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An eye catching and comprehensive review on dragon fruit (An exotic super fruit)

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Abstract

Dragon fruit (*Hylocereus* spp.) is a recently introduced super fruit in India, gaining popularity both in the rural and urban areas because of its attractive colour, delicious taste, high nutritive and medicinal values. It is adaptable to humid as well as semi-arid tropical and subtropical conditions. The growing acceptability of the fruit along with its immense antioxidants and medicinal properties. Red dragon fruit (*Hylocereus polyrhizus*) is one of Indonesia's commodities widely consumed and developed nowadays. Dragon fruit or pitaya is an exotic fruit that is much favored by the public because it has efficacy, benefits, and high nutritional value. The most well-known efficacy of dragon fruit is its antioxidant content. This article aims to explain the characteristics and postharvest handling of dragon fruit. Dragon fruit can be consumed directly or processed into juice, jam, syrup, and other products. Furthermore, every 100 g of dragon fruit peel contains 150.46 mg of betacyanin pigment. Dragon fruit peel also contains vitamins C, E, and A, alkaloids, terpenoids, flavonoids, thiamine, niacin, pyridoxine, cobalamin, phenolic, carotene, and Phyto albumin. It is reported to have the pharmacological activities like antioxidant, anticancer, anti-diabetic, anti-fertility, anti-ulcer, cardio protective and neuroprotective activities.

Keywords: Dragon fruit, dragon fruit peel, modified atmosphere packaging (MAP)

Introduction

Pitaya fruit has the potential to improve health since it contains bioactive chemicals that have a host of advantages, including anti-inflammatory, anti-cancer, anti-diabetic, and antibacterial properties. Owing to these advantageous properties, this fruit is being consumed more often over the globe. Dragon fruit is growing more and more popular worldwide. It can be eaten raw or mixed with drinks, sweets, and jellies. The food and pharmaceutical sectors can also employ the pigments as coloring agents^[1]. The fruit of various tropical climbing plants in the family *Cactaceae*, genus *Hylocereus*, is known as dragon fruit or pitaya. Pitayas are considered unusual fruits because of its unique shape and striking combinations of flesh and skin colors, such as red and pink, white and pink, red-purple, or yellow and white^[2]. Because of the bracts or scales on the fruit's skin, the fruit is known as pitaya, which translates to "the scaly fruit." The huge, creamy white flowers (25 cm in diameter) that bloom at night give it its beautiful significance^[3]. "Noble Woman" or "Queen of the Night," has a long day and a magnificent blossom that blooms at night. The fruit is also referred to as Jesus in the cradle, night blooming cereus, belle of the night, dragon fruit, Pithayas, and Strawberry Pear^[4]. The unusual and breathtaking dragon fruit (DF) has recently made its way into the Indian market and is rapidly gaining popularity in the agricultural sector and among the general public because of its captivating color, shape, size, and flesh^[5]. It has a high fiber content, a high concentration of vitamin C, and antioxidants such flavonoids, hydroxycinnamates, and saponins. The pulp of the dragon fruit is delicious, and it contains a large number of black seeds, which may contain antioxidants and minerals^[6].

The dragon fruit, a super fruit that has just lately been brought to India, is regarded as a fruit crop with great potential for profit. The fruit's striking colour, smooth, mouth-melting pulp, and delicious black seed embedded in the pulp, combined with its exceptional nutritional value, draw producers from all across India to plant this fruit crop^[7]. Although it is eaten, the existence of dragon fruit among humans is not limited to the eating of fresh fruit or fruit juice^[8]. The government of India is currently promoting the production of dragon fruit through a number of programs^[9].

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Fig 1: Pictorial representation of dragon fruits varieties

Taxonomy

Numerous names for the plant exist, including dragon fruit, pitaya, pitahaya, strawberry pear, night-blooming cereus, Belle of the Night, and Cinderella plant. There are eighteen species in the genus *Hylocereus* (A. Berger) Britton and Rose (1909). Table.1 displays the dragon fruit's systematic location [10].

