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A comprehensive review of dragon fruit (*Hylocereus* spp.): Botanical attributes, nutritional value, health benefits, and culinary applications

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Abstract
Dragon Fruit (*Hylocereus* spp.) is a unique and captivating fruit known for its vibrant appearance, distinct taste, and potential health benefits. This comprehensive review explores the botanical characteristics, nutritional composition, potential health advantages, and versatile applications of Dragon Fruit in the realm of culinary creations. It explores the various species and varieties of *Hylocereus*, their morphological characteristics, and the factors influencing their growth and cultivation. The paper delves into the nutritional composition, bioactive compounds, and antioxidant properties of the dragon fruit. Furthermore, it summarizes the current scientific knowledge regarding the potential health benefits of dragon fruit, including its role in promoting cardiovascular health, aiding digestion, managing diabetes, and enhancing immune function. Finally, the challenges and opportunities associated with dragon fruit production, post-harvest handling, and marketing are also discussed.

Keywords: Dragon fruit, botanical attributes, nutritional value, culinary application

1. Introduction
Pitaya (*Hylocereus* spp., sometimes known as dragon fruit) is a captivating tropical fruit praised for its eye-catching appearance and unusually sweet flavour**.** Dragon fruit has grown in popularity because of its eye-catching red or pink skin, white or red flesh, and tiny black seeds, as well as for its possible nutritional and health benefits. This fruit, part of the cactus family (Cactaceae), grows best in warm, humid climates, and cultivation of it has spread to many areas of the world, making it a widely available fruit**.** The rise in popularity of dragon fruit is brought on by both its sensory attraction and its renown as a superfruit packed with nutrients. For its alleged health-promoting qualities, it has drawn interest from dietitians, researchers, and health enthusiasts. Growing interest in organic and plant-based diets has increased demand for exotic fruits like dragon fruit, potentially opening up new markets for growers and producers (Vaillant *et al*., 2006) [21].
The dragon fruit, *Hylocereus undatus*, is a member of the Cactaceae family and is a native of Mexico, Central America, and South America (Haber *et al*., 1983) [12]. The plant is most likely native to Mexico, Central America, and northern South America, while its precise origin is unknown (Blanck *et al*., 2016) [5]. The dragon fruit has experienced a major increase in popularity on the global fruit market as a result of its unique appearance, mouthwatering flavour, and potential health advantages The fruit's exotic appearance and vivid colours have increased its appeal in domestic and foreign markets, which has boosted its economic relevance. It is also a preferred element in many culinary creations, including salads, smoothies, desserts, and beverages. Its sweet and reviving flavour is similar to a cross between a kiwi and a pear (Esquivel *et al*., 2007) [9]. Dragon fruit, also known as pitaya, is the fruit of several different tropical climbing plants in the genus *Hylocereus*, family Cactaceae Dragon fruit is a tropical fruit with its origins in North, Central, and South America However, it is currently produced commercially all over the world because of its easy adaptability to high light intensity and temperatures, excellent drought tolerance, broad range of tolerability to diverse soil salinities, and advantages to human health. Bahamas, Bermuda, Indonesia, Colombia, Israel, the Philippines, Myanmar, Malaysia, Mexico, Nicaragua, northern Australia, Okinawa (Japan), Sri Lanka, southern China, and southern Florida are just a few of the tropical and subtropical countries that cultivate it for profit (Silva *et al*., 2018) [26].
This fruit is currently the most profitable crop for Vietnamese farmers. The most extensive pitaya cultivation area in Asia is located in Vietnam, where it is cultivated in 63 out of 65

cities and provinces (Hoat *et al*. 2018; Hien 2019) [16, 15]. Vietnam is the main provider of dragon fruit due to an enormous rise in demand worldwide (Rahman *et al*., 2009) [3]. Given that a sizable portion of the population and economic resources are concentrated in coastal lowlands, deltas, and rural areas, Vietnam is one of the five countries most likely to be impacted by climate change (World Bank Group 2020) [39]. Climate change has an especially detrimental effect on agricultural production due to increasing seawater intrusion and a lack of irrigation water during the dry season. In the Mekong River Delta, where crops are suffering greatly from increased saltwater intrusion during the dry season, droughts have also become a recurring problem (US Forest Service 2011) [38].

