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A Review on Therapeutic Potential of Dragon Fruit (An Exotic Super Fruit)

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Abstract: ***Dragon fruit (Hylocereus spp.) is an emerging superfruit in India, gaining popularity in both rural and urban areas due to its vibrant color, delicious flavor, and exceptional nutritional and therapeutic properties. This fruit thrives in semi-arid tropical, subtropical, and humid environments. Its rising demand is driven by its rich antioxidant content and numerous health benefits.***

Among the different varieties, red dragon fruit (Hylocereus polyrhizus) is one of the most cultivated and consumed fruits in Indonesia. It has been found to exhibit significant antibacterial, antifungal, neuroprotective, cardioprotective, and antiplatelet properties. This comprehensive review highlights the various nutraceutical applications and health advantages of dragon fruit, along with its biological origin, history, geographic distribution, cultivation, and bioactive compounds present in different parts of the plant. With its increasing nutritional and commercial significance, dragon fruit is gaining recognition for its medicinal potential. Its bioactive components, including flavonoids, phenolics, and betalains, contribute to its health-promoting properties. Additionally, research suggests that dragon fruit may play a role in regulating lipid metabolism and blood glucose levels, making it a promising candidate for managing chronic conditions such as diabetes and obesity. To further support both health and economic development, more extensive studies on its phytochemical composition are essential.

Keywords: Dragon fruit, antioxidants, nutraceuticals, bioactive compounds, diabetes management.

I. INTRODUCTION

Dragon fruit (*Hylocereus spp.*), also known as pitaya, is becoming increasingly popular worldwide due to its unique appearance, delicious taste, and impressive health benefits. This tropical fruit is rich in bioactive compounds, including flavonoids, phenolics, and betalains, which contribute to its antioxidant, anti-inflammatory, antibacterial, and even anti-cancer properties. Because of these qualities, dragon fruit is now widely consumed and recognized as a nutritionally valuable superfood.[1,2,3]

Belonging to the Cactaceae family, dragon fruit is a climbing vine (*Hylocereus undatus* Haw.) that grows well in tropical and subtropical regions. It is cultivated both for its fruit and as an ornamental plant. The fruit is visually striking, with bright red skin covered in green scales and flesh that can be either red or white, speckled with tiny black seeds. These seeds, along with the fruit's pulp, contain important nutrients such as polyphenols, flavonoids, and vitamin C, which help protect the body from harmful free radicals and support overall health. Dragon fruit is not only valued for its health benefits but also for its versatility. It can be eaten fresh or added to smoothies, desserts, and salads. Additionally, its vibrant pigments make it a natural coloring agent used in food and pharmaceutical industries. Recent studies suggest that dragon fruit may play a role in managing chronic diseases like diabetes and obesity by helping to regulate blood sugar levels and improve lipid metabolism. In India, dragon fruit is gaining popularity among farmers due to its high market value and profit potential. With its growing demand in both domestic and international markets, it is becoming an important crop in the agricultural sector. However, to fully understand and utilize its health benefits, more research is needed on its phytochemical composition and medicinal properties.[4]



Fig no :1 Dragon fruit (Hylocerus Polyrhizus

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A. Taxonomy and Botanical Classification

1) The plant is known by various names, including:
- Dragon fruit
- Pitaya
- Pitahaya
- Strawberry pear
- Night-blooming cereus
- Belle of the Night
- Cinderella plant

2) Dragon fruit belongs to the genus *Hylocereus* (A. Berger) Britton and Rose, which was established in 1909.

3) There are a total of 18 species within the *Hylocereus* genus.

4) The systematic classification of dragon fruit is as follows:

B. Biological Hierarchy
- Kingdom: Plantae
- Subkingdom: Tracheobionta
- Division: Magnoliophyta
- Class: Magnoliposida
- Subclass: Caryophylidae
- Order: Caryophyllales
- Family: Cactaceae
- Subfamily: Cereoideae
- Tribe: Hylocereae
- Genus: *Hylocereus*

C. Pharmacological Activity of Dragon Fruit

Pharmacological activity of medicinal herbal plants has been shown in the treatment of various diseases; among these, dragon fruit has numerous pharmacological activities, as listed below:

II. HEALTH BENEFITS OF DRAGON FRUIT

A. Antioxidant Properties

Natural antioxidants derived from medicinal plants have gained significant attention due to their ability to protect cells from damage caused by free radicals, which are linked to various diseases, including cancer (Young & Woodside, 2001). Antioxidants such as flavonoids, polyphenols, and tocopherols help prevent or slow down oxidative damage to cellular components.