Table 1: Taxonomy of Pitaya fruit

Domain	Eukaryota
Kingdom	Plantae
Subkingdom	Tracheobionta
Superdivision	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Caryophyllidae
Order	Caryophyllales
Family	Cactaceae
Subfamily	Cereoideae
Tribe	Hylocereae
Genus	<i>Hylocereus</i>

Distribution

Approximately a century ago, the French brought *Hylocereus undatus* to Vietnam, where it was grown solely for the king. Later on, it gained popularity among a few of the nation's wealthiest families. It has lately become established as a backyard and orchard plant that genuinely supplies fruit to European and Southeast Asian export and local markets. In addition to being grown in gardens, the plants can be found growing naturally in Mexico, Central America, and South America. These days, orchards are grown with the intention of producing fruit for both domestic and foreign markets in North America and Europe. There are still only North American *Hylocereus* species. In the northern hemisphere, there are multiple pitahaya bloom flows from May to October. Each region has a different daily floral opening period. Vietnam is one of the five nations most vulnerable to climate change because a large portion of its population and economic resources are concentrated in coastal lowlands, deltas, and

rural areas [11]. Tropical and subtropical regions are used for pitaya cultivation. Farmers in Thailand, Australia, Israel, and the United States are among the countries where dragon fruit cultivation has garnered interest. Dragon fruit plants are typically found in a number of nations, including Australia, the US, Israel, Vietnam, Nicaragua, and Taiwan, where they have also been grown for commercial purposes. But the majority of these plants that bear dragon fruit are actually native to South and Central America, as well as Mexico. This dragon fruit plant can grow well in Israel, more specifically in the Negev Desert, where fruit production yields of 30% have been observed [12].

Botanical description

Dragon fruit stems have a propensity to rise, spread, and sprawl. They also have a great deal of branching. There could be four to seven fruits, with a maximum length of ten meters and a maximum diameter of ten to twelve centimetres per fruit. Areoles are spaced about 2 to 5 cm apart. The spines on adult branches range in length from 1 to 4 mm and are nearly conical to acicular. The hues range from greyish-brown to blue-green. They yield fruits that are oblong to oval in shape. It is 4-10 cm long and 3-8 cm thick. It features bracteoles and a broad, deep red frame. These fruits are made of a white pulp that contains a few edible tiny black seeds scattered throughout. For one cycle, the pitaya floescence should last roughly five days [13].

The following provides a detailed description of the five species that were classified by Britton and Rose in 1963: The long green stems of *H. Undatus* (Haw.) Britton & Rose are somewhat horny toward the age margins. Its long (up to 29 cm) flowers have green, or yellow-green, outer perianth segments and pure white inner perianth segments. The rosy-red fruits are oblong in shape and have large, long scales that are red and green at the tips. They measure 15 to 22 cm in length and weigh about 300 to 800 g. *Homo sapiens* (Weing.) Britton & Rose produces very large, 25 cm flowers with margins; the segments of the outer perianth are roughly reddish, the segments of the middle perianth are golden, and the segments of the inner perianth are white. The fruits are

oblong, scarlet, and covered in large scales. Their length and weight range is 10-15 cm and 150-400 g, respectively. Fruits have a nice texture and red flesh with lots of tiny black seeds embedded in the pulp. Very long (25-30 cm) flowers with margins, outer reddish perianth segments, particularly at the tips, and relatively short, yellowish stigma lobes are characteristics of *H. Polyrhizus* (Web.) Britton & Rose. Its red fruits are 10-12 cm long and weigh between 130 and 350 g. The fruits are oblong in shape, with varying-sized scales covering them; the flesh is red and contains a lot of tiny black seeds, and the texture and flavour are pleasing (Web) *H. Costaricensis* Perhaps the stoutest vines in this genus, Britton & Rose offers robust vines. The flowers resemble those of *H. Polyrhizus*, but the stems are waxy white. The fruits are crimson in hue, with a diameter of 10 to 15 cm and a weight of 250 to 600 g. Fruits are ovoid and covered in a variety of sized scales. Its flesh is a nice reddish-purple color with a lot of tiny black seeds, and it tastes good and have thin, non-horny stems that are green with margins. The top of the undulating ribs is where the areoles are found. Greenish at first, the spines quickly turn dark brown. The fruits weigh between 120 and 250 g and have a diameter of 7-9 cm. They are red in color. Its fruits are almost smooth and ovoid or oblong in shape ^[14].