Other names for the plant include Belle of the Night, Cinderella plant, strawberry pear, night-blooming cereus, dragon fruit, pitaya, and pitahaya. The genus *Hylocereus* spp., which contains 18 species, is distinguished by the following characteristics: iclimbing cacti, which are commonly an epiphytic and have elongated stems with branches that emit aerial roots and are typically 3-angled or 3-winged; ii) incredibly huge, funnel-shaped blooms with limbs that are as wide as they are long, which often bloom at night; iii) broad, leafy bracts on the ovary and hypanthium (pericarp), but no spines, feel, wool, or hairs; The fruit is frequently crimson and might be spherical or oblong in shape. (iv) The leafy bract on the hypanthium is comparable to the outer perianth segments, which are longer. The slender, acute or acuminate inner perianth segments are typically white but can infrequently turn scarlet. v) very many stamens, some of which are shorter than the style.vi) fruit is spherical to rectangular, usually scarlet and succulent, and has numerous wide ridges despite being spineless. vii) Small, black, elongate, or kidney-shaped seeds; large, green, and delicious bracts. (Britton and Rose 1920; Anderson 2001) [6, 2]. Among the three species, *H. megalanthus* (yellow pitaya, white pulp with yellow skin), *H. polyrhizus* (red pitaya), and *H. undatus* are the three that are most frequently grown for commercial purposes. (White Pitaya, pink skinned white pulp), in addition to the various kinds and hybrids (Choo & Yong, 2011) [7] (Table 1).

Table 1: Botanical attributes of the prevalent *Hylocereus* species

Species name	Botanical characteristics
Red pitayas or red pitayas with red meat are *H. polyrhizus* (F.A.C. Web.) Britton & Rose's (syn. *H. monacanthus*) names for them.	Flowers measure 25–30 cm in length. Particularly at the tips, the perianth is red. Short, lobed, and yellow in colour, the stigma. Fruit weighs between 130 and 350 g and is 10-12 cm long. It is oblong and covered in various-sized scales. It features crimson flesh that is filled with numerous tiny black seeds, a pleasing flesh texture, and a sweeter flavour. There are two types of *H. polyrhizus*: pink- and yellow-skinned (Ariffin *et al*. (2009) [3]; Le Bellec *et al*., (2006) [21]; Lim (2012) [22]; Siddiq and Nasir (2012) [34]; Wybraniec *et al*. (2001) [40].
H. venezuelensis Britton & Rose	Although it shares a close relationship with *H. polyrhizus*, it has bifid stigma. (Lobes. Le Bellec *et al*. (2006) [21]; Lim (2012) [22].
H. undatus (Haw.) Britton & Rose, a pitaya with white or crimson flesh.	Long, green leaves are seen. Flowers can grow up to 29 cm long. Outer green (or yellow-green) and interior white segments make up the perianth. Fruit is rosy-red, 15–22 cm long, and weighs 300–800 g. It has big, lengthy scales that are oblong in shape and have red and green tips. Its white flesh is filled with numerous tiny black seeds and has a lovely texture and flavour. Compared to the red-fleshed pitaya fruit, its fruit is somewhat to significantly less sweet (Ariffin *et al*. (2009) [3]; Le Bellec *et al*. (2006) [21]; Lim (2012) [22]; Siddiq and Nasir (2012) [34].
H. megalanthus (K. Schumann ex Vaupel) Ralf Bauer (syn *Selenicereus megalanthus*) (yellow pitaya)	Green, strong, three-ribbed, 1.5 cm thick stems with gently undulating borders and white areoles bearing one to three yellowish spines that are two to three millimetres long. Nighttime flowers are big, white, funnel-shaped, and between 32 and 38 cm long. The sections of the perianth are white inside and outside green. Stigma has lobes and is coloured green. Fruit is much smaller than redpitaya and is ovoid, tuberculate, spiny, yellow, and has many black seeds imbedded in a pleasant, luscious white flesh. It is the sweetest kind, and the fruits are often smaller in size (Ariffin *et al*. (2009) [3]; Lim (2012) [22]; Siddiq and Nasir (2012) [34].
H. purpusii (Weing.) Britton & Rose	The flower has edges and is 25 cm long. The segments of a perianth are roughly reddish on the outside, golden in the middle, and white on the inside. Fruit is oblong and has thick scales covering it. It weighs 150–400 g and measures 10-15 cm in length. It has a lovely flesh texture and crimson flesh with many small black seeds, but not a lot of them. (Le Bellec *et al*.,2006) [21].
H. ocamponis (S.D.) Britton & Rose	It and *H. purpusii* have a tight relationship. Only *H. ocamponis's* acicular and thin spines can tell them apart. (Le Bellec *et al*. (2006) [21]
H. costaricensis (Web.) Britton & Rose	White, waxy stems. The blossom of this plant is quite similar to *H. polyrhizus*. Fruit weighs between 250 and 600 g and has a diameter of 10-15 cm. It is ovoid and covered various-sized scales. Its flesh is reddish-purple with many tiny black seeds, and it tastes delicious (Le Bellec *et al*.,2006) [21].
H. trigonus (Haw.) Saff	The stem is thin, has green edges, and lacks horns. Fruit is crimson, ovoid or oblong, and almost smooth in appearance. It weighs between 120 and 250 g & has a diameter of 7-9 cm. It has a good flesh texture, white flesh that has many little black seeds, and a mild flavour (Le Bellec *et al*., 2006) [21]

