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Standardisation for Preparation and Storage Stability of Papaya (*Carica papaya*) Candy

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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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Original Research Article

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ABSTRACT

The lab experiment was conducted in the year 2021-2022 at Post Harvest Lab, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, in order to Standardisation for preparation and Storage Stability of Papaya Candy (*Carica papaya*) to evaluate the physico- chemical properties and consumers acceptability of different treatments Quality Characters. From the above experiment T_7 (1Kg papaya slice + sugar syrup @75^o B + Ginger extract@5%) showed better results in combination. Total soluble solids (T.S.S.), Total titratable acidity, Ascorbic acid content, Reducing sugar, non-reducing sugar, Total sugar, sensory evaluation of candy, Colour, Texture, Flavour, Taste, Overall acceptability whereas minimum was observed in T_0 (1Kg papaya slice + sugar syrup @75^o B +Control).

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Keywords: Papaya; analysis of variance; mean performance; quality characters; sensory evaluation of candy.

1. INTRODUCTION

The papaya (*Carica papaya* Linn.) belongs to the family Caricaceae is an important table fruit of tropical world which gives higher production of fruits per hectare next to banana. The production of papaya in India is about 59.51 lakh MT from 1.44 lakh hectares having productivity 41.3 MT/ha [1,2]. Papaya also seems to have antibacterial, antifungal, anti-viral, anti-inflammatory, antioxidant, and immune-stimulating effects. In addition, papaya is a source of the digestive enzyme papain, which is used as an industrial ingredient in brewing, meat tenderizing, pharmaceuticals, beauty products, and cosmetics.

Papaya is considered one of the most beneficial fruits as a good source of nutrients, fiber, and proteolytic enzymes. Its consumption has been attributed to aid digestion. Previous researchers focused their study on papain activity from the latex of the unripe fruit or other parts of the plant, and also in the quantification of papain present in the pulp [3,4]. Packaging and handling systems have been developed in many countries to move products from farm to consumer expeditiously in order to minimize quality degradation. Procedures include lowering temperature to slow respiration and senescence, maintaining optimal relative humidity to reduce water loss without accelerating decay, adding chemical preservatives to reduce physiological and microbial losses, and maintaining an optimal gaseous environment to slow respiration and senescence [5].

After ripening, the papaya fruit softens immediately leading to transportation losses up to 40 per cent, therefore fruit requires conversion into processed products, to ensure extended availability throughout the year [6].

However, due to inadequate facilities for post harvest handling, storage, processing and preservation, still the post-harvest losses are reported to be around 30%. Hence there is a need to take up scientific handling and post harvest management including processing to reduce the losses but, perishable nature and flat odour of papaya limits its commercial processing, though there are various value-added products viz. jam, jelly, beverages, dried products, etc. Further, osmotic drying help to improve some nutritional, organoleptic and functional properties of the fruit and vegetables [7]. Enzymatic and oxidative browning is prevented as the fruit's pieces are surrounded by sugar, thus making it possible to retain colour [8,9,10].

After harvest, fruits and vegetables degrade because they are living and organic things. Depending on the products' overall metabolic rate, the rate of deterioration differs widely among them, but for many it can be quite fast. The pace of post-harvest deterioration, for instance, has little impact in marketing chains where fruit is moved quickly from the farm to the consumer [11-13]. However, the distance between farm and market is growing as production areas are farther away from population centers. By extending the marketing periods into fewer windows of time, the intentional storage of some produce to increase return on investment prolongs the time between farm and end consumer. Keeping the above points, the present investigation was undertaken with the objective to study the shelf life of products and to find out the best product based on sensory test of papaya candy.

2. MATERIALS AND METHODS

The experimental was carried out to study the "Standardisation for preparation and storage stability of papaya candy (*Carica papaya*)" in the post-Harvest lab, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj, Uttar Pradesh, India, during 2021-2022. The area is situated on the south of Prayagraj on the right bank of Yamuna at Rewa road at a distance of about 6 km from Prayagraj city. It is situated at the 250.8ºN Latitude and 810.50ºE meters from sea level. Prayagraj has a sub-tropical climatic with uttermost in summer (in the month of May and June) with temperate reaching around 115ºF with hot blazing winds and in winter (December and January the temperature falls down as low as 32ºF. The average rainfall is around 1013.4 (mm) annually with maximum concentration during July to September with occasional showers in winter.

The Experiment was laid out in Completely randomized design (CRD) with 9 Treatments and 3 Replications. Observation to be recorded at 0,30,60,90(Days).

Table 1. Treatment combinations

Treatment	Combination
T_0	1Kg papaya slice + sugar syrup @75^o B + Control
T_1	1Kg papaya slice + sugar syrup @75^o B + Common salt @2%
T_2	1Kg papaya slice + sugar syrup @75^o B + Calcium chloride@1%
T_3	1Kg papaya slice + sugar syrup @75^o B + Potassium metabisulphite @0.25%
T_4	1Kg papaya slice + sugar syrup @75^o B + Citric acid @0.2%
T_5	1Kg papaya slice + sugar syrup @75^o B + Betel leaves extract @5%
T_6	1Kg papaya slice + sugar syrup @75^o B + Tulsi extract@5%
T_7	1Kg papaya slice + sugar syrup @75^o B + Ginger extract@5%
T_8	1Kg papaya slice + sugar syrup @75^o B + Spices extract@5%
T_9	1Kg papaya slice + sugar syrup @75^o B + Rose extract@5%

Fruit uniform in size, free from diseases and pests were selected. They were sorted based on maturity and washed thoroughly under running tap water and air dried to remove adhering water. The papaya candy packed in plastic bags was kept at ambient temperature and evaluated at 0 to 90 DAS (days of storage). First observation was recorded immediately after preparation of papaya candy and other readings were recorded after every 30 days interval. The last observation was recorded on 90 DAS (days of storage).

