF-7 cells. Because nitric oxide radical is known to be connected to the etiology of cancer, the extract's ability to scavenge nitric oxide can be linked to its anticancer effect (26). The use of nanoparticles in cancer treatment has various benefits. Arul et al. created fluorescent nitrogen-doped carbon dots (N-CDs) using aqueous ammonia and S. undatus extract as the carbon and nitrogen sources, respectively. The synthetic N-CDs had a 2.5 nm average size and a spherical shape. Following the characterization, N-CDs on the L-929 (Lymphoblastoid-929) and MCF-7 (Michigan Cancer Foundation-7) cell lines were examined using the MTT assay. N-CDs demonstrated a stronger cytotoxic effect on MCF-7 cells and a minor effect on L-929 cells, demonstrating their target specificity. The study found that fruit peel has a superior antiproliferative activity to fruit flesh (27). The total flavonoid and total polyphenol content of the flesh and peel of white and red pitayas were compared to their antiproliferative efficacy in a study by Kim et al. In comparison to the fruit meat, the flavonoid and polyphenol content of dragon fruit peels was 3 to 5 times higher. Similar to this, fruit peel extract

showed more antiproliferative activity than flesh extracts against AGS and MCF-7 cancer cells. Although there was a link between the phenolic content of dragon fruit and its antioxidant effects, one could not be drawn between antioxidant and antiproliferative activity (28). Green synthesis, which eliminates the use of potentially harmful chemicals and concentrates on the utilization of natural ingredients, is a great environmentally responsible way for creating nanoparticles.

Anti-diabetic Action.

Diabetes also referred to as diabetes mellitus, is a metabolic illness that is one of the main causes of death around the globe. The study of herbal or natural diabetic treatments is rapidly expanding. Insulin is said to be retained for a longer period by S.undatus because it exhibits cAMP phosphodiesterase inhibitory activity (29). White dragon fruit phytoconstituents are excellent for lowering blood glucose levels. According to Ajie et al., flavonoid content mediates hypoglycemic activity through three different pathways, including boosting insulin retention while inhibiting phosphodiesterase and decreasing oxidative stress through antioxidant action (30). Norhayati Abd Hadi and colleagues investigated the impact of red dragon fruit consumption on patients with type 2 diabetes lipid profiles, glucose levels, and other parameters. The findings demonstrated that red dragon fruit consumption helps type 2 diabetic patients maintain good blood glucose control and a healthy lipid profile. (31) Diabetes causes a lot of issues with wound healing. Aqueous extracts of the leaves, rind, fruit pulp, and flowers of S. undatus have been shown by Perez et al. to have a wound-healing effect. A striking rise in hydroxyproline content, total protein content, and DNA collagen content was seen following the topical administration of the aqueous extract. Additionally, epithelization and tensile strength have increased, promoting healing (32). Insulin resistance brought on by obesity can result in type 2 diabetes. White pitaya juice (WPJ) has been studied for its impact on obesity-related metabolic problems such as insulin resistance by Haizhao Song et al. In this investigation, C57BL/6J mice were employed, and they were fed a high-fat diet. As demonstrated by lower fasting blood glucose and insulin levels in mice treated with white pitaya, insulin resistance caused by obesity may be alleviated. This is explained by a decline in the expression of fibroblast growth factor-21 (FGF-21) (33). Other issues that are referred to as diabetic complications are invariably linked to diabetes. One fairly frequent cardiovascular consequence of diabetes is aortic stiffness. The impact of aqueous dragon fruit (S. undatus) pulp extract on cardiovascular issues in streptozotocin (STZ)-induced diabetic mice has been researched by Anand Swarup et al. With the use of dragon fruit extract, rats' elevated pulse wave velocity (PWV), systolic blood pressure, and pulse pressure could all be dramatically lowered. This demonstrates how well dragon fruit extract works to cure diabetes problems (34). Nalinee Poolsup et al. conducted a meta-analysis of the role of dragon fruit in causing hypoglycemia in prediabetic and diabetic patients. This scientific investigation demonstrated that the hypoglycemic impact of dragon fruit was more pronounced in subjects with prediabetes than in subjects with diabetes. Results indicated that dragon fruit might be used to prevent diabetes (35). As a result, dragon fruit is beneficial not only in the management of diabetic complications but also in the prevention and treatment of diabetes.

