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Short Communication

Dragon Fruit : An Exotic Nutritional Fruit

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Pitaya or Dragon fruit is a member of Cactaceae family and belongs to genus *Hylocereus* (tropical climbers). It is a hardy plant with least maintenance requirements, drought resistance, adaptation to high temperature and soil salinity. It is very well adapted to climate change and has a wide tolerance range for light intensity (in respect to sunlight and exposure). Today when each and every country of the world is facing problems related to food and nutritional security, the dragon fruit plant seems to an answer to fight it. The plant which is adaptable to varied climatic conditions and soil types, bears the fruits that are rich in many bioactive compounds including macro and micro minerals and vitamins. It contains higher moisture and fiber. It is rich in antioxidants[9]. The plant has its origin in the tropical areas of Mexico, North, Central and South America, but nowadays it is being cultivated widely throughout the world, especially as a commercial plant[6]. Today dragon fruit plant is commercially cultivated in many subtropical and tropical countries viz. Philippines, Japan (Okinawa), Indonesia, Israel, Bermuda, North Australia, West Indies, Bangladesh, South China, South Florida, Thailand, Srilanaka, Mayanmar, Colombia, Bahamas, Malaysia, Taiwan, Vietnam, Nicaragua, Mexico and others (Mercado-Silva 2018). In the current scenario, Vietnam has become the major exporter of dragon fruit throughout the world. The increasing global demand of the fruit and its adaptability to the changing climatic conditions, the plant/ fruit is becoming popular amongst the farmers of the coastal countries like Vietnam. Dragon fruit is also known for its medicinal properties and is practiced by traditional/folk/ herbal practioners of many Asian countries. India is also adapting the plant for its nutritional and health benefits. Many researchers and scientists are working on various aspects of dragon fruit in India. However, the fruit available in the markets, both local and urban, are still considered new and exotic by the consumers. However, as the population is getting conscious of its food consumption, its nutritional importance and health benefits, dragon fruit is gaining popularity at a faster pace.

Plant and Fruit

The plant: The plant of Dragon fruit is a climbing vine member of Cactacae family and once was popular as outdoor, ornamental plant with beautiful flowers[8]. The flowers are fragrant and nocturnal and thus are named as 'Noble woman' or 'Queen of the Night'. The popular name of Dragon fruits in south

Asian countries is 'pitaya' which means 'scaly fruit' (in Haitian language) because of bracts, horn or scale like structures on the outer surface of fruit. Due to its characteristic appearance, the other names of the fruit include Pitahaya, Strawberry pear, Cindrella plant, night-blooming cereus, Belle of night, Thanh Long or the green Dragon. As per an ancient belief, the dragon fruit was a result of fire- breathing dragons and thus the ancestors believed that the consumption of dragon fruit will give them similar ferocity and strength as that of a Dragon. The fruits resembles the egg of a Dragon and is also referred to as moon flower, lady of the night, queen of the night[10]. It is a perennial plant with a long day, oval shaped fruit with green foliaceous bracts or scales which resembles the skin of dragon. The plant is hardy and can withstand high temperature and saline soil conditions. The plant is a very low maintenance plant and responds well to inexpensive and easy agronomical practices. It is susceptible to fewer pests and diseases and thus the after care of the plant is also less. It can be a profitable option for organic farming as it performs well on compost and organic manures and its nitrogen demand is very less as compared to other fruit plants. The only investment it needs is the 'trellises' (semi-permanent type structure for climbing of plants and vines) for climbing the vines. It is a fast growing plant and starts fruiting from the second year of plantation. A single plant can survive and bear fruits for approximately 20years. Approximately 800 dragon fruit plants can be easily planted in one hectare of land.

Dragon fruit probably got its name from its flesh colour and shape which resembles the 'dragon' (The animal) of ancient times, as is shown in paintings and pictures. However the colour and appearance of fruit varies with the species. The commonly known features as described by many researchers is given in Table 1.

