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Unveiling The Power Of *Hylocereus Undatus* : A Review Of Its Medicinal Constituents And Pharmacological Activity

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Abstract: *Hylocereus undatus* belonging to the family *Cactaceae*, commonly known as dragon fruit a native of central America and Mexico. It is climbing cactus with a long slender stem that can reach up to 20 meter in length. The fruit are vibrant and exotic. That has gained popularity worldwide, as it has a unique appearance, with a scarily red or pink exterior and white or red flesh. *Hylocereus undatus* fruit is packed with various nutrients such as vitamins, minerals, fibers, and possess antioxidants properties and potential health benefits such as digestive health, weight management, immune support, skin health, etc. In this article we go across the various phytochemical constituents and their pharmacological action on the human body that are been discover In the fruits of plants.

Key Words: *Hylocereus undatus*, dragon fruit, antioxidants, immune support, phytochemicals, pharmacological action.

INTRODUCTION

The *Hylocereus undatus*, famously known as dragon fruit or strawberry pear, holds a multitude of names across cultures. In Vietnamese, it is called Thang Loy, in Spanish, Pitayo Roja, and in French, Pithaya Rouge, with nicknames like "Noble Woman," "Night-Blooming Cereus," and "Belle of the Night," this exotic fruit captivates both the eye and the palate [1]. Recently, dragon fruit has risen to superfood status in India and globally, thanks to its striking appearance, vibrant soft flesh, and speckled black seeds, all packed with health-boosting benefits.

Dragon fruit can be stored for up to 14 days at 10.5°C (50°F) for maximum freshness, a fast-growing cactus with a high nutritional profile, is a wonder of the plant kingdom. It may grow up to 1.5 to 2.5 meters in height [2]. The numerous phytochemicals constituents like flavonoids and other nutrients substances, provides significant pharmacological and health advantages, especially for the antioxidant activity and treatment of several infectious disorders, and other medicinal purposes, dragon fruit is highly valued, in the food and cosmetics sectors [3]. The fruits versatility makes it a natural gem for anything from ice creams, juices, jams, and jellies to cosmetics like lipsticks, face washes, and soaps [4]. This plant thrives in various regions including Central and South America, Vietnam, Thailand, Mexico, Colombia, Israel, Taiwan, Malaysia, the Philippines, Australia, and the United States. The favourable climate in these areas makes them ideal for large-scale cultivation of the fruit [5].

Historically, dragon fruit was a well-kept secret, known primarily by the indigenous peoples of Central and South America. Their deep connection to nature led them to explore and harness the medicinal properties of the plants around them, including the dragon fruit, long before the world caught on to its wonders. This version aims to be more engaging, focusing on the fruit's allure and its wide-ranging uses, while maintaining the factual details [5].

Responding to the surging market demand, this crop has found a vibrant foothold in various regions of India, particularly in the lush landscapes of Southern and Western India, including Andhra Pradesh, where the generous rainfall and fertile soil create an ideal environment for its cultivation [6].

SCIENTIFIC CATEGORIZATION

Hylocereus undatus is scientifically categorized according to Table 1[7].

Table 1: Scientific classification of *Hylocereus undatus.*

Kingdom	Plantae
Phylum	Tracheophyta
Class	Magnoliopsida
Order	Caryophyllales
Family	Cactaceae
Genus	Selenicereus
Species	*Hylocereus undatus*

MORPHOLOGICAL CHARACTERISTICS

Steam

The fleshy, vine-like stem is composed of several branching segments, each with three wavy wings and one to three spines, or sometimes more. The stems are usually cylindrical, sometimes triangular, and are frequently lined with sharp spines. These segments can grow to remarkable lengths, sometimes up to several meters, which enables the plant to climb or spread out across its surroundings with edge [8].

Leaves

Even while the cladodes of dragon fruit plants initially produce tiny, transient genuine leaves in their early stages of growth, they are rapidly abandoned. As the plant ages, these true leaves become less significant and have fewer uses than the bigger, more noticeable cladodes [8][9].

Fig.: *Hylocereus undatus* plant stem and cladodes of leaves [9].