The dragon fruit can withstand abiotic stress like drought and harsh temperatures, like other cacti, they are very adaptable to different environments. The plants exhibit a remarkable capacity to thrive in challenging climatic conditions, attributed to stem modifications for water storage (succulent nature), leaflessness, a protective waxy stem coating, nocturnal stomatal aperture, and utilization of the CAM (Crassulacean Acid Metabolism) photosynthetic pathway (Nie *et al*., 2015) [29]. It is being cultivated all over the world due to its tremendous industrial, medical, and commercial potential (Salazar *et al*., 2012) [31]. It was very recently brought to India, and many regions are starting to cultivate it. Due to its hardiness and low water and fertiliser needs, it may be grown with minimal effort in harsh weather conditions and poor soils. Both seeds and cuttings can be used to grow dragon fruit, however cuttings are the most popular and

straightforward method (Zee *et al*. 2004) [43].

As per cytological analyses, *H. megalanthus* showcases an innovative allotetraploid nature (2n = 4x = 44), emerging from the spontaneous hybridization of two closely allied diploid taxa. In contrast, *H. undatus*, *H. monacanthus*, and *H. costaricencis* retain a diploid configuration (2n = 2x = 22) (Tel-Zur *et al*., 2011) [36]. Known for its huge scaled fruits and aerial roots, Dragon fruit is a perennial, hemi-epiphytic, climbing cactus, embodying a fusion of botanical characteristics ripe for innovative exploration. Its triangular, succulent stem features spines and areoles together with wavy ribs. One of the distinctive characteristics that cacti have evolved may be a result of climatic adaptation is the areole. The highly specific structure of the areole, which consists of exceedingly compact nodes encircled by multiple hairs (trichomes), gives it a hairy or wooly appearance. The points of genesis for flower buds and spines are areoles, which are carried on ribs. Areoles and spines are significant morphological characteristics for identifying species because of their wide variation in form, colour, and appearance. Dragon fruit grows large (25–28 cm), gorgeous, bisexual, bell-shaped, and night-blooming blooms from the mature plant's areoles. The appearance of spherical, cream-colored flower buds emerging from areoles indicates the beginning of the reproductive phase. A flower's bud fully opens into a blossom after 25–35 days. The dragon fruit crop responds to photoperiod because long days cause it to blossom. In a tropical climate, the plants are capable of having up to 4-6 blooming flush each year (Jiang *et al*., 2012) [18]. The dragon fruit plant (*Hylocereus* spp.) is a rapidly evolving evergreen cactus that can reach heights of 1.5 to 2.5 metres, featuring slender, foliage-free branches akin to vines. It is a three-winged, succulent terrestrial or epiphytic cactus (Patel *et al*., 2019) [33]. High density commercial plantings are possible with 1100–1350 plants per hectare. The full commercial production of a plant can takes up to five years, at which point yields of 20 to 30 tonnes per hectare can be anticipated.7 *Hylocereus* is specifically designed to measure in tropical settings with little to no rain. After flowering, the cactus-like trees that bear dragon fruit set 30 to 50 days later and may normally go through 5 to 6 cycles of harvesting annually. It may be grown as a weed for free in many places, and some nations consider it to be an invasive species (Hitendraprasad *et al*., 2019) [15].