Microscopy

Scanning Electron Microscopy (SEM)

A desiccator was used to dry the pollen grains that were collected from flowers during a thesis and placed on adhesive tape that was fastened to an aluminium stub. Stigmas of pollinated and unpollinated flowers were fixed in FAA (37% formaldehyde, 100% acetic acid, 80% alcohol) for 24 hours before being put in a vacuum pump to extract air from the tissue. After carefully washing the samples with distilled

water, they were post-fixed for two hours in 1% osmium tetroxide. Next, they underwent a series of dehydration treatments in varying degrees of alcohol (30, 50, 70, 75, 90, 95, and 100%), and finally they were dried at the critical point (Baltec CPD 030, Germany). The gold-sputter-coated dried pollen grain and stigma samples (Polaron E5100, USA) were analyzed at a 15 kV accelerating voltage using a scanning electron microscope (JEOL JSM-5610 LV SEM, Japan).

Light Microscopy (LM)

After subjecting the samples to a progressive series of alcohol (30, 50, 70, 75, 90, 95, and 100%), methyl benzoate containing 1% celloidin was added. After that, the samples were cleaned in xylene and progressively infiltrated over the course of an overnight period in serial ratios of xylene and paraffin (3:1, 1:1, 1:3, and 0:1). The embedded and solidified blocks were sectioned using a rotary microtome (SM2000 R, Leica Biosystems, USA) at a thickness of 12 μm . Toluidine Blue O stain was used to view serial sections of the style under a light microscope (Leitz Wetzlar, Germany).

Fluorescence Microscopy

With a razor blade, longitudinal and transverse sections of fixed styles were cut from the style base (close to the ovary), the middle portion of the style (10 cm below the stigma), and the top of the style (near the stigma). The samples were cleaned and allowed to soften for an entire night at room temperature ($25 \pm 2^\circ\text{C}$) in 1.0 mol·L⁻¹ of NaOH (Adapted from Martin, 1959). After that, sections were cleaned, soaked in deionized water for two hours, and stained for the next two days with 1.0% decolorized aniline blue in 0.1 mol·L⁻¹ potassium phosphate (K₃PO₄) solution. Samples were viewed under a Leica DMRA II fluorescence microscope (Germany) fitted with a UV excitation filter set to a wavelength of 356 nm after being gently compressed under a coverslip ^[15].

Table 2: Present Bioactive Compound and Therapeutic Effects of Bioactive Compound

S. No.	Present Bioactive Compound	Therapeutic Effects of Bioactive Compound
1.	Alkaloids	Antiplatelet Agents, Anticancer Agents, Antibacterial Agents. Anesthetic Property, Anti-inflammatory
2.	Phenols	Antioxidant, Antibacterial/Antifungal/Antiviral, Anticancer
3.	Saponins	Anti-inflammatory, Antimicrobial, Anticancer
4.	Steroid	Anabolic Properties, Anti-inflammatory, Cholesterol Lowering Properties, Antidiabetic, Analgesic, Anthelmintic activities
5.	Tannins	Antioxidant, Antibacterial, Anti-carcinogen, Antimutagenic, Styptic and astringent Properties, Anti-adhesive
6.	Terpenoids	Anticancer, Antimicrobial, Antifungal, Antiviral, Antihyperglycemic, Analgesic, Anti-inflammatory, Anti-parasitic

Phytochemistry

The nutrients and phytochemicals found in dragon fruit are beneficial to the body. Numerous investigations have revealed that dragon fruit may be able to shield people from disease. 33 The value of the fruits of the *Hylocereus* cactus has increased lately. Certain phytochemicals found in dragon fruit or pitaya include carbohydrates, proteins, saponin phenolic compounds, terpenoids, oils, flavonoids, tannins, phenols, coumarin, and

steroids. Nutritional analyses show that the fruit contains all the nutrients required for a balanced diet, including minerals, fat, vitamins, and crude fiber ^[16]. An overview of the current bioactive substances discovered in dragon fruit (*Hylocereus* spp.) stems and their potential medicinal uses ^[17]

Plant Name: Dragon Fruit Stem (*Hylocereus* spp.)

