



Received on 21 May 2024; received in revised form, 26 June 2024; accepted, 29 June 2024; published 30 June 2024

## EXPLORING THE THERAPEUTIC POTENTIAL OF DRAGON FRUIT: AN INSIGHTFUL REVIEW

Shivam Bhadauria, Mansi, Tirath Choudhary and Simran Chaurasia \*

Department of Pharmaceutical Sciences & Technology, Maharaja Ranjit Singh Punjab Technical University, Bathinda - 151001, Punjab, India.

### Keywords:

Dragon Fruit, Pitaya, Cactaceae, Phytochemicals, Nutraceutical, Hylocereus

### Correspondence to Author:

**Simran Chaurasia**

Department of Pharmaceutical Sciences & Technology, Maharaja Ranjit Singh Punjab Technical University, Bathinda - 151001, Punjab, India.

E-mail: simranchaurasia.777@gmail.com

**ABSTRACT:** Dragon Fruit (*Hylocereus* spp.) or pitaya, belonging to the family Cactaceae is an exotic fruit known for its prominent flavour and versatility of its health benefits. With a wide variety of its species, this tropical fruit stands out for its low maintenance, higher yield, and remarkable resilience, making it a lucrative option for cultivation. It's a rich source of antioxidants, exhibiting a spectrum of nutritional profile comprising of essential nutrients and phytochemicals like proteins, fats, carbohydrates, fibres, vitamins, minerals, alkaloids, oils, terpenoids, flavonoids, tannins, phenols and steroids. Consumption of dragon fruit offers numerous health benefits including regulation of blood sugar levels in type 2 diabetes, bolstering heart health, strong bones and immune system, accelerated wound healing and improved carbohydrate metabolism. Furthermore, dragon fruit has also shown antibacterial, antifungal, neuroprotective, cardioprotective and antiplatelet activity with significant results. This comprehensive review delves into the medicinal benefits and myriad nutraceutical value of dragon fruit. In addition, the review also portrays the history, biological source, geographical habitat, collection, cultivation of pitaya along with the numerous bioactive compounds found in various parts of this plant. As a result of the therapeutic traits of this exotic fruit, the consumption and utilization of dragon fruit has recently grown in status both economically and nutritionally. Therefore, further in-depth exploration of the repository of phytoconstituents that this fruit offers is needed to promote both health and economic growth.

**INTRODUCTION:** Dragon Fruit (*Hylocereus undatus*), often known as pitaya is a medicinal plant belonging to the family cactaceae and is widespread in two distinct genera such as 'Hylocereus' and 'Selenicereus'. The most frequently cultivated varieties belong to the genus *Hylocereus*<sup>1</sup>.

Pitaya or dragon fruit is commonly accessible in three main variants namely *Hylocereus undatus* (red skin with white pulp), *Hylocereus monacanthus* formerly known to be *Hylocereus polyrhizus* (red skin with red pulp), as well as *Hylocereus megalanthus* which is previously known as *Selenicereus megalanthus* (yellow skin and white pulp).

Frequently, produced and consumed species of dragon fruits are known to be red pitaya and yellow pitaya. Dragon fruit pulp is succulent, delicate and filled with seeds of diameter of 3mm. It is due to the presence of high content of water, minerals,

	<p>QUICK RESPONSE CODE</p>
	<p>DOI: 10.13040/IJPSR.0975-8232.IJP.11(6).222-34</p>
<p>Article can be accessed online on: <a href="http://www.ijpjournal.com">www.ijpjournal.com</a></p>	
<p>DOI link: <a href="https://doi.org/10.13040/IJPSR.0975-8232.IJP.11(6).222-34">https://doi.org/10.13040/IJPSR.0975-8232.IJP.11(6).222-34</a></p>	

antioxidants, and low-calorie intake that dragon fruit has gained popularity over the past few years. Commercially dragon fruit's cultivation is possible up to 1700 meters above the mean sea level, with 500-1500mm rainfall fall annually. Due to its adaption to high temperature and requirement of minute amount of water for growth, dragon fruit has prodigious potential as a new-fangled crop for mediterranean growers.

Amid the pre- Columbian times, dragon fruit (*H. undatus*), gained admiration and spread throughout the different regions of Caribbean and the Americas. Indeed, this was achieved through its dispersal by both humans and birds, who recognized its potential for cultivation of fruits. The pitaya, originates from the sub - tropical and tropical forests of Mexico, Central America, and Northern South America<sup>2,3</sup>. Undoubtedly, in these regions, dragon fruit occurs naturally and is distributed widely. During the 16<sup>th</sup> century, the Spanish introduced this fruit to the Philippines whereas a French priest brought this fruit to Indo-China in mid-19<sup>th</sup> century. Later, dragon fruit adapted the climatic conditions of the region and became a significant fruit. Eventually, throughout the South-East Asia this fruit crop became important and started being cultivated in tropics and sub tropic regions of the globe<sup>4</sup>.

Cultivation of this fruit in India is often seen in the states of Maharashtra, Karnataka, Gujarat, West Bengal among others. Vietnam on the other hand tops the chart globally being the major cultivator of the fruit<sup>3</sup>. *Hylocereus undatus* stems have capability to sprawl, spread, and rise with abundant branches. Whereas, these stems can contain 4-7 fruits each hypothetically, which have size of up to 10 m length and 10-12 cm in diameter. Areoles are roughly 2-5 m away from each other. This fruit can be grown both sexually as well as asexually. The plants which are propagated through seeds take more time to attain maturation. For the propagation of dragon fruit, cutting is the most efficient and rapid method. To safeguard fruitful planting of dragon fruit, it is suggested to employ cutting of length 15-30 meters and possess inclined cut on stem. It is instructed to prepare cutting 1-2 days erstwhile to planting and pile them up for the same period prior to potting<sup>5</sup>. Dragon fruit belongs to the cactaceae family and the genus *Hylocereus*.

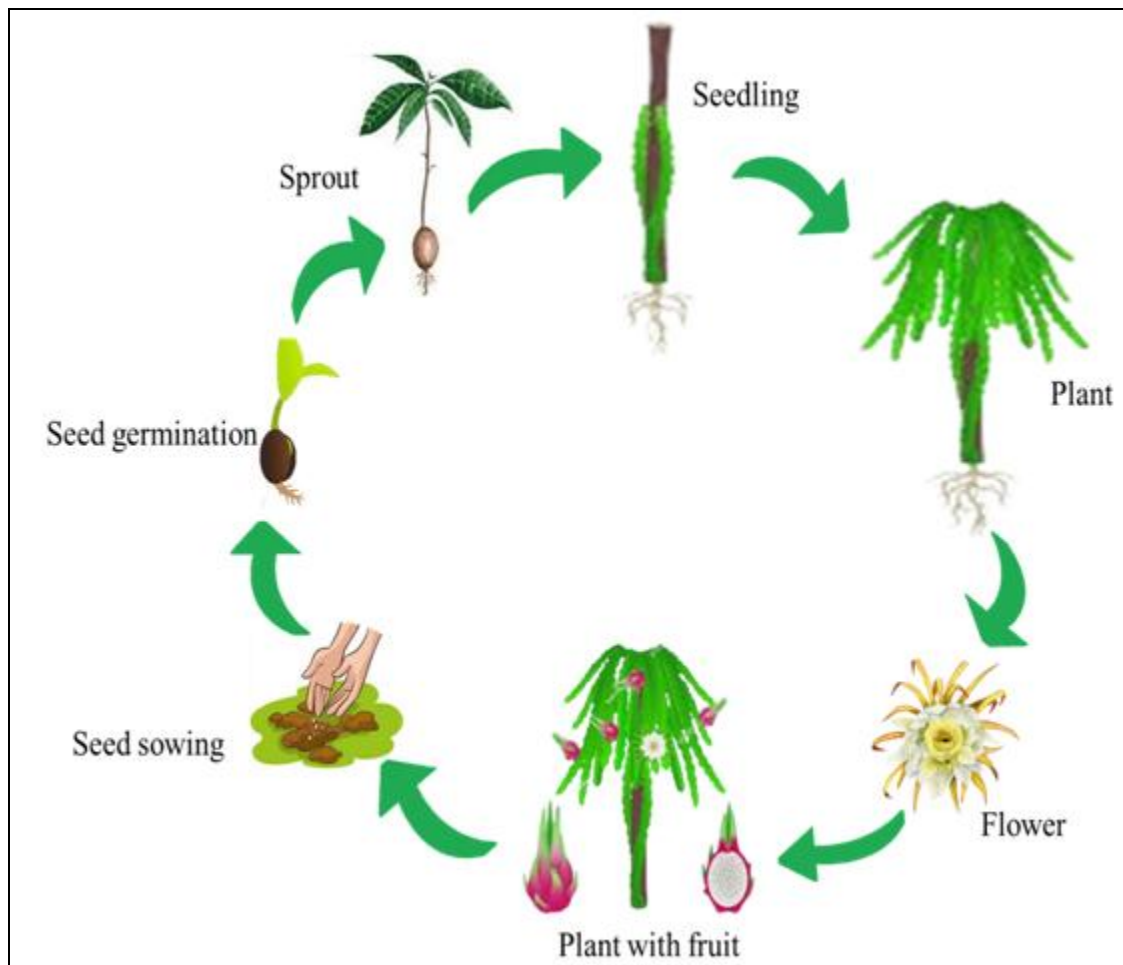
The *Hylocereus* genus chiefly consists of rising vine cacti with aerial roots that harvest a smooth berry with large scales. These species are mainly diploid with chromosome count  $2n=22$ . Nevertheless, pitayas are frequently admired for their ornamental abilities. They also embrace approximately 250 cultivated species that yield fruit and are employed for industrial purpose. It is necessary to note that few of these species hold financial importance.

