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Hidden Gems of Dragon Fruit: Its Role in Pharmacognosy and Therapeutics

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Abstract

The Cactaceae family includes the medicinal plant Hylocereus spp., also known as dragon fruit. The skin's unique morphology, which reflects the body's oval form, is characteristic of dragon fruit. Dry conditions are ideal for dragon fruit growth. Dragon fruit, also known as pitaya, is a fantastic functional food that has attracted attention recently due to its numerous therapeutic benefits, including antioxidant, anti-cancer, anti-diabetic, anti-microbial, hepatoprotective, and anti-hyperlipidemic properties. It also offers nutraceutical benefits because of its prebiotic activity. Additionally, it demonstrates anti-inflammatory, anti-viral, anti-anemia, wound healing, and microvascular protective qualities. Many phytoconstituents that can be extracted from peels, seeds, and meat parts, including polyphenols, pigments, flavonols, palmatic acids, isopenoids, steroids, vitamins, carbohydrates, minerals, and roughage, have contributed to these therapeutic benefits. The largest variety of crops is reportedly grown in India. Dragon fruit is no different. Dragon fruit is ideal in Maharashtra and certain regions of Gujarat and Rajasthan. It has been discovered that a dragon fruit-producing company is a feasible source of food, money, and jobs. The restricted number of commercial producers of dragon fruit is predicted to contribute to the high marketability of the product in the local market.

Keywords: *Hylocereus SPP*, hepatoprotective, betacynin, agroclimatic, colletotrichum, cytotoxicity.

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INTRODUCTION

Pitaya, often known as dragon fruit, belongs to the *Cactaceae* family and is found in the *Selnicereus* and *Hylocereus* genera. Most commercially developed varieties are found in the *Hylocereus* genus, which has over 16 species [1]. *Hylocereus megalanthus*, also known as yellow dragon fruit because of its yellow skin and white flesh, *Hylocereus polyrhizus*, which also has red skin and white flesh, and *Hylocereus undatus*, also known as white dragon fruit because of its red skin and white flesh, are among the species of the fruit that have been the subject of much research [2]. It's unique not just because of the skin surface that grows with "scales" but also because the term "moon flower or mistress of the night" arises throughout its growth, implying that dragon fruit blossoms only occur at night [3]. Both the non-edible and edible components of dragon fruit, such as the flesh and seed, are rich in phenolic compounds, pigments, isopenoids, palmitic acids, flavonols, organic compounds, minerals, and roughage, among other phytoconstituents [4, 5].

Dragon fruit, which belongs to the *Cactaceae* family, is best suited for arid climates with temperatures no higher than 45°C [6]. As a fruit, it is susceptible to temperature fluctuations. Due to the presence of these different phytoconstituents, the fruit has a number of therapeutic qualities, such as free radical scavengers, anti-neoplastic, anti-diabetic agent, anti-bacterial, hypolipidemic agent, anti-fatness, anti-hepatotoxicity, anti-sickness, inflammation reducer, virus protection, and tissue repair properties [7, 8]. Many diseases have been treated using dragon fruit in Asian countries as part of traditional medicine. For example, bronchitis, diabetes, mumps, hyperactivity, and TB have all been treated using *H. undatus* blooms. In Taiwan, the fruit has been used to replace rice and provide nutritional fiber to diabetics [9]. The hue or pigmentation of dragon fruit's flesh, which is a result of betacyanin's action in the fruit, is one of its most appealing features. Dragon fruit pigments are said to be unusual since they are available in a variety of hues, such as red, yellow, and white (Figure 1) [10].

Four Types of Dragons Fruits Mainly Grown in India Are

- *Hylocerus Undatus:* Red skin having white flesh fruits.
- *Hylocerus Polyrhizus:* Red skin with pink flesh fruits.
- *Hylocerus Costaricencis:* Red skin with purple flesh fruits.
- *Selenicereus Megalanthus:* Yellow skin with white flesh fruits.

