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# Physico Chemical, Nutraceutical, Morphological and Anatomical Features of Dragon Fruit: Review

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**Abstract**
Dragon fruit, a fruit crop that are cultivating large scale for its economic need. Many types of its varieties are available such as the edible portion is red, white, purple, orange, yellow in colors. Besides the nutritional properties, the fruit also contain properties such as antioxidant, antidiabetic, antiviral, anticancerous, antifungal etc. This article provides a comprehensive review of the current understanding of Physico Chemical, Nutraceutical, Morphological and Anatomical Features of Dragon Fruit.

**Keywords:** Dragon fruit, *Selenicereus,* Cactoideae, Betacyanin

## INTRODUCTION

*Selenicereus s*pecies are semi epiphytic plant that are grown majorly in the tropical regions of southern and central part of America. Due to its physical appearance, taste, nutritional properties, adaptation to different growing conditions, they are widely cultivated on all over the world. Through various scheme, government of India encourages its cultivation in different regions of India (Akath singh et al., 2022). Areas with high temperature ($30^0$ C – $40^0$C) or extended day light are suitable for the cultivation of this fruit crop. However, farmers are irrigating the plant during extreme summer seasons (Md. Ashaduzzaman Nur et al., 2023).

According to APG system of classification, Dragon fruit belongs to kingdom- plantae, clade-eudicots, order-caryophyllales, family-cactaceae, sub family-cactoideae and genus Selenicereus. Different species comes under this genus, some of them are *S. polyrhizus, S.veneuelensis, S. undatus, S.megalanthus, S. purpusii, S. ocamponis, S.costaricensis, S. trigonus* etc (en.wikipedia.org). *Hylocereus tricostatus* (Gosselin) Britton & Rose, and *Hylocereus undatus* (`Haworth) Britton & Rose are the synonyms (vi.wikipedia.org).

Even though this plant genus is belonging to cactaceae family, they are characterized by climbing vine with aerial roots that bear a glabrous berry with large scales (Sandeep Kumar et al., 2022). The shrubby plant has succulent stem and the branches are often thickened and angled. The flowers are regular, hermaphrodite and solitary. Calyx tube is adnate to the ovary and corolla are united at the base. Both sepals and petals show imbricate aestivation. Stamens are many and adnate at the base. Ovary are one celled and ovules are many with parietal placentation. Seeds are many and oblong (Gamble).

Anatomical variation occurs in the sub family of cactaceae. Persistent epidermis, thickened cortex and palisade cortex are the common anatomical features of the succulent plants. Tendency to form multiple

epidermis, multiseriate thick-walled hypodermis, presence of mucilaginous cell, vascularized cortex, scanty paratracheal parenchyma and indeterminate growth are the features of the order cactoideae (James, 2005).

The succulent plants show crassulacean acid metabolism (CAM) pathway (Harshitha et al., 2024). The presence of CAM increases water use efficiency and reduces the risk of photoinhibition. This favors the survival of the particular plant during the extreme environmental condition (O. Hernandez-Gonzalez and O. B. Villarreal 2007). The dragon fruits are often enriched with different kinds of nutritive components like proteins, vitamins, carbohydrate, etc. So, these fruits are one of the remedies for malnutrition (Andre Leonardo et al., 2023).

*Selenicereus spp*. are diploid in nature with chromosome number 2n=22 (Sandeep Kumar et al., 2022). The difference in the number of chromosomes is due to the changes present in morphological characters. The number of chromosomes in *S. megalanthus* is tetraploid, where one set of chromosomes consist of four homologous chromosomes. The shape of the chromosomes is metacentric and sub metacentric (Ari setyowati et al., 2018).

Recently, there has been a progressive increase in non-communicable chronic diseases due to the climatic changes and malnutrition. Among them, cardiovascular diseases (CVD) are the deadliest diseases in the world (32% of all global deaths) especially in western countries. Besides mortality, these conditions are associated with the leading cause of disabilities. Therefore, preventive measures are essential and crucial to reduce the risk factors. Fruit and vegetables are good for healthy diet, and their consumption in adequate amounts can diminish the risk of obesity, diabetes, CVD, and some types of cancer (www.ncbi.nlm.nih.gov).