Table 1 Physical appearance of the Dragon fruit

S. No.	Species	Colour	Source
1	*Hylocereus polyrhizus*	red flesh with pink skin	Britton and Rose 1920
2	*Hylocereus undatus*	white flesh with pink skin	Britton 1918
3	*Hylocereus costaricensis OR Selenicereus megalanthus* (K. Schum. ex Vaupel) *(synonym Hylocereus megalanthus*)	red-purple flesh with red skin	Britton and Rose 1909 Moran 1953 Ortiz-Hernández and Carrillo-Salazar 2012; Mu-niz et al. 2019

The fruit: Dragon fruit belongs to the category of non-climacteric fruits which ripens itself on plants and can be harvested between 30-50 days of fruit set. The fruit develops in the form of an oblong, large shaped epigenous berry which has scale/ bract like growth on the outer skin. The fruit is initially green in colour which turns red to purple (depending on the variety and species) with ripening. The scales or the bracts don't change their colour but grows with increase in the size of the fruit and are quite visible on a fully grown fruit. With

the onset of ripening, the peel looses moisture and the pulp inside gains moisture to become more fleshy and juicy. The pulp contains very small sized black coloured seeds spread all over the pulp[11]. If the fruits are not harvested at 50days and left for more ripening on the plant, the fruit turns heavier and sweeter[3]. However, it makes it more softer and thus it tends to split. This undoubtly becomes a challenge for further storage and marketing purposes and it reduces the shelf life of the fruit as well. The non-climacteric nature of fruit makes it to respire less after harvesting however there is visible loss in weight and moisture content of the fruit after the 8th day of harvest. There is shriveling in the fruit and the storage life and quality of the fruit is adversely affected (Arevalo-Galarza and Ortiuz-Hernandes, 2004). Dragon fruits keep well at the temperature of 7-10^{O}C (with 90-98% relative humidity) for upto 45 days. For marketing purposes fruits can be easily stored at a temperature of 8^{O}C, preferably in perforated bags or boxes for 25-30 days. Precautions should be taken not to change the temperature of the fruit drastically and frequently.

Nutritional & Health Benefits

The fruit is highly acclaimed for its nutritional properties especially the Vitamin C (ascorbic acid) content of the fruit. The nutritional composition of the fruit varies with origin, crop, species and maturity of fruit[7,12,13]. Freshly extracted pulp of dragon fruit (100g) has been reported to contain 80 per cent moisture, 8.5 to 13.0g of carbohydrates, 0.4 to 2.2g crude protein and 6g total sugar. The range of nutrients indicates that it varies with origin and species of dragon fruit[5, 13, 14]. Red flesh varieties of dragon fruit are rich in antioxidants, phosphorous and calcium. Vitamin C content of dragon fruit, as estimated by different workers at different places and with different species varied surprisingly. However, these variations were attributed to many factors including oxidative degradation of ascorbic acid when exposed to sunlight and air, especially during the extraction process and sample preparation, cultivation type, maturity stage of harvested fruit, storage and transportation conditions and many more in addition to crop species and origin. Table 2 illustrates various findings in respect to Vitamin C content of Dragon fruit.

Table 2 Vitamin C content of Dragon fruit of different species

S. No.	Species/ Origin	Vitamin C content (mg/100g)	Reference
1	*H. costaricensis (*super red pitaya org. Pasuruan (East Java)) *H. undatus* (white pulp org. Bantul districts (Yo-gyakarta))	6.0 mg 3.4 mg	Rahmawati and Mahajoeno (2009)
2	*H. polyrhizus* *H. undatus*	36.65mg 31.05 mg	Choo and Yong (2011)
3	*Hylocereus* sp., cv. Red Jaina (red skin with red pulp) *Hylocereus* sp., cv. David Bowie (red skin with white pulp)	55.8 mg 13.0 mg	Mahattanatawee et al. 2006