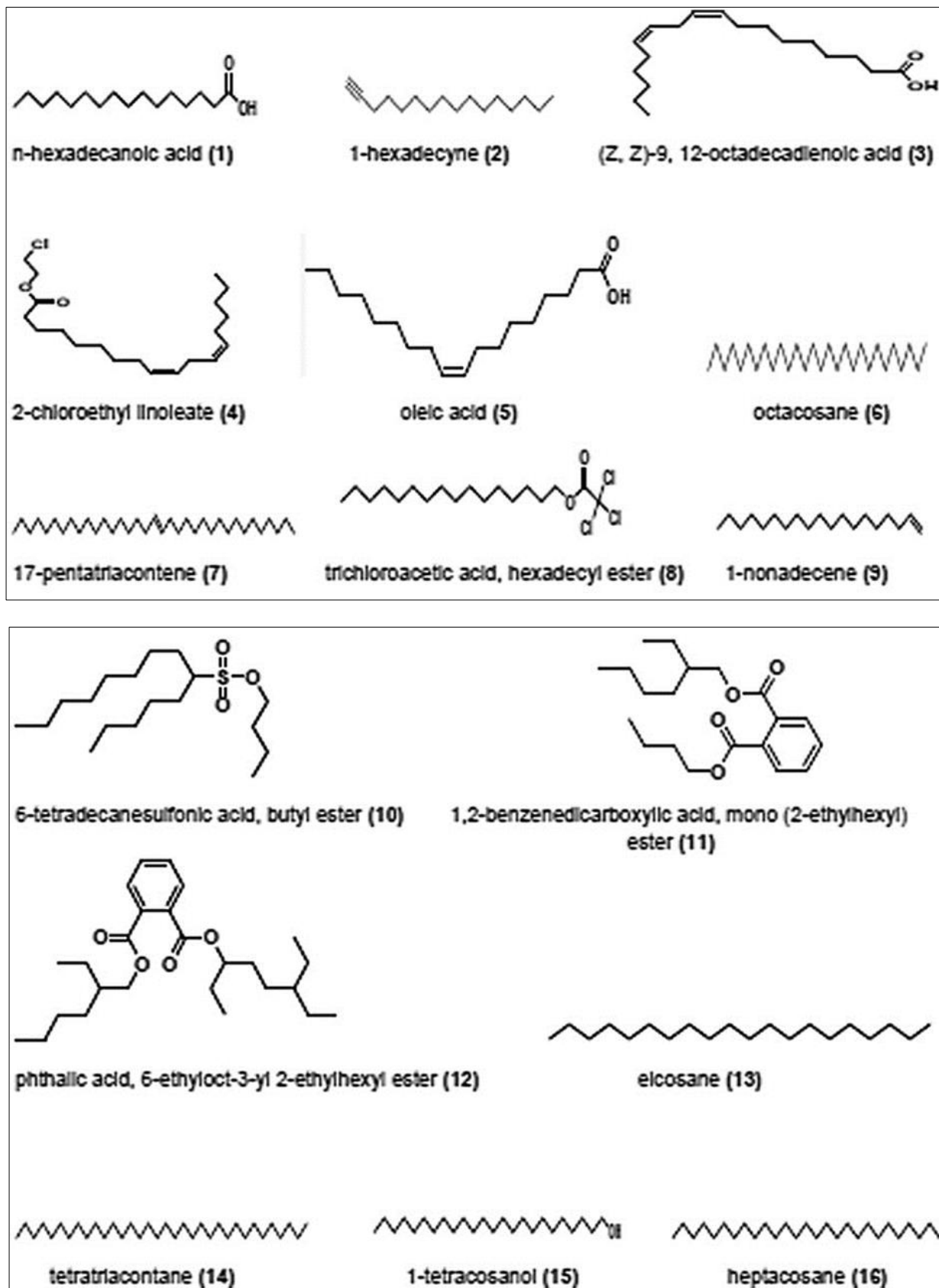


Fig 2: Chemical compounds of Dragon fruit

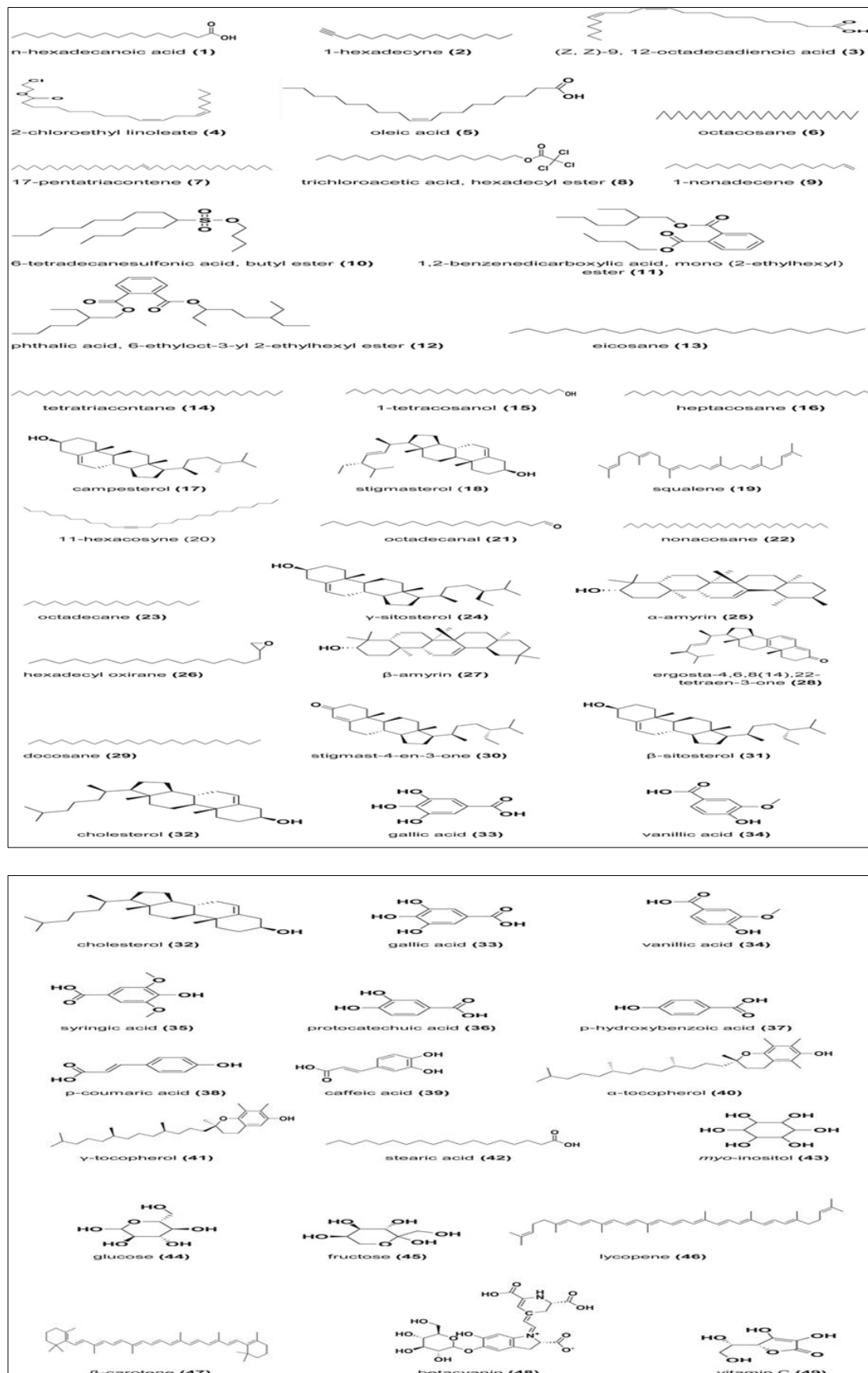


Fig 3: Chemical compounds of Dragon fruit

The phytoconstituents found in dragon fruit include oleic acid, 1. Octacosane, hexadecyl ester, trichloroacetic acid, and tetracosanol Phthalic acid, 1-hexadecyne, 2-chloroethyl linoleate, 6-tetradecanesulfonic acid, 6-ethyloct-3yl-2-ethylhexyl ester, butyl ester, tetratriacontane, heptacosane, n-

hexadecanoic acid, Mono (2 ethylhexyl) ester, 1,2-benzenedicarboxylic acid, 12-octadecadienoic acid, (Z,Z)-9, 17-pentatriacontene, eicosane, and γ -sitosterol [18].