The edible species of cactaceae family are differentiated on the basis of their stem habit, color of peel, color of pulp<sup>6</sup>. Dragon fruit or Pitaya, is the most demanded fresh fruit in human population. It is well known for its phytochemical contents as well as its health benefits. Several minerals and nutrients can be found in red dragon fruit such as Vitamin B3, B1, B2, Fats, Carbohydrates, Protein, Betacyanin, Phyto-albumin, Carotene, Cobalamin, Ascorbic Acid (Vitamin C)<sup>7</sup>. Red dragon fruits have a beneficial effect on digestive processes. They are anti- diabetic, and have the ability to calm down the blood pressure of the body. Furthermore, dragon fruits also have the ability to neutralize the toxins present in the body especially the heavy metal toxins. The Phyto-albumin content present in dragon fruit consists of a high level of antioxidants and iron content aiding to the management to cancer and anaemia respectively<sup>8</sup>.

Dragon fruit is a storehouse of betacyanin which is a substance that plays a crucial role in providing colour and pigment to the dragon fruit flesh and therefore enhances the appearance of the fruit<sup>9</sup>. Dragon fruit shows a positive result in treatment of diseases such as inflammation, diabetes, cancer, etc<sup>10</sup>. Pitaya peel functions as a colouring as well as a thickening agent for different cosmetic preparations<sup>11</sup>. A study has shown that the peel of dragon fruit has more flavonoid content as compared to the flesh while on the other hand, the chloroform extract of pitaya peel has a property of killing both gram positive as well as gram-negative bacteria and is therefore classified as an antibacterial agent<sup>12</sup>. Furthermore, dragon fruit peel also has anti-inflammatory property because it consists of betalains, that play a significant role in the inhibition of the transcription factor NF-kB which results in the production of inflammatory genes like TNF- $\alpha$  and IL-1 $\beta$ <sup>13</sup>.

Dragon fruit seeds, rich in polyunsaturated fatty acids (omega-3 and omega-6 fatty acids) play a crucial role in reducing the triglyceride level and minimizing the risk of cardiovascular diseases<sup>11</sup>. Due to the high content of fibres present in the seeds, it is capable of eliminating the toxins from the body along with a healthy bowel and steady sugar level in blood<sup>14</sup>. Dragon fruit seed is also rich in linoleic acid and fat contents<sup>11</sup>. Dragon fruit roots has a wonderful ability of controlling blood

sugar level and also provide treatment for kidney problems<sup>15</sup>. The main advantage of dragon fruit is that it may be sown once and continue to provide fruit for approximately 20 years whereas the main drawback is that after two years of planting it will start bearing fruit and need roughly 5 years for becoming productive completely<sup>16, 17</sup>. Dragon fruit is a fruit that requires more attention at the time of cultivation, harvesting, storage, processing, and transportation.



**FIG. 1: LIFE CYCLE OF DRAGON FRUIT**

**Geographic Distribution:** Approximately 100 years ago, Dragon fruit (*Hylocereus undatus*) was familiarized in Vietnam by the French. Recently, this fruit has been planted as a courtyard plant as well as an orchard plant. Furthermore, dragon fruit has been established for local consumption and for export in European and South Asian markets. Countries such as South and Central America, Mexico, intrinsically grow this crop, whereas it is even cultivated in the gardens. Currently, North America is the only country in which *Hylocereus* species are still found. The bloom flow of many

dragon fruits can be seen from the time of May to October in the northern hemisphere while period of floral opening of the crop varies from area to area. Subsequently, a large percentage of Vietnam's inhabitants as well as economic resources are located in rural, deltas and coastal lowlands, the country has been classified as one of the five most vulnerable to climate change<sup>18</sup>. *Hylocereus* species are known to be semi-epiphytes and consequently prefers to grow in shaded environments. However, species like *H. undatus*, *H. costaricensis* and *H. purpusii* can bear full exposure to sun. None the

less, excessive heat and inadequate supply of water might lead to the damage of stems as well as dropping of flower buds<sup>19</sup>. In Guadeloupe and Saint- Martin (French west indies), 50% shade is required for the growth of *H. trigonus*. Moreover, presence of excessive water may cause premature loss of flower and fruit<sup>20</sup>. *Hylocereus* species have ability to adjust to different variety of well-drained soil. In India, states such as Gujarat, Maharashtra and Karnataka are the top producers and approximately contributes in 70% of India's overall dragon fruit production. The arid areas of Kutch (Gujrat), Western Maharashtra and northern Karnataka are the main cultivation region of dragon fruit in India. In general, southern, and western states, are involved in producing dragon fruit in large amount since 5 to 8 years. For an instance, in Karnataka more than 600 farmers have adopted cultivation of pitaya in past five years after observing the positive outcomes<sup>21</sup>.

**Cultivation:** Dragon fruit is semi-epiphytic in nature. It frequently favours a dry subtropical and tropical environment of growth with an optimum temperature ranging from 21-29°C. It can bear freezing temperature for a very short time. Moreover, Pitaya requires a sufficient rainfall as well as sunshine, typically fluctuating from 600 to 1300 mm with flashing dry and wet periods. In addition, Dragon fruit prefers moderate temperature for growth whereas, the flowering and fruit setting process of the crop might get hindered by the excessive sunlight and full shade. Due to over-irrigation, pitaya undergoes flower dropping, yellowing, and splitting. Seed and Stem cutting also helps in the propagation of dragon fruit.

It takes approximately 4-5 years for a seed to produce flowers as well as fruits; However, in the case of vegetatively propagated crops, flowering befalls within 3 years. The flowering process of the pitaya takes place exclusively at night which can disturb the pollination process. In the zones where there is a shortage of pollinating agents and lack of genetic diversity, manual cross-pollination becomes essential for ensuring fruit development. Flowering as well as fruit setting of the pitaya can get affected by the several factors such as photo-period, temperature, rainfall, relative humidity, and light intensity. To increase the dragon fruit production, it is advised to combine 50 g of Urea,

Muriate of Potassium (100g), gypsum (100g), TSP (100g) along with borax (10g) per plant pit. Sprinklers with diameter of 1- 1.5 meters are preferred for watering the plants, which will focus the water in the root region. The maturation process of pitaya takes near about 28-30 days after blossoming. The physio-morphological characteristics are affected by the timing of flowering and the type of dragon fruit is being planted<sup>22</sup>.