Roots

The *Hylocereus undatus* is a remarkable combination of desert hardiness and tropical splendor, with every feature, from its sprawling stems to its nocturnal flowers—telling a story of strength and grace. The fruit is firmly rooted in the ground, and its shallow roots skillfully absorb water and nutrients, while its aerial roots reach upward, seeking support as the plant strives toward sunlight [8].

Fig.: *Hylocereus undatus* roots [8].

Seeds

In *Hylocereus undatus*, fruits contain tiny edible seeds, typically measuring 1 to 2 mm in size, with a round or ovoid shape and a striking jet-black colour, contain a variety of beneficial components, including linolenic acid, linolic acid, palmitoleic acid, cis-vaccenic acid, stearic acid, oleic acid, myristic acid, and palmitic acid [10].

Fig.: Seed of *Hylocereus undatus* fruits.

Flowers

Hylocereus undatus flowers are impressively large, ranging from 25 to 30 cm long and 15 to 20 cm wide, with a graceful trumpet-like shape that broadens at the top and narrows at the base. Their vibrant whitish or greenish-yellow colour emit a sweet, intense fragrance, drawing attention during their unique nighttime bloom. These blooms unfurl under the cover of darkness, revealing their captivating beauty for a brief, enchanting display [11].

Fig.: Flower of *Hylocereus undatus* [11].

Fruit

The *Hylocereus undatus* fruit presents itself as a vibrant ovoid or ellipsoid treasure, with a distinct exterior that gleams in hues of bold pink, vivid red, or radiant yellow. Its unusual structure, covered in fleshy, scale-like bracts, gives the fruit a striking, almost otherworldly appearance [12].

There are 3 species of dragon fruit-

- *Hylocereus undatus* - Red-skinned fruit with white flesh.
- *Hylocereus Costaricensis* - Red-skinned fruit with red flesh
- *Hylocereus megalanthus* - Yellow-skinned fruit with white flesh

A **B** **C**

Fig.: A- *Hylocereus Costaricensis*, **B**- *Hylocereus megalanthus*, **C**- *Hylocereus undatus*

Peel

The *Hylocereus undatus* peel is a natural armor smooth, waxy, and vibrant in pinks or reds designed to lock in moisture and shield the fruit from harsh elements. Its signature bracts resemble dragon scales, giving it a unique look while helping reduce water loss. Beneath the surface, a fibrous layer cushions the juicy core, while vivid pigments provide UV protection and add antioxidant properties. This peel functions as nature's high-tech packaging: tough, eye-catching, and efficient [13].

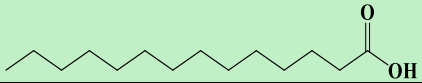
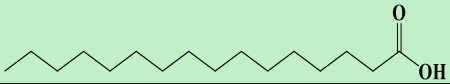
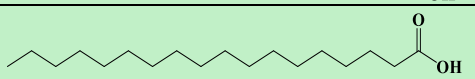
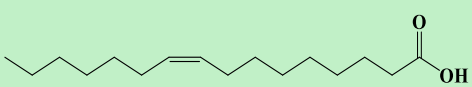
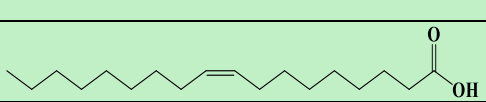
Fig.: Outer and inner surface of the peel of *Hylocereus undatus*

