DRAGON FRUIT AND ITS VALUE ADDITION

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Abstract

Dragon fruit, also known as pitaya or strawberry pear, is a vine cactus species belonging to the family Cactaceae. There are three species of dragon fruit in the genus *Hylocereus* and one species in the genus *Selenicereus*. Varieties of dragon fruit, including *Hylocereus undatus*, *Hylocereus polyrhizus*, and *Hylocereus megalanthus*. Vietnam, China, and Indonesia are the three major countries contributing to more than 93% of the world's dragon fruit production. In India, dragon fruit cultivation has increased significantly in recent years, with major states like Karnataka, Maharashtra, Gujarat, Telangana, Andhra Pradesh, and West Bengal promoting commercial production. Dragon fruit thrives in tropical climates with an optimum temperature range of 20°C to 30°C and well-distributed annual rainfall of 100-150 cm. It prefers light acidic soil with a pH ranging from 5.5 to 6.5. The fruit is rich in various nutrients, vitamins, minerals, and dietary fibers, making it a beneficial superfood for weight loss, diabetes control, cholesterol reduction, and strengthening the immune system. Dragon fruit has a short shelf life and should be stored at around 10°C with 93% relative humidity to maintain its quality and freshness for up to 15 to 17 days. Various value-added products can be derived from dragon fruit, such as dragon fruit jelly, jam, seed oil extraction, and even the synthesis of ZnO nanoparticles from dragon fruit peel. Overall, dragon fruit is a versatile and nutritious fruit that has become a significant economic fruit species worldwide, catering to the growing demand for exotic and health-promoting foods.

Key words: Dragon fruit, Nutrient composition, Value-added products.

1. Introduction.

Dragon fruit is a vine cactus species belonging to the family Cactaceae Its plant is attractive due to its exotic appearance. Dragon fruits are gaining popularity for their nutritional and medicinal properties. This fruit is considered as an important economic fruit species worldwide due to its nutritional value (Sonawane, 2017)

Plate 1. Dragon fruit

Dragon fruit, pitaya or strawberry pear (*Hylocereus spp. and Selenicereus spp*.) or Kamalam is emerging as a super crop worldwide, even in the marginal lands, owing to its health and medicinal benefits. It is basically a climbing cactus vine, originated from Central and South America, tolerant to the abiotic stresses and resistant to pests and diseases. It has many advantages including low water and nutrient requirements, relatively less requirement of resources for establishing the orchard and maintenance; multiple harvest of fruit in a year potential to sustain high yield up to 20 years, high benefit to cost ratio and high nutraceuticals and functional properties (e.g. rich in antioxidants and fibres). . Commonly, this fruit is named as pitaya because of the bracts or scales on the fruit skin and hence the name of pitaya meaning ‘‘the scaly fruit’ (www.krishi.icar.gov.in)

2. Taxonomy and variety of dragon fruit

There are three species of dragon fruit in the genus Hylocereus and one species in the genus Selenicereus. Varieties of *Hylocereus megalanthus* , *Hylocereus polyrhizus*, and *Hylocereus undatus* as well as hybrids of these three species are grown commercially worldwide. Selenicereus megalanthus is grown commercially on smaller scales in South America and is especially popular in Colombia (www.tropicalfruitnursery.com).

Table 1: Varieties of Dragon Fruit

Varieties	Peel colour	Pulp colour
Hylocereus undatus	Red	White fleshed
Hylocereus polyrhizus	Red	Red fleshed
Hylocereus megalanthus	yellow	White fleshed

(a) **(b)** **(c)**

Plate 2. (a) *Hylocereus undatus* **(b) *Hylocereus polyrhizus*** **(c) *Hylocereus megalanthus***

3. Dragon Fruit Production in World

Dragon fruit was introduced during 1990 for its commercial cultivation in south Asian tropical countries. At present, significant production and expansion of fruit is occurring in many countries viz., Vietnam, China, Mexico, Colombia, Nicaragua, Ecuador, Thailand, Malaysia, Indonesia, Australia and United States. However, its production and marketing data is rarely available apart from its spontaneous expansion around world. Three major countries viz., Vietnam, China and Indonesia contributes more than 93% of dragon fruit production of world. The share of Vietnam alone is more than half (51.1%) of the world production over an area of 55, 419 ha with average productivity of 22–35 metric tonnes (MT)/hector (ha)/year. The volume of dragon fruit produced in Vietnam is more than 1 million metric tonnes of worth US ($) 895.70 million (Chen and Paull, 2018). China is second largest producer contributing 33.3% of world production of dragon fruit i.e. producing about 7, 00,000 MT dragon fruit of worth US ($) 397 million over growing areas of 40,000 ha with average productivity of 17.5 MT/ha/year (Wakchaure *et al.*, 2020).

