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Development of Wood Apple Jujube Jellies: Physicochemical, Sensorial and Stability Properties

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Jujube looks like jelly and is prepared by addition of fruit,sugar ,Gelatin and water. In India production of fruit is second highest and wood apple is seasonal and underutilised fruit so to popularise this underutilised fruit and supply throughout the year, value added product jujube was developed. underutilised fruit so to popularise this underutilised fruit and supply throughout the year, value added product jujube was developed *Limonia acidissima* is widely recognized for its medicinal properties renowned for its therapeutic benefits and boosts numerous documented medicinal applications.

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The aim of this study is to develop value added wood apple jujube soft candy product and to evaluate physico-chemical, nutrient, sensory and storage studies of the developed product.
The control group (which was made with the addition of 10g of citric acid) achieved the highest over all sensory score of 8.59 followed by wood apple jujube -1(which was made with the addition of 45g of wood apple pulp), recording scores of 7.55.
Jujubes exhibited a protein content of 18.25g/100g, a notable moisture level of 47.55g/100g, followed by 32.20g/100g carbohydrates, with the lowest attributed to fat at 0.2g/100g. The amount of crude fiber was measured at 1g/100 g, alongside its calorific value. The jujubes, Wood apple jujube-1 (which comprises 45 g of wood apple and 30 g of sugar), were packed in High density poly ethylene and kept under normal and Refrigerated conditions. A decline in mean scores was observed for appearance (4.65), texture (5.4), color (5.5), aroma (5.75), flavor (5.2), and overall acceptability (4.6) when stored at ambient temperature over a nine-day span compared to the starting values.

Keywords: Wood apple; jujube; nutritive value; storage studies; sensory evaluation; soft candy.

1. INTRODUCTION

Wood apple (*Limonia acidissima* Linn.), commonly known as Bael, is amonotypic genus Limonia, native to India and also cultivated in Bangladesh, Pakistan and SriLanka (Bakshi et al., 2001, Asna 2021)Common names in English include wood-apple, elephant-apple, monkey fruit, curd fruit and Kathbel.

Jellies and gummies are extremely popular among children under 17 because of their natural and chewy texture, as noted by Moloughney in 2011. These products are made up of a gel-like composition that consists of at least 45g of fruit per 100g, as well as sugars in the form of sucrose syrup and/or glucose, at concentrations of around 55g per 100g. Additionally, they contain gelling agents, acids, flavours, and colours as indicated by Cappa et al. in 2015 and Mutlu et al. in 2018.

Jujube also called jube or juju, is a type of chewy candy. The excessive consumption of jellies and gummies is believed to have a negative impact on public health due to their high sugar and food additive content, as well as the presence of undesirable compounds formed during heat treatment, such as hydroxymethyl-2-furaldehyde and acrylamide. These products have indeed been linked to a high incidence of tooth decay, hyperglycemia, and obesity (Khawaja., 2019 and Rippe and Angelopoulos., 2016).

Limonia acidissima is widely recognized for its medicinal properties and has multiple documented medicinal applications. It exhibits various biological activities such as adaptogenic activity, hepatoprotective effects, and its use against blood impurities, leucorrhea, dyspepsia, and jaundice (Anon, 1992).

The wood apple fruit has a round to oval shape and measures 5 to 12.5 cm wide. It has a woody, extremely hard rind that is challenging to crack and appears greyish-white and scurfy, with a thickness of about six mm. The pulp is brown, mealy, odorous, resinous, astringent, and can be either acid or sweetish, containing numerous small, white seeds scattered throughout (Anitha, 2015, Rang et al. 2003 and Hilly et al, 2002).

Fig. 1.Wood apple fruit

In India production of fruit is second highest and wood apple is seasonal and underutilised fruit so to popularise this underutilised fruit and supply throughout the year, value added product jujube was developed. The main objectives of this study is to develop value added wood apple jujube soft candy product and to evaluate physico-chemical, nutrient, sensory and storage studies of the developed product.

2. MATERIALS AND METHODS

For the preparation of jujube product ingredients like wood apple, sugar, gelatine, and citric acids were procured from local market of Bangalore.

