Dragon fruit *(Hylocereus polyrhizus.)* Leather: Development and and its quality assessment

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Abstract:

The present investigation was carried out in preservation laboratory, Dept. of Food Processing Technology, CFT, VNMKV, Parbhani during 2021-2024. The Dragon fruit leather was prepared by the different blending ratio of Dragon Fruit Pulp, sugar , Jaggery powder, Pectin, citric acid. Among them 100 ml Dragon Fruit pulp , 35gm Jaggery Powder, 2 gm Pectin, 0.5 gm citric acid, treatment (L_4) recorded as best blending ratio as the treatment recorded maximum TSS (66°Brix), pH (5.25), moisture (18%), acidity (0.30%), ascorbic acid (300 mg/100 g), reducing sugar (20.00%) and total sugar (40.00%) contents. The prepared Dragon fruit leather was stored at ambient temperature (30 ± 2 °C) and refrigerated (5 ± 2°C) conditions for 90 days to study their storage feasibility. Storage studies revealed that Dragon fruit leather maintained good quality for 90 days when stored at ambient (30 ± 2°C) and refrigerated (5 ± 2°C) conditions, with minimal sensory and chemical deterioration.

Keywords: Dragon fruit, Dragon fruit pulp, Leather, Jaggery powder.

Introduction:

Fruits are excellent source of energy, minerals, vitamins, bioactive compounds (Phenols, carotenoids) and fibre. Fruits are an important nutritional requirement of human being as these foods not only meet the quantitative needs to some extent but also supply vitamins and minerals which improve the quality of the diet and maintain health. It is, therefore, necessary to make them available for consumption throughout the year in fresh or processed/preserved form. The post-harvest losses of fresh fruits are estimated to be 25-30% due to inadequate post-harvest handling and non-availability of good post-harvest infrastructure. Preservation of the produce is one of the ways to control post-harvest losses.

Dragon fruit is also known as Strawberry Pear, Dragon fruit, Pithaya, Night blooming Cereus, Belle of the night, Conderella plant and Jesus in the Cradle. 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’’ Several types of dragon fruits based on its colour of the peel and pulp are found throughout the world but mainly cultivated is red peel with white pulp.

Dragon fruit was introduced in India late 90s. But the area under dragon fruit is still very limited. In India, it is cultivated on very limited scale. A very few farmers of Karnataka, Kerala, Tamil Nadu, Maharashtra, Gujarat and Andhra Pradesh have taken up dragon fruit cultivation. The total area under dragon fruit cultivation is less than 100 acres. Formerly uncultivated, marginal lands are used to establish dragon fruit orchards. The stem is green in colour, weak and requires support for growth (Tripathi et al., 2014).

Dragon fruit has very attractive colour and mellow mouth melting pulp with black colour edible seed embedded in the pulp along with tremendous nutritive property which attract the growers from different part of India to cultivate this fruit crop which is originated in Mexico and Central and South America . (Britton and Rose, 1963).

Dragon fruit can be considered as a potential source of micronutrients and antioxidants, which are found in the peel, flesh and seeds. The dragon fruit flesh may also be a possible source of oligosaccharide for prebiotic production (Liaotrakoon et al., 2011) .

The dragon fruit contains beta-carotene, lycopene and vitamin E, with average concentrations of 1.4 mg/100 g, 3.4 mg/100 g and 0.26 mg/100 g of edible portion, respectively (Charoensiri *et al*., 2009). The seed of dragon fruit contains 50 % essential fatty acids, i.e. 48 % linoleic acid and 1.5 % linolenic acid (Ariffin et al., 2009).

Fruit leather, also called a fruit bar or a fruit slab, is a dehydrated fruit based confectionary dietary product which is often eaten as snack or dessert (Raab and Oehler, 2000). It is chewy and flavourful, naturally low in fat and high in fibre and carbohydrates; It is also lightweight and easily stored and packed (Ayotte, 1980).