Table 2. Dragon Fruit Production in World

Country	Production area (ha)	Production (MT)	Productivity (MT ha^{-1})
Vietnam	55,419	10,74,242	22-35
China	40,000	7,00,000	17.5
Indonesia	8,491	2,21,832	23.6
Thailand	3,482	26,000	7.5
Taiwan	2490.6	49,108	19.7
Malaysia	680	7,820	11.5
Philippines	485	6,062.5	10-15
Cambodia	440	4,840	11.0
India	400	4,200	8.0-10.5
USA	324	5,832	18.0
Australia	40	740	18.5
South Africa	12	100	8.3
Total	1,12,264	21,00,777	-

Source: (Wakchaure *et al.,* 2020)

4. Dragon Fruit Production in India

In India, dragon fruit was introduced during the late 1990s. Initially cultivation of dragon fruit was started by the farmers from Karnataka, Maharashtra, Gujarat, Kerala, Tamil Nadu, Orissa, West Bengal, Andhra Pradesh, Telagana and Andaman & Nicobar Islands . Nowadays, its cultivation has extended to Rajasthan, Punjab, Haryana, Madhya Pradesh, Uttar Pradesh and North Eastern States. According to recent estimates, India's dragon fruit production increased drastically to more than 12,000 MT over an area of 3,000–4,000 ha in 2020. These estimates are based on the first–hand information collected by the ICAR–NIASM from progressive growers, entrepreneurs, consultants and officials of state agricultural departments across the country. The sudden rise in production and cultivated area are mainly because of states like Karnataka, Maharashtra, Gujarat, Telegana, Andhra Pradesh and West Bengal, which have taken initiatives to promote commercial production after 2018 onwards. Out of total 3,085 ha, more than 80% area (2,468 ha) is under new cultivation with less than 18 months old plantation. Further, average productivity of these areas is ranging from 1.5 to 3.1 MT/ha. While remaining 20% cultivation area (617 ha) is already well established and attained its full maturity level with average productivity of 8–13.5 MT/ha. Indian farmers, who follows good cultivation practices under drip irrigation, can get up to 4.5

tonnes of fruit per ha in the first year after planting, up to 7.5–10 tonnes/ha in the second years and 16–24 tonnes/ha on third year onwards (Wakchaure *et al.*, 2020).

Table 3. Dragon fruit production in India

Major States	Total Area (ha)	New area (ha) 80%,	Productivity (MT/ha),	Production in (MT),	Old Area (ha),	Productivity (MT/ha)	Production in (MT),	Total production (MT)
A,P	104.4	112.3	1.5	168.5	28.1	10.2	286.5	455.0
Telangana	80.9	64.8	1.8	116.6	16.2	10.0	161.9	278.4
T.N	121.4	97.1	2.2	213.7	24.3	12.0	291.4	505.1
W.B	303.5	242.8	2.1	509.9	60.7	11	667.7	1177.7
MH	323.8	259.0	3.1	802.9	64.8	13.5	874.1	1677.1
Karnataka	485.6	388.5	3.0	1165.5	97.1	12.4	1204.4	2369.9
Gujarat	1214.1	971.3	2.2	2136.8	242.8	8.0	1942.4	4079.3
Rajasthan	38.4	30.8	1.5	46.1	7.7	8.0	61.5	107.6
Meghalaya	174.0	139.2	2.8	389.8	34.8	11.4	396.8	786.6
Others	202.3	161.9	1.5	242.8	40.5	10.7	433.9	676.7
Total/Average	3084.6	2467.7	2.2	5792.6	616.9	10.7	6320.7	12,113.4

