DRAGON FRUIT AND ITS VALUE ADDITION

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.

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I. INTRODUCTION

Dragon fruit, a cactus vine species within the Cactaceae family, is renowned for its captivating exotic visual appeal. The rising recognition of its nutritional and therapeutic attributes is propelling dragon fruits into the spotlight. Its exceptional nutritional value positions it as a significant global contender in the realm of economically vital fruit species. (Sonawane, 2017)

Plate 1: Dragon fruit

Dragon fruit, also known as pitaya or strawberry pear (Hylocereus spp. and Selenicereus spp.), is garnering global attention as a super crop, even in challenging environments, due to its numerous health and medicinal advantages. Originating from Central and South America, this climbing cactus vine possesses remarkable resilience to environmental stresses and a natural resistance to pests and diseases.The plant offers several benefits, including minimal water and nutrient requirements, making it well-suited for cultivation in resource-limited areas. Its establishment and maintenance demand relatively fewer resources compared to other orchard crops. With the potential for multiple fruit harvests each year and the ability to sustain high yields for up to two decades, dragon fruit boasts a favorable benefit-to-cost ratio. Furthermore, the fruit is rich in nutraceuticals and functional properties, such as antioxidants and dietary fibers. The term "pitaya" is commonly used to refer to this fruit due to the presence of bracts or scales on its outer skin, hence the moniker "pitaya," which translates to "scaly fruit." (www.krishi.icar.gov.in)

II. TAXONOMY AND VARIETY OF DRAGON FRUIT

Commercially grown worldwide, there exist three species of dragon fruit within the Hylocereus genus—*Hylocereus megalanthus*, *Hylocereus polyrhizus*, and *Hylocereus undatus*. These species, along with their hybrids, find global cultivation. Meanwhile, the Selenicereus genus is represented by the species *Selenicereus megalanthus*, which is cultivated on a smaller scale for commercial purposes, primarily in South America, gaining significant popularity 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*

III. DRAGON FRUIT PRODUCTION IN WORLD

Dragon fruit, also known as pitaya, was first introduced for commercial cultivation in South Asian tropical countries in 1990. Since then, it has experienced significant production and expansion in various countries, including Vietnam, China, Mexico, Colombia, Nicaragua, Ecuador, Thailand, Malaysia, Indonesia, Australia, and the United States. However, comprehensive production and marketing data for dragon fruit is scarce, despite its widespread growth worldwide. Among these countries, Vietnam, China, and Indonesia are the major contributors to global dragon fruit production, accounting for over 93% of the total output.Vietnam holds the largest share, producing more than half (51.1%) of the world's dragon fruit on an expansive area of 55,419 hectares. The average productivity of dragon fruit in Vietnam ranges from 22 to 35 metric tonnes (MT) per hectare per year. The country's dragon fruit volume surpasses 1 million metric tonnes, valued at around $895.70 million USD (Chen and Paull, 2018).China ranks as the second-largest producer, contributing 33.3% of the global dragon fruit production. China's output consists of approximately 700,000 MT of dragon fruit, equivalent to a value of $397 million USD. The cultivation spans an area of 40,000 hectares with an average yield of 17.5 MT per hectare per 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)

IV. DRAGON FRUIT PRODUCTION IN INDIA

In the late 1990s, dragon fruit was introduced in India, initially cultivated by farmers primarily from states like Karnataka, Maharashtra, Gujarat, Kerala, Tamil Nadu, Orissa, West Bengal, Andhra Pradesh, Telangana, and the Andaman & Nicobar Islands. Over time, dragon fruit cultivation expanded to include states like Rajasthan, Punjab, Haryana, Madhya Pradesh, Uttar Pradesh, and the North Eastern States.Recent estimates indicate a significant surge in India's dragon fruit production, exceeding 12,000 metric tons across an area of 3,000–4,000 hectares in 2020. These estimates are based on data collected directly from progressive growers, entrepreneurs, consultants, and officials of state agricultural departments by the ICAR–NIASM. This remarkable increase in production and cultivated area is largely attributed to proactive measures taken by states like Karnataka, Maharashtra, Gujarat, Telangana, Andhra Pradesh, and West Bengal, which initiated efforts to promote commercial production starting from 2018 onwards.Among the total cultivated area of 3,085 hectares, more than 80% (2,468 hectares) is dedicated to new cultivation with plantations less than 18 months old. The average productivity of these new areas ranges from 1.5 to 3.1 metric tons per hectare. The remaining 20% of cultivation area (617 hectares) is well-established and has reached full maturity, with an average productivity ranging from 8 to 13.5 metric tons per hectare.Indian farmers who adhere to sound cultivation practices, particularly under drip irrigation, can achieve impressive yields. They can harvest up to 4.5 metric tons of fruit per hectare in the first year after planting, 7.5–10 metric tons per hectare

in the second year, and a substantial 16–24 metric tons per hectare from the 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)	Productionin (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