The pigmentation of dragon fruit flesh such as red, purple, yellow, white is given by betacyanin pigment and red dragon fruit could be considered as a valuable economic product. It is freshly consumed or used for jams, beverages, and wine. Not only the flesh of the plant but also other plant part can be used as food and fodder. The powdered plant part, fruit flesh, peels are nutritionally constrained and used for the pharmacological studies. Studies revealed that premature stem of dragon fruit has more nutritional value than the mature stem (Ruzainah et al., 2009) and it can also be used for therapeutically studies (Rabab et al., 2021).

The characteristic feature of an antioxidant is to scavenge the free radicals due to their redox hydrogen donators and singlet oxygen quenchers (Rabab et al., 2021). The free radicals can be scavenged by the natural and synthetic antioxidants. The studies indicated that, the frequent consumption of natural antioxidants can reduce the risk of cardio-vascular disease and cancer. Dragon fruits are rich with ascorbate and other antioxidant molecules (Edet et al., 2015). The red pulp colour of dragon fruit is often rich with betanin pigments and they are rich sources of antioxidants (Sudarjat et al., 2019).

## Discussion

### Morphology of the plant

#### Stem:

The plant exhibits a remarkable capacity to thrive in challenging climatic conditions attributed to stem modification for water storage. The stem of the plant is climbing, branch profusely, leaflessness, protective waxy coating, show nocturnal stomatal aperture and show CAM pathway. The length of the plant varies within species approximately ranging from 5 to 10 meters. The small area that bears the spines are areoles

which is 2mm size and the adult branches are one to four centimeter in length. The needle is conical and the color is usually black but it varies and it have also had an epidermis which is green in colour. In *S.megalnthus* green strong three ribbed stem with 1.5 cm thick and it have an undulating borders. *S. trigonus* stem is thin and lack thorns and *S. costaricensis* have white waxy stems. Papery bast sheath are also present in the initial stages (Utamsingh, 2019).

**Flower:**

The floral initiation is happening on the areoles of the plant. The flowers are large, bisexual nocturnal and bell shaped. The appearance of the spherical, cream colored flower buds indicates the reproductive phase of the plant. The flower is bracteate, actinomorphic scented and have peri carpel with two to five centimeter in length. The flower consists of an outer tepal and inner tepal. The outer tepals are about sixty to sixty-five in number and inner tepals are lanceolate sharp, pointed, white in color.

In *S. polyrhizus*, the perianth is red and the stigma is short yellow in color. *S. undatus* the flower can grow up to 29cm length, it has outer yellow green and inner white segments make the perianth (Feby et al., 2023). In *S. megalanthus*, stigma has lobes and green colored. *S. purpussii*, perianth are red, gold and white colors in the inner, middle and outer regions. (Joanna, 2022)

**Fruit:**

The fruit is oblong to oval with six to twelve centimeter long. The flesh, pericarp and the weight of the fruit varies depending upon the species. *S. polyrhizus* fruit is covered with various sized scales, it has pink and yellow skinned with white flesh of 130 to 350gram size. *S. undatus* fruit is rosy red, weighs 300 to 800 grams with white flesh, scales are oblong in shape with red and green tips. The fruit of *S. megalanthus* is smaller when it is compared with all other varieties of dragon fruit. It is ovoid, tuberculate, spiny and yellow flesh. The flesh of *S. purpussi* is crimson colored and 150 to 400 grams in weight. The *S. costaricensis* is ovoid with reddish purple flesh. In all varieties of dragon fruits small edible black colored seeds are present (Ana cruz, 2021).