Nutritional activity.

The food and pharmaceutical industries have combined to form the nutraceutical sector. These "functional" foods purport to provide nutrients and additional health advantages. Dietary fiber, probiotics, prebiotics, polyunsaturated fatty acids, antioxidant vitamins, polyphenols, and spices are examples of nutraceuticals (36). Nutraceutical properties of dragon fruit fall under the categories of prebiotics, polyunsaturated fatty acids, antioxidant vitamins, and polyphenols. Prebiotics are primarily no digestible oligosaccharides that enhance intestinal bacterial activity, hence enhancing general health. According to Ng Lay Tze et al., dragon fruit has a lot of protein, fat, ash, fiber, and antioxidants. Fruit powder made from entire fruit is a fantastic dietary supplement (37). Using ethanol as a solvent, Wichienchot et al. were able to extract glucose, fructose, and oligosaccharides from white and red-fleshed dragon fruit. The extraction solvent has a significant impact on the molecular weight of extract constituents. By using yeast cultivation, glucose and fructose were separated from the extract's oligosaccharides, which may operate as prebiotics. To determine the molecular weights of oligosaccharides, mass spectroscopy was performed. An analysis of the obtained molecular weights of 716, 700, 490, and 474 Da revealed the presence of oligosaccharides. Mixed oligosaccharides demonstrated the crucial characteristics of prebiotics, namely non-degradability and stimulation of colonic flora. These oligosaccharides are not degradable, as evidenced by the inability of artificial human gastric juice and human - amylase to hydrolyze them. Additionally, it was discovered that they promoted the development of lactobacilli and bifidobacteria, demonstrating their prebiotic qualities (38).

Anti-oxidant action.

Oxidative stress in the human body is known to be brought on by reactive oxygen species (ROS). These free radicals could have an impact on biological proteins from oxidative damage, which can also harm genes.

Numerous fatal degenerative diseases, including cancer, heart disease, and Alzheimer's disease, are made more likely by this. The body's natural antioxidants might not always be enough to neutralize ROS production. Antioxidant supplementation is therefore advised to lessen the hazard of many chronic diseases. The toxicity and carcinogenicity of synthetic antioxidants like butylated hydroxyl anisole (BHA) and butylated hydroxyl toluene (BHT) are a source of worry. As a result, their usage in food and pharmaceutical goods is limited. Natural antioxidants are a more affordable and secure substitute (39). Naturally occurring antioxidants are mostly found in fruits, vegetables, and whole grains. Dragon fruit contains phenolic compounds, vitamins C and E, carotenes, and betanin, all of which have significant antioxidant effects. In their study, Hui Luo et al. hypothesized that the polyphenols in dragon fruit are responsible for the fruit's antioxidant properties. Polyphenols are successfully extracted via supercritical carbon dioxide extraction. Using the DPPH (1, 1-diphenyl-2-picrylhydrazyl) radical scavenging test, the antioxidant activity of dragon fruit was measured in terms of the IC50 value. Utilizing analytical tools like a UV-visible spectrophotometer, it is possible to quantify the reduction of the purple DPPH radical to the yellow hydrazine compound due to the presence of antioxidant chemicals in the sample. The dragon fruit's lower IC50 value indicated that it had strong antioxidant properties (40). Ayyub Md Som et al. investigated the antioxidant activity of Hylocereus foliage and peels and found that fruit peels had a greater total phenolic content in methanol extract (48.15 mg GAE/100 g extract) than foliage (30.3 mg GAE/100 g extract). Peel's methanol extract had more antioxidant activity, as measured by the DPPH radical scavenging experiment than foliage (88.81%) did. 2019; Som, Ahmat, Abdul Hamid, and Aziz Uddin. B. Mahayothee et al. investigated the impact of drying circumstances such as temperature (40, 50, 60, 70, and 80°C) and air velocities (1.0 and 1.5 ms1) on drying time and antioxidant potential. Even though isomerization of betacyanin was noticed, drying time can be significantly reduced by raising the drying temperature without altering betacyanin concentration or antioxidant activity. The authors are Mahyothee, Komonsing, Khuwijitjaru, Nagle, and Müller (2019). K.-H. Lee et al. examined the impact of spray drying on the antioxidant activity of dragon fruit. Maltodextrin content of 30% (w/v) and inlet air temperatures of 120°C and 110°C were found to be ideal for producing free- flowing spray drying powder from red and white dragon fruit juices. The spray-dried powder had a spherical shape and particles that ranged in size from 3 to 7 m. In comparison to fruit juice, the spray-dried powder had less antioxidant capacity. The spray-dried powder was stored at 25°C for 25 days under various humidity conditions (33%, 43%, 54%, or 75% RH), and it was found that none of the conditions had an impact on the antioxidant activity. However, 33% RH was the best storage setting to prevent structural changes in the sample (41). a pair of red and white dragon fruits were reported to contain hydroxyl cinnamate phenols, which were verified by Mahattanatawee et al. using HPLC-PDA analysis. It is possible to establish a strong positive association between phenolic concentration and antioxidant capability. The cultivar was found to have an impact on the number of phytoconstituents, particularly phenols, in dragon fruit, which therefore has an impact on antioxidant capacity. ORAC (oxygen radical absorbance capacity) and DPPH tests were used to measure the antioxidant activity (42). In a comparison of the antioxidant capacity of purees from red and white-fleshed dragon fruit, Liaotrakoon et al. found that red dragon fruit has stronger antioxidant activity. Compared to unheated purees, the antioxidant activity of fruit purees heated for 0 to 60 minutes at temperatures between 50°C and 90°C was increased. This demonstrates how important thermal processing is for improving the anti-oxidative capacity of dragon fruit (43). To preserve or even enhance the antioxidant properties of dragon fruit, which can be utilized as a dietary supplement to prevent numerous life-threatening illnesses, suitable preservation techniques and treatment must be applied. Diabetes-related vascular problems are known to be caused by oxidative stress. Anand Swarup et al. have successfully shown that the use of dragon fruit extract as a medication was effective in minimizing oxidative damage and aortic stiffness in rats with STZ-induced diabetes (44). The antioxidant activity of red dragon fruit extract in rats given vigorous exercise was investigated in a study by Harahap, and Novita Sari. Increased levels of Creatine kinase (CK) are indicators of tissue damage brought on by the production of free radicals during vigorous exercise. Lactic acid and Creatine kinase (CK) levels were found to be decreased by red dragon fruit extract, which can be explained by the extract's capacity for antioxidants (45).