The main advantages of making fruit leather is to preserve fruit by drying and, hence, controlling postharvest spoilage. Making fruit leather, from ripe or slightly over-ripe fruits that are not suitable for fresh consumption will enable producers to satisfy market demand during off season periods. Fruit with minor blemishes and bruises that is not suitable for canning and freezing can be used to make fruit leather (Raab and Oehler, 2000).

Fruit leather is eaten without further preparation and can be consumed directly as a snack or chopped into small pieces combined with nuts and breakfast cereals (Irwandi *et al.,* 1998).

Fruit leather that is made without sugar is a healthy choice of snacks for diabetic adults or children (Bharambhe *et al.,* 2009).

In the current growing market of fruit leathers, commercial packaging is necessary. Packaging materials for fruit leather are required to prolong the shelf-life of the product and, normally, relate to the stability of water activity, microbiological stability, sensory properties, and physicochemical characteristics. The present study aimed to standardize the recipe for better quality of Dragon fruit leather, to evaluate sensory parameters during storage and to find out the consumer acceptability and economic feasibility of Dragon fruit leather.

Materials and Methods

The current study was conducted at the College of Food Technology, VNMKV, Parbhani, during year 2022-2024.

Materials:

The good quality of raw materials during this study such as Dragon fruit were purchased from local market.

Chemicals and glassware's:

The analytical grade chemicals and glassware utilized in this study were sourced from the College of Food Technology, VNMKV, Parbhani.

Equipment's and Machinery:

The College of Food Technology, VNMKV, Parbhani provided access to various equipment including an analytical weighing balance, hot air oven, grinder, muffle furnace, Soxhlet apparatus, and microkjeldhal digestion and distillation unit.

Methodology and Formulation for preparation of Dragon fruit Leather:

Dragon fruit leather was made labeled from L_0 to L_4. Various formulations were created by adjusting the proportions of ingredients as outlined in Table 1. Each formulation uses a constant base of 100 ml of dragon fruit pulp. The pectin quantities remain consistent across all versions at 1 gram respectively, ensuring that any textural differences observed in the Dragon fruit Leather are due primarily to the variations in sweetener rather than differences in the gelling agents. In the formulations, sugar and jaggery are adjusted to explore their impact on the Dragon fruit Leather final taste and texture. Starting with L_0, which contains 35 grams of sugar and no jaggery, each subsequent formulation decreases the amount of sugar by 10 grams and increases the amount of jaggery by 10 grams, culminating in 4, which contains only 35

grams of sugar and no jaggery. This progressive substitution of sugar with jaggery is likely designed to assess how well jaggery can replace sugar in terms of sweetness, texture, and overall acceptability of the jelly candy. Additionally, Pectin and citric acid is consistently used at 2 grams and 0.5 grams respectively in each formulation to maintain a steady level of acidity, which can influence both the setting of the Leather and its flavour profile. This controlled approach allows for a focused examination of how varying levels of natural and refined sweeteners affect the sensory characteristics of the Dragon fruit leather. By maintaining fixed amounts of dragon fruit pulp, pectin, and citric acid, the study aims to isolate the effects of sugar and jaggery variations on the final product, providing clear insights into the potential for sugar replacement in confectionery items.