V. CLIMATIC CONDITIONS OF DRAGON FRUIT

Dragon fruit thrives in tropical climates and exhibits remarkable adaptability. To ensure successful cultivation, it requires an optimal temperature range of approximately 20°C to 30°C. A well-distributed annual rainfall of 100-150 cm is essential for its growth. While abundant sunlight is crucial, prolonged exposure to direct sunlight might not be ideal. The crop can be effectively grown in tropical wet, intermediate, and dry zones, aided by proper irrigation facilities. However, regions with heavy rainfall should be avoided, as excessive rain can lead to flower and fruit drop. Ideal cultivation altitudes span up to 1500 meters above sea level. It's important to note that both extremely high and extremely low temperatures are unsuitable for the plant's development. It prefers light acidic soils, typically with a pH ranging from 5.5 to 6.5. Sandy loam soils enriched with ample organic matter provide the best conditions for dragon fruit cultivation. Even sandy soils, when enriched with organic matter, create a favorable environment for optimal plant growth (Tripathi *et al.,*

2016).

VI. BIOCHEMICAL CONSTITUENTS OF DRAGON FRUIT

Dragon fruit is recognized as a tropical superfood owing to its abundant nutrients and low calorie content. Its impressive nutritional profile supports the management of chronic conditions, enhances gastrointestinal well-being, and reinforces the body's immune system. Packed with an array of vitamins, minerals, and dietary fibers, dragon fruit stands out as an excellent choice for aiding weight loss, managing diabetes, reducing cholesterol levels, and more (www.krishi.icar.gov.in).

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

Components	Amount	Remarks
Flavonoids	Red fleshed 46.29 ± 2.47 mg RE/100g FW and white fleshed 26.71 ± 4.46mg RE/100 g FW	• Flavonoids are acts on brain cells and blood vessels to reduce the risk of heart disease. • It minimizes heart diseases andmaintains blood pressure
Betalains	42.71 ± 2.48 mg/100 g fresh pulp (red fleshed)	• Betalains can combat oxidativestress and may have the ability to suppress cancer cells. • It has the ability to aid in weightloss, improves digestion and strengthen the immune system.
Hydroxycinnamates	Minor amounts of hydroxycinnamicacids	• 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 ofvarious human cancer cell lines

Lilinolenic noleicacid 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

1. **Nutritional Composition of Dragon Fruit:** Dragon fruit is hailed as a remarkable fruit due to its exceptional nutritional and medicinal attributes. Revered for its potential to regulate blood sugar levels in type 2 diabetes, dried dragon fruit is often incorporated into diabetic diet plans. Fruits, in general, are lauded for their contributions to carbohydrate metabolism, fortifying bone and dental health, nurturing heart tissues, fostering robust blood and tissue development, bolstering the immune system, expediting the healing of wounds and bruises, mitigating respiratory tract infections, and even possessing mild laxative properties owing to their substantial fiber content. Furthermore, dragon fruit is believed to possess the ability to reduce cholesterol levels, maintain equilibrium in blood sugar concentrations, thwart colon cancer, enhance kidney function and bone density, promote optimal brain function, augment visual acuity, and even serve as an ingredient in cosmetics (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)

VII. DRAGON FRUIT HARVESTING

Optimal fruit yield from dragon fruit plants typically commences around 12 to 15 months after the initial planting. Achieving the most favorable fruit maturity entails monitoring the change in fruit epicarp color, which transitions from green to red. An ideal harvest window has been identified approximately seven days following this color shift. The fruit-bearing season spans from June to September, offering multiple harvest opportunities, averaging three to four times a month.Fruit characteristics vary, with weights falling within the range of 300 to 800 grams. Over the course of three years following planting, a single plant post can yield an average of 30 to 35 kilograms. As of now, the prevailing farm gate prices range from INR 80.00 to 120.00 per kilogram.Opportunities for advancement in the realm of dragon fruit harvesting tools are considerable. Enhancements can be made to existing equipment or novel tools can be developed to streamline the harvesting process. This could lead to increased efficiency, reduced labor requirements, and improved overall productivity in dragon fruit cultivation. **(**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)