Inflammation-reducing effects.

The composition of dragon fruit, which includes substances like squalene and betalains, gives it antioxidant and anti-inflammatory effects. Maltodextrin-encapsulated and non-encapsulated betalains from the peel extract of H. polyrhizus were found to have anti-inflammatory properties, according to Rodriguez et al. (2016). Although betalains can have their bioactivity extended by encapsulation, they are unstable and sensitive to elements that can cause degradation, such as temperature, pH, oxygen, or light.

Wound healing activity.

The process of healing a wound is a multi-stage process that involves many different cell populations, the extracellular matrix, and the action of soluble mediators like growth factors and cytokines. It is designed to

restore the integrity of injured tissues. Clinical pathology faces a daily problem with wound management, which frequently fails in the absence of the proper physiological, endocrine, and nutritional support tested the wound-healing abilities of ethanol- water extracts from several Hylocereus polyrhizus components, including the peel, stem, and flower. The scratch assay was used to examine the capacity of cells to migrate using the NIH-3T3 fibroblast cell line. The findings demonstrated that the stem and flower of drag-on fruit extracts in 95% aqueous ethanol at the concentration of 1000 g mL-1 stimulated fibroblast migration after 24 h, which is essential for the wound healing process. In this investigation, the dragon fruit extracts from the stem, peel, and flower in 95% aqueous ethanol demonstrated high activity in protecting DNA from damage. The potent antioxidants found in dragon fruit extracts include phenolic and flavonoid components that are engaged in activities including DNA protection and wound healing. These compounds have potential uses in the culinary, cosmetic, and pharmaceutical industries. Using injured streptozotocin-diabetic rats, (46) investigated the wound-healing properties of aqueous extracts of S. undatus leaves, rind, pulp, and flowers. Excision and incision wounds were created on the backs of each rat, and for seven days, different concentrations of aqueous extracts (0.05%, 0.1%, 0.2%, 0.4%, and 0.5%) were applied topically twice daily. Daily observations were made of both types of wounds to track how the scratches and scars changed over time (including the number of days). necessary for the scar to fade). Additionally, on day ten following the removal of the sutures on day seven, the tensile strength for incisional wounds was assessed. The findings demonstrated that topical pitaya extract application greatly aided in wound healing and that S. undatus exhibited no hypoglycemic activity. However, only the aqueous extracts of the flowers and leaves had a large amount of wound-healing potential, whereas the extracts of the pulp and peel had less potent wound-healing potential and the rind extract had just a minimal cicatrizing impact. The S. undatus flower extract had the most noticeable impact on the injured areas. (46) concluded that topical application of S. undatus extracts improved epithelization and facilitated the healing process in streptozotocin-diabetic rats by increasing hydroxyproline (related to enhanced collagen synthesis), tensile strength, total proteins, and DNA collagen content. Further proof of the advantages of dragon fruit in wound healing processes through the creation of collagen fiber density was provided by a study by Juliastuti et al. (2020). The density of collagen fibers increased following tooth extraction in Wistar rats treated with a 30% concentration of H. polyrhizus peel ethanol extract, according to the scientists' observations.