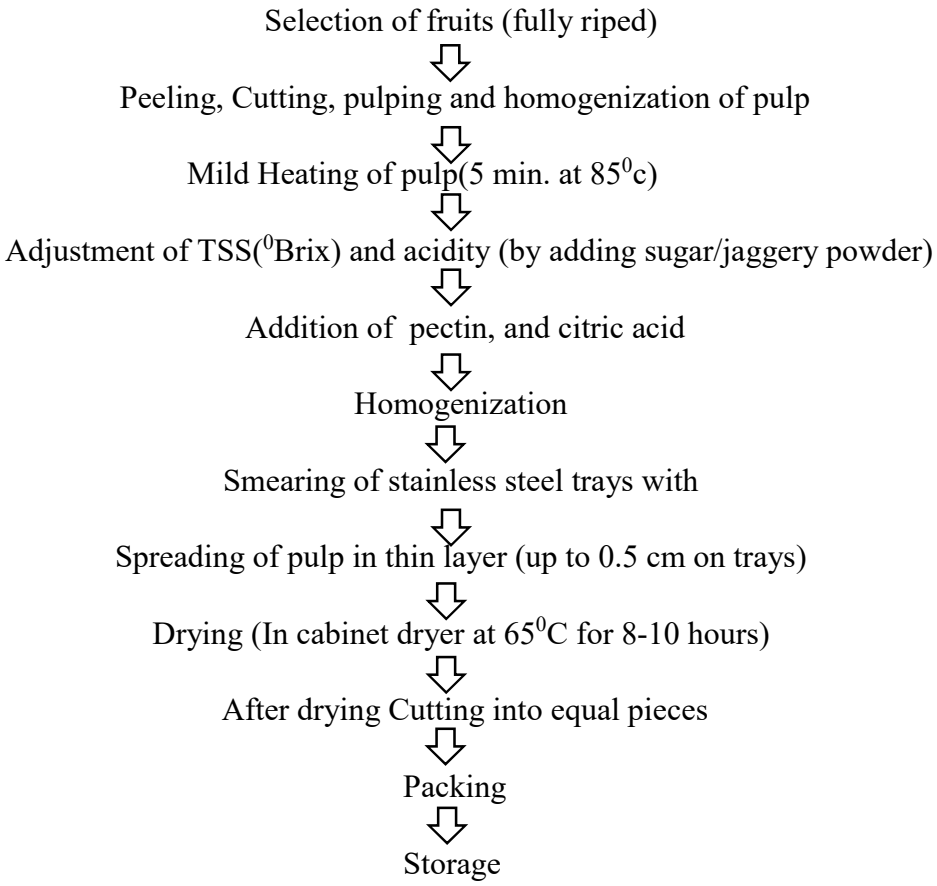
Table 1: Formulations for standardization of different level of jaggery powder and ingredients for dragon fruit Leather.

Formulation	Ingredients				
	Dragon Fruit Pulp (g)	**Sugar (g)**	**Jaggery (g)**	**Pectin(g)**	**Citric Acid(g)**
L0	100	35	-	2	0.5
L1	100	25	10	2	0.5
L2	100	15	20	2	0.5
L3	100	5	30	2	0.5
L4	100	0	35	2	0.5

Where,

L_0 =100ml Dragon Fruit Pulp+35gm sugar + 2gm Pectin +0.5 gm citric acid
L_1=100ml Dragon Fruit Pulp +25gm sugar +10gm Jaggery Powder+2gm Pectin +0.5 gm citric acid
L_2 =100 ml Dragon Fruit pulp+15gm sugar +20gm Jaggery Powder+ 2gm Pectin +0.5 gm citric acid
L_3=100 ml Dragon Fruit pulp +5 gm sugar + 30gm Jaggery Powder+2gm Pectin +0.5 gm citric acid
L_4=100 ml Dragon Fruit pulp + 35gm Jaggery Powder+2 gm Pectin +0.5 gm citric acid

Preparation of Dragon Fruit Leather



Flow sheet 1: Preparation of Dragon fruit leather

The detailed process for preparing dragon fruit leather is outlined in the flow sheet 1. It begins with the careful selection of fully ripened dragon fruits, ensuring optimal flavor and sweetness for the final product. The selected fruits undergo peeling, cutting, pulping, and homogenization to obtain a smooth pulp consistency. Once the pulp is prepared, it is heated to 85°C to facilitate further processing. At this stage, adjustments are made to the Total Soluble Solids (TSS) level and acidity by adding sugar to achieve the desired sweetness and balance of flavors.

Following this, pectin (2 gm) and citric acid (0.5 gm), are added to the pulp mixture to aid in thickening, enhance acidity, and preserve the quality of the final product. The mixture undergoes homogenization to ensure uniform distribution of ingredients. Meanwhile, stainless steel trays are coated with glycerin to prevent sticking, and the prepared pulp is spread evenly in thin layers in the trays. The trays are then placed in a drier and dried at 65°C for 6 to 8 hours, allowing the pulp to dehydrate and solidify into leather-like sheets. Once dried, the dragon fruit leather is cut into desired sizes and wrapped in aluminum foil for packaging. Finally, the packaged dragon fruit leather is labeled, packaged, and stored for consumption. This

meticulous process results in flavorful, chewy dragon fruit leather that can be enjoyed as a nutritious snack or dessert.