Dragon fruit plants prefer organically rich, sandy or loamy soil that drains well. The pH range of the soil should be between 6.0 and 7.0, ranging from slightly acidic to neutral. Waterlogging can be avoided by having good drainage because too much moisture can cause root rot and other problems (Bartholomew *et al*., 2019) [4]. There are several ways to cultivate dragon fruit, including: The most popular and simple technique of proliferation is stem cuttings. A healthy stem section should be cut, let too dry for a couple of days to produce a callus, and then planted in a soil that drains well. A new plant will emerge from the cutting's growing roots. Dragon fruit seeds can also be used to grow more of the fruit. Though the process can take longer with seeds than with stem cuttings, keep in mind that they might not generate children that are exactly like the parent plant. Grafting another technique for growing dragon fruit is grafting. A sound root system is created by grafting a healthy stem segment from the chosen variety onto the rootstock of another cactus species (Daher *et al*., 2020) [8].

Scale insects can attack dragon fruit trees, draining the sap from the stems and resulting in sluggish growth and leaf browning. Mealybugs are tiny, white insects that also consume the sap of plants, stunting growth and promoting the spread of sooty mould. The feeding on plant cells, these small arachnids can harm plants, resulting in yellow patches on the leaves and webbing on the stems. Anthracnose is a fungal disease that affects fruits, branches, and stems, leaving behind black, sunken lesions. Fruit rot and the health of the plant may result from it. Bacterial Soft Rot the bacterial condition results in the softening and destruction of tissues, frequently beginning at the plant's base and working its way up. Stem Canker A fungal pathogen is responsible for the formation of sunken, black lesions on the stems as a result of stem canker (Harman *et al*., 2019) [14].

2. Nutritional Composition

Dragon fruit (*Hylocereus* spp.) are cultivated for commercial purposes in a range of species and variations, and their nutritional composition fluctuates based on various factors, encompassing species, geographical location, and cultivation methodologies, thereby reflecting an evolving landscape of innovation (Thi-Thuy-Hai Luu *et al*., 2021) [37]. The innovative aspects in the nutritional composition of white-flesh dragon fruit per 100 g edible portion include moisture content (averaging 85.3%), protein (1.1 g), fat (0.57 g), crude fiber (1.34 g), energy (67.7 Kcal), ash (0.56 g), carbohydrates (11.2 g), glucose (5.7 g), fructose (3.2 g), as well as the presence of sucrose, sorbitol (0.33 g), vitamin C (3.0 g), and essential minerals like Mg, K, Na, Zn, and P (Tamanna Perween *et al*., 2018). The nutritional makeup and phytochemical properties of red dragon fruit substantially vary depending on the area in which it is grown (Nurul *et al*., 2014) [30]. "Enhanced mineral content, including elevated levels of potassium, phosphorus, sodium, and magnesium, distinguishes dragon fruit from mangosteen, mango, or pineapple." (Gunasena *et al*., 2007) [11]. The red pitaya fruit's probiotic properties and high levels of antioxidants as a result have been established (Fathordoobady *et al*., 2016; Xu *et al*., 2016) [10, 41].