Anti-obesity and anti-hyperlipidemia actions.

According to Pol et al. (2018), dyslipidemia is a complex condition and a significant risk factor for unfavorable cardiovascular events because it is known to encourage atherosclerosis. During 30 days, Hernawati et al. (2018) gave various groups of hyperlipidemic Balb-C male mice varying doses of pitaya peel powder, ranging from 50 to 200 mg kg-1 body weight (BW), to assess the impact of red dragon fruit peel powder (H. polyrhizus) on blood lipid levels. Following treatment, total cholesterol, triglycerides, and low-density lipoprotein cholesterol (LDL-c) levels in blood samples from each group were examined. The results revealed that all of these parameters dropped as red dragon fruit peel powder dosages increased. Due to the advantages of its composition, pitaya peel powder included in diets would help to avoid hyperlipidemia, according to Hernawati et al. (2018). Because it traps cholesterol and bile acids in the small intestine, it can increase insulin sensitivity and also increases satiety. I A high content of crude fiber in the peel (69.30% total dietary fiber, divided into 56.50% insoluble food fiber and 14.82% soluble food fiber); ii) A high content of antioxidants, phenol, and particularly tocotrienol.

Action against anemia.

Pitaya provides vital nutrients, such as iron (Fe), vitamins C, E, and B12, thiamine, and riboflavin, which are precursors needed for erythropoiesis. An evaluation of the impact of drag-on fruit on postpartum mothers—who are thought to be sensitive to anemia—was done by Rahmawati et al. in 2019. For 14 days, postpartum women received 400 ccs of H. polyrhizus fruit juice (made from 500 g of pitaya). According to the findings, the treatment group's levels of hemoglobin, hematocrit, and erythrocytes dramatically rose when compared to the control group. Rah-Mayawati et al. (2019) claim that the high vitamin C content of dragon fruit is what gives it its anti-anemia properties since it makes it easier to absorb the non-heme iron and iron essential for the creation of blood. Prebiotic capacity. Prebiotics are non-digestible oligosaccharides that promote the development of healthy bacteria in the colon and have anti-inflammatory properties that can help prevent internal disorders such as colon cancer. According to Wichienchot et al. (2010), the primary carbohydrates in white and red-fleshed dragon fruit are glucose, fructose, and certain oligosaccharides, with total concentrations of 86.2 and 89.6 g kg-1, respectively. 75 percent of the dry matter of the fruit of Selenicereus undatus is made up of mixed oligosaccharides, with polymerization levels 2, 3, 4, and 5 predominating. In the ethanoic flesh extract of S. undatus, mixed oligosaccharide content was quantified at 85% (47). Dragon fruit oligosaccharides (DFO) enhanced fecal bifido bacteria and lactobacilli but decreased Bacteroides and clostridia, according to Pantai et al (2020).'s evaluation of the qualities of dragon fruit as possible prebiotics and immunological capacity

stimulants. The study also demonstrated that DFO has immune response- boosting capabilities by raising immunoglobulin A and G concentrations. The dragon fruit was studied by Wichienchot et al. (2010) as a potential source of high-yielding oligosaccharides for industrial prebiotic synthesis. They discovered that 80% (by weight) ethanol with a solvent-to- flesh ratio of 2:1 at room temperature (about 28 °C) provided the best extraction results for pitaya meat. According to their findings, dragon fruit oligosaccharides offer several functional qualities that make them appropriate as ingredients in functional food and nutraceutical products. Prebiotic properties, particularly resistance to acid conditions in the human stomach, partial resistance to human salivary-amylase, and the ability to stimulate the growth of lactobacilli and bifidobacteria, are some of these properties. These characteristics include reduced calorie intake and insulinemia when compared to digestible carbohydrates. Additional advantages of using dragon fruit as a dietary supplement include increased colonic smooth muscle contractions without morphological change, bulk-forming facilitation, and laxative stimulation to enhance fecal output and intestinal motility (48).