Proximate Analysis

Various chemical properties of the samples were examined such as moisture content, ash, fat, protein and total carbohydrate. Each process was performed three times and the results were reported as the average value according to their respective standard methods as described in (A.O.A.C., 2005).

Determination of minerals

Two grams of the defatted sample was weighed and burned at 550 °C. The obtained ash was then treated with concentrated hydrochloric acid (HCl) on a hot plate. After digestion the material was filtered using Whatsman No. 42 filter paper and the volume was makeup to 100 ml with distilled water for mineral analysis by following the procedures given by (A.O.A.C., 2005).

Determination of dietary fiber

The dietary fiber such as total dietary fiber (TDF), soluble dietary fiber (SDF) and insoluble dietary fiber (IDF) was estimated from samples using (AOAC, 2005) method.

Statistical analysis

The data obtained was analysed statistically by Completely Randomized Design (CRD) as per the procedure given by Panse and Sukhatme (1985). The analysis of variance revealed at significance of p 0.05 level S.E. and C.D. at 5% level is mentioned wherever required.

Result and Discussion:

Proximate composition of Dragon fruit Leather incorporated with jaggery powder instead of sugar

Table 2. provides detailed information of the physicochemical composition of Dragon fruit Leather across different formulations (L_0 to L_4) is provided, detailing the content of Moisture, Tss, pH, Acidity, Carbohydrate, Crude fiber. The variations observed in the physicochemical content can be explained by the changing ratios of sugar to jaggery in each formulation, as these ingredients can influence the overall profile of the products.

The proximate composition of a food product holds significant importance in both its processing and consumption. A nutritionally complete food should contain adequate amounts

of both macronutrients (such as carbohydrates, proteins, fats, fiber) and micronutrients (including vitamins and minerals). For instance, the levels of moisture, fat, protein, carbohydrates, crude fiber, Tss and Ph in Dragon fruit Leather enriched with jaggery powder instead of sugar were measured and are detailed in Table 2.

Table 2: Effect on physicochemical composition of Dragon fruit leather of different formulations

Formulations	Moisture %	TSS ^{0}Bx	pH	Acidity %	Carbohydrate %	Protein %	Fat %	Fiber %
L_0	17.25	65.5	5.10	0.34	77.15	0.75	0.48	4.1
L_1	17.50	65.6	5.10	0.33	77.26	0.75	0.49	4.1
L_2	17.75	65.7	5.20	0.32	77.55	0.75	0.50	4.2
L_3	17.90	65.9	5.20	0.32	77.80	0.76	0.50	4.2
L_4	18.00	66.0	5.25	0.30	78.00	0.76	0.50	4.2
SE±	1.191	0.058	0.018	0.018	0.063	0.010	0.009	0.009
CD@5 %	3.614	0.177	0.056	0.056	0.191	0.030	0.028	0.027

*Each value is average of three determinations.

The study examined the proximate composition of Dragon fruit Leather enriched with jaggery powder instead of sugar. The data depicted in the table above indicates that as the proportion of jaggery powder increased in the Dragon fruit leather there was a notable rise in moisture, Tss, pH, protein, fat, crude fiber , and Carbohydrate content along with a decrease in acidity content.

Above table indicates that the Dragon fruit Leather has a moisture content varies from (L_0 to L_4) 17.25 to 18.00%. Treatment L_0 Contained 17.25%, L_1 contained 17.50%, L_2 contained 17.75%, L_3 contained 17.90%, L_4 contained 18.00 % moisture content. Treatment L_4 had higher moisture content. There were the significant differences in moisture content of Leather prepared by using different treatments. The TSS content of Dragon fruit Leather was ranged from 65.5 to 66 ºBrix. Treatment L_0 Contained 65.5^{0}Bx, L_1 contained 65.6^{0}Bx, L_2 contained 65.7^{0}Bx, L_3 contained 65.9^{0}Bx, L_4 contained 66.00^{0}Bx of Total soluble solid. There