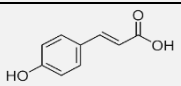
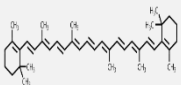
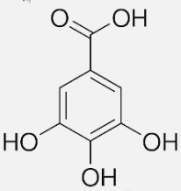
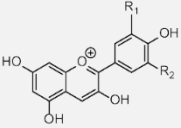
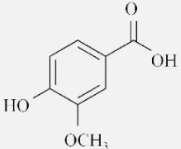
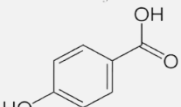
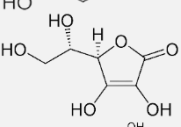
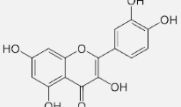
**Collection:** Dragon fruit changes its color from green to red or rosy- pink throughout its maturation stage naturally around 25 or 27 days after blooming<sup>23</sup>. The collection of *H. costaricensis* takes approximately 30 days whereas, the fruit attains maximum coloration after 4 to 5 days which can lead to splitting and economic loss. Due to absence of peduncle, collection of pitaya becomes challenging. Presently, the collection technique includes gently twisting the fruit in clockwise direction, without causing any potential damage to the fruits<sup>24</sup>. Although, these fruits are not so delicate but still certain precautions are taken to ensure the good quality of product such as cautious handling during processing and storage, particularly for *H. costaricensis* whose foliate scale is brittle<sup>25</sup>.

**Phytoconstituents:** Various bioactive compounds are present in different parts of the pitaya fruit. Majorly found bioactive compounds belong to fatty acids, sterols, tocopherols, tannins and flavonoids<sup>26</sup>. It is also observed that pitaya fruit consists of considerable number of vitamins such as ascorbic acid, riboflavin, thiamin, niacin and minerals like p-coumaric acid,  $\beta$ -carotene,  $\beta$ -amyryn, gallic acid, lycopene, vanillic acid, p-hydroxybenzoic acid<sup>27</sup>. *Hylocereus polyrhizus*, species contain higher concentrations of polyphenolic compounds which are generally found in Israel and Thailand. While on the other hand, *Hylocereus megalanthus* species contain higher levels of reducing sugars like glucose, fructose which is cultivated in Israel. Terpenoids such as limonene, carvone, retinoid, lutein & lycopene are generally present in the peel of the fruit. Peel of the fruit also has red colored pigment known as betacyanin<sup>28</sup>. Numerous flavonoids like kaempferol, quercetin, isoflavones, naringenin & isorhamnetin are found in abundance. In spite of these above bioactive compounds of

various classes, tannins are also found in fruit in two forms, hydrolyzable and condensed form. Proanthocyanidins, anthocyanidins are the forms of condensed tannins and gallotannins, ellagitannins are the forms of hydrolyzable tannins. On the other hand, phytosterols like tyrosol and hydroxytyrosol

and fatty acids like linolenic acid, palmitic acid are present in entire fruit <sup>7</sup>. *Hylocereus undatus* species is also enriched in carbohydrates, saponins, steroids, anthocyanins, glycosides, tannins and phenols <sup>29</sup>.

**TABLE 1: MAJORITY OF PHYTOCONSTITUENTS FOUND IN DIFFERENT SPECIES OF HYLOCEREUS**

Phytoconstituent	Chemical structure	Part Used	Therapeutic activity	References
p coumaric acid		Pulp & seed	Antidiabetic, Antilipidemic	<sup>30</sup>
β-carotene		Pulp	Antioxidant, Antidiabetic	28
Gallic acid		Peel, pulp & seed	Antioxidant, Antidiabetic, Prevent obesity	28
Anthocyanins		Peel & Pulp	Anti-inflammatory, Antioxidant	26
Vanillic acid		Peel & pulp	Antioxidant, Anti-inflammatory, Antidiabetic, Antiproliferative	26
p-hydroxybenzoic acid		Peel & pulp	Antioxidant	26
Ascorbic acid		Peel & pulp	Antioxidant, Anticancer, Antidiabetic, Antilipidemic	29
Quercetin		Peel & pulp	Antioxidant, Anti-inflammatory, Antidiabetic	26

**Uses:** Dragon fruit has numerous health benefits & nutritional values due to its bioactive compounds or phytoconstituents such as minerals, carbohydrates, vitamins, dietary fibres and antioxidants present in various forms. Leaves of the pitaya plant have diuretic and wound healing properties and sometimes also utilized for ornamental purpose due to its attractive appearance. Flowers of the plant have nutritional value, often used in salads, soup and tea <sup>29</sup>. Roots are helpful in regulating renal problems and blood glucose levels. Peel of fruit is utilized as a natural dye in food after processing. Phytoconstituents are found in abundance which generally belong to the class of flavonoids like kaempferol, quercetin and isorhamnetin. Peel of the

fruit possess radical scavenging and metal chelating properties. Phenols like tyrosol, hydroxytyrosol, gallic acid, vanillic acid and p-coumaric acid having antimicrobial, anti-inflammatory & antilipidemic activities <sup>31</sup>. Tannins such as gallotannins, proanthocyanidins, anthocyanidins and ellagitannins possess antiviral, antibacterial, anti-inflammatory and anti-cancerous properties. Fatty acids such as linolenic acid, palmitic acid & oleic acid exhibit the cosmeceutical properties for skin moisturization & hydration.

**Wound Healing Activity:** Wound healing process aims to restore the damaged tissues, which occur in several phases and includes numerous cell

populations and the action of growth factors and cytokines. Various studies show that the extracts of dragon fruit, stem and flower improves the fibroblasts' migration which is responsible for wound healing process. Phenolic compounds and flavonoids are also present in antioxidants containing extracts, which helps in DNA protection and wound healing activities<sup>30</sup>. Major problem in diabetes is wound healing. Dragon fruit exhibits gallic acid which is a feasible wound healing agent either in normal or hyperglycemic conditions<sup>28</sup>. Thus, migration of the keratinocyte and fibroblast cells accelerated by strong category of antioxidants present in gallic acid is further responsible for the activation of growth factors involved in wound healing<sup>29</sup>.

**Anticancer Activity:** Various studies have shown the anticancer properties of dragon fruit. The researchers have found that nanoparticles of fruit

help in inhibiting the growth of MCF-7 breast cancer cells, human prostate cancer cell lines, human gastric cancer cell lines. Species of *H. undatus* and *H. polyrhizus* reduces the risk of colon cancer by producing acetic acid, propionic acid and lactic acid. Phenolic acids, beta-cyanin, beta-sitosterol, beta-amyrin, alpha-amyrin, beta-carotene and flavonoids are the prominent bioactive compounds that are majorly responsible for exhibiting anticancer activity. Bioactive compounds of the fruit are effective against the human liver cancer, breast cancer and melanoma cells. The peel has more inhibitory effect than flesh against the growth of cancer cells and melanoma cells but both the peel as well as the flesh are rich in antioxidants and polyphenols<sup>26</sup>. *Hylocereus polyrhizus* species contain lycopene, a natural antioxidant which is conceded for prevention of cancer causing free radical formation.