Conclusion.

Pitaya also referred to as dragon fruit, is a rich source of several phytoconstituents. The fruit has components in its flesh, peel, and seed that have pharmacological and/or nutraceutical effects. some of the pharmacological behaviors demonstrated Dragon fruit has anti-inflammatory, antibacterial, and anticancer properties. It is useful for treating diabetic people as well as useful for preventing complications from diabetes. In addition to this, the fruit also demonstrates prebiotic qualities, indicating its value as a nutraceutical. Since it contains a lot of betacyanin, it can be utilized as a natural coloring agent in a variety of consumer goods, including dairy products, jams, jellies, candies, etc. This may work well in place of artificial colorants. It is therefore hoped that targeted research on this miracle fruit will aid in the treatment of several contemporary, life- threatening ailments.

References

1. Salehi, B., Fokou, P. V. T., Sharifi-Rad, M., Zucca, P., Pezzani, R., Martins, N., & Sharifi- Rad, J. (2019). The therapeutic potential of naringenin: A review of clinical trials. Pharmaceuticals, 12(1), 11. https://doi. org/10.3390/ph120 10011
2. Salehi, B., Sharopov, F., Martorell, M., Rajkovic, J., Ademiluyi, A. O., Sharifi-Rad, M.,
3. … Sharifi-Rad, J. (2018). Phytochemicals in Helicobacter pylori infections: What are we doing now?International Journal of Molecular Sciences, 19(8), 2361. https://doi.org/10.3390/ ijms1 9082361
4. Hor, S. Y., Ahmad, M., Farsi, E., Yam, M. F., Hashim, M. A., Lim, C. P., … Asmawi, M.
5. Z. (2012). Safety assessment of methanol extract of red dragon fruit (Hylocereus polyrhizus): Acute and subchronic toxicity studies. Regulatory Toxicology and Pharmacology, 63(1), 106–114. https://doi.org/10.1016/j.yrtph.2012.03.006
6. 4. Dartsch, P. C., Kler, A., & Kriesl, E. (2009). Antioxidative and anti-inflammatory potential of different functional drink concepts in vitro. Phytotherapy Research, 23(2), 165–171. https://doi.org/10.1002/ ptr.2577
7. 5. Luo, H., Cai, Y., Peng, Z., Liu, T., & Yang, S. (2014). Chemical composition and in vitro evaluation of the cytotoxic and antioxidant activities of supercritical carbon dioxide extracts of pitaya (dragon fruit) peel. Chemistry Central Journal, 8(1), 1–7. https://doi. org/10.1186/1752-153X-8-1
8. 6. Dartsch, P. C., Kler, A., & Kriesl, E. (2009). Antioxidative and anti-inflammatory potential of different functional drink concepts in vitro. Phytotherapy Research, 23(2), 165–171. https://doi.org/10.1002/ ptr.2577
9. 7. Tao, J., Qiao, G., Wen, X.-P., Gao, G.-L., Liu, T., Peng, Z.-J., Zhang, B.-X. (2014). Characterization of genetic relationship of dragon fruit accessions (Hylocereus spp.) by morphological traits and ISSR markers. Scientia Horticulturae, 170, 82–88. https://doi.org/10.1016/J.SCIEN TA.2014.03.006
10. 8. Ariffin, A. A., Bakar, J., Tan, C. P., Rahman, R. A., Karim, R., & Loi, C. C. (2009). Essential fatty acids of pitaya (dragon fruit) seed oil. Food Chemistry, 114(2), 561–564. https://doi.org/10.1016/J.FOODC HEM.2008.09.108
11. 9. Dartsch, P. C., Kler, A., & Kriesl, E. (2009). Antioxidative and anti-inflammatory potential of different functional drink concepts in vitro. Phytotherapy Research, 23(2), 165–171. https://doi.org/10.1002/ ptr.2577
12. 10. Rebecca, O. P. S., Boyce, A. N., & Chandran, S. (2010). Pigment identification and antioxidant properties of red dragon fruit (Hylocereus polyrhizus). African Journal of Biotechnology, 9(10), 1450–1454.