were no significant differences between the TSS content of Dragon fruit Leather. The pH value varies from 5.10 to 5.25, suggests a slightly acidic nature, which is beneficial for both flavor enhancement and preservation. It was observed from the data that the highest value of pH 5.25 for L_4 treatment. The pH value of a product plays an important role in preservation of pulp. The low pH inhibits the activity of microorganism specially the Bacteria. Lowering of pH value is the result of increased acidity and vice versa. The pH values however, observed to be high at initial day of storage in all the treatments. The acidity was maintained to 0.34 %to 0.30 % for (L_0 to L_4) treatments during preparation of fresh Dragon Fruit Leather who influencing tartness and stability,With increase in pH value there was decrease in % acidity ranging from 0.34 to 0.30 %. The acidity of the Dragon fruit leather was found higher value 0.34% in treatment L_0 and minimum value 0.30% in L_4 treatment.

Carbohydrates dominate the composition from 77.15 %to 78.00%. The fat and protein content were relatively low 0.76% (L_4) and 0.50 % (L_4) respectively typical for fruit-based confections. The crude fiber content varies from (L_0 to L_4) 4.1% to 4.2%, contributing modestly to digestive health. These findings were closely resembled those reported by Kourany et al. (2017), Totre, (2016), Chavan and Shaik, (2015), Kotlawar et al. (2011).

Mineral composition of Dragon fruit Jelly Candy incorporated with jaggery powder instead of sugar

Table 3 provides detailed information of the mineral composition of Dragon fruit Leather across different formulations (L_0 to L_4) is provided, detailing the content of calcium, phosphorus, magnesium, iron, and zinc. The variations observed in the mineral content can be explained by the changing ratios of sugar to jaggery powder in each formulation, as these ingredients can influence the overall mineral profile of the products.

Table 3. Mineral analysis of Dragon fruit leather

Formulations	Content (mg/100g)				
	Calcium	**Phosphorus**	**Magnesium**	**Iron**	**Zinc**
L_0	20.1	24.3	30.1	1.1	0.5
L_1	22.2	25.2	31.2	1.4	0.6
L_2	22.1	26.2	31.9	1.6	0.7
L_3	23.2	26.8	33.2	1.9	0.8

L_4	26.9	29.6	34.8	2.0	0.9
SE±	0.121	0.104	0.068	0.079	0.015
CD@5%	0.367	0.316	0.206	0.242	0.045

*Each value is average of three determinations

Table 3 showed increasing trend in mineral constituents, this could be due to addition of jaggery powder. For instance, treatment L_0, with the highest sugar content, typically shows the lowest mineral scores. Conversely treatment L_4, with the highest jaggery content, scored highest in terms of minerals content. This could be attributed to jaggery's higher mineral content compared to refined sugar, as jaggery is less processed and retains more natural nutrients.