5. Climatic Conditions of Dragon Fruit

Dragon fruit adapts well to tropical climates. The optimum temperature range for dragon fruit cultivation is about 20^0C – 30^0C with well distributed annual rainfall of 100-150 cm. It need good sunlight, but not suitable for long period. It can be cultivated in tropical wet zone or intermediate zone as well as dry zone with the irrigation facilities. Heavy rain fall areas are not suitable for the crop. As excessive rain causes flower drop and fruit drop. Generally an altitude up to 1500 m altitude is suitable for the cultivation. Very high temperature and very low temperature is not suitable for the growth of the plant. Dragon fruit plant prefer light acidic soil with pH ranging from 5.5 to 6.5 sandy loam soil with high organic matter are suitable for the cultivation for the dragon fruit. Sandy soils with organic matters also provides good condition for plant growth (Tripathi *et al.*, 2016).

6. Biochemical Constituents of Dragon Fruit

Dragon fruit is considered to be one of the tropical super foods due to its nutrient richness. It is rich in various nutrients and low in calories. It helps control chronic illnesses, improves the health of alimentary canal and boosting the body's immunity. It is also rich in various vitamins, minerals and dietary fibres. All these beneficial factors make dragon fruit as the best option for weight loss treatment, control of diabetes, lowering the cholesterol level, etc (www.krishi.icar.gov.in).

Table 4.Functions of some of the main antioxidants compounds and minerals

Components	Amount	Amount
Flavonoids	Red fleshed 46.29 ± 2.47 mg RE/100 g FW and white fleshed 26.71 ± 4.46 mg RE/100 g FW	• Flavonoids are acts on brain cells and blood vessels to reduce the risk of heart disease. • It minimizes heart diseases and maintains blood pressure
Betalains	42.71 ± 2.48 mg/100 g fresh pulp (red fleshed)	• Betalains can combat oxidative stress and may have the ability to suppress cancer cells. • It has the ability to aid in weight loss, improves digestion and strengthen the immune system.
Hydroxycinnamates	Minor amounts of hydroxycinnamic acids	It helps to prevent cancer.
Carotenoids (Beta-carotene)	1.4 mg/100 g (white fleshed)	Reduced risk of cancer and cardio-vascular diseases
Lycopene	3.4 mg/100 (white fleshed)	Lycopene inhibiting the cell growth of various human cancer cell lines
Lilinolenic noleic acid and acid	Seeds rich with 50% of essential fatty acids	Its high in polyunsaturated fats (omega-3 and omega-6 fatty acids) that reduce triglycerides and lower the risk of cardiovascular disorders

Vitamin C	White-fleshed 31.11 ± 3.85 mg / 100g FW & Red fleshed 20.00 ± 1.33 mg / 100g FW	Vitamin C would help in fighting against cough and asthma and enhances the immune system and also stimulate the activity of other antioxidants in the body
Phosphorus (P) and calcium (Ca)	P 22.5 mg/100g and Ca 8.5 mg/100g	Phosphorus and calcium which helps to reinforce bones and plays an important role in tissue formation and forms healthy teeth
Iron	1.9 mg/100g	Red Dragon fruit having so much iron, which increases haemoglobin and erythrocyte levels in pregnant women

6.1 Nutritional composition of Dragon fruit

Dragon fruit is considered as a heavenly fruit on the earth with high nutritive and medicinal values. It is considered to lower blood sugars in type 2 diabetes. Therefore, the dried dragon fruit is included in diabetic diet plan. Eating fruit is considered beneficial for carbohydrate metabolism, strengthening bones and teethes, heart tissues, healthy blood and tissue formation, strengthening immune system, faster healing of bruises and wounds, respiratory tract infections and even as a mild laxative due to substantial fibre content. Dragon fruit is believed to able to lower cholesterol concentration, to balance blood sugar concentration, to prevent colon cancer, to strengthen kidney function and bone, to strengthen the brain workings, increasing the sharpness of the eyes as well as cosmetic ingredients (Jalgaonkar *et al.,* 2021).