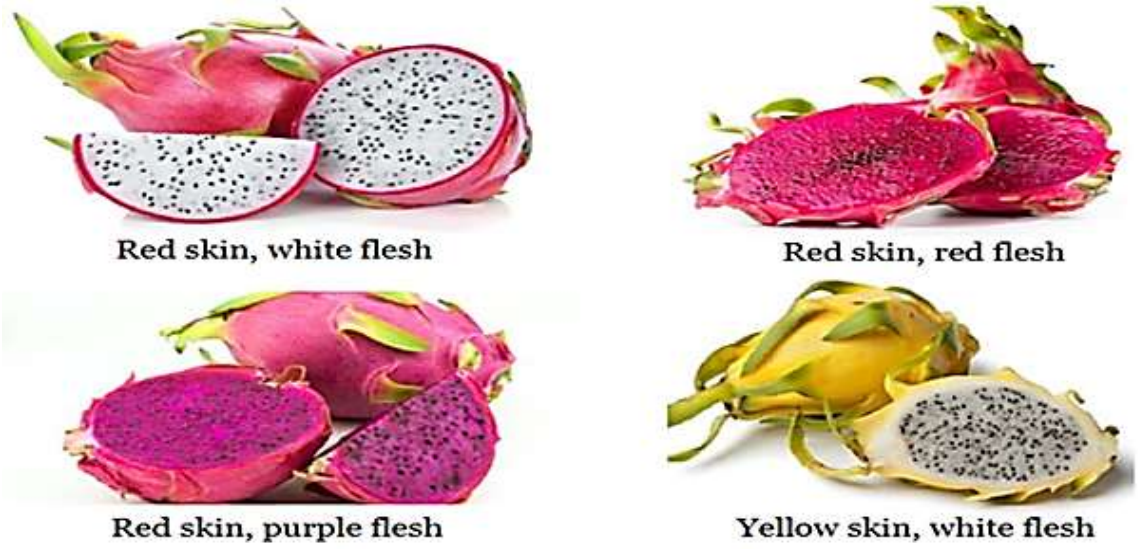

Figure 1. Types of dragon fruit.

Taxation

- *Kingdom: Plantae*
- *Division: Spermatophyta*
- *Class: Dicotyledonae*
- *Order: Cactales*
- *Family: Cactaceae*
- *Genus: Hylocereus*
- *Spesies: Hylocereus polyrhizus, Hylocereus undatus, Hylocereus megalanthus [11].*

Plant Information

One kind of cactus that possesses terrestrial or epiphytic traits is the pitaya, often known as dragon fruit. For this dragon fruit plant to develop as best it can using aerial roots, enough light exposure, airborne nutrients, and arboreal humidity, it needs support poles or other trees. The stems of dragon fruit plants can branch, broaden, ascend, and scandent. The stem has a triangular physical form and is lanky and watery [12]. Dry, tropical, and subtropical regions with highs of 40°C are ideal for dragon

fruit cultivation. On physically shaped plants, such as cactus, this dragon fruit will mature 30 to 50 days after the first blossoming. This dragon fruit vine often bears fruit five to six times a year [13].

Phytoconstituents of Dragon Fruit

Due to its abundance in many classes of phytoconstituents with potential medical use, dragon fruit has a high nutritional and commercial value. It contains a higher amount of minerals, such as calcium, phosphorus, magnesium, sodium, potassium, iron, and terpenoids, as well as pigments, fatty acids, vitamins, carbohydrates, and polyphenols that have a variety of therapeutic applications [14]. The alkaloids are cholinesterase inhibitors, such as donepezil, tacrine, rivastigmine, and velnacrine, which are used to treat Alzheimer's disease. Certain coumarins, such as phenylpropanoids, which are found in both extracts, have anti-inflammatory, anti-bacterial, anti-tubercular, anti-fungal, and antiviral properties. Lupane, glycine, betulinic acid, and oleanolic acid are examples of saponins that can be utilized to treat diabetes and kidney disease (Figure 2) [15].

Origin and Geographical Distribution

It is extensively dispersed and occurs naturally in forests of Mexico and North and South America, where it is thought to be native. It has expanded from its origin to a number of nations, including Australia, China, Guatemala, Hawaii, Indonesia, Israel, Malaysia, Taiwan, Thailand, and Vietnam. This fruit crop has just lately been brought to India, where it is mostly grown in Gujarat, Karnataka, and Maharashtra, although it is also grown in other regions [16].