The majority of the carbohydrates in the dragon fruit include glucose, fructose, and a few oligosaccharides. The dragon fruit's peel, in particular, has the highest concentration of macronutrients and is full of pectin and dietary fibres. The ability of the peel to extract pectin has been the subject of numerous investigations. Physical and chemical properties of dragon pectin Fruit skin. Peel pectin has strong absorption propertiesn the ability towards cholesterol that aids in reducing effects of blood cholesterol (Haitao Jianget *et al*., 2021) [13]. Vitamin C, vitamin B1, vitamin B2, vitamin B3, vitamin E, and vitamin A are all present in the pulp of dragon fruit (Haitao Jianget *et al*., 2021) [13]. Additionally, it contains vital elements including zinc, phosphorus, iron, calcium, and magnesium as well (Thi-Thuy-Hai Luu *et al*., 2021) [37].

The highly abundant antioxidant found in the dragon fruit are used by the food processing sector as prebiotic enrichment and natural colourants (Yanyi Huang *et al*., 2021) [42]. Emerging Innovations: Betalains, Betacyanin, Flavonoids, Hydroxycinnamates, and Polyphenols (Rao and sasanka 2015). All three parts of a dragon fruit—the seeds, peel, and pulp—contain polyphenols, but the seeds and peel have a higher concentration (Yanyi Huang *et al*., 2021) [42]. Lignin, which flavonoids, and phenolic acids are also included in this

group of plant-based antioxidants. These have a strong ability to scavenge free radicals, which reduces the chance of developing chronic illnesses. Hydroxycinnamates help prevent cancer, while flavonoids have a significant role in protecting brain cells and blood vessels, which reduces the chance of heart issues (Md. Farid Hossain *et al*., 2020) [25].

The fatty acid profile present in the dragon fruit seed encompasses linoleic acid, linolenic acid, along with other notable constituents such as palmitic acid (17.5%), oleic acid (22.7%), and cis-vaccenic acid (3.0%), as well as additional fatty acids (Yanyi Huang *et al*., 2021) [42]. Linoleic acid, linolenic acid, and other fatty acids such as palmitic acid (17.5%), oleic acid (22.7%), and cis-vaccenic acid (3.0%) are the main fatty acids that are present in the seeds of dragon fruit (Md. Farid Hossain *et al*., 2020) [25]. Many research have shown that the red dragon fruit peel contains significant amounts of lipids such as stearic acid pentenoic acid, docosanoic acid, propanoic acid, and butanoic acid (Haitao Jianget *et al*., 2021) [13].

A wide spectrum of bioactivities, such as those that are anti-obesity, anti-cancer, antioxidant, and antibacterial, are displayed by the natural colour betacyanin. These contribute to the prevention of heart attacks and the mitigation of oxidative liver damage (Haitao Jianget *et al*., 2021) [13]. As a natural colour ingredient, betacyanins are found in ice cream, biscuits, and yoghurt. Compared to the dried dragon fruit pulp, the dragon fruit peel produced more betacyanins, which are then used as natural colourants or useful components in food items (Haitao Jianget *et al*., 2021) [13].

Health can be enhanced by phytonutrients, secondary metabolites derived from plants. Consumers, food makers, and scientists are all becoming increasingly interested in the role that antioxidant components play in preserving health and warding off cancer and coronary heart disease. The trend for the future is therefore towards functional foods that have specific health benefits. Studies conducted *in vitro* revealed that antioxidant phytonutrients such phenolic compounds and vitamins may both be essential for shielding biological systems from the damaging effects of oxidative stress (Kalt *et al*., 2005) [19].

Diabetics are one of the groups of people who cause the most deaths globally. Diabetes mellitus is a metabolic illness that can be treated with natural and herbal therapies (Monica Joshi *et al*., 2019) [27]. According to reports, dragon fruit has phosphodiesterase inhibitory activity, which lowers blood sugar levels. According to studies the presence of flavonoids enhances insulin retention by inhibiting phosphodiesterase and reducing oxidative stress (Ajie *et al*., 2015). The peel of the dragon fruit, which contains choline, dopamine hydrochloride, amaranthin, amine, and N-benzylmethylene isomethylamine, has been used to isolate the fruit's alkaloids. Choline and N-benzylmethylene isomethylamine are the two alkaloids found in dragon fruit peel that are most common. However, red dragon fruit collects more alkaloids than green dragon fruit (Haitao Jianget *et al*., 2021) [13].