Table 5. Nutritional composition of Dragon fruit

Composition	White fleshed dragon fruit	Red fleshed dragon fruit
Energy (kcal)	130	283
Protein (g)	0.5	0.2-1.1
Fat (g)	0.1	0.6-3.4
Carbohydrate (g)	9.5	11.2
Glucose (g)	5.5	4.7-5.7
Fructose (g)	1.9	1.8-3.2
Crude fiber (g)	0.3	0.7-1.3
Calcium (mg)	3.1-6	2.3-10.2
Sodium (mg)	3.3	7.3-8.9
Potassium (mg)	399.5	228.4-272
Iron (mg)	0.4	0.6-3.4
Mg (mg)	26.6	31.3-38.9
Phosphorous (mg)	19	27.5-36.1

Source :(Jalgaonkar *et al.,* 2021)

7. Dragon fruit harvesting

The plant start yielding after 12-15 months from the date of planting and the fruit maturity could be optimized with the change of fruit epicarp color from green to red. Proper time of harvesting was found after seven days of color transition. The plants yield the fruits in the months between June to September, and harvest could be done three to four times in a month, The fruit weight ranged between 300-800g, and the average yield from the single post is realized about 30 to 35 kgs from the three years old planting. Present farm gate price ranged between INR. 80.00 to 120.00 per kg. There is a scope for improvement of existing tools or development of novel tools/equipment for harvesting of dragon fruit **(**Arivalagan *et al.,* 2019).

Table 6. Dragon fruit quality parameters

Cultivars	No. of fruits /pole	Fruit Weight (g)	Fruit Length (cm)	Fruit Breadth (cm)	Pulp Weight (g)	Skin Weight (g)	Seed Weight (g)	Pulp Recovery Ratio (%)	TSS (^{O}Brix)
White Fleshed	14	457.0	15.21	27.35	321.20	122.60	2.02	70.28	9.75
Red Fleshed	22	331.4	14.56	24.31	246.70	84.00	1.88	74.44	11.54

Source: (Arivalagan *et al.*, 2019)

8. Storage and Shelf Life of Dragon Fruits

Storage at 10°C with 93% relative humidity (RH) is considered the optimum condition for storing harvested dragon fruits to maintain their quality. In these conditions, it will retain higher storage life of up to 15 to 17 days. If the temperature is too cold, it will soften and damage the Dragon Fruit. Similarly, when the storing temperature increases over the optimum levels, the spine goes yellow and loses its fresh appearance. Keep cool technology suitable for the fruit to maintain freshness; the quality is the main factor that the fruit can be shipped worldwide. Dragon Fruit is a short shelf-life, non-climacteric fruit that can be easily destroyed by mould growth during storage. An investigative study about peppermint oil as an alternative method to inhibit surface wounding and prolong the shelf-life of dragon fruit during storage. In addition, essential oil vapour maintained a firm fruit, the green colour of the bract, titratable acid value, and total phenolic content after 21 days in comparison to the control. (Paull, 2014; Dutta and Neong , 2021)

9.0 VALUE ADDITIOIN

9.1 Dragon Fruit Jelly

- The dragon fruit pulp contains 82.5-83% moisture, 0.16-0.23% protein, 0.21- 0.61% fat, 0.7-0.9% fiber, 6.3-8.8 mg calcium, 30.2-36.1 mg phosphorous, 0.5-061 mg iron, 8-9 mg vitamin C
- Pectin contents are known as pectic polysaccharide which helps gellification in proper concentration of pH and sugar. Different concentrations of added pectin bring variability in organoleptic and physico-chemical properties of jam and jelly.
- the better quality of dragon fruit jelly can be prepared by using 1000 ml fruit extract, 550 g sugar, and 11 g of pectin with better organoleptic properties as well as chemical

composition and good storage stability at both storage (ambient and refrigerated) conditions up to 3 months storage period (Panchal *et al*., 2018).