13. 11. Ramli, N. S., Ismail, P., & Rahmat, A. (2014). Influence of conventional and ultrasonic-assisted extraction on phenolic contents, betacyanin contents, and antioxidant capacity of red dragon fruit (Hylocereus polyrhizus). The Scientific World Journal, 2014, 1–7. https://doi.org/10.1155/2014/964731
14. 12. Wichienchot, S., Jatupornpipat, M., & Rastall, R. A. (2010). Oligosaccharides of pitaya (dragon fruit) flesh and their prebiotic properties. Food Chemistry, 120(3), 850–857. https://doi.org/10.1016/J.FOODC HEM.2009.11.026
15. 13. Ramli, N. S., Ismail, P., & Rahmat, A. (2014). Influence of conventional and ultrasonic-assisted extraction on phenolic contents, betacyanin contents, and antioxidant capacity of red dragon fruit (Hylocereus polyrhizus). The Scientific World Journal, 2014, 1–7. https://doi.org/10.1155/2014/964731
16. 14. Ismail, M. N. S., Hani, N. R. M., & Meon, Z. (2012). Extraction and characterization of pectin from dragon fruit (Hylocereus polyrhizus) using various extraction conditions. Sains Malaysiana, 41(1), 41–45. Retrieved from https://pdfs.semanticsc holar.org/d054/9f094 2090682887 39a9b 284b9 44bf9 a559c7.pdf
17. 15. Luo, H., Cai, Y., Peng, Z., Liu, T., & Yang, S. (2014). Chemical composition and in vitro evaluation of the cytotoxic and antioxidant activities of supercritical carbon dioxide extracts of pitaya (dragon fruit) peel. Chemistry Central Journal, 8(1), 1–7. https://doi. org/10.1186/1752-153X-8-1
18. 16. Lim, H. K., Tan, C. P., Karim, R., Ariffin, A. A., & Bakar, J. (2010). Chemical composition and DSC thermal properties of two species of Hylocereus cacti seed oil: Hylocereus undatus and Hylocereus polyrhizus. Food Chemistry, 119(4), 1326–1331. https://doi.org/10.1016/J.FOODC HEM.2009.09.002
19. 17. Liaotrakoon, W., De Clercq, N., Van Hoed, V., & Dewettinck, K. (2013). Dragon fruit (Hylocereus spp.) seed oils: Their characterization and stability under storage conditions.