3. Food Application of Dragon Fruit

It is evident that the demand for dragon fruit has surged in recent years due to its nutritional values and health benefits. This fruit has emerged as a pivotal player in the food industry and has garnered the focus of researchers, leading to diverse innovative processed offerings.

3.1 Dragon Fruit Juice

Dragon fruit juice is an extremely nutritious fruit juice that is rich in vitamin C and antioxidants like betacyanin and phenolic compounds. Dragon fruit juice is a renowned and important processed item made from dragon fruit. Since consumers desire low viscous and transparent nutritious fruit juice, clarifying is done because it has higher turbidity and viscosity in order to gain economic relevance and acceptability (Kirti Jalgaonkar *et al*., 2020) [20]. Dragon fruit juice provides many benefits that make it more valuable as an item for the food business and customers, as well as enhancing its organoleptic features, prolonging its shelf life, and increasing its attractiveness and recognition (Kirti Jalgaonkar *et al*., 2020) [20].

3.2 Dragon Fruit Juice Powder

The nutritious value of dragon fruit is well known, but it isn't always in season, thus fruit juice has been produced to make it available all year round (Kirti Jalgaonkar *et al*., 2020) [20]. Since it has a long shelf life and strong economic value, it can be used as a functional food by being added to different processed meals. It is produced using the most popular industrial approach, spray drying. Maltodextrin is used to make fruit powders less sticky since the negative of these juice powders is that they are sticky when they are first made. According to Kirti Jalgaonkar and colleagues (2020) [20], adding dragon fruit powder to various composite foods might boost their nutritional value and, if necessary, make up for any nutritional deficiencies (Kirti Jalgaonkar *et al*., 2020) [20].

3.3 Dragon Fruit Wine

As we are aware, wine has been cherished as a timeless traditional libation since ancient times. Leveraging contemporary technology, a groundbreaking approach has emerged in the production of wine using the fruit pulp of dragon fruit (Kirti Jalgaonkar *et al*., 2020) [20]. The dragon fruit wine boasts a pH level of 4.29 and an impressive total soluble solids (TS) measurement of 23.07°Brix. This extracted juice undergoes a transformative fermentation process, orchestrated within a multi-layered ferment tank ingeniously interleaved with fruits and sugar. A meticulous 8-week fermentation period is observed, followed by a phase of pasteurization and judicious storage (Kirti Jalgaonkar *et al*., 2020) [20].

3.4 Ice-cream with Dragon Fruit

The dragon fruit is homogenized through the incorporation of diced pulp, and this procedure assesses the physiochemical attributes of the fruit, encompassing factors like meltability, texture, hue, betacyanin concentration, antioxidant potency, and sensory profile. Milk, sugar, and whipped cream are mixed and beaten to create a uniform liquid composition. after being aged for four to six hours in the refrigerator at or below 4 °C. To integrate air, stabiliser is added and beaten once more. The sensory qualities of dragon fruit ice cream are tested as a final test (Mahan Mahesh *et al*., 2021) [24]. It was shown that 12% dragon fruit pulp in ice cream boosted its acceptability and satiated market demands (Mahan Mahesh *et al*., 2021) [24]. Fat made from whole or skim milk has replaced dragon fruit in ice cream (Lima *et al*., 2020) [23]. The overall amount of dietary fibres, amino acids, antioxidant capacity, and lipids was also increased, which enhanced the texture and abundance of the ice cream (Lima *et al*. 2020) [23].

3.5 Dragon Fruit Yogurt

Dairy-based items like dragon fruit-based milk and yoghurt can efficiently utilise prebiotic fatty acids from dragon fruit as a colourant. Numerous research has been conducted on the yoghurt manufactured from dragon fruit's nutritional benefits and antioxidant content. The results showed that the pulp or flesh of the dragon fruit can hasten fermented while reducing the pH of milk. By using dragon fruit, yoghurt had better whey content and improved water retaining capacity. The red-purple dragon fruit was the subject of a detailed metabolic and prospective application study by the author (Lima *et al*.,2020) [23] It was found that this fruit had little impact on other senses, such as fragrance. But it had enhanced the colour and the visual appeal, showing that it might be used as a naturally enhancing colour quality for food products and the food industry (Lima *et al*., 2020) [23].