Cultivation and Collection

- *Soil and Climate:* Dragon fruit can be cultivated in a variety of soil types, such as sandy loam, clay-dominated soils, murrum, etc., but it needs well-drained soil to support healthy growth and prevent bacterial rot. A pH of 5.5 to 6.5 is ideal for growth in soil. It can withstand some salt in the soil and favors slightly acidic soil. A yearly average temperature of 20–30ºC and 500–1500 mm of rainfall is needed [17].
- *Varieties:* Most of the dragon fruit types and variations that are currently grown in farmers' fields are imports from other nations. There are no records of a methodical dragon fruit breeding effort in the nation for varietal or germplasm assessment. The growers in India primarily like crimson-pulped dragon fruits [18].
- *Pruning Requirement:* Pruning is the process of gradually removing undesired shoots to promote fruiting and plant growth on a support system. After planting, corrective trimming is done in the first few years. Around the support, stems continue to grow. Limiting bunch growth is the goal of maintenance pruning, which can be done as early as the second year after planting [19].
- *Water Requirement:* Compared to most other C3 fruit crops, including pears, citrus, etc., this fruit requires just 10% of the water. They recommend 120 to 150 mm of irrigation per year to suit its water needs [20].
- *Mannur and Irrigation:* Carefully applying manures and fertilizers will increase the amount and quality of fruit produced. For three years mature plants, suggested application of 540 g of N_2, 720 g of P, 300 g of K and 20 kg manure per plant per year in four splits in Vietnam conditions. Application of an enriched microbial culture as a microbial enhancer for natural nutrient delivery, such as Ghana jeevamrit and Desi cow dung, which are made using jaggery, pulse flour, desi cow dung, and virgin soil [21].
- *Harvesting:* To develop suitable pre- and post-harvest technologies for dragon fruit, researchers in Binh Thuan Province, Vietnam, examined the quality assurance system for the fruit. The following is a summary of the research on dragon fruit harvesting indices, post-harvest storage conditions, grading, and quality factors [22].
- *Yield and Storage:* It was highlighted that storing six different varieties at 5°C and 10°C caused a minor darkening of the inner skin color. There was no discernible impact of storage on the peel's flavor, sweetness, texture, color, or overall visual appeal. When fruit was stored at 5°C, its

antioxidant activity was reduced; however, at 10°C, it remained unchanged, and its betacyanin concentration was the same as it was expected to be at harvest [23].

Health Benefits

The antioxidants and high nutritious content of dragon fruit make it a super fruit. This fruit can be processed and used on a table. The best fruit for salads is bracts, which have vibrant red and white flesh with tasty little black seeds embedded in them. From the pulp, value-added goods, like juice, jelly, jam, candies, syrup, and wine, can also be made. Fruit peel has a lot of pectin in it, it can also be utilized as a raw material and food coloring agent [24].

- *Nutrituve Value:* The nutritional analysis's findings indicate that the average pitaya has the following nutritional characteristics: moisture, protein, fat, vitamin C, vitamin A, ash, crude fiber, glucose, fructose, sorbitol, and carbohydrate. Additionally, pitaya includes several minerals, including iron, phosphorus, sodium, potassium, niacin, calcium, magnesium, and zinc [25].
- *Medicinal Value:* Red dragon fruit, with its abundance of nutrients and minerals, aids in the healing of the digestive system, decreases blood pressure, neutralizes toxins in the body, particularly those from heavy metals, relieves coughs and asthma, and guards against several cancers, including colon cancer. Dragon fruit's phytoalbumin concentration, which has a very high antioxidant value, has a role in cancer prevention [26]. In the world of medicine, white dragon fruit (*Hyolecerus undatus*) aids in the healing of wounds. White dragon fruit leaves and floral water extract, when combined in topical formulations, have been shown to have a high level of efficacy in promoting wound healing [27].

PHARMACOLOGICAL ACTIVITY

Antimicrobial Activity

The antimicrobial activity of dragon fruit against a range of microorganisms has also been demonstrated. Red dragon fruit's antibacterial action was shown to be ineffective in a study against ten different gram-positive and six different gram-negative bacterial strains when stored in a refrigerator. The broth micro dilution method was utilized to determine the minimum inhibitory concentration (MIC) to evaluate the antibacterial activity [28]. The antibacterial effectiveness of red and white dragon fruit leaf extract's antibacterial effectiveness against meningitis-causing bacteria (*Neisseria meningitidis*, *Listeria monocytogenes*, and *S. pneumoniae*) was assessed in a study. Because flavonoids can form compounds with bacterial cell walls, their presence may be responsible for their antibacterial effect [29].