Ethno botany

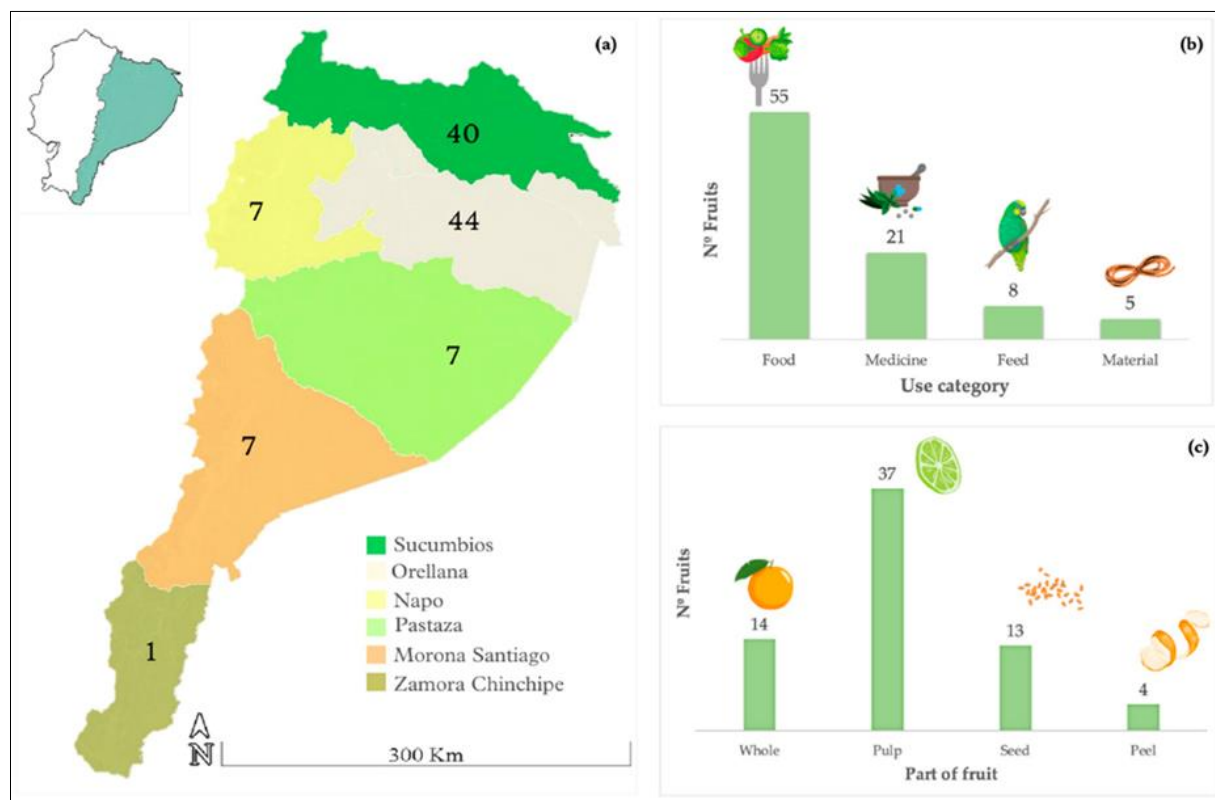


Fig. 4: (a) Location of number of fruits reported by province in the Ecuadorian Amazon. (b) Fruits use categories identified. (c) Part of the fruit used and reported in the investigations

It was possible to identify 55 species of edible fruits that had been researched in the Ecuadorian Amazon thanks to the information analysis. Orellana and Sucumbíos were the provinces with the highest number of studies identified (Fig 2). Medication was the category of use that came after food, and then came animal food and material. Fresh fruit is how the fruits are typically eaten, and the pulp was found to be the most popular part. Instead of being imported (23), the majority of the fruits are native species (32). A wide variety of fruits were used; 26 families of edible fruits were found in the Ecuadorian Amazon according to the works analyzed. *Areaceae* counted for the largest number of species with ten, followed by *Rubiaceae* (five), *Malvaceae*, and *Myrtaceae* (four) [19].

Pharmacological properties

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:

Antioxidant property

A class of naturally occurring chemicals called antioxidants is present in a wide variety of fruits and can help shield our bodies' physiological systems from oxidative stress. Dragon fruit with a high fiber content, polyphenol content, and antioxidant content. Antioxidants, including flavonoids, polyphenols, and tocopherols, are crucial in preventing or postponing the oxidation of cellular components. Antioxidants, vitamin C, polyunsaturated fatty acids, B vitamins, carotene, protein, and minerals like calcium, iron, potassium, sodium, etc. are all abundant in the pulp of dragon fruit. It has frequently been discovered that the dragon fruit's peel has greater antioxidant potential than the flesh. The peel and flesh may contain various bioactive compounds, which could be the cause of this. There was typically a correlation

between high radical scavenging activity and high phenolic content. The high phenolic content of *Hylocereus polyrhizus* (15.92 mg Gallic acid/g) contributes to its great antioxidant activity [20].