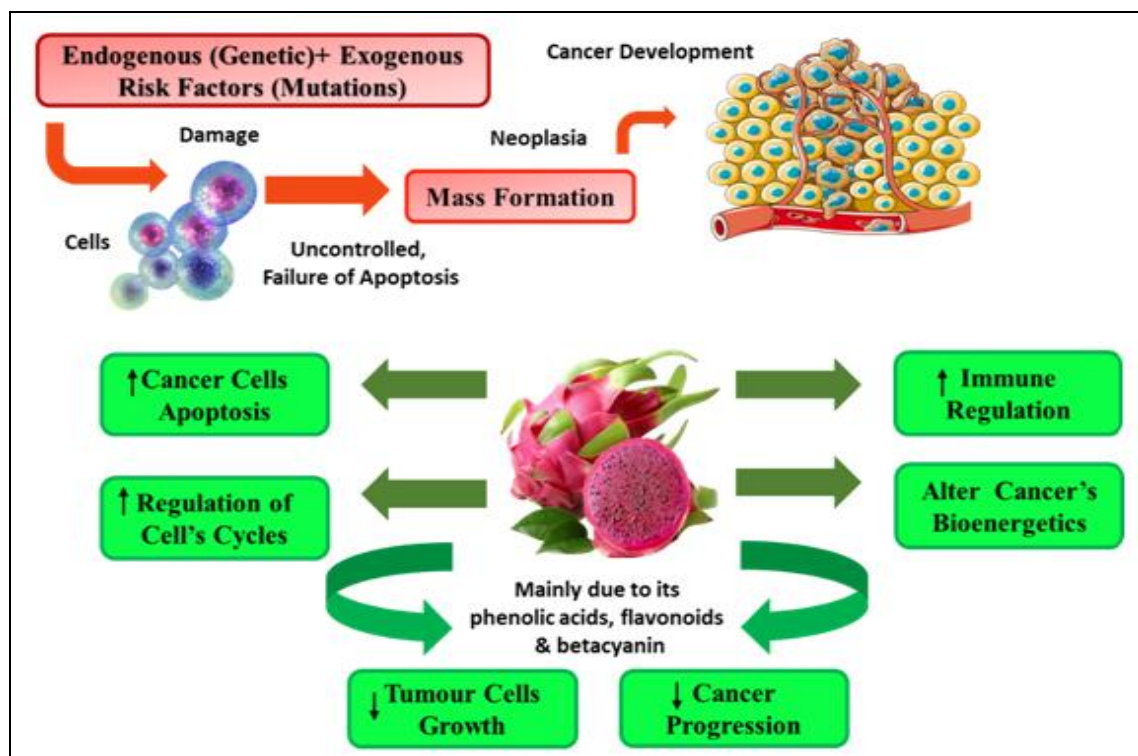


FIG. 2: DIAGRAMMATIC REPRESENTATION OF ANTICANCER ACTIVITY OF DRAGON FRUIT

**Antifungal Activity:** Dragon fruit has various uses and helps in preventing multiple disease conditions. Numerous studies carried out on the bioactive compounds present in dragon fruit and extracted by suitable procedures. Antioxidant and antifungal properties of the peel were determined against the fungi (*Candida albicans*) by using different extracts of the fruit peel. Research was carried out

on extracted pigments and secondary metabolites against candida albicans by using the Resazurin Microtiter Assay. The study inferred that ethyl acetate possess highest inhibition power in which gallic acid & quercetin are present in abundant amounts. Betalain is the natural pigment present in *Hylocereus* species which is responsible for providing natural colour to flowers and fruits.

Betalains, polyphenols and flavonoid based extracts of the dragon fruit possess antifungal activity<sup>32</sup>.

**Hypolipidemic Activity:** Hyperlipidemia is a complicated condition in which high levels of cholesterol and saturated fatty acids are detected in the blood. This increases the risk of cardiovascular diseases. Peel powder contains Betalain which if used in diets, reduces the high levels of Low density Lipoproteins, total cholesterol & triglycerides in blood and increases the levels of High density Lipoproteins resulting in healthy body and preventing Hyperlipidemia<sup>29</sup>. Additionally, the flesh has hypolipidemic properties that prevent atherosclerosis and elevate cholesterol and fat levels in the faces. 9, 12-Octadecadienoic acid present in the fruit belongs to fatty acid class and possess hypocholesterolemic activity<sup>33</sup>.

**Hepatoprotective Activity:** Tri-terpenoids glycosides, tannins, saponins and flavonoids are the bioactive compounds present in fruit which possess hepatoprotective activity<sup>34</sup>. These phytoconstituents provide shield to the liver against fat peroxidation followed by progression in Serum Glutamic-Pyruvic Transaminase (SGPT) & Serum Glutamic-Oxaloacetic Transaminase (SGOT). *Hylocereus polyrhizus* species protect the liver from damage caused due to the carbon tetrachloride<sup>31</sup>. Dragon fruit also possess tocopherols and phenolic compounds which reduces hepatic injuries and ameliorate the liver function after recovery<sup>35</sup>. Another research on hepatoprotective effect of methanolic extract of dragon fruit against acetaminophen induced liver damage was carried out. The evaluation of serum enzyme levels of alanine, aspartate aminotransferase, alkaline phosphate and total bilirubin concluded that the extract has the ability to recover or protect liver<sup>36</sup>.

**Neuroprotective Activity:** In above mentioned roles, neuroprotective activity is another active characteristic of the dragon fruit. Seeds of the fruit possess bioactive compounds. Majorly Essential fatty acids have neuroprotective activity and helps in preventing neurodegenerative diseases such as Alzheimer disease (AD), Parkinson disease (PD) and Amyotrophic lateral sclerosis (ALS)<sup>37</sup>. *Hylocereus polyrhizus* species help in preventing and improving the injuries caused due to the lead induced brain toxicity. Flesh contains

phytochemicals like flavonoids, phenols and anthocyanins which have the potential to prevent neurodegenerative diseases. Action of the bioactive compounds differ according to the geographical or demographic conditions<sup>38</sup>.

**Diuretic Activity:** Leaves and the fruit possess the natural diuretic properties. Saponins are responsible for the diuretic property. These secondary metabolites also provide protection and give a waxy layer to plants for better yield. Saponins such as oleanolic acid, betulinic acid, glycine and lupane are helpful in preventing chronic kidney disease<sup>37</sup>. Methyl ester, 9,12-octadecadienoic acid, 9,12,15-octadecatrienoic acid and 9,12,15-octadecatrienoic acid have diuretic activity<sup>33</sup>.

**Antimicrobial Activity:** Betacyanin, a red coloured pigment in the peel of the fruit has antimicrobial properties and antioxidant properties. Different mechanisms, like cell wall lysis and production of reactive oxygen species, are involved in killing microbes<sup>30</sup>. Broth microdilution assay results highlighted that, refrigerated fruits have higher amount of betacyanin than freshly harvested fruits. Refrigerated fruits have better MIC (minimum inhibitory concentration) value and are effective against ten strains of gram -positive bacteria such as *Bacillus cereus*, *Staphylococcus aureus*, *Enterococcus faecalis*, *Listeria monocytogenes* and six strains of gram-negative bacteria namely of *Escherichia coli*, *Yersinia enterocolitica*, *salmonella Typhimurium* and *Campylobacter jejuni*. Another method to identify the potential of fruit peel again microbes is disc diffusion method. Chloroform mediated extracts of the fruit peel have potent antimicrobial or antibacterial effect. *Hylocereus polyrhizus* species' extract with chloramphenicol showed synergistic inhibitory effect against the *Pseudomonas aeruginosa*. Silver nanoparticles of dragon fruit peel are also active against both the gram- negative and gram-positive bacteria<sup>28</sup>. Plant cell, when come in contact with microbial contaminants, produce secondary metabolites which are involved in defence mechanism against the particular diseases caused by viruses, bacteria and fungi. Both *Hylocereus undatus* and *Hylocereus polyrhizus* species fruit extracts show antibacterial activity against wide range of bacterial species and microbes<sup>34</sup>.

**Anti-inflammatory Activity:** Dragon fruit contains phytoconstituents namely Betalains and Squalene which are responsible for the antioxidant and anti-inflammatory activity. Betalains are highly unstable because they degrade easily in the presence of temperature, light, pH and oxygen but by encapsulation or through addition of impermeable and protective layer, its activity can be increased<sup>30</sup>. *Hylocereus polyrhizus* species have high concentration of betalains and have high anti-inflammatory activity due to the abundantly present antioxidants. By reducing the free radicals, inflammation is decreased by anti-inflammatory action<sup>29</sup>.