**Anatomy of the plant**

The cross-section of the aerial root is almost circular, it has a lignified central pith followed by a star shaped xylem and a vascular cambium. The group of parenchymatous cells between the xylem poles represents the primary phloem. The lignified tissues extended radially to form a star- shaped structure composed of wood fibers of all varieties of dragon fruit. The transverse section of style, ground tissue of *S. polyrhizus* is made up of parenchymatous cells and interspersed with vascular bundles. Mucilage tracts and starch granules were also seen in the adjacent cells of transmitting tissue that act as a food resource for the growing pollen tubes within the style. The transmitting tissues were made up of small and compact cells with a thin wall that formed a distinct layer within the style. Phenolic compounds were also found within papillae structures (Utamsingh, 2019)

**Physico chemical parameters of dragon fruit**

The bioactive compounds are present in dragon fruit, total soluble solids (Brix) of fruit pulp increased steadily with the progression of maturity until 40 DAA, whereas it decreased after 45 DAA. The total sugars in dragon fruit increased continuously from 4.10 (at 20 DAA) to 16.73mg (at 40DAA) and then decreased towards the end of maturity. Total phenols were also influenced significantly by developmental stages and ranged from 72.69 (at 40 DAA) to a 114.8 mg catechin equivalent (Akath singh et al., 2022).

The *Hylecereus polyrhizus* reveals that the moisture content in flesh is 83 g and in stem it is 98 g. The protein content is same in stem and flesh. Fat content, ascorbate and crude fiber in flesh is less when compared with stem (Ruzainah Ali Jaafar et al., 2009).

Irrespective of fruit developmental stages, the macro mineral content in fruit was in the order of potassium, magnesium, calcium, phosphorus. Similarly, among the micro minerals, zinc is higher. The phosphorus content ranged from 0.114% (at 35 DAA) to 0.129% (at 45 DAA), there was rise from 20 DAA to 25 DAA, followed by a decrease up to 40 DAA. Whereas, potassium content increased up to 35 DAA with a maximum value (0.814%) and there after decreased gradually. Calcium content ranged from 0.128% (at 20 DAA) to 0.148% (at 35 DAA). The magnesium content in dragon fruit pulp increased with fruit development process from 20 to 45DAA, and ranged from 0.148% (at 20 DAA) to 0.172% (at 45 DAA). Both iron and zinc increased up to 35 DAA, followed by slight decrease in subsequent developmental stages, but the decrease was insignificant. Iron content ranged from 49.55 mg (at 20 DAA) to 64.85 mg (at 35 DAA), whereas the zinc content ranged from 11.4 mg (at 20 DAA) to 15.7mg (at 30 DAA) (Akath Singh et al., 2022). The peel of *H. undatus* was enriched with Ca, Mg and in contrast, Fe, P, K, and Na were rich in *H. polyrhizus*. Significant amounts of Cu, Ca, Zn, Na and Fe were present in the pulp of *H. polyrhizus* (Md. Ashaduzzaman Nur et al., 2023).

The effect of blanching and drying temperatures on physicochemical properties of red dragon fruit peel powder were also studied. Dragon fruit peel were pre-treated with hot water at 90 °C for 2 minutes before being dried in hot air oven dryer at 50 °C, 60 °C and 70 °C. Results showed that the powdered sample of blanched and dried at 50 °C had significantly higher fiber, water activity and moisture content than those of an unblanched or blanched dried at 60 °C and 70 °C. Result also showed that the colour of this powder was similar to the fresh dragon fruit peel. The powder that was blanched and dried at 50 °C was the best condition which contains the highest amount of fiber with good physicochemical properties (Nor Anis Shafira Rosidi et al., 2021).

The irradiation process causes few changes in pitaya husk flours, making it a good alternative for flour preservation. The flours were irradiated with 0, 1, 2 and 4 kGy. The highest values for humidity were found in samples submitted to 2 kGy (6.46%). There was no significant difference for protein values. The sample submitted to 2 kGy obtained a 55.5% increase in lipid levels. The ash contents varied between 12.95% and 14.04%. The maximum value for the total energy value and pH were 328.15 kcal and 4.47, respectively and there is no presence of anti-nutritional compounds and tannins were detected. The fiber content was maintained with an average of 56.54%. The carbohydrate profile revealed that sucrose is the predominant sugar in flours with a 0.995% content (Andre Leonardo dos Santos et al., 2022).