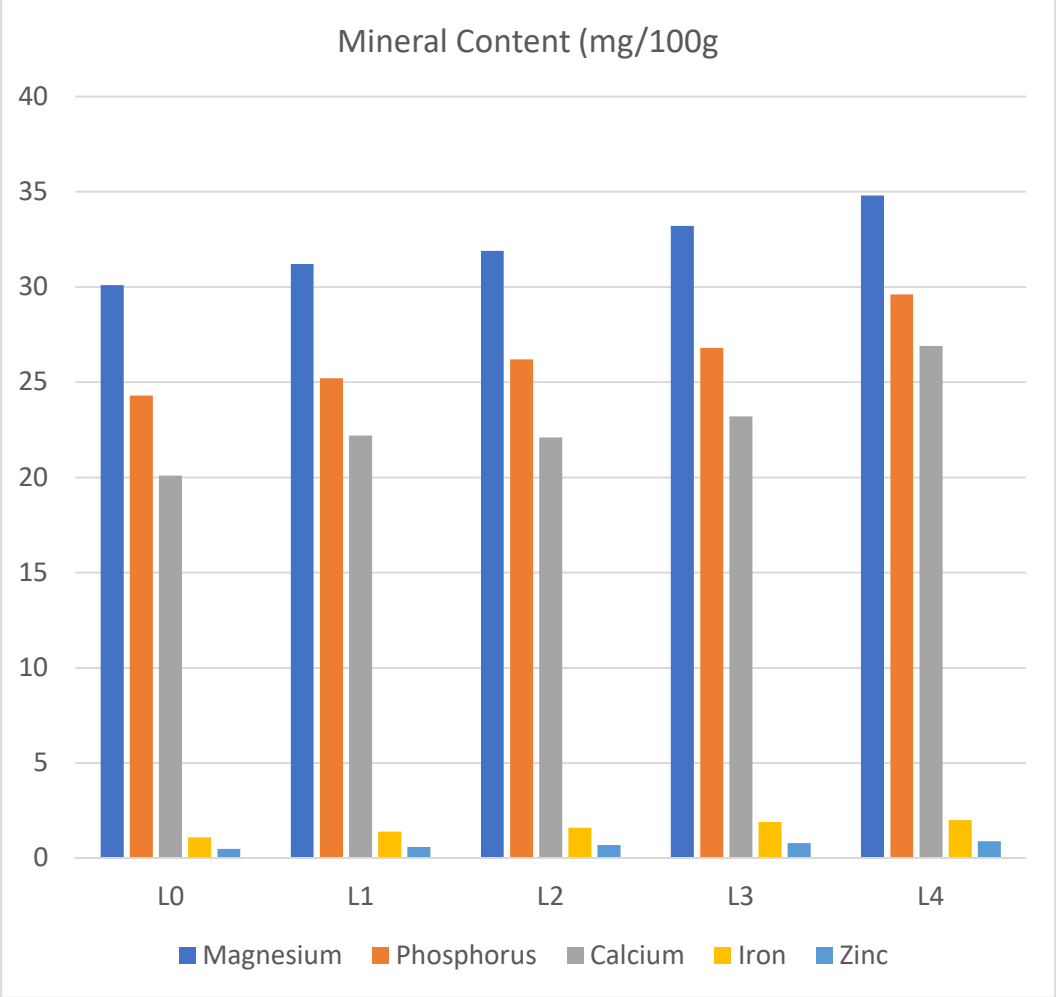


Fig. 1: Mineral characteristics of Dragon fruit Leather

The mineral content of L_0 formulation Dragon fruit leather was evaluated and it was been observed that magnesium content was30.1 mg, calcium content 20.1 mg , phosphorus content 24.3 mg, iron content 1.1 mg and zinc content 0.5 mg. Whereas L_1 formulation content magnesium 31.2 mg, calcium 20.2 mg, phosphorus 25.2 mg, iron content 1.4 mg and zinc 0.6 mg. Whereas in L_2 formulation magnesium content of 31.9 mg, calcium content 22.1 mg, phosphorus content 26.2 mg, iron content 1.6 mg and zinc content 0.7 mg. and in L_3 formulation magnesium content 33.2 mg, calcium 23.2 mg, phosphorus 26.8 mg, iron 1.9 mg and zinc 0.8 mg. Furthermore, it was also observed that L_4 formulation magnesium content of 34.8 mg, calcium content 26.9 mg, phosphorus content 29.6 mg, iron content 2.0 mg and zinc content 0.9 mg.

Result of this investigation showed that utilization of jaggery powder in preparation of Dragon fruit leather increases the total mineral content. This increase in mineral content in formulation L_0 and L_4 is due to jaggery's known nutritional profile, which includes significant amounts of minerals not present in refined sugar. The obtained results were in close resemblance with studies reported by Srinivas and Darshan (2022) and Joshi et al. (2019)

Conclusion

The use of jaggery powder instead of sugar improved the nutritional status of Dragon fruit leather in different formulations. The proximate composition and mineral content of all Dragon fruit Leather samples were seen increasing which may be attributed to the addition of jaggery powder. Traditional confectionary product like Dragon fruit Leather could be prepared by incorporating with 100% Dragon fruit Pulp and 35gm jaggery powder was found to be highly acceptable in terms of nutritional qualities.

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