Betalains have the capacity to impede the transcription factor NF-κB which results in the inability to isolate the inflammatory genes like IL-1β and TNF-α. The research investigation performed on the dragon fruit showed the strong inhibition potential against acetylcholinesterase enzyme, confirming that dragon fruit shows the anti-inflammatory activity. Additionally, dragon fruit is highly potent on Cyclooxygenase and Lipoxygenase enzyme, thereby resulting in blockage of leukotriene and prostaglandin pathway. This result concluded that dragon fruit has anti-inflammatory properties<sup>37</sup>.

**Antiulcer Activity:** Quercetin is the phytoconstituent which is majorly responsible for the antiulcer activity in dragon fruit. It belongs to the class of flavonoids which is generally found in peels of the *Hylocereus polyrhizus* species. There is a proven fact that 35% of cases show complete distress by 2–4 days and 90% of cases show complete distress within 4–7 days. Relapse frequency can be decreased and minor symptoms can be relieved with Quercetin<sup>37</sup>. An investigational study showed the anti-ulcerative effects of dragon fruit extract at different doses. Various methods were used to carry out the investigation like the immunohistochemical, histopathological and molecular methods. Extract of the fruit is effective against the ulcers caused by indomethacin. It is also concluded that the protective action of the dragon fruit extract is due to the inactivation of COX-1 and COX-2 pathway which reduces oxidative stress<sup>39</sup>. Additionally, carbohydrates found in fruit extracts also help in the treatment of gastrointestinal diseases<sup>33</sup>.

**Antioxidant Activity:** Species of *Hylocereus* particularly *polyrhizus* is a rich source of betalains and other bioactive constituents like vitamins, flavonoids and phenolic compounds that have potentially relevant antioxidant properties.

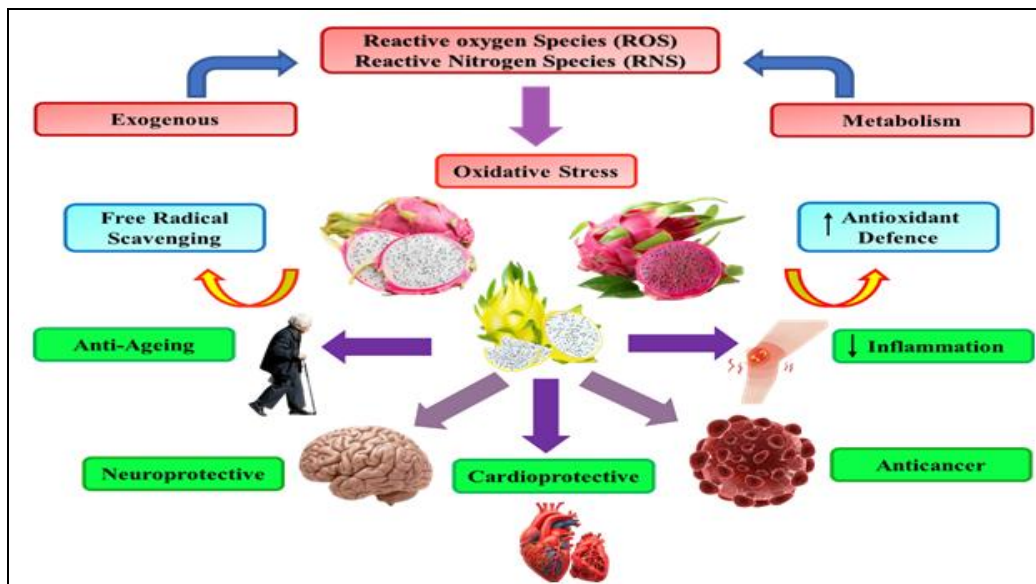


FIG. 3: ANTIOXIDANT EFFECTS OF HYLOCEREUS SPECIES & ITS HEALTH EFFECTS. ↑Increase; ↓Decrease<sup>26</sup>

The oil extracted from seeds and peel of *H. undatus* is an essential source of antioxidant compounds with greater flavonoid content found in peels than pulp. *Hylocereus polyrhizus* species exhibit high phenolic content of about 15.92 mg Gallic Acid/g

owing to greater antioxidant activity. The antioxidant property of dragon fruit was investigated and it was inferred that the total antioxidant status was less in pre-diabetic and normocholesterolemic subjects that consumed red



pitaya. Research envisaged by Harahap & Amelia demonstrated the ability of fruit extract to minimize the oxidative damage production in animal species. Various studies also suggest that the pulp extract has the potential to lower the oxidative damage in

STZ-induced diabetes in rats. Study conducted by Putri *et al.* suggested that the consumption of red dragon fruit could condense malondialdehyde levels in diabetic rats <sup>40</sup>.