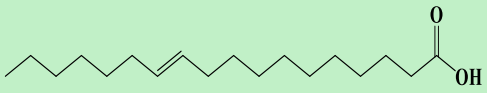
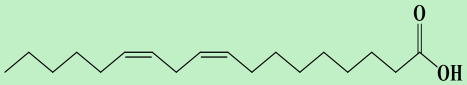
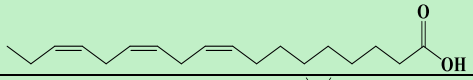
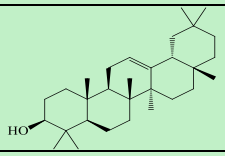
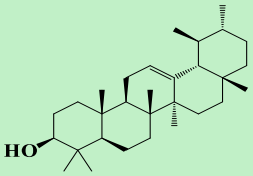
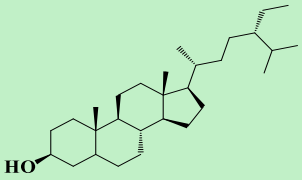
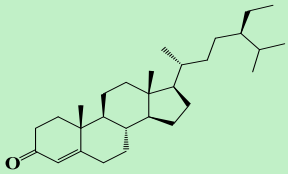
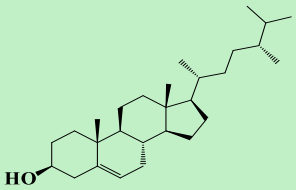
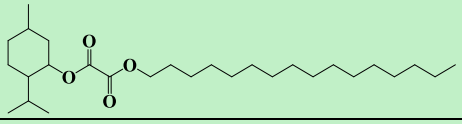
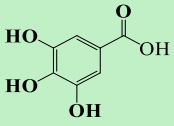
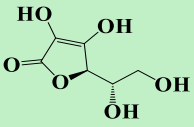
REVIEW AND DISCUSSION

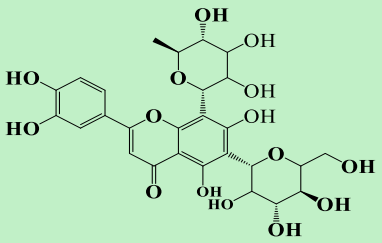
PHYTOCHEMICALS COMPOSITION OF *HYLOCEREUS UNDATES*

The *Hylocereus undatus* contains many types of phytochemicals and biologically active chemical composition which is beneficial for different aspects of human health and it protects and prevents the human body from various types of diseases, mentioned in Table 2 [14], [15].

Table 2: Biologically active chemical constituents found in *Hylocereus undatus* fruits.

Chemical Constituents	Structure	Uses
Myristic acid		It controls the metabolic process.
Palmitic acid		Helps in body growth and glowing skin.
Stearic acid		Provide hydration to the skin
Palmitoleic acid		Beneficial for diabetes patients (Antidiabetic agent)
Oleic acid		Anti-inflammatory & Anti-lipid dermic

Cis-vaccenic acid		Reduce cholesterol level in body Control triglyceride level in the body.
Linolic acid		Used cardiac arrhythmia to prevent irregular heartbeat
Linolenic acid		Reduce the risk of heart disease
β-amyrin		Antioxidant property
α-amyrin		Work as anti-inflammatory Anxiolytic, antidepressant immunostimulant
Octacosane		Antibacterial activity
Tetracosanol		Anti-inflammatory
Chemical Constituents	**Structure**	**Uses**
Sitosterol		Anti-cancer decreases the level of cholesterol in the body
Stigmas-4-en-3-one		Anti-microbial activity
Campestralol		Decrease the cholesterol absorption in the human intestine
Hexadecy-1 ester		Provide moisturization to the skin
Eicosane		It offers to protective effect antioxidant potential & inflammatory
Gallic acid		Treat anti- fertility
Ascorbic acid		Used as anti-platelet

Flavonoid		Antioxidant, Anti-inflammatory, Anti-cancer, Anti-microbial, used to maintain metabolic process, protect cardiovascular function,

PHARMACOLOGICAL ACTION OF DRAGON FRUIT ON DIFFERENT TYPES OF DISEASES.

ANTIDIABETIC

Palmitoleic acid, a unique monounsaturated fatty acid found in dragon fruit, is crucial for boosting insulin sensitivity, making it an effective component in diabetes management. This compound enhances glucose uptake in muscle cells and increases insulin receptor activity, which helps lower insulin resistance [16]. Its potentially improves insulin function and supports long-term wellness for those with diabetes [17].