3.6 Wheat Product with Dragon Fruit

Every food product, but especially baked goods like breads, cookies, noodles, and pasta, contains wheat. The presence of glutenin and gliadin, two protein components of gluten, can transform wheat flour into an elastic dough when coupled with water. Because the dragon fruit includes dietary fibres, it is used in traditional wheat-based items. Studies have been conducted as a result of rising health consciousness among customers. It also shows how phenolic acids and antioxidants can be used to make the dough's natural red colour more appealing. Red and white dragon fruits can both be added to the bread to improve its physical properties. Additionally, you can add dragon fruit peel to noodles and biscuits. The beta-lane and flavonoid content of the customer's plain wheat noodles is lower than that of dragon fruit peel powder.

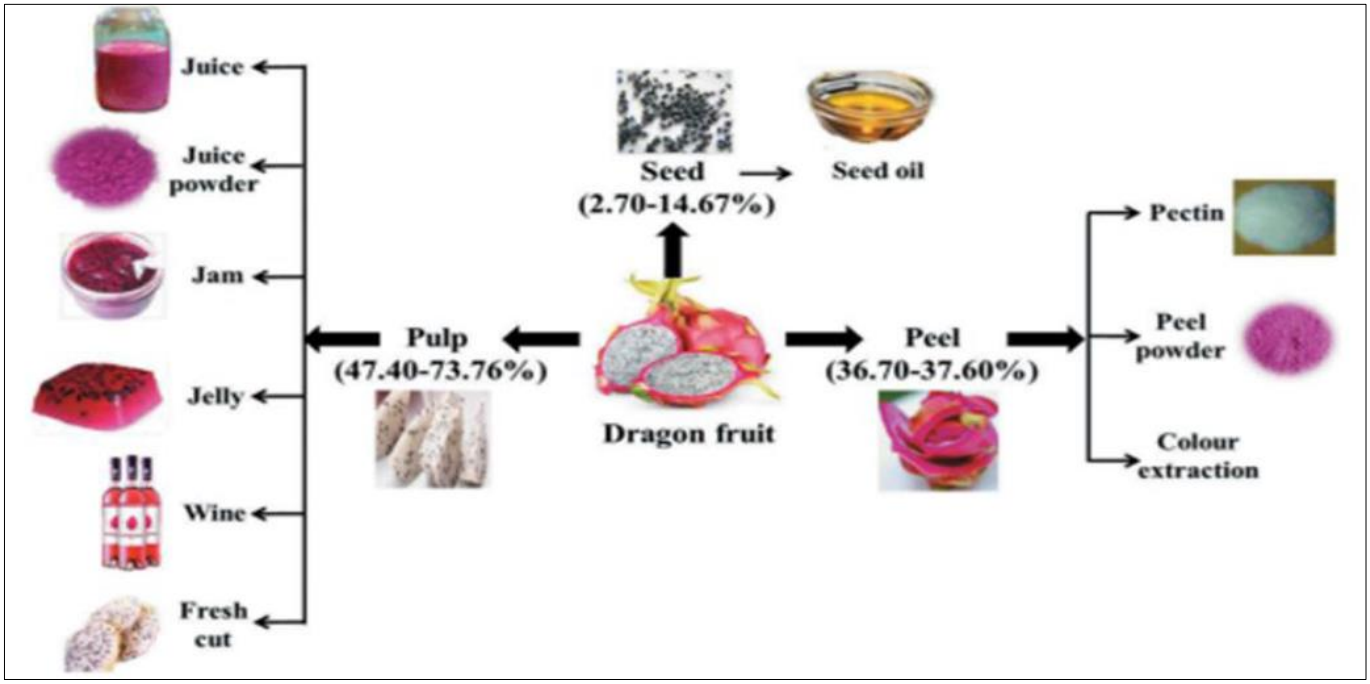

Fig 1: Various innovative food products crafted from dragon fruit (Kirti Jalgaonkar *et al*., 2020) [20]