2.1 Development and Standardization of Wood Apple Jujubes

For preparation of jujube wood apple pulp, gelatin, sugar and water were used. the procedure for development of wood apple jujube is shown in Fig 2. For standardization of wood apple jujubes (Table 1) four variation of wood apple pulp was used (45g. 35g. 25g and 15g) and the product was compared with control (citric acid) According to Saindane and Nakade. 2018., fortified Beetroot and orange Jelly making involves important constituents such as pectin, acid, and sugar. Beetroot jelly fortified with orange which is in the proportion of 60:40 respectively.

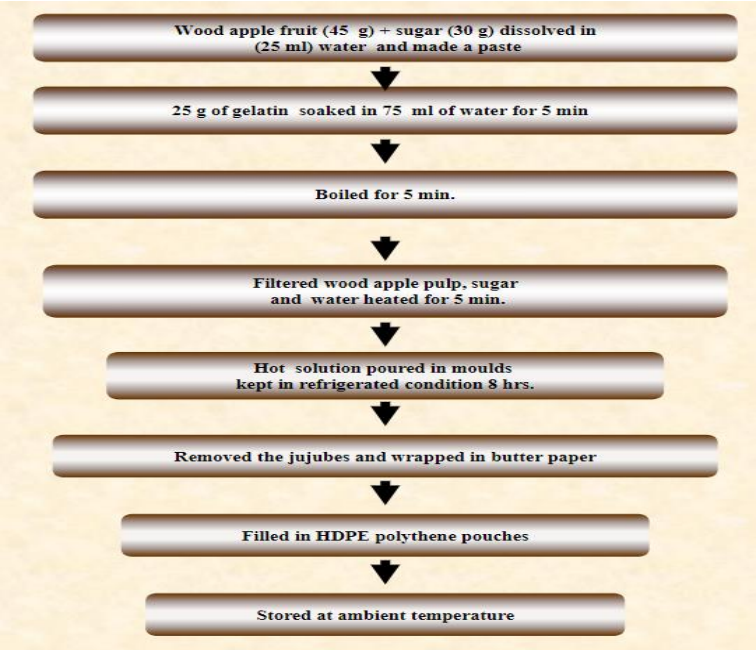

Fig. 2. Flow chart for preparation of wood apple Jujubes

Fig. 3. Value added products from wood apple (Jujube)

Table 1. Development and standardization of wood apple jujubes

Sl. No.	Ingredients (g)	Control	WAJ-1	WAJ-2	WAJ-3	WAJ-4
1	Fruit Pulp	-	45	35	25	15
2	Sugar	50	30	40	50	60
3	Gelatine	40	25	25	25	25
4	Citric acid	10	-	-	-	-
	Total	100	100	100	100	100

WAJ- Wood apple jujubes

2.2 Organoleptic Evaluation

Organoleptic evaluation was carried out by semi trained panellist (number 30) using 9-point hedonic scale.

2.3 Shelf-Life Study of Developed Products

The jujubes, Wood apple jujube-1 (which comprises 45 g of wood apple and 30 g of sugar), were packed in High density poly ethylene and kept under normal and Refrigerated conditions. Microbial studies were carried out.

2.4 Physicochemical Analysis of the Product (AOAC., 1995)

Wood apple pulp was used for the analysis of moisture, protein, fat, ash, crude fibre, calcium, phosphorus, iron and zinc. Carbohydrate content of samples was computed by difference method. Analysis was conducted in triplicates using analytical grade chemicals. Results were expressed on dry weight basis.

Statistical analysis was carried out by using SPSS software.

3. RESULTS AND DISCUSSION

3.1 Organoleptic Evaluation of Value-Added Products from Wood Apple Fruit

Control sample revealed higher sensory scores of 8.74, 8.44, 8.42, 8.13, 8.18 and 8.59 for appearance, texture, colour, aroma, taste and overall acceptability respectively as compared to the other two treatments. It was followed by A (prepared by adding 45gms of wood apple pulp) which scored 8.00, 7.65, 7.70, 7.30, 7.75, 7.55 for appearance, texture, colour, aroma, taste, and overall acceptability respectively. The lowest score for overall acceptability (7.06) was recorded by Wood Apple Jujube-4(by adding 15 g of wood apple pulp). There was a significant difference between the treatments for all sensory attributes of jujubes (Table2). According to Mutlu et al. 2018, The use of natural juices or purees of orange, strawberry, and other red fruits or even fruit by-products have been considered for the manufacturing of jellies. These can not only improve the organoleptic properties (colour, flavour, and texture) of gummies and jellies but also the use of anthocyanin extracts when added into gelatin and pectin gels, can provide an alternative to synthetic colorants.