Anti-cancer activity

Numerous studies have demonstrated the anticancer properties of dragon fruit's flavonoids, polyphenols, and betanin. In just one dosage, the dragon fruit skin that was extracted using a 50:50 mixture of water and ethanol solvent demonstrated antiproliferative activity against human hepatocellular carcinoma cells. The precise nature of the anticancer activity of dragon fruit is still being investigated and cannot be determined with certainty. Nevertheless, prior studies have indicated that the anticancer effect of polyphenols in dragon fruit may be mediated through a mediated pathway and factor suppression on nucleic-kappa B. growth factor receptors, anti-inflammatory, antioxidant mechanisms, and inhibition of angiogenesis, induction of cell cycle arrest and apoptosis, and activation of protein kinase. The natural antioxidant lycopene, which is found in red flesh, is known to prevent cancer. Antioxidants shield cells from potentially harmful reactive oxygen species and stop the production of free radicals, which can lead to cancer [21].

Antimicrobial Property

Numerous scientists looked into the chemistry of betalains, which are the main bioactive substances found in *H. polyrhizus*. The peel extracts of red dragon fruit were obtained through solvent maceration at pH 5, where phytochemical characteristics, total phenolic content, antioxidant activity, and antimicrobial activity were noted. The local dragon fruit's ethanol and methanol extracts demonstrated superior antibacterial activity overall against *Bacillus*, *Vibrio*, *Escherichia coli*, and *Staphylococcus* species [20]. The antibacterial activity of ethanol, hexane extract, and

chloroform from the skin of white dragon fruit was determined by disc diffusion analysis, and it was found that both gram-positive and gram-negative bacteria could be inhibited within an inhibition region of roughly 7 to 9 mm ^[22].

Antidiabetic activity

Numerous investigations have demonstrated the antidiabetic effect of dragon fruit. Red dragon fruit can help patients with Type II Diabetes lower their blood glucose levels. Glucose is the component in red dragon fruit that lowers blood sugar. Apart from glucose, the dietary fiber in dragon fruit also serves to lessen the rate at which food is broken down in the intestines, which lowers the production of blood glucose. The application of dragon fruit extends beyond just its flesh in terms of its antidiabetic properties. The skin and seeds of dragon fruit also have anti-diabetic properties. Dragon fruit seeds have saponins in them that dissolve in water extracts and have anti-diabetic properties, particularly for type II diabetics. In the meantime, soluble fibres found in dragon fruit skin are thought to have the ability to control the body's blood sugar levels ^[23].

Antifungal activity

Two yeasts, *Candida albicans* and *Rhizoctonia solani*, and four molds, *Aspergillus flavus*, *Fusarium oxysporum*, *Botrytis cinerea*, and *Cladosporium herbarum*-the research panel that includes laboratory control strains obtained from the American Type Culture Collection (ATCC)-are present in extracts and fractions of flesh and peels of red pitaya fruits that exhibit polyphenol antifungal activity ^[24].

Anti-inflammatory activity

On dragon fruit, anti-inflammatory action has been observed. The skin and flesh of the dragon fruit were combined, and the mixture was separated using vacuum-distilled water, water, and drying. Following that, the outcomes will be applied to bioassay testing against 5-lipoxygenase (5-Lipox), acetyl cholinesterase enzymes (AChE), and clooxygenase-2 (COX-2). According to the findings of these investigations, extracts made from the flesh of dragon fruits performed exceptionally well in the bioassay test against the three enzymes and had a greater inhibitory effect on the enzyme acetylcholinesterase than on the other two. This has demonstrated that dragon fruit can reduce inflammation, as evidenced by the mechanism directly associated with cholinergic anti-inflammatory effects. Moreover, the effects of dragon fruit flesh on the COX and Lipox enzymes suggest that it has a strong potency that may obstruct the pathways leading to leukotriene and prostaglandins. This indicates that the characteristics of dragon fruit include anti-inflammatory qualities. The ethanol extract from red dragon fruit peel has an ingredient called betalain, which inhibits the transcription factor NF- κ B. This prevents the separation of inflammatory genes like TNF- α and IL-1 β ^[25].