**TABLE 2: PHARMACOLOGICAL ACTION OF DRAGON FRUIT ON THE BASIS OF THEIR ACTIVITY**

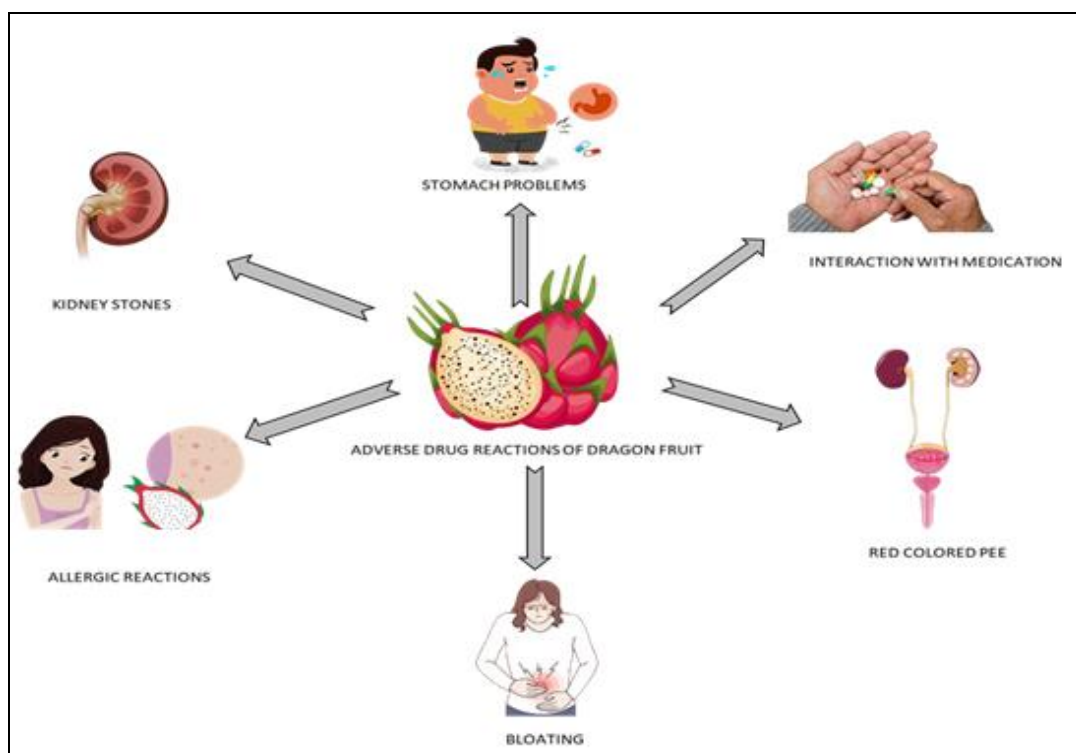
S. no.	Activity	Species used	Pharmacological activity	References
1	Wound healing	<i>H. undatus</i>	Having action on soluble mediators such as growth factors and cytokines results in restoration of damaged tissue or wound	41
2	Anticancer activity	<i>H. polyrhizus</i>	Flavonoids, polyphenols and Beta-amyrin and lycopene suppress breast cancer cells which acts by targeting various tumorigenic cellular pathways	42
3	Antifungal activity	<i>H. polyrhizus</i>	Research Studies conducted by microdilution method shows that phytol, Quercetin and gallic acid have generally effective against the fungi <i>species</i> like candida albicans	43
4	Hypolipidemic activity	<i>H. polyrhizus</i>	Triglycerides, total cholesterol, low density lipoproteins are reduced by using flesh of the dragon fruit. It prevents atherosclerosis by their hypolipidemic and anti-obesity activity.	44
5	Hepatoprotective activity	<i>H. undatus</i>	Animal studies concluded that methanolic extract from pitaya shows more effect against the silymarin. Dragon fruit have the hepatoprotective potential and antioxidant properties also	45
6	Neuroprotective activity	<i>H. undatus</i> and <i>H. polyrhizus</i>	Flavonoids, fatty acids and anthocyanins prevent the injuries induced due to lead toxicity which results in markedly low levels of norepinephrine and 5-hydroxytryptamine. Dragon fruit helps the brain tissue to revive and protect from further degradation	43,46
7	Diuretic activity	<i>H. polyrhizus</i> , <i>H. undatus</i>	Saponins, methyl ester, 9, 12, 15-octadecatrienoic acid and other fatty acid possess diuretic activity. They are also used in treating chronic kidney diseases	47,43
8	Antimicrobial activity	<i>H. polyrhizus</i>	Betacyanin and another secondary metabolites such as flavonoids make the plant's cells to resist against the attacks of viruses, bacteria and fungi	42
9	Anti-inflammatory activity	<i>H. polyrhizus</i>	Due to presence of betalains and squalene fruit has anti-inflammatory property, betalains mainly act as antioxidants. Free radicals mainly act on the mediators results in the decrease in inflammatory response	41
10	Anti-anemic activity	<i>H. polyrhizus</i>	Dragon fruit possess vitamin C in abundance and it helps in the production of non-heme iron which further responsible for the formation of blood. Due to high iron concentration, it regulates the erythrocytes and haemoglobin levels in anemic patients and pregnant women	42
11	Anti-infertility activity	<i>H. undatus</i>	Gallic acid as antioxidant helps in increasing mobility, size and number of the spermatozoa in the epididymis	43
12	Anti-aging activity	<i>H. polyrhizus</i>	Betalains which generally contains betacyanin and betaxanthin acts as antiaging agents by interacting with the free radical <i>species</i> and remove them out from body which are responsible for aging and heart problems also	43
13	Antidiabetic activity	<i>H. undatus</i> , <i>H. polyrhizus</i>	Antioxidants and dietary soluble fibers of dragon fruit lessened the insulin resistance	44
14	Antioxidant activity	<i>H. polyrhizus</i> , <i>H. megalanthus</i>	Gallic acid, vitamin C content and alkaloids have protective effect against the cellular damage caused by free radicals which may leads to the serious disorders like cancer. Due to all these bioactive phytochemicals dragon fruit peel has strong radical scavenging activity.	42
15	Anti-ulcer activity	<i>H. polyrhizus</i> , <i>H. megalanthus</i>	Peel extract contains quercetin which has the potential to treat the ulcers within 2 days or week by reducing the systems and frequency of relapses	43

**TABLE 3: COMPARISON OF NUTRITIONAL COMPONENTS OF THE SPECIES OF PITAYA FRUIT<sup>30</sup>**

Nutritional Components	<i>Hylocereus Undatus</i> (%)	<i>Hylocereus Polyrhizus</i> (%)
Total Carbohydrates (g)	11.2	11.2
Fats	0.1	0.21-0.61
Proteins	1.1	0.159-0.229
Glucose	5.5	4.7-5.7
Vitamin C (mg/100g)	3	8-9
Iron	3.37	0.6-3.4
Energy (KJ)	130	283
Calcium	10.2	2.3-10.2
Phosphorus	27.5	27.5-36.1
Magnesium	38.9	31.3-38.9
Potassium	272	272-328.4
Crude fibers	1.34	0.7-0.9
Fructose	1.9	1.8-3.2
Sodium	8.9	7.3-8.9

**Adverse Reactions:** Dragon fruit is known for its visually captivating look and potential benefits of health. Therefore, consuming dragon fruit in moderation is considered to be safe for maximum population. Nevertheless, unlike many other foods, pitaya or dragon fruit can also cause certain adverse

reactions in certain individuals. Some frequently observed side effects associated dragon fruit includes stomach problems, reddish coloured urine, medication interactions, kidney stones, bloating of stomach among others.



**FIG. 4: ADVERSE REACTIONS OF DRAGON FRUIT**

**Utilization of Dragon Fruit:** Pitaya fruit is globally known for its charismatic colours, juice and the gratifying taste. It is consumed in its raw form and dried form. Its natural colourant property makes it suitable for the preparation of numerous beverages and drinks. Fresh fruits, fresh flowering buds and young shoots of the *Hylocereus* species are also used as vegetables, although dried parts are

used as local or traditional medicine. Peel of the fruit contains high amount of betalains and pectins which makes it suitable as a natural food thickener. Various preparations like candies, jams, jellies, ice creams and shakes are made from the raw and processed fruits. Fruits are also served as soups and pickles. Plant stem and skin pulps are also used in cosmeceutical industry because of its skin

moistening effect, mainly beauty soaps are prepared<sup>27</sup>. *Hylocereus* species have multiple health effects from fruit pulp, plant parts as well as waste. Various nutraceutical activities are detected

and beneficial products such as beverages, powder, dried chips, yoghurt and other fermented products are processed these days<sup>48</sup>.

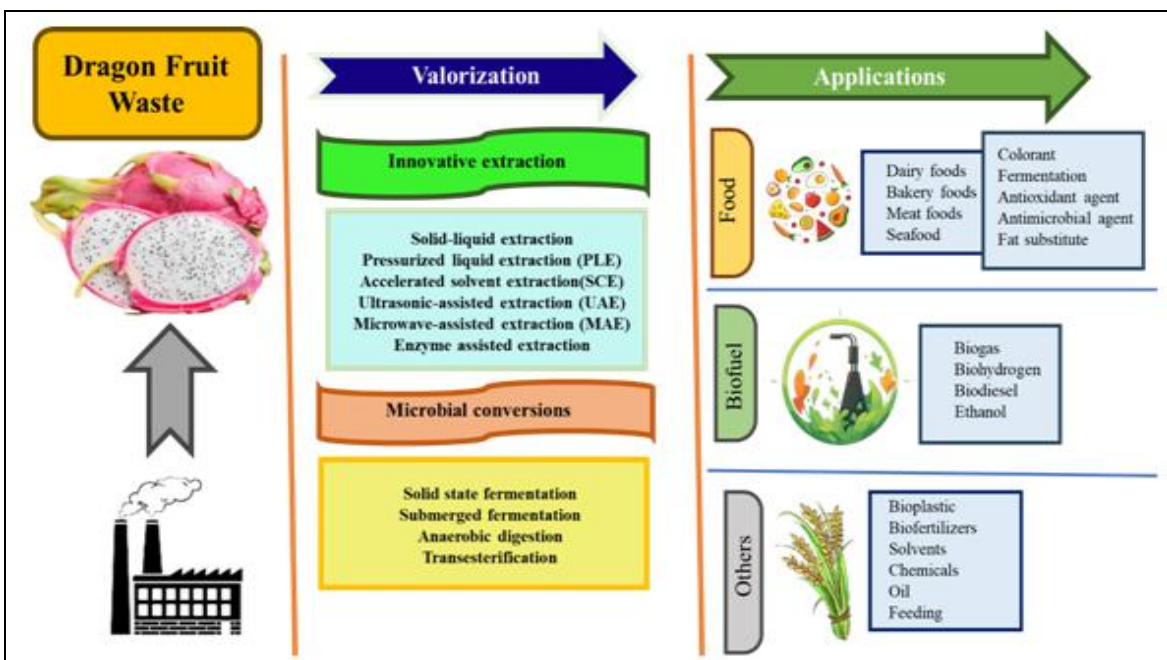


FIG. 5: DRAGON FRUIT WASTE UTILIZATION AND ITS APPLICATIONS<sup>49</sup>



FIG. 6: VALUE ADDED PRODUCTS OF DRAGON FRUIT<sup>49</sup>

**CONCLUSION:** In conclusion dragon fruit emerges out to be a remarkable fruit with immense therapeutic and nutritive value. Its diverse range of essential nutrients and phytochemicals renders it a potent assistance in promoting health and well-being. From regulating blood sugar levels to enhancing heart health and for tifying the immune