VIII. STORAGE AND SHELF LIFE OF DRAGON FRUITS

The ideal storage conditions for preserving the quality of harvested dragon fruits involve maintaining a temperature of 10°C along with a relative humidity (RH) of 93%. These conditions promote a longer storage life of around 15 to 17 days. Deviating from this temperature can lead to detrimental effects such as excessive softening and damage, while higher temperatures can cause the fruit's spines to turn yellow and its overall freshness to decline. To ensure the global suitability of dragon fruits for shipment, it's important to implement appropriate cooling technologies that effectively maintain the fruit's freshness. Given the fruit's limited shelf life and susceptibility to mold growth during storage, maintaining quality is a critical consideration. Researchers have conducted a thorough investigation into the potential of peppermint oil as an alternative approach to extend the shelf life of dragon fruit by preventing surface damage. The study found that using essential oil vapor, particularly peppermint oil, helps maintain the firmness of the fruit, the green color of the bract, and key qualities such as titratable acid value and total phenolic content. This positive impact was sustained even after 21 days of storage, surpassing the effects observed in the control group. (Paull, 2014; Dutta and Neong , 2021)

VALUE ADDITIOIN

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 properconcentration 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

2. **Dragon Fruit Jam:** The fruit flesh was shredded and blended into fruit pulps and weighed to 500g. 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).

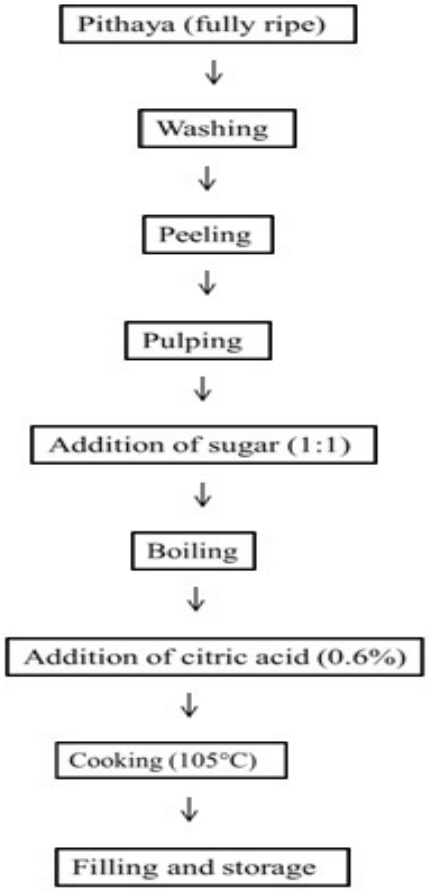

Figure 2: Process flow chart for dragon fruit jam

Plate 4: Dragon fruit jam

3. **Dragon Fruit Seed Oil Extraction:** The seed oils extracted from dragon fruit are rich in essential fatty acids, with a notable concentration of linoleic acid (WFSO). Additionally, these oils are abundant in natural antioxidants, particularly tocopherols, predominantly found in red-fleshed seed oil (RFSO). This unique composition positions dragon fruit seed oils as valuable resources. During the oxidation process, both the peroxide value (PV) and peroxide formation index exhibited an upward trend. This occurred concurrently with a reduction in tocopherol levels. This connection underscores the role of tocopherols in mitigating oxidation. Nevertheless, even after a span of 12 weeks under controlled temperature (CT) and room temperature (RT) conditions, the dragon fruit seed oils retained a substantial amount of tocopherols. Notably, they displayed a sluggish rate of oxidation, indicating a remarkable degree of oxidative stability (Jalgaonkar *et al.,* 2021).