Plate 3 : Drago fruit jelly

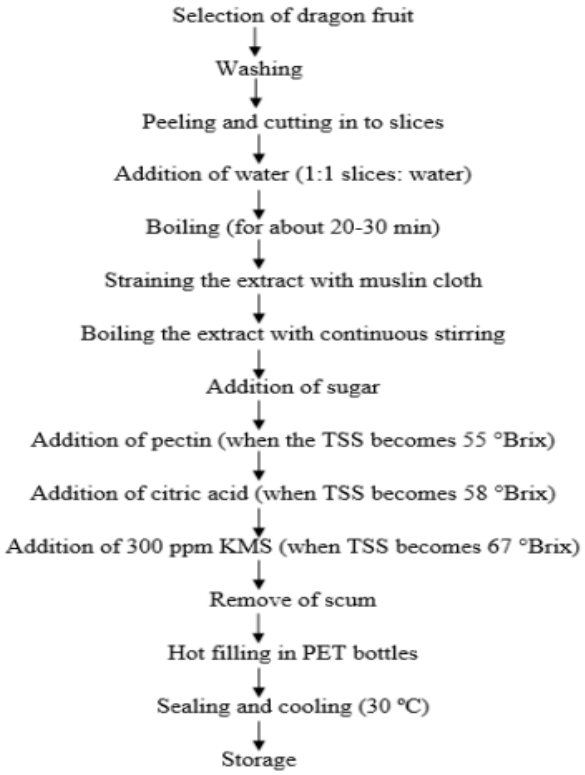

Figure 1. Process flow chart for dragon fruit jelly

9.2 Dragon Fruit Jam

The fruit flesh was shredded and blended into fruit pulps and weighed to 500 g. Pectin 1% (based on the fruit pulp weigh) was dissolved into 50 ml of water and subsequently added into fruit pulp. The mixture of fruit pulp and pectin, 55% of sugar and 0.5% of citric acid were heated at 103-105oC for 10 minutes until homogeneous and gelled. The fruit jam directly hot-filled into sterilized bottles and the lids were closed as soon as possible. The bottled jam was further sterilized in a water bath for 10 minutes.(Kiranmai, 2022).