ANTI-INFLAMMATORY

The impressive array of bioactive compounds in dragon fruit, each playing a vital role in combating inflammation. Alpha amyrin, a powerful triterpene, helps inhibit inflammatory pathways, while oleic acid actively reduces inflammatory markers, fostering better health. Complementing these effects, 1-tetracosanol contributes to further alleviating inflammation. Together, these compounds create a synergistic effect, making dragon fruit a vibrant and beneficial choice for those seeking to manage inflammation and enhance their overall wellness [18].

ANTIOXIDANT

Amyrin and nonacosane are two noteworthy compounds found in dragon fruit that significantly contribute to its antioxidant properties. Beta amyrin, a type of triterpenoid, is recognized for its ability to neutralize free radicals, which are unstable molecules that can cause cellular damage and contribute to various diseases. This compound not only helps protect cells from oxidative stress but also supports the immune system and may reduce inflammation [19].

Nonacosane, a long-chain alkane, complements this action by enhancing cellular communication. This is vital for maintaining cellular balance and promoting effective signaling pathways, which are essential for cell repair and regeneration. Together, these compounds work in harmony, amplifying the overall health benefits of dragon fruit [20].

The combination of beta amyrin and nonacosane establishes dragon fruit as a powerhouse of antioxidants, making it a valuable addition to a health-conscious diet. By mitigating oxidative stress and promoting cellular health, dragon fruit exemplifies the benefits of incorporating nutrient-rich foods into our daily routines [20].

MAINTAIN METABOLIC PROCESSES

Myristic acid plays a vital role in metabolic processes by serving as an energy source through β-oxidation in mitochondria. It is essential for synthesizing lipids, including triglycerides and phospholipids, which are crucial for maintaining cell membrane integrity. By affecting membrane fluidity, myristic acid influences nutrient transport and cell signaling pathways. Additionally, myristic acid is involved in the production of certain hormones that help regulate metabolic functions, highlighting its importance for overall metabolic health [21].

ANTI LIPIDEMIC

The compounds in dragon fruit, particularly campesterol, and sitosterol, play important roles by lowering cholesterol levels. Campesterol helps reduce LDL (Low-Density Lipoprotein), which is a bad cholesterol, by blocking its absorption in the intestines, while sitosterol competes with dietary cholesterol, which can further decrease blood cholesterol levels. Oleic acid aids this process by increasing HDL (High-Density Lipoprotein), a good cholesterol, and improving the overall lipid profile [22].

PREVENT HEART DISEASE

Dragon fruit is a standout choice for heart health, offering a unique blend of beneficial nutrients. Its high Linolenic acid content an omega-3 fatty acid helps reduce inflammation, a key factor in heart disease. This nutrient not only supports higher levels of HDL but also aids in lowering triglycerides, leading to a healthier lipid profile. Moreover, linoleic acid, an omega-6 fatty acid present in the fruit, helps decrease LDL levels, promoting overall cardiovascular wellness [23].

ANTI-ANXIOLYTIC AND ANTI-DEPRESSANT ACTIVITY

Alpha amyrin, a triterpene found in dragon fruit, is being explored for its potential effects on anxiety relief and also acts as anti-depressant. This compound interacts with neurotransmitter systems, particularly GABA, which is crucial for promoting relaxation and reducing anxiety [24].

α-amyrin also interacts with key neurotransmitters such as serotonin, norepinephrine, and dopamine, which play crucial roles in mood regulation. Additionally, its anti-inflammatory effects may reduce neuroinflammation linked to mood disorders, while its antioxidant properties help protect brain cells from oxidative stress. Moreover, alpha amyrin may influence the hypothalamic-pituitary-adrenal (HPA) axis, which is important for managing the body's response to stress [25].

IMMUNOSTIMULANT

Dragon fruit enhances immune cell function through various bioactive compounds that positively affect macrophages and lymphocytes. One of its key effects is the activation of macrophages, which are crucial for the innate immune response [26]. Compounds such as polysaccharides and flavonoids may boost their phagocytic activity, enabling these cells to more effectively engulf and destroy pathogens [27]. Additionally, dragon fruit can stimulate macrophages to produce cytokines, signalling molecules that coordinate the immune response, thereby increasing the recruitment and activation of other immune cells [26], [27].