Activities to Prevent Inflammation

Studies have indicated that dragon fruit has anti-inflammatory qualities. After the dragon fruit's peel and meat were mixed, the mixture was separated using vacuum-distilled water and drying [30]. The high anti-inflammatory action of betalains from *H. polyrhizus* peels can be ascribed to their substantial antioxidant activity, as free radicals are the primary pro-inflammatory mediators and the inflammatory cascade is sustained in their presence. Additionally, scavenging free radicals might lessen the inflammatory response [31].

Anti-Cancer Activity

The flavonoids, polyphenols, and betanin found in dragon fruit have been shown in several studies to have anticancer effects. One dosage of a 50:50 mixture of ethanol and water was used to extract the dragon fruit skin, which demonstrated an antiproliferative action against human hepatocellular carcinoma cells [32]. Fruit peels include steroids and pentacyclic triterpenoids, which have been linked to anti-cancer benefits. Higher concentrations of these bioactives have been found in the *H. polyrhizus* species [33].

Activity of Hyperlipidimic

56.50% of the fruit's 69.30% crude fibers are insoluble food fibers, whereas 14.82% are soluble fibers. By producing fatty acid fermentation products, blocking the synthesis of cholesterol, and decreasing triglycerol secretion, the insoluble fibers hinder the production of hepatic fatty acids. The

production of cholesterol is also regulated by the activity of 3-hydroxy-3-methylglutaryl-coenzyme A (HMG-CoA) reductase [34].

Anti Animic Activity

Many herbal remedies are used to avoid anemia during pregnancy; one such remedy is the use of exotic fruit, which is utilized as an iron supplement to strengthen pregnant women's stamina. Iron, vitamin C, calcium, potassium, and magnesium have all been found in red dragon fruit; the first two are thought to be excellent sources of antioxidants, which lower blood pressure and blood sugar [35].

Anti Diabetic Activity

Dragon fruit that was fresh and samples that had been heat-processed were prepared for this purpose. Each sample had different amounts of phenolic content, dietary fiber, and scavenging properties. Subsequently, these were administered to insulin-resistant rats for a 6-week period to examine *H. polyrhizus's* anti-insulin resistance potential [36]. The use of dragon fruit extends beyond its flesh for antidiabetic properties. The skin and seeds of dragon fruit also have anti-diabetic properties [37].

Wound Healing Property

Red dragon fruit's quercetin and tannins are widely known for helping to speed up the healing of wounds. Flavonoids were demonstrated to oversee collagen production, and the presence of quercetin was thought to oversee wound closure via the promotion of angiogenesis, an increase in the number of epithelial cells, and the proliferation of fibroblasts [38].

Hepatoprotective Activity

It is true that the extracts from dragon fruit help rats that have been poisoned because of the increased concentration of antioxidants resulting from the CCl4 consumption described above. It has been demonstrated that the liver can be effectively shielded by dragon fruit extracts from chronic damage when CCl4–56 is used to produce it in test animals [39].

Value of Neuroprotective

The phytochemical makeup of dragon fruit actively supports neuroprotective function, especially in preventing neurodegenerative diseases. The phytochemical component of dragon fruit includes essential fatty acids, which may actively contribute to neuroprotective activity and fend off neurodegenerative diseases [40].

Antiviral Potential

Dragon fruit's possible antiviral qualities have also drawn interest. Chang et al., for example, investigated the antiviral activity of betacyanin produced from red dragon fruit against the type 2 dengue virus [41].

Prebiotic Effect

Digestion, constipation, inflammation, and irritable bowel illness are just a few of the issues that can arise when the microbiota in the gut becomes out of balance. The gut flora is preserved by the actions of prebiotics and probiotics. Studies have demonstrated the prebiotic properties of oligosaccharides obtained from dragon fruit, and they can be utilized as supplements for a variety of gastrointestinal disorders [42].

Different Products Based on Dragon Fruit (Figure 3)

- *Juice:* A functional health drink with an overall acceptance of 8.50 was created by Jalgaonkar et al. using 3% sugar syrup, 22% pomegranate juice, 5% grape juice, and 70% dragon fruit juice. One of the most significant processed goods with a higher level of popularity and recognition is dragon fruit juice [43].

- *Powder:* Due to its long shelf life, good value, and simplicity of incorporation as a natural colorant in many processed foods, dragon fruit powder is widely used as a functional food. An industrial method called spray drying is used to extract powder from various fruit juices while retaining as much of the nutrients and other active ingredients as possible [44].
- *Wine:* To create a fermented beverage with red dragon fruits, Foong et al. found that the fruit pulp had 1.42% betanin, but raw fruit pulp had between 0.23% and 0.39% betacyanin. It has been determined that both the prepared pasteurized and unpasteurized fermented drinks are safe to eat [45].