Cardio protective activity

The anti-thrombotic effect of the polyphenols in *H. polyrhizus* flesh enhances its already strong cardio protective qualities ^[26]. Two heat processing techniques for this dragon fruit were applied to rats in one study. According to the analysis's findings, red pitaya's cardio protective ingredients are antioxidant material and polyphenols ^[27].

Neuroprotective activity

Among the many health advantages of dragon fruit is its connection to nerve work's neuroprotective properties, as was

previously mentioned. Dragon fruit's phytochemical composition actively contributes to neuroprotective effects, particularly in averting neurodegenerative illnesses. Dragon fruit contains essential fatty acids, a phytochemical that actively participates in neuroprotector activity and may prevent neurodegenerative diseases ^[28].

Cytoprotective activity

Pitaya is a fantastic source of ascorbic acid, polyphenols, and betalains, among other natural antioxidants ^[29]. Being a fiber-rich dragon fruit, it facilitates the breakdown of food ^[30]. Pitaya peel contains soluble fibers that may aid in the digestion process by neutralizing harmful substances like heavy metals and may also help control blood sugar levels in individuals with type II diabetes. Additionally, the mucilage found in pitaya peels may be advantageous for cholesterol metabolism ^[31].

Hypolipidemic activity

Rats' hypolipidemic activity was assessed using an extract from the flesh of dragon fruits. The extract from dragon fruit flesh has the potential to significantly increase serum HDL cholesterol, total fecal cholesterol, and fat while significantly lowering TG, LDL, total cholesterol, and total cholesterol ratio over HDL cholesterol, body weight, and Lee index obesity. This study demonstrated the biological effects of extract from dragon fruit flesh, including anti-obesity and hypolipidemic properties that may prevent atherosclerosis. Consuming flesh extract from dragon fruit may increase the quantity of fat and cholesterol in excrement in addition to binding them from the feed ^[32].

Antiulcer activity

Topical quercetin from the skin of *Hylocereus polyrhizus*, or red dragon fruit, has antiulcer properties. Results showing complete distress in 35% of cases within 2-4 days and in 90% of cases within 4-7 days attest to this. Quercetin helps with mild symptom relief and lowering the frequency of relapses ^[33].

Anti-infertility activity

According to an experiment, extract from dragon fruit can enhance testicular histology and preserve sperm motility. Gallic acid, an antioxidant found in white dragon, has the tendency to improve spermatozoa quality by increasing their motility, quantity, and morphology in the epididymis ^[34].

Antiplatelet activity

Antiplatelet action because ethanol and ethyl acetate extracts from dragon fruit have inhibitory effects on platelet aggregations caused by different agonists in a concentration-dependent manner, the fruit has antiplatelet activity ^[35].

Hepatoprotective activity

Rats that have been poisoned do benefit from dragon fruit extracts. Owing to the high concentration of antioxidants derived from the aforementioned consumption of CCl₄. Particularly, flavonoids and triterpenes are phytochemical components that protect the liver from fat peroxidation; however, the silymarin capsule has little protective effect against liver injury due to an improvement in serum glutamic-oxaloacetic transaminase (SGOT) and serum glutamic-pyruvic transaminase (SGPT). When induced with CCl₄, it has been demonstrated that dragon fruit extracts effectively shield the liver from chronic damage in test animals ^[36].

Analgesic activity

Gallic acid (3, 4, 5-trihydroxybenzoic acid), an organic compound found in plant materials with antioxidant, antibacterial, antiviral, and analgesic properties, is present in pitaya and many other plants [37].

Conclusion

Dragon fruit is a fruit that contains various benefits from the fruit and the peel of the fruit. Dragon fruit has a characteristic red color, has a soft, scaly peel, and has a considerable number of black seeds. The fruit peel that takes 22% of the whole fruit contains polyphenols as antioxidants and natural anthocyanin dyes which are pretty high. Dragon fruit has the potential for herbal tea beverage products containing high antioxidants and natural dyes. Using the human senses, sorting dragon fruit crops is based on color, size, and physical defects. Dragon fruit can last up to 10 days at room temperature. After two weeks of storage, dragon fruit is still in reasonably good condition at a temperature of 14 °C. The flesh on the skin of dragon fruit can be used in making herbal teas, jelly, syrup, and various kinds of functional food products that are beneficial to the body.

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Conflicts of interest

None

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