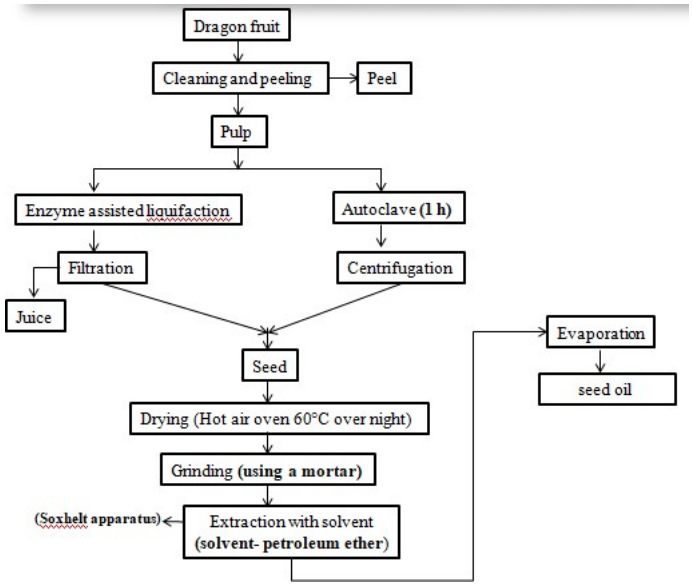

Figure 4: Process flowchart for dragon fruit oil extractionTable 8: Fatty acid composition of two dragon fruit oil seeds

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)

4. **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.

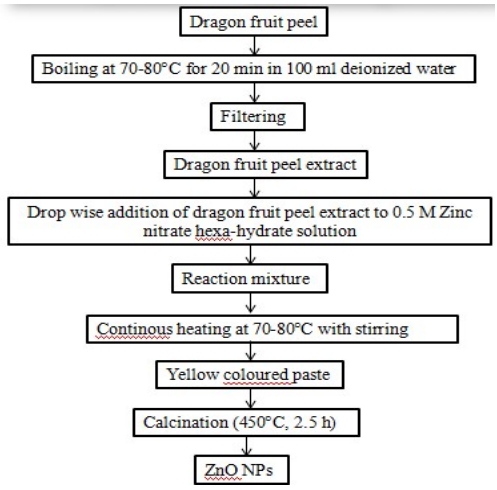

Figure 5: Process flowchart for Synthesis of ZnO nano-particles from dragon fruit peel

5. **Dragon Fruit Wine**

- The rise in popularity of colored fruit wines can largely be attributed to their potent antioxidant properties, stemming from the natural pigments they contain. These pigments not only contribute to the vibrant hues of the wines but also hold promising health benefits, including their potential to combat cancer, age-related ailments, neurological disorders, inflammation, diabetes, and bacterial infections.
- Dragon fruit, a prime example of such colored fruits, holds the potential to serve as a valuable source for crafting these wines. By incorporating dragon fruit into the production of fruit wines, it's plausible to stimulate the growth of local wine-making industries and thereby curtail the need for importing alcoholic beverages. This dual advantage not only taps into the lucrative nature of wine but also contributes to regional economic development. (Dimero *et al.,* 2018).

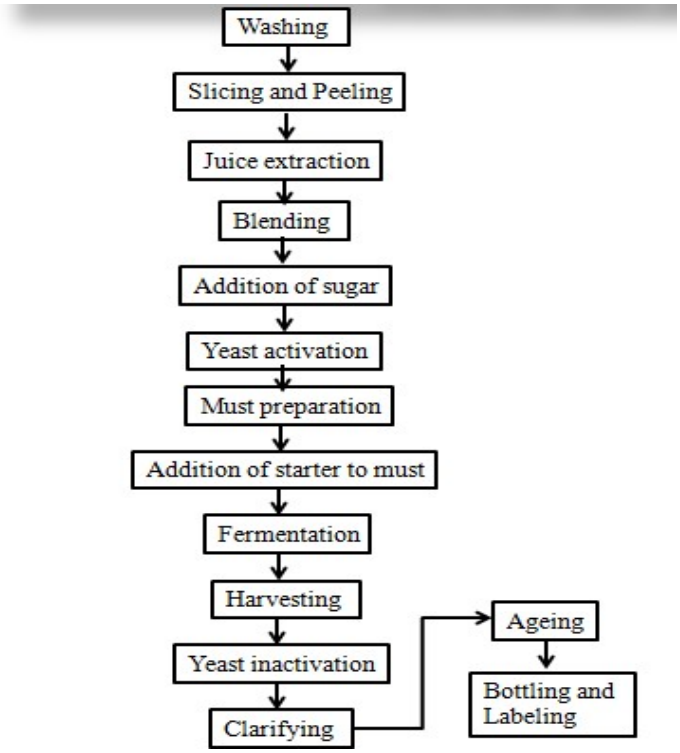

Figure 6 : Process flowchart for dragon fruit wine

Plate 5: Dragon fruit wine

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