Dragon fruit is an excellent source of antioxidants, particularly in its pulp, which contains vitamin C, polyunsaturated fatty acids, B vitamins, carotene, proteins, and essential minerals such as calcium, iron, potassium, and sodium. Interestingly, studies suggest that the peel of dragon fruit possesses a higher antioxidant capacity than the flesh. This difference may be attributed to the varying bioactive compounds present in both parts of the fruit.[4,5,6,7]

B. Anti-Cancer Properties

Research has demonstrated the anti-cancer potential of flavonoids, polyphenols, and betanin found in dragon fruit. Extracts from dragon fruit peel, obtained using a 50:50 mixture of water and ethanol, have shown significant antiproliferative effects against human hepatocellular carcinoma cells.

Luo et al. (2014) found that supercritical carbon dioxide extracts from the peels of *Hylocereus polyrhizus* and *Hylocereus undatus* exhibited both antioxidant and cytotoxic properties. These extracts demonstrated cytotoxic effects against three cancer cell lines:
- PC3 (human prostate cancer)
- Bcap-37 (human breast cancer)
- MGC-803 (human gastric cancer)

The extracts had IC50 values ranging from 0.61 to 0.73 mg/mL, indicating their potential as anti-cancer agents. However, further research is needed to fully understand the mechanisms behind these effects.[8,9]

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C. Antiplatelet Activity

Ethanol and ethyl acetate extracts from dragon fruit have demonstrated significant antiplatelet properties. These extracts show a concentration-dependent ability to inhibit platelet aggregation induced by different agonists, suggesting that dragon fruit may help prevent blood clot formation and improve cardiovascular health.[10]

D. Anti-Inflammatory Properties

Dragon fruit has been shown to exhibit strong anti-inflammatory effects. In studies, a mixture of dragon fruit skin and flesh was processed using vacuum-distilled water and then dried for further analysis. The resulting extracts were tested for their effects on key inflammatory enzymes, including:

- 5-Lipoxygenase (5-Lipox)
- Acetylcholinesterase (AChE)
- Cyclooxygenase-2 (COX-2)

Extracts derived from dragon fruit flesh demonstrated remarkable inhibitory effects on all three enzymes, with the strongest effect observed on acetylcholinesterase. This suggests that dragon fruit may help reduce inflammation through mechanisms linked to cholinergic anti-inflammatory pathways. Additionally, its impact on COX and Lipox enzymes indicates a potential role in blocking pathways involved in leukotriene and prostaglandin production, which are associated with inflammatory responses.

III. HEALTH BENEFITS AND CULTIVATION TECHNIQUES OF DRAGON FRUIT

A. Antimicrobial Properties

Dragon fruit (*Hylocereus polyrhizus*) contains betalains, the primary bioactive compounds responsible for its antimicrobial activity. The peel extracts, obtained through solvent maceration at pH 5, have been analyzed for their phytochemical composition, total phenolic content, and antioxidant and antimicrobial properties.

Ethanol and methanol extracts from dragon fruit have shown strong antibacterial effects against:

- *Bacillus*
- *Vibrio*
- *Escherichia coli*
- *Staphylococcus*

Additionally, ethanol and hexane extracts contribute to neuroprotective effects, potentially preventing neurodegenerative diseases. Dragon fruit is also rich in essential fatty acids, which further enhance its neuroprotective benefits.[11,12]

B. Antimicrobial Activity

Betacyanin, a red pigment found in dragon fruit peel, exhibits both antimicrobial and antioxidant properties. Its mechanisms of action include:

- Disrupting microbial cell walls
- Generating reactive oxygen species (ROS)
- Preventing bacterial biofilm formation
- Inhibiting microbial DNA replication and energy synthesis
- Neutralizing bacterial toxins

Studies indicate that dragon fruit extracts can effectively combat bacterial infections, highlighting its potential in food preservation and natural antimicrobial applications.[13,14,15]

C. Hypolipidemic Activity

The flesh extract of dragon fruit has demonstrated significant hypolipidemic (cholesterol-lowering) effects in animal studies. Key findings include:

- Increased HDL (good cholesterol)
- Reduced triglycerides, LDL (bad cholesterol), and total cholesterol
- Enhanced fat and cholesterol excretion

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These properties suggest that dragon fruit may help prevent conditions like atherosclerosis and hyperlipidemia, both of which contribute to cardiovascular diseases. The peel, rich in betalains, has also been found to lower cholesterol and triglyceride levels while improving overall lipid profiles.