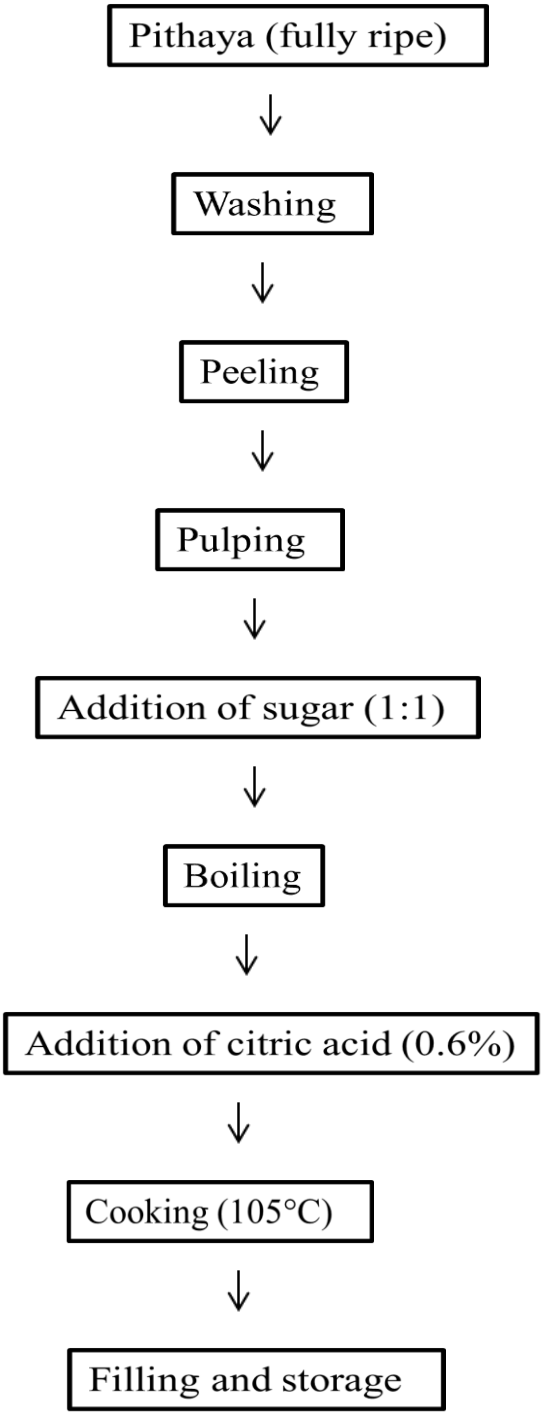

Figure 2. Process flow chart for dragon fruit jam

Plate 4. Dragon fruit jam

9.3 Dragon fruit powder incorporated biscuits

- Biscuit formulation may contain Vanaspati (vegetable oil) or refined edible oil, butter, ghee, margarine, or their mixture with other minor ingredients.
- Biscuits are fortified with a wide variety of cereal like finger millet, gram flour, soy flour, etc. (Pawde *et al.*, 2020)

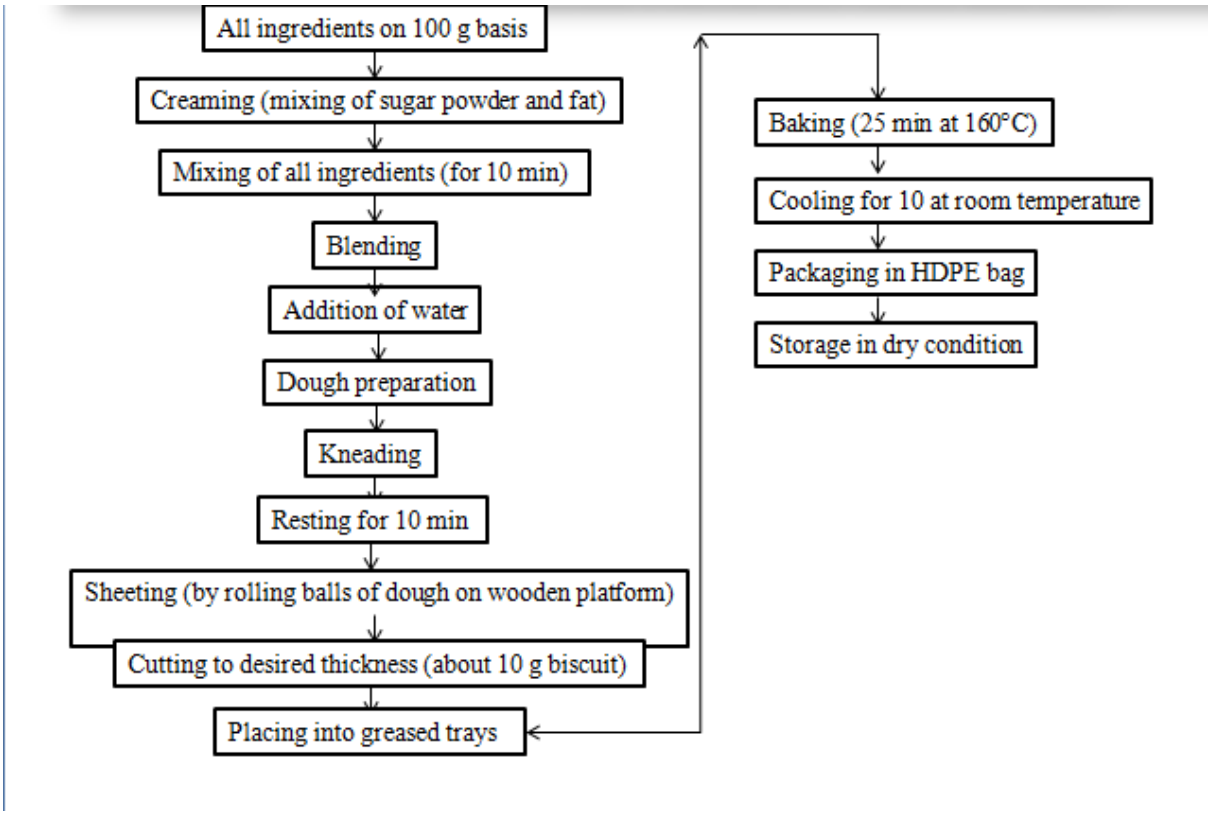

Figure 3. Dragon fruit powder incorporated biscuits

9.4 Dragon fruit Seed oil extraction

The dragon fruit seed oils are high in essential fatty acids particularly in WFSO, and contain a significant amount of natural antioxidants, tocopherols, especially in RFSO. Thus, the dragon fruit seed oils can be considered as high-value oils due to their oil composition. The process of oxidation took place and simultaneously both the PV and the peroxide formation index increased whilst the disappearance of tocopherols was observed. This correlation indicates that tocopherols are used against the oxidation. However, after 12 weeks under CT and RT conditions, the dragon fruit seed oils still contained a relatively high amount of tocopherols and showed a low oxidation rate, demonstrating a high oxidative stability (Jalgaonkar *et al.*, 2021).