Physicochemical properties and nutritional composition of the peel and pulp of *Hylocereus polyrhizus* and *Hylocereus undatus* has no significant differences in specific gravity and pH were observed in the extract from the different parts of the two species, but the peel extracts from both species were more acidic and stable than others. The anthocyanin contents were remarkably higher in the *H. polyrhizus* species. In nutritional analysis, the moisture, total sugar and reducing sugar contents in the pulp of *H. undatus* were 86.33%, 7.97% and 4.35%, respectively, and these values were higher than those in the pulp of *H. polyrhizus*. Meanwhile, 10.35% carbohydrate was detected in the pulp of *H. polyrhizus*, which was significant compared to *H. undatus*. The peel of *H. polyrhizus* contained 1.02% crude fat, 1.235% crude protein and 3.96% ash, these amounts were larger than those of *H. undatus* (Md. Ashaduzzaman Nur et al., 2023).

The study on the crossing effect of Dragon fruit revealed that the cross-pollinated varieties increase the fruit yield than self-pollinated. This improvement in pollination process has resulted in better process of fertilization resulted in the increase of size, diameter, length, and weight of fruit, and the sugar content of fruit. Manual pollination or crossing between red flesh with white flesh dragon fruit is needed to get better yield with good economic benefits (Muhammad Subandi et al., 2018). The study on molecular level shows that the 43 RAPD markers efficiently estimated genetic diversity among 15 dragon fruit germplasms by revealing 86.05% polymorphic loci and heterozygosity of 0.372. the information helps for the nomenclature, management, conservation and improvement of the dragon fruit in Bangladesh (T. Rifat et al., 2019).

Antioxidant Property

The total antioxidant capacity increases and reached the maximum at 35 DAA, followed by a light decrease during the later stages of fruit development. The vitamin content in pulp varied from 92.73 to 22.9mg from 20 to 45 DAA (Akath singh et al., 2022). Similarly, there was a rapid rise in free radical scavenging activity from 20 DAA to 25DAA and then stabilising to 35 DAA. Moreover, DPPH radical scavenging activity ranged from 30.73% to 74.32% (Md. Ashaduzzaman Nur et al., 2023).

## Conclusion

The review suggests about the morphological, anatomical, nutritional and antioxidant properties of economic fruit, *Selenicereus*. The morphological and anatomical characteristics of the varieties of dragon fruit is almost similar but the colour difference in perianth, fruit size, flesh colors are varying in different varieties. The adjacent thorn distance and number of thorns are also a remarkable morphological character to distinguish the varieties. The anatomy of roots revealed the presence of epidermis, hypodermis, cortex, vascular bundle and pith. The number of vascular bundles is varied in different varieties. The cytological studies revealed that this genus is tetraploid and the chromosomes are mostly metacentric and submetacentric. A well rich nutrient content is one of the possibilities to prevent various diseases. Physicochemical characteristics such as fruit pulp weight gain, fruit firmness, sugars, acidity, carbohydrate, fat, dietary fiber and soluble proteins recorded their optimum level at maturity. The study depicted that red-fleshed dragon fruit has significant levels of betalains, vitamin C, total phenolic content, total flavonoids and total antioxidant capacity with free radical scavenging activity. Different minerals are present in the flesh of fruit like Cu, Ca, Zn, Na, K, P, Fe. Among this, Phosphorus content is maintained the same amount from initial stages to the stage of maturity where as rest of the minerals shows a slight decrease in their total amount at the time of maturity from initial stages. The fruit is a promising source of alternative medicine that might serve as an antioxidant, anticancer, antibacterial and antidiabetic agents. The flesh on the skin of dragon fruit can be used in herbal teas, jelly, syrup and various kinds of functional food products that are beneficial to the body.

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