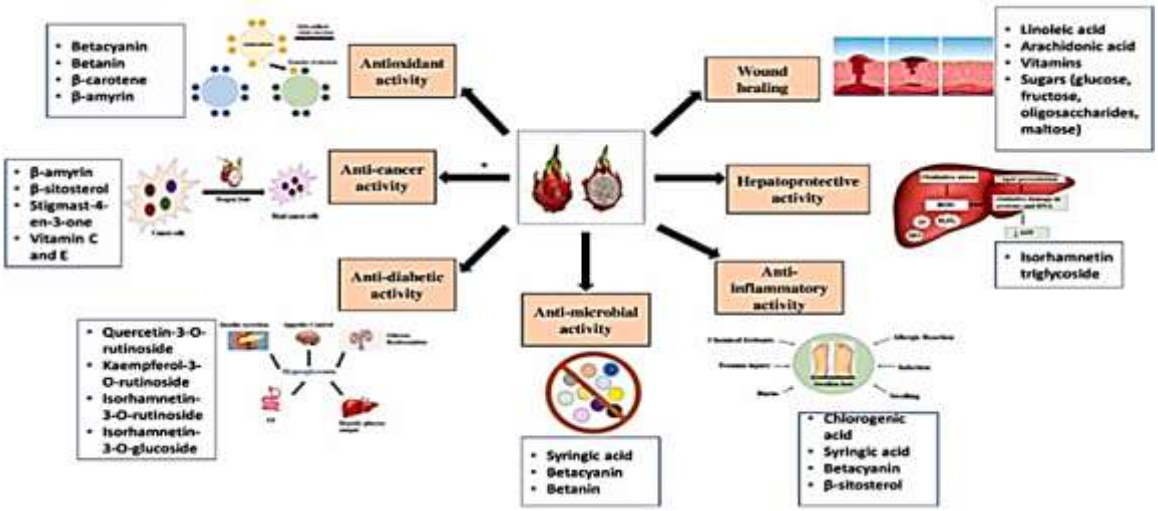

Figure 2. Various health-promoting qualities of dragon fruit's phytoconstituents.

- *Dried Chips:* DF chips and investigated the effects of pretreatments like hot air drying (at 65°C, 1.2 m/s air velocity, and 12% relative humidity) and freeze-drying (using a vacuum freeze dryer at 0.1 kPa pressure and −55°C condenser temperature, further drying at 30°C for 12 hours), followed by explosion puffing drying (treated with high temperature, i.e., 90°C and at atmospheric pressure, depressurized in less than 0.2 s, then dried continuously with 60°C temperature under 3 kPa vacuum until less than 7% moisture content) [46].
- *Jam/Jelly:* The value addition of DF to jelly-like goods would aid in preservation and provide the commercially available, high-quality product that is now underrepresented in the market. Pectin, acid concentration, sugar content, and endpoint detection are crucial ingredients to consider while making jam or jelly to ensure high-quality results. Pectin facilitates the formation of a gel by supplying the right quantity of sugar and fruit acid [47].

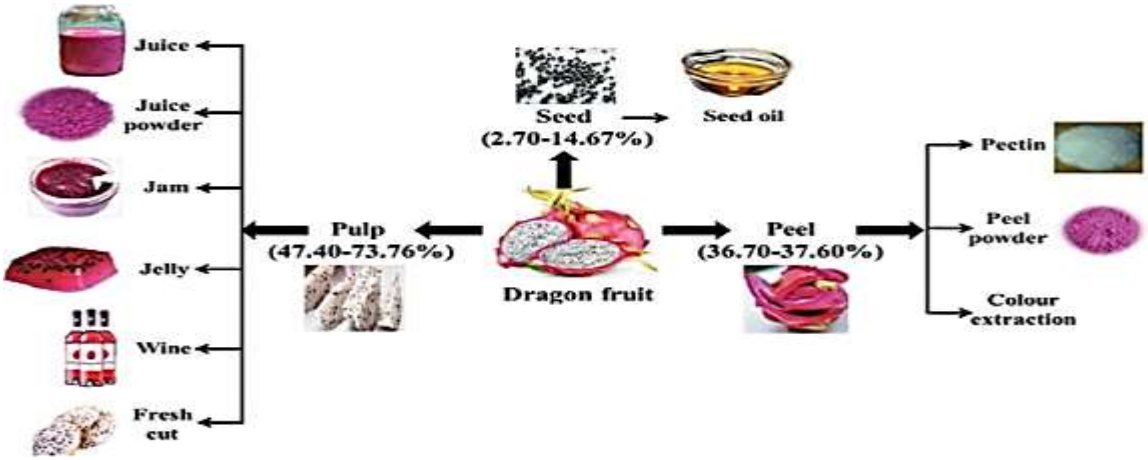

Figure 3. Various processed/value-added products made from dragon fruit.