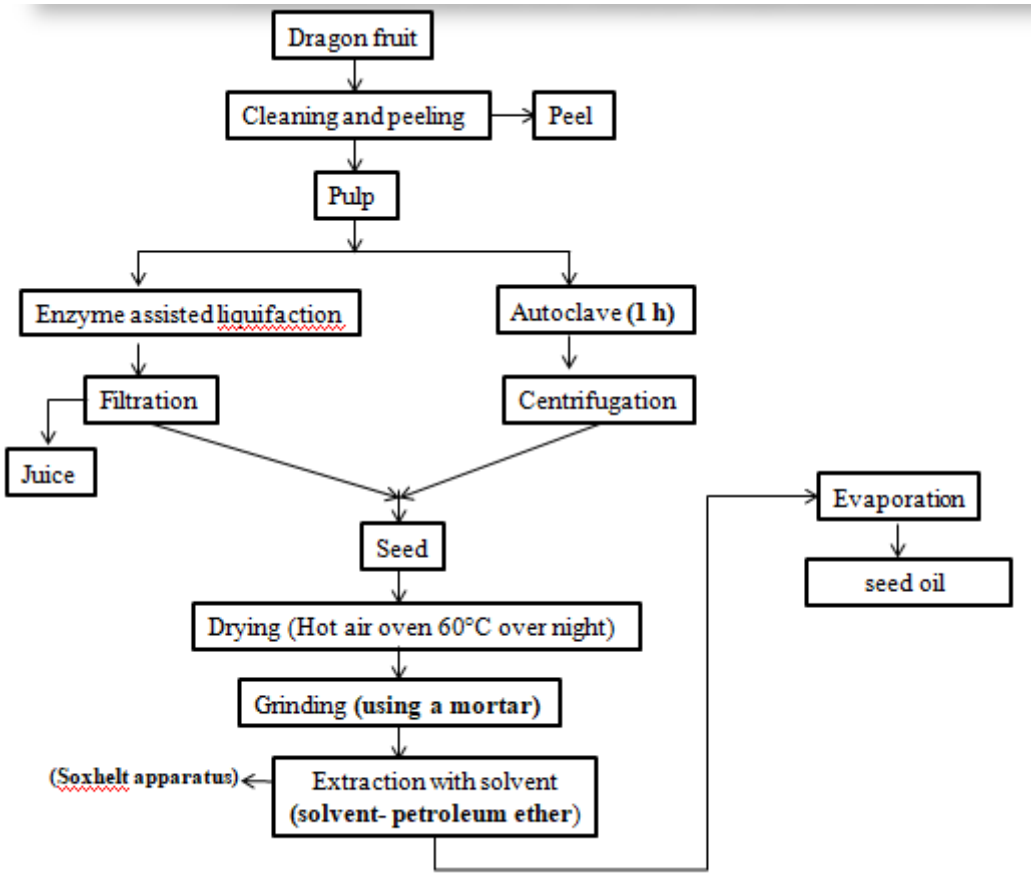

Figure 4: Process flowchart for dragon fruit oil extraction

Table 8: Fatty acid composition of two dragon fruit oil seeds

Composition	***Hylocereus polyrhizus***	***Hylocereus undatus***
Fatty acids (%)	0.2	0.3
Myristic acid (%)	17.9	17.1
Palmitic acid (%)	5+.49	4.37
Stearic acid (%)	0.91	0.61
Palmitoleic acid (%)	21.6	23.8
Oleic acid (%)	3.14	2.81
Cis-vaccenic acid (%)	49.6	50.1
Linoleic acid (%)	1.21	0.98

Source: (Jalgaonkar *et al.*, 2021)

9.5 Synthesis of ZnO Nanoparticles From Dragon Fruit Peel

The green-synthesized ZnO NPs were efficiently utilized for the photodegradation of toxic MB dye. The detailed experimental results show that no significant photodegradation was observed either under solar irradiation in the absence of ZnO NPs or vice versa confirming synergic effect of green-synthesized ZnO NPs and sunlight on the photodegradation of MB dye. However, in the presence of ZnO NPs under solar irradiation almost 95% degradation of MB dye was observed in 120 min.