system, the perks of consuming dragon fruit are diverse and far-reaching. Furthermore, its antibacterial, antifungal, and neuroprotective properties highlight its potential as a therapeutic agent against various ailments. The rising economic and nutritional significance of dragon fruit underscores the importance of further research

to unlock its full potential. By diving deeper into its phytoconstituents and exploring new applications, we can harness its benefits to promote both human health and economic growth. Dragon fruit represents not only a delicious tropical delicacy but also a valuable resource for improving overall well-being. In essence, dragon fruit symbolizes nature's bounty, offering a tormenting blend of flavour and nutrients. Its cultivation and utilization present promising opportunities for sustainable agriculture and innovative health solutions. Through continued exploration and appreciation of its multifaceted attributes, dragon fruit holds the promise of a healthier and more prosperous future.

**ACKNOWLEDGEMENT:** The authors would like to express their gratitude to Department of Pharmaceutical Sciences & Technology, Maharaja Ranjit Singh Punjab Technical University, Bathinda, Punjab for their kind support. The authors are highly grateful to Ms. Chaurasia S. for her guidance and mentorship throughout.

**CONFLICTS OF INTEREST:** The authors declare that there are no conflicts of interest.

## REFERENCES:

1. Jalgaonkar K, Mahawar MK, Bibwe B and Kannaujia P: Postharvest Profile, Processing and Waste Utilization of Dragon Fruit (*Hylocereus* spp.): A Review. Food Reviews International 2022; 38(4): 733–759.
2. Britton NL and Rose JN: The Cactaceae: Descriptions and Illustrations of Plants of the Cactus Family; Courier Corporation 1963; 3.
3. VH ES, Utomo SB, Syukri Y and Redjeki T: Phytochemical screening and analysis polyphenolic antioxidant activity of methanolic extract of white dragon fruit (*Hylocereus undatus*). Indonesian Journal of Pharmacy 2012; 23 (1): 60–64.
4. Nerd A, Sitrit Y, Kaushik RA and Mizrahi Y: High summer temperatures inhibit flowering in vine pitaya crops (*Hylocereus* spp.). Sci Hortic 2002; 96 (1–4): 343–350.
5. Mori CV, Patel AR, Parmar VK and Patel GS: Dragon Fruit (Kamalam): An Excellent Exotic Fruit Crop of India 2023.
6. Balendres MA and Bengoa JC: Diseases of Dragon Fruit (*Hylocereus* species): Etiology and Current Management Options. Crop Protection 2019; 126: 104920.
7. Safira A, Savitri SL and Putri ARB: Hamonangan- Google Scholar. [https://scholar.google.com/scholar?hl=en&as\\_sdt=0%2C5&q=Safira%2C+A.%3B+Savitri%2C+S.L.%3B+Putri%2C+A.R.B.%3B+Hamonangan%2C+J.M.%3B+Safinda%2C+B.%3B+Solikhah%2C+T.I.%3B+Khairullah%2C+A.R.%3B+Puspitarani%2C+G.A.+Review+on+the+pharmacological+and+health+aspects+of+Hylocereus+or+Pitaya%3A+A+An+update.+J.+Drug+Deliv.+Ther.+2021%2C+11%2C](https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Safira%2C+A.%3B+Savitri%2C+S.L.%3B+Putri%2C+A.R.B.%3B+Hamonangan%2C+J.M.%3B+Safinda%2C+B.%3B+Solikhah%2C+T.I.%3B+Khairullah%2C+A.R.%3B+Puspitarani%2C+G.A.+Review+on+the+pharmacological+and+health+aspects+of+Hylocereus+or+Pitaya%3A+A+An+update.+J.+Drug+Deliv.+Ther.+2021%2C+11%2C)

- +297%E2%80%93303.+%5B&btnG= (accessed 2024-02-24).
8. Shekade DP, Patil PD, Mote GV and Sahoo AK: Potential Use of dragon fruit and taro leaves as functional food: a review. European Journal of Engineering Science and Technology 2018; 1(1): 10–20.
  9. Latif AZBA, Haque M, Shanmugasundaram C and Rao US: Clinical study of preventive potentials of consumption of buah naga [cactaceae] against paracetamol-induced hepatotoxicity as well as the other associated biological effects. Asian Journal of Research in Pharmaceutical Science 2012; 2(1): 16–23.
  10. Lourith N and Kanlayavattanukul M: Antioxidant and Stability of Dragon Fruit Peel Colour. Agro Food Industry Hi Tech 2013; 24(3): 56–58.
  11. Kumar SB, Issac R and Prabha ML: Functional and health-promoting bioactivities of dragon fruit. Drug Invention Today 2018; 10.
  12. Nurmahani MM, Osman A, Abdul Hamid A, Mohamad Ghazali F and Pak Dek MS: Antibacterial Property of *Hylocereus polyrhizus* and *Hylocereus undatus* Peel Extracts 2012.
  13. Hapsari A and Pujiastutik YE: The Potential effect of red dragon fruit (*Hylocereus polyrhizus*) peel ethanol extract on endometriosis progressivity in endometriosis mice. jurnal kedokteran hewan-indonesian. Journal of Veterinary Sciences 2018; 12(2).
  14. Mizrahi Y and Nerd A: Climbing and columnar cacti: new arid land fruit crops. Perspectives on new crops and new uses 1999; 1: 358–366.
  15. Mande DD, Kumbhare MR and Surana AR: Phytochemical composition, biological activities and nutritional aspects of *Hylocereus undatus*: A Review. Infectious Diseases and Herbal Medicine 2023; 4(1).
  16. Perween T, Mandal KK and Hasan MA: Dragon fruit: an exotic super future fruit of India. J Pharmacogn Phytochem 2018; 7(2): 1022–1026.
  17. Dhande C and Bagchi P: A study on the nutritional and medicinal properties in dragon fruit: a review. in international conference on advances in nano-neuro-bio-quantum (ICAN 2023); Atlantis Press 2023; 55–63.
  18. Mande DD, Kumbhare MR and Surana AR: Phytochemical composition, biological activities and nutritional aspects of *Hylocereus undatus*: A Review. Infectious Diseases and Herbal Medicine 2023; 4(1).
  19. Raveh E, Nerd A and Mizrahi Y: Responses of two hemiepiphytic fruit crop cacti to different degrees of shade. Sci Hortic 1998; 73 (2–3): 151–164.
  20. Hossain MM: Postharvest Quality and Shelf Life of Dragon Fruit (*Hylocereus* pp.) as Influenced by Preharvest Fruit Bagging Materials. Journal of Agriculture, Food and Environment (JAFE) ISSN (Online Version): 2708-5694 2020; 1(4): 33–40.
  21. Wakchaure GC, Kumar S, Meena KK, Rane J and Pathak H: Dragon fruit cultivation in India: scope, constraints and policy issues. Technical Bulletin 2021; 27: 47.
  22. Hossain FM, Numan SMN and Akhtar S: Cultivation, nutritional value, and health benefits of dragon fruit (*Hylocereus* spp.): A Review. IJHST 2021; 8(3): 259–69.
  23. Nerd A, Gutman F and Mizrahi Y: Ripening and postharvest behaviour of fruits of two *Hylocereus* species (Cactaceae). Postharvest Biol Technol 1999; 17(1): 39–45.
  24. Jalgaonkar K, Mahawar MK, Bibwe B and Kannaujia P: Postharvest profile, processing and waste utilization of dragon fruit (*Hylocereus* spp.): A Review. Food Reviews International 2022; 38(4): 733–759.