ANTIBACTERIAL

Dragon fruit, especially from the Hylocereus genus, is gaining attention for its antibacterial properties due to its wealth of bioactive compounds. Fruit is rich in polyphenols, flavonoids, and vitamin C, which enhance its nutritional profile and contribute to its ability to fight bacterial infections [28].

The antibacterial activity of dragon fruit operates through multiple mechanisms. Polyphenols and flavonoids can compromise bacterial cell membranes, resulting in cell damage, while also preventing biofilm formation, which is vital for bacterial adherence and survival [29]. Additionally, these compounds may induce oxidative stress, further impairing bacterial viability. Extracts from dragon fruit are effective against a range of pathogens, including Escherichia coli, Staphylococcus aureus, and Salmonella spp. This highlights the potential of dragon fruit as a natural antibacterial agent with applications in food preservation and health products [30].

ANTIPLATELET

A rich content of antioxidants, particularly ascorbic acid (vitamin C). This vitamin plays a crucial role in enhancing anti-platelet activity by mitigating oxidative stress, which can protect platelets from damage and reduce their aggregation. Additionally, ascorbic acid boosts nitric oxide levels, promoting blood vessel dilation and further inhibiting platelet activation, vitamin C may influence certain coagulation factors, enhancing its cardiovascular benefits. Overall, the unique properties of dragon fruit and its ascorbic acid content make it a valuable addition for those aiming to support heart health [31].

ANTI-CANCER

Dragon fruit is emerging as a promising addition to cancer treatment strategies, thanks to its array of bioactive compounds. This vibrant fruit is rich in antioxidants, including vitamin C, betalains, and flavonoids, which help reduce oxidative stress—an important factor in cancer cell development. Additionally, specific polysaccharides found in dragon fruit have demonstrated the potential to inhibit tumour growth in laboratory studies [32].

The mechanisms through which dragon fruit may exert its anti-cancer effects are significant. It may directly hinder cancer cell growth by using its antioxidants to neutralize free radicals that can cause DNA damage, a critical step in cancer progression. Moreover, the fibres in dragon fruit support digestive health and detoxification, which can enhance the immune system's ability to fight off cancer [33].

TREAT SKIN DISEASE

Dragon fruit is gaining popularity as a beneficial ingredient for skin health. Its striking pink skin and speckled flesh make it visually appealing, but it's the nutrient content that truly stands out. This fruit is rich in vitamin C and various antioxidants like betalains and flavonoids, which help protect skin cells from oxidative damage that can lead to premature aging and other skin problems [34].

What sets dragon fruit apart is its range of skin benefits. Its anti-inflammatory properties can soothe conditions such as acne and eczema, while its antibacterial effects may help reduce acne-causing bacteria. Additionally, the natural exfoliating properties of dragon fruit can assist in unclogging pores, leading to a clearer complexion [35].

The high-water content in dragon fruit is excellent for hydration, making it particularly beneficial for dry or sensitive skin. Regular use can enhance skin tone and texture, promoting a radiant appearance [36].

CONCLUSION

Hylocereus undates, commonly known as dragon fruit, is a very beneficial fruit, by including dragon fruit into their diet, people may benefit from the many advantages of palmitoleic acid, amyrin, and nonacosane for better glycemic management, antioxidants, and anti-inflammatory properties. Additionally, it has a major impact on enhancing heart health and reducing the risk of heart disease. By interacting with the immune system in several ways, triterpenoid, which is found in dragon fruit, shows great promise for regulating immunological responses. It notably enhances the activity of both macrophages and T lymphocytes. When incorporating dragon fruit into your skincare regimen, you may create a basic mask by mixing the flesh and leaving it on your face for 15 to 20 minutes to enable the nutrients to seep in. In addition to supporting skin health, eating dragon fruit—whether on its own or in salads or smoothies can have interior advantages. Incorporating dragon fruit into a balanced diet may thus offer a tasty way to enhance mental well-being, complementing conventional treatments for depression and exploring new avenues in natural mental health approaches, and a delicious step toward better cardiovascular health.

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