3. Health Benefits and Therapeutic Potential

Dragon fruit, known for its elevated water content relative to its nutrient composition per 100 g, can not only serve as a thirst-quencher but also be innovatively harnessed as a natural culinary coloring agent. Depending on the desired flavour, dragon fruit can also be eaten as jam, juice, or preserves. In addition to providing relief from asthma and coughing, dragon fruit has a lot of vitamin C, which speeds up the healing of cuts and wounds when consumed regularly. However, the high vitamin C content in dragon fruit is essential for boosting immunity and the body's natural antioxidant defences. Dragon fruit has a lot of flavonoids that protect against cardiovascular issues. It also helps to treat vaginal discharge and bleeding issues. However, because dragon fruit is high in fibre, it helps with meal digestion. Dragon fruit is particularly rich in the B vitamin family (B1, B2, and B3), which is important for its health advantages. In addition to serving as a multivitamin, the vitamin B2 in dragon fruit helps to reduce appetite loss and improve it. Enhancing energy production and glucose metabolism is made possible by vitamin B1. Additionally, the vitamin B3 found in dragon fruit helps to moisturise and smoothen skin while also helping to lower levels of harmful cholesterol. Additionally, it enhances vision and lowers blood pressure. Dragon fruit is advantageous for lowering blood sugar levels in people with type 2 diabetes because the glucose in it aids diabetics in controlling their blood sugar levels. Dragon fruit contains high levels of calcium and phosphorus, which help to create healthy tissue, strong bones, and teeth (Parmar *et al*., 2019) [32].

The highly contagious illness COVID-19 is passed from person to person. The disease is spread through a number of indirect transmission pathways as well. While hydroxychloroquine, an anti-rheumatic medication, and various antiviral drugs such as remdesivir and lopinavir with ritonavir, have been employed in clinical practice, ongoing research continues to explore their effectiveness and safety, heralding a new era of medical innovation. Supportive care is necessary because there is presently no cure for COVID-19 infection.to improve immunity and prevent illness. Functional foods may be able to both prevent viral infection and modulate the immune system, according to studies. One such

cuisine is the revolutionary superfruit from India known as dragon fruit. Because of its enticing appearance and nutritional value, it has gained popularity. They are rich in betalains, which protect the body from a number of illnesses associated to oxidative stress, as well as vitamins, minerals, and antioxidants. The seeds of the dragon fruit are an excellent source of linoleic acid and have a high polyphenol content. In this COVID-19 scenario, the fruit is inescapable as a functional food and can be encouraged to be consumed. Studies have shown that patients with co-morbid diseases have a higher risk of oxidative stress-related diseases and help fight viruses, so the demand for these foods is increasing. Additionally, studies indicated that dragon fruit possessed immune-boosting, anti-diabetic, antioxidant, and hypocholesterolemic properties (Naik *et al*., 2010 [28]. Another crucial vitamin, vitamin A, works with other fat-soluble nutrients to boost immunity and fight disease. These include retinol, retinoic acid, or beta carotene (Huang *et al*., 2018) [17].

4. Conclusion

Dragon Fruit (*Hylocereus* spp.) stands out as a fascinating and versatile fruit that encompasses a spectrum of botanical, nutritional, and health aspects, making it an appealing ingredient for various food applications. Throughout this review, we have delved into its unique characteristics, highlighting its striking appearance, diverse species, and adaptability to different climates. Its nutritional profile, rich in antioxidants, fiber, and essential vitamins, underscores its potential as a health-promoting addition to diets. As we explored its culinary applications, it became evident that Dragon Fruit can play a transformative role in the realm of food. From smoothies and salads to jams and desserts, this fruit offers both a visual spectacle and a delightful flavor, enhancing the sensory experience of consumers. Its subtle sweetness and ability to blend seamlessly with other ingredients make it a sought-after choice for innovative chefs and home cooks alike. The health benefits attributed to Dragon Fruit, including its potential to support immune function, digestive health, and antioxidant protection, further elevate its appeal. As research continues, uncovering its specific bioactive compounds and potential therapeutic properties, the fruit's reputation as a functional food could grow stronger.

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