25. Perween T, Mandal KK and Hasan MA: Dragon fruit: an exotic super future fruit of India. *J Pharmacogn Phytochem* 2018; 7(2): 1022–1026.
26. Nishikito DF, Borges ACA, Laurindo LF, Otoboni AMMB, Direito R, Goulart R, de A, Nicolau CCT, Fiorini AMR, Sinatora RV and Barbalho SM: Anti-inflammatory, antioxidant, and other health effects of dragon fruit and potential delivery systems for its bioactive compounds. *Pharmaceutics* 2023; 15(1): 159.
27. Hossain FM, Numan SMN and Akhtar S: Cultivation, nutritional value, and health benefits of dragon fruit (*Hylocereus* spp.): A Review. *Int J Hort Sci Technol* 2021; 8(3): 259–269.
28. Joshi M and Prabhakar B: Phytoconstituents and Pharmacotherapeutic Benefits of Pitaya: A Wonder Fruit. *J Food Biochem* 2020; 44(7): 13260.
29. Mande DD, Kumbhare MR and Surana AR: Phytochemical composition, biological activities and nutritional aspects of *Hylocereus undatus*: A Review. *Infectious Diseases and Herbal Medicine* 2023; 4(1).
30. Tarte I, Singh A, Dar AH, Sharma A, Altaf A and Sharma P: Unfolding the potential of dragon fruit (*Hylocereus* spp.) for Value Addition: A Review. *Food* 2023; 4(2): 76.
31. Safira A, Savitri SL, Putri ARB, Hamonangan JM, Safinda B, Solikhah TI, Khairullah AR and Puspitarani GA: Review on the Pharmacological and Health Aspects of *Hylocereus* or Pitaya: An Update. *Journal of Drug Delivery and Therapeutics* 2021; 11(6): 297–303.
32. Luu TTH, Le TL, Huynh N and Quintela-Alonso P: Dragon fruit: a review of health benefits and nutrients and its sustainable Development under Climate Changes in Vietnam 2021.
33. Kylanel AN, Sugiaman VK and Pranata N: Fibroblast viability test toward red dragon fruit (*Hylocereus polyrhizus*) Peel Ethanolic Extract. *Systematic Reviews in Pharmacy* 2020; 11(12).
34. Cahyati WH and Putringtyas ND: The benefits and uses of red dragon fruit in food consumption. in *ismina 2021: proceedings of the 5th international conference on sports, health, and physical education*. ISMINA 2021, 28-29 April 2021, Semarang, Central Java, Indonesia; European Alliance for Innovation 2021; 332.
35. Hendra R, Masdeatresia L, Almurdati M, Abdulah R and Haryani Y: Antifungal activity of red dragon peel (*Hylocereus polyrhizus*). In *IOP Conference Series: Materials Science and Engineering*; IOP Publishing 2020; 833: 012014.
36. Sushmitha HS, Roy CL, Gogoi D, Velagala RD, Nagarathna A, Balasubramanian S and Rajadurai M: Phytochemical and Pharmacological Studies on *Hylocereus undatus* Seeds: an *in-vitro* approach. *World Journal of Pharmacological Research* 2018; 7(14): 986–1006.
37. Safira A and Savitri SAPJ: of D.; 2021, undefined. Review on the Pharmacological and Health Aspects of *Hylocereus* or Pitaya: An Update. *jddtonline. Info A Safira, SL Savitri, ARB Putri, JM Hamonangan, B Safinda, TI Solikhah, AR Khairullah* *Journal of Drug Delivery and Therapeutics*, 2021; *jddtonline.info* 2021. <https://doi.org/10.22270/jddt.v11i6.5181>.
38. Singh S and Kumar S: A review on nutritional, medicinal and bio-active compound of dragon fruit *Hylocereus polyrhizus* (fac weber) britton & rose. *Int J Biochem Res Rev* 2023; 32(5): 57–67.
39. Islam AMT, Chowdhury MAU, Uddin ME, Rahman MM, Habib MR, Uddin MGM and Rahman MA: Protective effect of methanolic extract of *Hylocereus polyrhizus* Fruits on Carbon Tetra Chloride-Induced Hepatotoxicity in Rat. *European J Med Plants* 2013; 3(4): 500.
40. Rebecca OPS, Boyce AN and Chandran S: Pigment identification and antioxidant properties of red dragon fruit (*Hylocereus polyrhizus*). *Afr J Biotechnol* 2010; 9(10): 1450–1454.
41. Mande DD, Kumbhare MR and Surana AR: Phytochemical composition, biological activities and nutritional aspects of *Hylocereus undatus*: A Review. *Infectious Diseases and Herbal Medicine* 2023; 4(1).
42. Singh S and Kumar S: A review on nutritional, medicinal and bio-active compound of dragon fruit *Hylocereus polyrhizus* (FAC Weber) Britton & Rose. *Int J Biochem Res Rev* 2023; 3(5): 57–67.
43. Safira A, Savitri SL, Putri ARB, Hamonangan JM, Safinda B, Solikhah TI, Khairullah AR, Puspitarani and GA: Review on the Pharmacological and Health Aspects of *Hylocereus* or Pitaya: An Update. *Journal of Drug Delivery and Therapeutics* 2021; 11(6): 297–303.
44. Luu TTH, Le TL, Huynh N and Quintela-Alonso P: Dragon fruit: a review of health benefits and nutrients and its sustainable. *Development under Climate Changes in Vietnam* 2021.
45. Islam AMT, Chowdhury MAU, Uddin ME, Rahman MM, Habib MR, Uddin MGM and Rahman MA: Protective effect of methanolic extract of *Hylocereus polyrhizus* fruits on carbon tetra chloride-induced hepatotoxicity in rat. *European J Med Plants* 2013; 3(4): 500.
46. Elgazar AF, Shalaby MA and Ibrahim ES: Potential effectiveness of flesh-red dragon fruit juice in the improvement of consequence injury from lead acetate-induced neurotoxicity in rats. *J Pharm Negat Results* 2023; 894–906.
47. Sushmitha HS, Roy CL, Gogoi D, Velagala RD, Nagarathna A, Balasubramanian S and Rajadurai M: Phytochemical and Pharmacological Studies on *Hylocereus undatus* Seeds: an *in-vitro* approach. *World Journal of Pharmacological Research* 2018; 7(14): 986–1006.
48. Toktay E, Yayla M, Sahin L, Harmankaya A, Ozic C, Aksu Kilicle P, Gurbuz MA, Erbas E, Demir O and Bayram P: The Effects of Dragon Fruit (*Hylocereus polyrhizus*) extract on Indomethacin-induced Stomach Ulcer in Rats. *J Food Biochem* 2022; 46 (9): e14274.
49. Tripathi M, Diwan D, Shukla AC, Gaffey J, Pathak N, Dashora K, Pandey A, Sharma M, Guleria S and Varjani S: Valorization of dragon fruit waste to value-added bioproducts and formulations: a review. *Crit Rev Biotechnol* 2023; 1–19.

**How to cite this article:**

Bhadauria S, Mansi, Choudhary T and Chaurasia S: Exploring the therapeutic potential of dragon fruit: an insightful review. *Int J Pharmacognosy* 2024; 11(6): 222-34. doi link: [http://dx.doi.org/10.13040/IJPSR.0975-8232.IJP.11\(6\).222-34](http://dx.doi.org/10.13040/IJPSR.0975-8232.IJP.11(6).222-34).

This Journal licensed under a Creative Commons Attribution-Non-commercial-Share Alike 3.0 Unported License.

This article can be downloaded to **Android OS** based mobile. Scan QR Code using Code/Bar Scanner from your mobile. (Scanners are available on Google Playstore)