IV. CULTIVATION TECHNIQUES OF DRAGON FRUIT

A. *Growth Requirements*

Dragon fruit is a semi-epiphytic plant that thrives in subtropical and tropical climates. Ideal conditions for growth include:

- Temperature: 21-29°C (can tolerate brief freezing temperatures)
- Rainfall: 600-1300 mm annually, with alternating dry and wet seasons
- Sunlight: Moderate exposure (excessive sunlight or full shade can hinder flowering and fruiting)
- Irrigation: Avoid overwatering, as it may cause flower drop, yellowing, and fruit splitting

B. *Propagation Methods*

Dragon fruit can be propagated through various techniques, with stem cuttings being the most effective for commercial farming. Common propagation methods include:

- Stem cutting (most efficient and widely used)
- Seed propagation (takes longer, about 4-5 years for fruiting)
- Grafting
- Micropropagation (tissue culture for large-scale production)

C. *Support Systems and Planting Density*

Since dragon fruit plants are climbers, they require a proper support structure. Common support systems include:

- Concrete or wooden poles
- Trellises or vertical structures

Optimal planting density ensures better yield and management efficiency.

D. *Pruning and Training*

Regular pruning and training improve plant health and maximize fruit yield.

- Initial training: Helps guide plant growth around support structures
- Pruning: Removes dead or overcrowded branches to enhance air circulation and fruit production

E. *Nutrient and Irrigation Management*

Balanced nutrition is crucial for high-yield production. Recommended fertilization includes:

- Nitrogen (N): 200-300 kg/ha/year for vegetative growth
- Phosphorus (P): 100-150 kg P_2O_5/ha/year for root and flower development
- Potassium (K): 200-300 kg K_2O/ha/year for fruit quality and disease resistance
- Calcium (Ca) & Magnesium (Mg): Essential for cell wall integrity and chlorophyll synthesis
- Micronutrients: Iron (Fe), Zinc (Zn), and Boron (B) applied as foliar sprays to prevent deficiencies

F. *Irrigation Techniques*

- Sprinkler irrigation: Recommended for efficient water distribution
- Drip irrigation: Helps conserve water and maintain consistent moisture in the root zone

G. *Harvesting and Post-Harvest Management*

- Dragon fruit typically matures **28-30 days** after flowering.
- Harvesting at the right time is crucial for maintaining fruit quality.
- Proper post-harvest handling extends shelf life and preserves nutritional value.

By implementing effective cultivation practices, dragon fruit farming can be optimized for both high yield and superior fruit quality.[16,17,18]

V. HEALTH BENEFITS OF DRAGON FRUIT

A. Nutritional Profile

The genus Hylocereus encompasses several species, yet only a select few are cultivated for their commercial and nutritional significance, including Hylocereus undatus, Hylocereus polyrhizus, and Hylocereus costaricensis. The red dragon fruit serves as an abundant source of essential nutrients and minerals, including vitamins B1, B2, B3, and C, along with protein, fats, carbohydrates, crude fiber, flavonoids, thiamin, niacin, pyridoxine, cobalamin, phenolics, betacyanins, polyphenols, and carotene. Notably, red dragon fruit (Hylocereus polyrhizus) is particularly high in phytoalbumins, which demonstrate significant antioxidant properties. Consequently, the red pitaya fruit is recognized for its probiotic characteristics and potent antioxidant applications.