Table 2. Organoleptic scores of jujube (n=30)

Treatments	Appearance	Texture	Colour	Aroma	Taste	Overall acceptability
Control	8.74	8.44	8.42	8.13	8.18	8.59
WAJ-1 (45g/100g)	8.00	7.65	7.70	7.30	7.75	7.55
WAJ-2 (35g/100g)	7.75	7.25	7.50	7.30	7.43	7.19
WAI-3 (25g/100g)	7.53	7.39	7.25	7.20	7.30	7.09
WAJ-4 (15g/100g)	7.35	7.21	7.13	7.05	7.16	7.06
F-Value	*	*	*	*	*	*
SEm±	0.17	0.17	0.17	0.17	0.18	0.18
CD at 5%	0.47	0.42	0.48	0.48	0.50	0.50

**Significant at 5 per cent; WAJ - wood apple jujube*

Table 3. Macro nutrient composition of developed products (per 100g)

Products	Moisture (g)	Protein (g)	Fat (g)	Total Ash (g)	Crude Fibre (g)	Carbohydrates (g)	Energy (KCal)
Jujube (45g/100g)	47.55	18.25	0.20	0.80	1.00	32.20	203

Fresh wood apple pulp 45g/100g added

3.2 Macronutrient Composition of Wood Apple Jujube

3.2.1 Nutrient analysis of wood apple jujube

Table 3 shows the Wood apple (soft candy) Jujube has protein content of 18.25g/100g had high content of moisture (47.55g/100g) followed by carbohydrates (32.20g/100g) and the least was observed in fat (0.2g/100g). The crude fibre was found to be (1.00g/100g) whereas calorific value (203 Kcal) was observed. According to Lemos *et al* 2021 developed for the two gummy formulations, one with orange juice and honey and the other with a mix of berries. Both formulations according to Edwards, 2002 showed moisture content value slower than recommended (24g/100g) for this type of product. this ensures that the moisture content and water activity are low and enable possibly good conservation. results showed the moisture content in the range 18–21g/100g Lemos *et.al* 2021.being in accordance with previous studies, which reported a water content of 18–22g/100g in jelly candies (Mutlu et al. 2018, Bussiere G, Serpelloni, 1985.and Periche., 2016).

3.2.2 Micronutrient composition of wood apple jujube

Table 4 shows calcium content in jujubes is 154.50 mg, followed by 69.5gms of phosphorous. According to Lemos 2021, the developed formulations showed a lower energetic value when compared to the commercially available formulations (39.8–73.8 kcal/100 g vs 351 kcal/100 g). As expected, the orange gummy jelly, which contained 8.6% of honey, provided more energy than the berries mix formulation with no added sugars.

3.2 Physicochemical Analysis of Wood Apple Products

Table 5 reveals the effect of storage on pH and titratable acidity of wood apple products. An increase in pH of jujube from 4.42 to 4.45 was observed under ambient condition for a period of nine days. Statistical analysis revealed that there was non-significant difference in pH during storage period. Titratable acidity decreased from 0.69 to 0.68 during storage period of nine days. According to Urooj., 2021, there was no change in the pH during the entire storage.

3.3 Effect of Storage on Organoleptic Evaluation of the Developed Wood Apple Jujube

Jujube contains 45g/100g wood apple pulp was selected for shelflife study. Environmental conditions may vary the sensory quality profile of products. In the present study, the effect of factors such as temperature and duration on jujubes was studied for a period of 9 days.

3.4 Sensory Scores of Jujubes

Effect of storage on sensory parameters of jujube is demonstrated in Table 6. The jujube stored in High Density Poly Ethylene covers and stored under both refrigerated and ambient conditions for shelf life study. Among the two conditions deterioration is rapid at ambient condition whereas decrease was slow under refrigerated conditions. Decrease in mean scores was observed for appearance (4.65), texture (5.4), colour (5.5), aroma (5.75), taste (5.2) and overallacceptability (4.6) under ambient temperaturestorage condition over the period of 9 dayscompared to initial. The sensory attributes were.