Dragon fruit as whole is very nutritious. Both the peels and seeds are equally nutritious as the fruit pulp. The skin or the peel of dragon fruits (sp. *H. undatus*) are rich in biologically important fatty acids viz., linoleic (50.8%,), palmitic acid (21.5%) and oleic acid (21.5%) (Jerônimo *et al*., 2015) which are found to reduce LDL and VLDL in serum cholesterol[2]. On the same note seed oil from dragon fruit (red and white pitaya) were found rich in essential fatty acids namely, Linoleic and linolenic acid besides oleic, palmitic and cis-vaccenic acid[1]. The composition of these fatty acids make drgaon fruit a suitable choice for maintaining cell membranes, proper functioning of brain and normal transmission of nerve impulses in the body[5]. Dragon fruit is rich source of Omega-3 and Omega-6 fatty acids, which makes it popular amongst the CVD (Cardio Vascular Disease) affected population[4]. At the same time the cholesterol content of the fruit is very low and contains partially good amounts of proteins. Its minute sized seeds when consumed with fruit flesh acts as laxative and aids digestion. Presence of fibre in fruits helps regulating blood sugar levels and thus aids in diabetes control. The anti-oxidants, vitamin B and C present in dragon fruit helps to keep the skin healthy, tight and glowing. In addition young stem of dragon fruit is found to be good source of minerals including calcium, potassium, phosphorous, sodium, magnesium, iron and zinc. These stems contain approximately 10.0–12.1 g per 100 g crude protein and approximately 7.8–8.1 g per 100 g fibre on dry weight basis (Ortiz-Hernández and Carrillo-Salazar 2012).

The nutritional composition of dragon fruit, pulp, flower, buds and even the stems make it ‘super food’ and in many countries it is used for the treatment of many diseases (Perween *et al*., 2018). The fruit is rich in antioxidants, Vitamin C and other minerals and vitamins which are found to help in curing or preventing the occurrence of diseases including diabetes, high blood pressure, colon cancer. It is found to neutralize the toxic effect of undesirable heavy metals. It is helpful in controlling blood sugar levels, improves dental health and reduces cholesterol levels in the blood. High moisture content of dragon fruit helps to quench the thirst. Its regular consumption boosts the immunity of individuals and aid in healing cuts and wounds faster as well as improves the body system to fight against diseases like asthma and cough. Presence of B group vitamins in dragon fruit helps in improving the conditions related to loss of appetite improves carbohydrate metabolism and thus aids energy production in the body. It fights bad cholesterol in the body and thus helps to relieve symptoms of hypertension. Consumption of dragon fruit is found to improve eye sight, bone health and keeps the skin healthy and moisturized. The fiber in the fruits helps in curing symptoms of Type 2 diabetes by controlling and regulating blood sugar levels. Presence of minerals like calcium and phosphorous reinforces new tissue and cell formation. Dragon fruit is a rich source of flavonoids, which is helpful in treating excessive bleeding and vaginal discharge. It is also found to benefit in heart diseases and keeping the heart healthy.

Food uses and processing

The attractive colour of the pulp, delicate taste and above all the nutritional and health benefits of dragon fruit has made it popular amongst the health conscious and foodie people all over the world. A variety of fruit products including fermented and non-fermented beverages, jelly, candy, preserve and many more. Young, fresh stems and flower buds are eaten raw as vegetables and/ or in salads. The buds are dried and ten utilized in the preparation of vegetables, jam, preserve etc. Dried buds are a part of medicine in Taiwan. These fresh buds and flowers are also served on restaurants as salads and juices. Malaysian people use dragon fruit for the preparation of wine. In food processing industries the products where pulp is added as a colouring agent or an important ingredient in soups, tea, juices, pizza and other items.

Conclusion

Dragon fruit is an exotic fruit plant but is suitable for the areas which experience long dry spells and harsh temperature variations. As the world is experiencing climate change issues and the weather is challenging the farmers and farming practices, farming of dragon fruit can be beneficial for small land holders and for farmers with limited resources. Farming of dragon fruit can also be adopted for developing waste lands and for raising agroforestry especially in dry and arid regions. The current demand of the fruit and related products in the national and international market suggests that farming of dragon fruit could ensure comparatively good income of farmers with least risk. Further, government and other related organizations may encourage farming of dragon fruit with improved species and agricultural practices for sustainable income and livelihood.

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