Nutrient	Nutrient Amount per(100g)	Daily value (%)
Water	87g	-
Protein	1.1g	2.1
Fat	0.4g	-
Fiber	3g	12
Carbohydrates	11.0g	3.4
VitB1(Thiamine)	0.04mg	2.7
VitB2(Riboflavin)	0.05mg	2.9
VitB3(Niacin)	0.16mg	0.8
Calcium (Ca)	8.5mg	0.9
Iron(Fe)	1.9mg	10.6
VitC(Ascorbic acid)	20.5mg	34.2
Phosphrous(P)	22.5mg	2.3

Tab: 1 Nutritional value of ripen dragon fruit

B. Health Benefits

Dragon fruit has attracted interest not only due to its distinctive look and flavor but also for its possible health advantages. The fruit boasts a rich nutritional composition, encompassing a variety of vitamins, minerals, and bioactive substances, which may contribute to its beneficial effects on human health. Although further research is required to comprehensively understand and validate these benefits, current studies indicate several potential positive outcomes.[19,20]

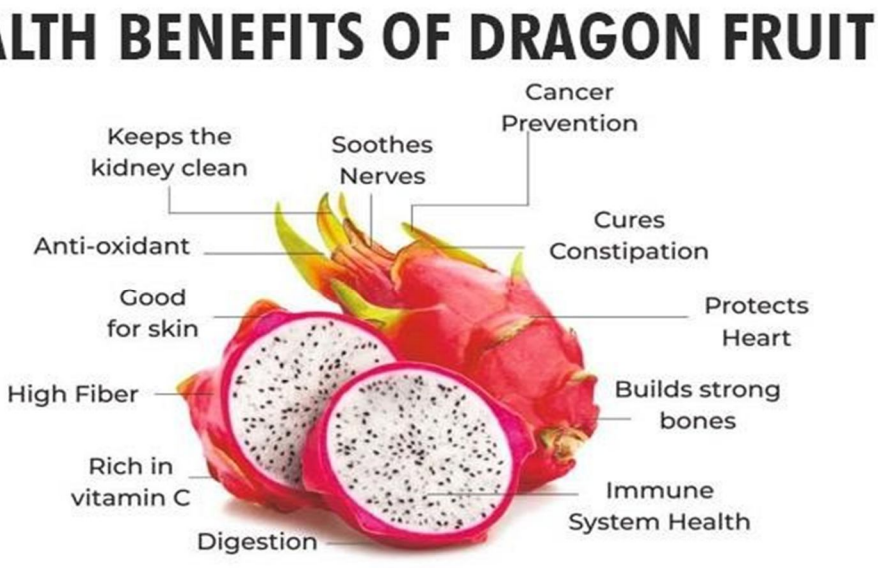


Fig No :3

C. Therapeutic Applications

1) Neuroprotective Effects: Initial research indicates that dragon fruit may possess neuroprotective properties, likely attributed to its antioxidant and anti-inflammatory characteristics.

2) Dragon fruit is rich in health benefits and nutritional value, owing to its bioactive compounds, including minerals, carbohydrates, vitamins, dietary fibers, and various forms of antioxidants. The leaves of the pitaya plant exhibit diuretic and wound healing properties and are sometimes used for ornamental purposes due to their appealing appearance. Additionally, the flowers of the plant are nutritionally valuable and are often incorporated into salads, soups, and teas.

3) Cardiovascular Protection: In addition to its influence on lipid profiles, dragon fruit may offer further cardiovascular advantages, including potential anti-hypertensive effects.

D. Adverse Side Effects

Dragon fruit is renowned for its striking appearance and potential health benefits. Consequently, moderate consumption is generally regarded as safe for the majority of the population. However, unlike many other foods, pitaya can elicit certain adverse reactions in some individuals. Common side effects associated with dragon fruit include gastrointestinal issues, reddish urine, interactions with medications, kidney stones, and abdominal bloating.

1) While isolated allergic reactions have been documented, dragon fruit is generally safe for consumption, aside from these rare instances.

2) Symptoms such as hives, vomiting, and tongue swelling are indicative of this type of reaction, although they appear to be exceedingly rare.

3) Consuming a significant amount of dragon fruit may result in pink or red urine; however, this symptom is often less serious than it may seem.[21,22]

VI. CONCLUSION

Dragon fruit is a highly nutritious and visually striking fruit, offering health benefits from both its flesh and peel. Rich in antioxidants such as polyphenols and anthocyanins, it holds significant potential as a functional food. The fruit's unique composition makes it suitable for various applications, including fresh consumption, herbal tea production, and natural food coloring. Sensory evaluation, based on attributes like color, size, and texture, plays a crucial role in determining fruit quality.