20. Journal of the American Oil Chemists' Society, 90(2), 207–215. https://doi.org/10.1007/ s11746-012-2151-6
21. 18. Rebecca, O. P., San, B. A. N., &Somasundram, C. (2012). Isolation and identification of Myo-inositol crystals from dragon fruit (Hylocereus polyrhizus). Molecules, 17(4), 4583– 4594. https://doi.org/10.3390/ molec ules1 7044583
22. 19. Wichienchot, S., Jatupornpipat, M., & Rastall, R. A. (2010). Oligosaccharides of pitaya (dragon fruit) flesh and their prebiotic properties. Food Chemistry, 120(3), 850–857. https://doi.org/10.1016/J.FOODC HEM.2009.11.026
23. 20. Charoensiri, R., Kongkachuichai, R., Suknicom, S., & Sungpuag, P. (2009). Beta-carotene, lycopene, and alpha-tocopherol contents of selected Thai fruits. Food Chemistry, 113(1), 202–207. https://doi. org/10.1016/J.FOODC HEM.2008.07.074
24. 21. Priatni, S., & Pradita, A. (2015). Stability study of betacyanin extract from red dragon fruit (Hylocereus polyrhizus) peels. Procedia Chemistry, 16, 438–444. https://doi.org/10.1016/J.PROCHE.2015.12.076
25. 22. Minh, N. P., Phu, N., Nhan, T., Tha, D. T., Thuy, L. K., Khai, L. Q., & Tu, L. N. (2019). Different aspects affecting to the production of dragon fruit (Hylocereus Undatus) Nectar. Journal of Pharmaceutical Sciences and Research, 11(3), 1040–1043.
26. 23. Cox, E., Nambiar, S., & Baden, L. (2019). Needed: Antimicrobial development. New England Journal of Medicine, 380(8), 783–785. https://doi. org/10.1056/NEJMe 1901525
27. 24. Phongtongpasuk, S., Poadang, S., & Yongvanich, N. (2016). Environmental-friendly method for synthesis of silver nanoparticles from dragon fruit peel extract and their antibacterial activities. Energy Procedia, 89, 239–247. https://doi.org/10.1016/J. EGYPRO.2016.05.031
28. 25. Luo, H., Cai, Y., Peng, Z., Liu, T., & Yang, S. (2014). Chemical composition and in vitro evaluation of the cytotoxic and antioxidant activities of supercritical carbon dioxide extracts of pitaya (dragon fruit) peel. Chemistry Central Journal, 8(1), 1–7. https://doi. org/10.1186/1752-153X-8-1
29. 26. Jayakumar, R., & Kanthimathi, M. S. (2011). Inhibitory effects of fruit extracts on nitric oxide-induced proliferation in MCF-7 cells. Food Chemistry, 126(3), 956–960. https://doi.org/10.1016/J.FOODC HEM.2010.11.093
30. 27. Song, H., Zheng, Z., Wu, J., Lai, J., Chu, Q., & Zheng, X. (2016). White pitaya (Hylocereus undatus) juice attenuates insulin resistance and hepatic steatosis in diet-induced obese mice. PLoS ONE, 11(2),e0149670. https://doi.org/10.1371/journ al.pone.0149670
31. 28. Kim, H., Choi, H.-K., Moon, J. Y., Kim, Y. S., Mosaddik, A., & Cho, S. K. (2011). Comparative antioxidant and antiproliferative activities of red and white pitayas and their correlation

with flavonoid and polyphenol content. Journal of Food Science, 76(1), C38– C45. https://doi. org/10.1111/j.1750-3841.2010.01908.x