Table 4. Micro nutrient composition of developed products (mg per 100g)

Products	Calcium (mg)	Phosphorus (mg)	Iron (mg)	Zinc (mg)	Copper (mg)	Manganese (mg)
Jujube (45g)	154.50	69.5	0.27	0.30	0.18	0.16

Product jujubes, fresh wood apple 45g added

Table 5. Effect of storage on pH content and titratable acidity in wood apple jujube

pH	
Duration	Jujubes
Initial	4.42
Final	4.45
Mean	4.43
F-value	NS
SEM±	0.005
CD at 5%	0.021
Titratable acidity	
Duration	Jujubes
Initial	0.69
Final	0.68
Mean	0.688
F-value	*
SEm±	0.001
CD at 5%	0.004

Table 6. Effect of storage on sensory characteristics of jujubes (n=30)

Temperature	**Time (days)**	**Appearance**	**Texture**	**Colour**	**Aroma**	**Taste**	**Overall acceptability**
Ambient	Initial	8.00	7.65	7.70	7.30	7.75	7.55
	3days	6.80	7.65	8.00	7.50	7.45	7.30
	6days	5.65	7.15	7.50	6.8	6.45	7.25
	9days	4.65	5.4	5.50	5.75	5.20	4.60
Refrigerated	Initial	8.00	7.65	7.70	7.30	7.75	7.55
	3days	7.65	7.35	7.40	7.30	7.85	7.50
	6 days	7.50	6.90	6.95	7.15	7.70	7.45
	9days	7.20	6.60	6.45	6.95	7.40	6.95
Temperature	F value	**	NS	NS	**	**	**
	SEM±	0.07	0.08	0.09	0.08	0.06	0.08
	CD @ 5 %	0.21	0.21	0.24	0.23	0.17	0.22
Duration	F value	**	**	**	**	**	**
	SEM±	0.11	0.11	0.12	0.12	0.09	0.11
	CD @ 5 %	0.29	0.30	0.33	0.32	0.24	0.32
Interaction	F value	**	**	**	**	**	**
	SEM±	0.15	0.15	0.17	0.16	0.12	0.16
	CD @ 5 %	0.41	0.42	0.47	0.38	0.29	0.45

**Significant at 5 per cent level; **Significant at 1 per cent level; NS- non significant*

maintained well under refrigerated storage. Under ambient conditions overall acceptability decreased from 7.55 to 4.6 whereas under refrigerated conditions it decreases to 6.95 on 9th day of storage. Temperature and duration play important role in maintaining the shelf life of product.

3.5 Effect of Storage on Microbial Load on Wood Apple Jujube

Microbial load (moulds and yeast) of jujube (wood apple pulp 45g/100g) at initial, 3rd , 6th ,9th days of storage was estimated by using standard plate count method and results are showed in Table 7.

3.6 Microbial Load of Jujube

Wood apple jujube-1(45 g of wood apple and 30 g of sugar) was packed in High Density Poly Ethylene and stored under ambient conditions.

Table 7 shows the microbial load of jujube and results revealed that, as the number of days of storage increased, the Colony - Forming Unit for moulds and yeast, increased from 1.67×10^4 and 1.00×10^4 to 12.33×10^4 and 9.00×10^4 respectively

Table 7. Effect of storage on microbial load of jujubes

Duration	Moulds (× 10^4 CFU)	Yeast (× 10^4 CFU)
Initial	1.67	1.00
3rd day	5.00	2.67
6th day	10.33	5.00
9th day	12.33	9.00
F-value	*	*
SEM±	1.23	0.53
CD at 5%	3.99	1.72

for a period of 9 day. Significant difference was observed for moulds and yeast count at five per cent level. According to Urooj., 2021 there was no change in the pH during the entire storage.

4. CONCLUSION

The control group achieved the highest sensory ratings, followed by Wood apple jujube-1 which incorporated 45g/100g wood apple pulp. The control group (which was made with the addition of 10g of citric acid) achieved the highest overall sensory score of 8.59 followed by wood apple jujube -1(which was made with the addition of 45g of wood apple pulp), recording scores of 7.55. Wood apple (soft candy) Jujube has protein content of 18.25g/100g had high content of moisture (47.55g/100g) followed by carbohydrates (32.20g/100g) and the least was observed in fat (0.2g/100g). As the duration of storage extended, microbial contamination also escalated. Titratable acidity shows a decrease in values 0.69 to 0.68 as the duration increased from initial to nine days.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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