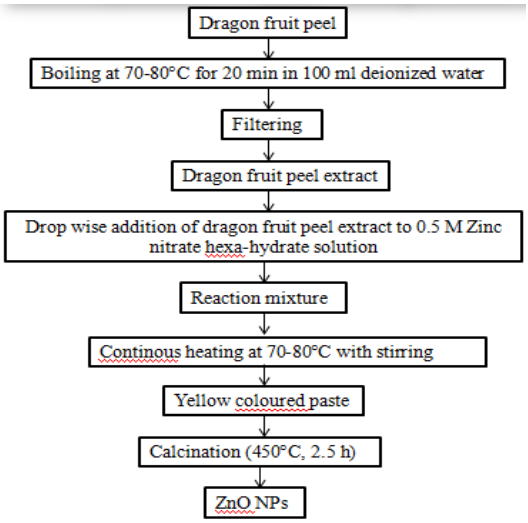

Figure 5: Process flowchart for Synthesis of ZnO nano-particles from dragon fruit peel

9.6 Dragon Fruit Wine

- Colored fruit wines are gaining much popularity because of their powerful antioxidant activity due to the naturally-occurring pigments.
- In addition, the pigments in colored fruit wines have potential health effects against cancer, aging, neurological diseases, inflammation, diabetes and bacterial infections.
- Wine is considered to be a high-value product which may be produced from dragon fruits.
- Utilization of dragon fruit in fruit wines can possibly stimulate development of local wine manufacturing and may help reduce importation of alcoholic beverages. (Dimero *et al.*, 2018).

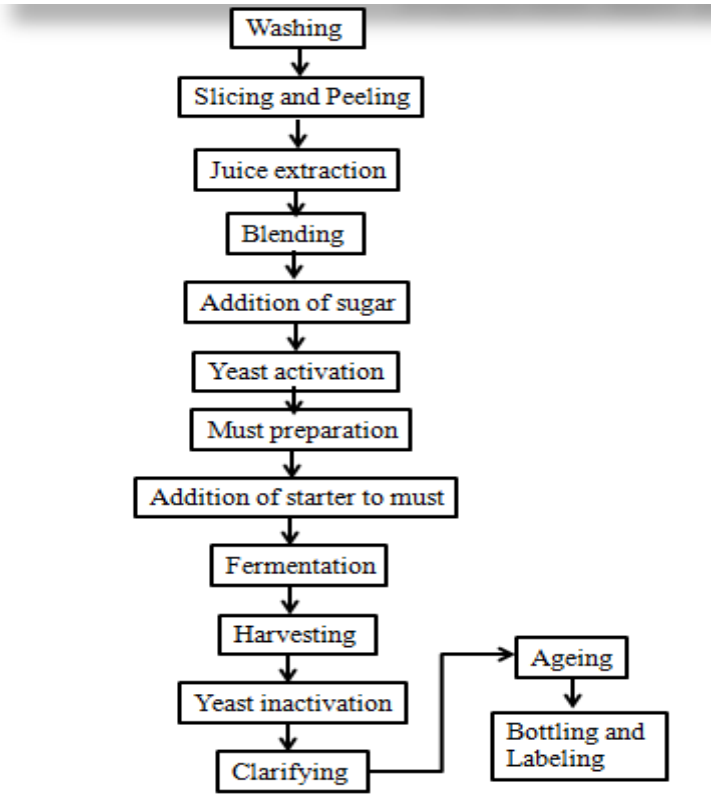

Figure 6 : Process flowchart for dragon fruit wine

Plate 5: Dragon fruit wine

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