32. 29. Prabhakar, P. K., & Doble, M. (2008). Target-based therapeutic approach towards diabetes mellitus using medicinal plants. Current Diabetes Reviews, 4(4), 291–308. Retrieved from http://www.ncbi. nlm.nih.gov/pubme d/18991598
33. 30. Ajie, R. B. (2015). White dragon fruit (Hylocereus undatus) potential as diabetes mellitus treatment. Journal Majority, 4(1). Retrieved fromhttp://juke.kedoTeranan.unila.ac.id/index.php/majocitytarticlele/ view/503/504
34. 31. Hadi, A., Mohamad, M., Rohin, A. K., & Yusof, M. (n.d.). Effects of red pitaya fruit (Hylocereus polyrhizus) consumption on blood glucose level and lipid profile in type 2 diabetic subjects. Retrieved froHTTPtp:// borne oscine nce.ums.edu.my/wp- Contatnt/uploa ds/2012/09/EFFECts-of-red-pitaya-fruit-hylic ereus-polymer hizus- consumption-on-blood-glucose-level-and-.pdf
35. 32. Perez, G. R. M., Vargas, S. R., & Ortiz, H. Y. D. (2005). Wound healing properties of Hylocereus undatus on diabetic rats. Phytotherapy Research, 19(8), 665–668. https://doi.org/10.1002/ptr.1724
36. 33. Song, H., Zheng, Z., Wu, J., Lai, J., Chu, Q., & Zheng, X. (2016). White pitaya (Hylocereus undatus) juice attenuates insulin resistance and hepatic steatosis in diet-induced obese mice. PLoS ONE, 11(2),e0149670. https://doi.org/10.1371/journ al.pone.0149670
37. 34. Anand Swarup, K. L., Sattar, M., Abdullah, N., Abdulla, M., Salman, I., Rathore, H., & Johns, E. (2010). Effect of dragon fruit extract on oxidative stress and aortic stiffness in streptozotocin-induced diabetes in rats. Pharmacognosy Research, 2(1), 31. https://doi. org/10.4103/0974-8490.60582
38. 35. Poolsup, N., Suksomboon, N., & Paw, N. J. (2017). Effect of dragon fruit on glycemic control in prediabetes and type 2 diabetes: A systematic review and meta-analysis. PLoS ONE, 12(9), 1–12. https://doi. org/10.1371/journ an l.pone.0184577
39. 36. Das, L., Bhaumik, E., Raychaudhuri, U., & Chakraborty, R. (2012). Role of nutraceuticals in human health. Journal of Food Science and Technology, 49(2), 173–183. https://doi.org/10.1007/s13197-011-0269-4
40. 37. Tze, N. L., Han, C. P., Yusof, Y. A., Ling, C. N., Talib, R. A., Taip, F. S., & Aziz, M. G. (2012). Physicochemical and nutritional properties of spray-dried pitaya fruit powder aa s natural colorant. Food Science and Biotechnology, 21(3), 675–682. https://doi.org/10.1007/ s10068-012-0088-z
41. 38. Wichienchot, S., Jatupornpipat, M., & Rastall, R. A. (2010). Oligosaccharides of pitaya (dragon fruit) flesh and their prebiotic properties. Food Chemistry, 120(3), 850–857. https://doi.org/10.1016/J.FOODC HEM.2009.11.026
42. 39. Gülçin, İ. (2012). Antioxidant activity of food constituents: An overview. Archives of Toxicology, 86(3), 345–391. https://doi.org/10.1007/ s00204-011-0774-2
43. 40. Luo, H., Cai, Y., Peng, Z., Liu, T., & Yang, S. (2014). Chemical composition and in vitro evaluation of the cytotoxic and antioxidant activities of supercritical carbon dioxide extracts of pitaya (dragon fruit) peel. Chemistry Central Journal, 8(1), 1–7. https://doi.org/10.1186/1752-153X-8-1
44. 41. Lee, K. H., Wu, T. Y., & Siow, L. F. (2013). Spray drying of red (Hylocereus polyrhizus) and white (Hylocereus undatus) dragon fruit juices: Physicochemical and antioxidant properties of the powder. International Journal of Food Science and Technology, 48(11), 2391–2399. https://doi.org/10.1111/ijfs.12230
45. 42. Mahattanatawee, K., Manthey, J. A., Luzio, G., Talcott, S. T., Goodner, K., & Baldwin, E.(2006). Total antioxidant activity and fiber content of select Florida-grown tropical fruits. Journal of Agricultural and Food Chemistry, 54(19), 7355–7363. https://doi.org/10.1021/JF060 566S.
46. 43. Liaotrakoon, W., De Clercq, N., Van Hoed, V., & Dewettinck, K. (2013). Dragon fruit (Hylocereus spp.) seed oils: Their characterization and stability under storage conditions. Journal of the American Oil Chemists' Society, 90(2), 207–215. https://doi.org/10.1007/ s11746-012-2151-6
47. 44. Anand Swarup, K. L., Sattar, M., Abdullah, N., Abdulla, M., Salman, I., Rathore, H., & Johns, E. (2010). Effect of dragon fruit extract on oxidative stress and aortic stiffness in streptozotocin-induced diabetes in rats. Pharmacognosy Research, 2(1), 31. https://doi. org/10.4103/0974-8490.60582
48. 45. Harahap, N. S., & Amelia, R. (2019). Red dragon fruit (Hylocereus polyrhizus) extract decreases the lactic acid levels and creatine kinase activity in rats receiving heavy physical exercise. Open Access Macedonian Journal of Medical Sciences, 7(14), 2232–2235. https://doi.org/10.3889/ oamjms.2019.626

49. 46. Perez, G. R. M., Vargas, S. R., & Ortiz, H. Y. D. (2005). Wound healing properties of Hylocereus undatus on diabetic rats. Phytotherapy Research, 19(8), 665–668. https://doi.org/10.1002/ptr.1724
50. 47. Gengatharan, A., Dykes, G. A., & Choo, W. S. (2016). Stability of betacyanin from red pitahaya (Hylocereus polyrhizus) and its potential application as a natural colorant in milk. International Journal of Food Science & Technology, 51(2), 427–434. https://doi.org/10.1111/ijfs.12999
51. 48. Mahayothee, B., Komonsing, N., Khuwijitjaru, P., Nagle, M., & Müller, J. (2019). Influence of drying conditions on color, betacyanin content, and antioxidant capacities in dried red-fleshed dragon fruit (Hylocereus polyrhizus). International Journal of Food Science and Technology, 54(2), 460–470. https://doi.org/10.1111/ijfs.13958