Challenges

There are 21 known species of fungi that can infect dragon fruit and produce various diseases; the most common and destructive of these is anthracnose. Many species of Colletotrichum, including *C. gloeosporioides, C. karstii, C. aenigma, C. truncatum, and C. siamense*, are the cause of this disease [48]. Dragon fruit post-harvest difficulties include water loss, mechanical damage, and chilling injuries. The symptoms of a chilling injury include darkening scales, browning of the flesh's outer layer, fruit turning translucent, shriveling, and diminished flavor from low storage temperatures. The temperature range between 5 and 10°C is where chilling damage might happen. In addition, it is influenced by the ripening stage, genetic background, and growth environment. The formation of wrinkles on the surface of dragon fruit is another significant issue that typically shortens its shelf life, degrades its appearance, and makes it less marketable.

Future Prospective

Dragon fruit coloring powder's launch as a new product for the food business is presented by a natural food enhancer made from dragon fruit. Because of its high fiber, antioxidant, vitamin, and mineral content, dragon fruit is regarded as a superfood and is, therefore, appealing to consumers who are health conscious. The market is growing quickly due to the rising demand for organic food products and the use of dragon fruit in a variety of products, including drinks, jams, sauces, ice creams, and salad dressings. The fruit is used in a variety of industries, including food and beverage, cosmetics, personal care, and pharmaceuticals, due to its special qualities and health advantages. All things considered, the growing interest in dragon fruit and its expanding market share suggest that it has a lot of potential for usage as a nutraceutical and in a variety of international product developments.

CONCLUSIONS

Pitaya, also referred to as dragon fruit, is a member of the Cactaceae family and is found in the genera *Hylocereus* and *Selnicereus.* With over 16 different species, the *Hylocereus* genus is home to most commercially grown variants. The edible sections of dragon fruit, such as the meat and seed, as well as the non-edible parts, are excellent sources of numerous phytoconstituents, such as vitamins, minerals, fatty acids, flavonoids, terpenoids, pigments, phenolic compounds, and dietary fibers. Dragon fruit has a wide range of phytoconstituents that have been associated with several health advantages, such as hepatoprotective, antioxidant, anti-cancer, anti-diabetic, antibacterial, and antihyperlipidemic effects. The fruit's components also have anti-inflammatory, antiviral, anti-anemic, prebiotic, and microvascular protective qualities. They can aid with wound healing. The phytoconstituents that are present in dragon fruit include n-hexadecanoic acid, 1-hexadecyne, 2-chloroethyl linoleate, butyl ester, tetratriacontane, heptacosane, oleic acid, Lupane, glycine, betulinic acid, Octacosane, hexadecyl ester, trichloroacetic acid, and tetracosanol Phthalic acid 1,2-benzenedicarboxylic acid, y-sitosterol, 17-pentatriacontene, eicosane, (Z, Z)-9, 12-octadecadienoic acid, and mono (2 ethylhexyl) ester. Although preclinical studies have demonstrated the safety and efficacy of the phytochemicals obtained from dragon fruit, clinical research is still necessary to confirm the potential therapeutic advantages. Examining the procedures is also crucial for extracting significant amounts of bioactives. The increased demand for organic food items and the usage of dragon fruit in a wide range of goods, including beverages, jams, sauces, ice creams, and salad dressings, are driving the market's rapid expansion. Because of its unique properties and health benefits, the fruit is employed in a wide range of sectors, including food and beverage, cosmetics, personal care, and medicines. All things considered, the increasing market share and growing interest in dragon fruit indicate that it has a lot of potential for use as a nutraceutical and in a range of international product developments. However, there are challenges that need to be addressed both before and after cultivation. These fruits get various benefits to boost the energy for sports players in the form of juice. They are also useful in cosmetics preparation for beautifying and smoothing the skin.

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