With a relatively long shelf life—remaining fresh for up to ten days at room temperature and up to two weeks under controlled storage—dragon fruit is a viable commercial crop. Research continues to explore its potential in preventing and managing health conditions, though it should complement, rather than replace, a balanced diet and medical treatments.

In India, off-season cultivation presents an opportunity for expanded production. However, the current market price remains high, indicating a need for strategic marketing and supply chain improvements. As demand grows, future efforts should focus on optimizing production techniques and enhancing accessibility to maximize both economic and nutritional benefits.

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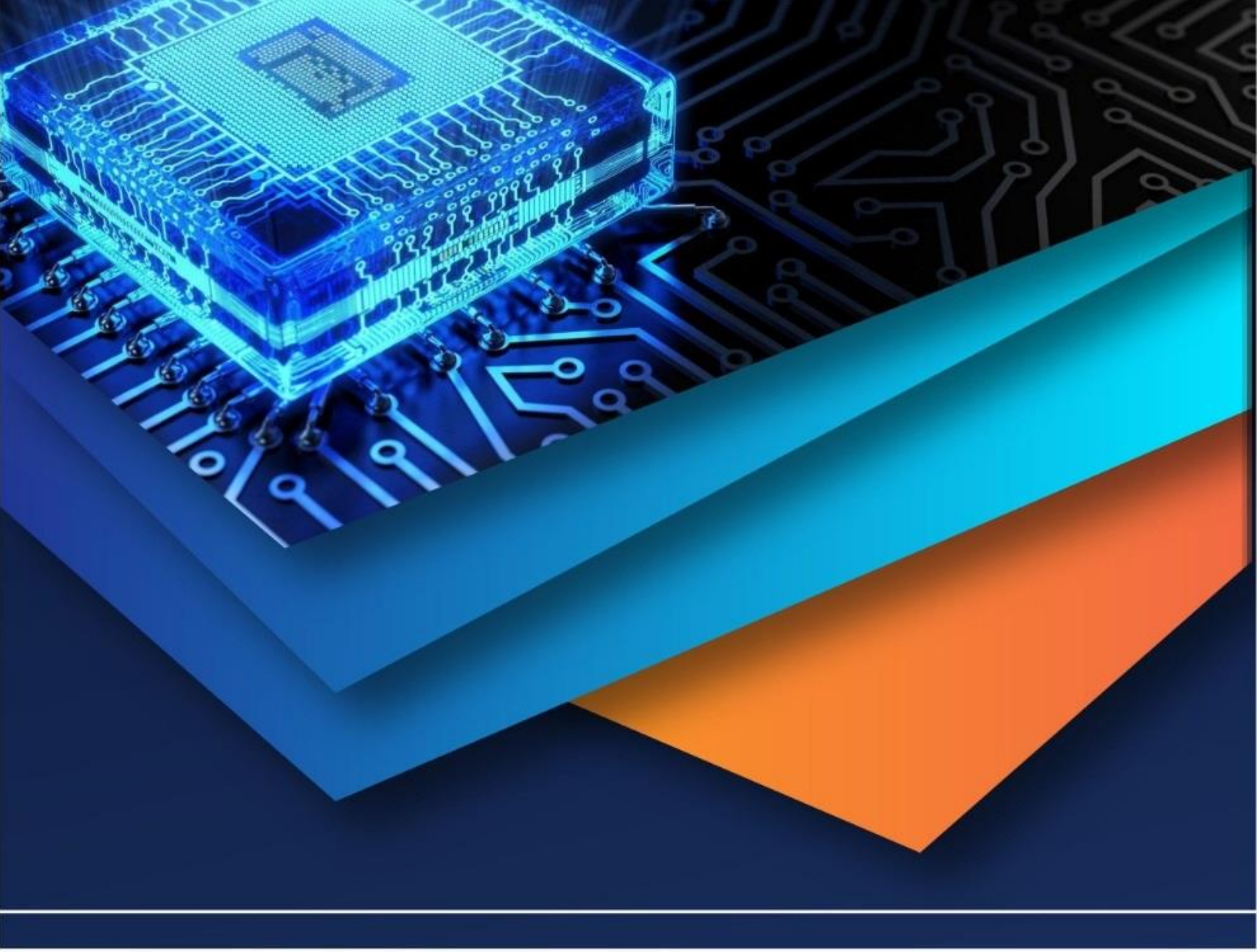
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