The following parameters were measured and evaluated in this study.

1. **Quality Characters**

i. TSS (^{0}Brix)
ii. Acidity (%)
iii. Ascorbic acid (Vitamin-C)
iv. Reducing sugar
v. Non- Reducing sugar
vi. Total sugar
vii. Storage stability

2. **Sensory Tests**

i. Colour and appearance
ii. Texture
iii. Flavour
iv. Taste
v. Overall acceptability

2.1 Statistical Analysis

Analysis of variance (ANOVA) for all the treatments in Completely Randomized Design (CRD) was carried out. The significant and non-significant of the treatment effect was judged with the help of 'F' variance ratio test. Calculated 'F' value was compared with the table value of 'F' at 5% level of significance. If the calculated value exceeds the table value, the effect was considered to be significant. The significant difference between the means were tested against the critical difference at 5% level of significance.

3. RESULTS AND DISCUSSION

Papaya candy was stored for 3 months and observations were recorded at the interval of 30 days on various physico-chemical and organoleptic parameters. Data were analyzed statistically and results were presented and discussed in the light of research work done in India.

3.1 Quality Characters

Total soluble solids: TSS has shown an increasing trend during storage and maximum TSS was recorded 80.33 in T7 (1Kg papaya slice + sugar syrup @75oB + Ginger extract @5%) and minimum 77.66^0 Brix in T0 (1Kg papaya slice + sugar syrup @75oB + Control that the processing employed for preparation of candy has forced out the water content to give place to the soluble solids in terms of sugar, salt, lime and other soluble ingredients present in the various pre- treatment. Similar results were given by Bhat et al. [14] with the aonla candy also showed increasing TSS content of the fruit, Ahmad and Tariq (2004), Manivasagan *et al*. (2006) and Mall and Tandon (2007).

Total titratable acidity: Acidity has shown an increasing trend during storage and maximum Acidity was recorded 0.113% in T7 (1Kg papaya slice + sugar syrup @75oB + Ginger extract @5%) and minimum 0.104% in T0 (1Kg papaya slice + sugar syrup @75oB + Control).

Treatment showed the increasing trend in acidity during storage period. This type of trend in the acid content could be mainly due to formation of sulphureous acid during storage. Similar

finding has been reported by Gupta and Dhawan (1996), Singh and Kumar [15], Maciel *et al.* (1999).

Ascorbic acid content: Ascorbic acid has shown decreasing trend during storage and maximum Ascorbic acid was recorded 3.10 mg/100gm in T7 (1Kg papaya slice + sugar syrup @75oB + Ginger extract @5%) and minimum is 2.82 mg/100g in T0 (1Kg papaya slice + sugar syrup @75oB + Control). The processing of the fruits through various pre-treatments employed for preparation of candies resulted in remarkable loss of vitamin-'C' for a value of 18.21 mg/100 g fresh fruits.

Reducing Sugars: Reducing sugar has shown an increasing trend during storage and maximum Reducing sugar was recorded 54.27% in T7 (1Kg papaya slice + sugar syrup @75oB + Ginger extract @5%) and minimum is 51.97% in T0 (1Kg papaya slice + sugar syrup @75oB + Control). The increase in reducing sugar might be due to breakdown of polysaccharides into oligosaccharides and monosaccharides.

Non-reducing sugar: Non-reducing sugar has shown an increasing trend during storage and maximum Non-reducing sugar was recorded 29.68% in T7 (1Kg papaya slice + sugar syrup @75oB + Ginger extract@5%) and minimum is 28.00% in T0 (1Kg papaya slice + sugar syrup @75oB +Control).

Usually, high sugar content makes the moisture unavailable for the growth of microorganisms, thus improves the shelf life of food. Similar results were reported by Daisy and Gehlot (2006).

Total sugar: Total sugar has shown an increasing trend during storage and maximum Total sugar was recorded 83.95% in T7 (1Kg papaya slice + sugar syrup @75oB + Ginger extract @5%) and minimum is 79.97% in T0 (1Kg papaya slice + sugar syrup @75oB + Control). Similar results were reported by Krishnaveni et al. (2001) in jack fruit RTS**,** Jain et al. (2004) in papaya cubes.

Storage Stability: The maximum Storage Stability was found 87 Days in T7 (1Kg papaya slice + sugar syrup @75oB + Ginger extract@5%) followed by 85 days in T6(1Kg papaya slice + sugar syrup @75oB + Tulsi extract@5%) and minimum was found 78 Days in T0(1Kg papaya slice + sugar syrup @75oB + Control).

3.2 Sensory Tests

Colour and appearance: Based on sensory test the colour and appearance has shown decreasing trend during storage and maximum score for colour and appearance was recorded 8.27 in T7 (1Kg papaya slice + sugar syrup @75oB + Ginger extract @5%) and lowest is 6.80 in T0 (1Kg papaya slice + sugar syrup @75oB + Control). Colour is an attribute of food quality and loss of colour by osmotic dehydration process is one of the most significant changes. Similar results were reported by Heredia (2004) and Singh et al., [16].

Texture: The texture has shown decreasing trend during storage and maximum score for texture was recorded 8.27 in T7 (1Kg papaya slice + sugar syrup @75oB + Ginger extract @5%) and lowest is 7.00 in T0 (1Kg papaya slice + sugar syrup @75oB + Control). This might be due to degradation of volatile substance and flavour constituents. Similar results were reported by Ames (2003) and Chavan (2010).

Flavour: The flavour has shown decreasing trend during storage and maximum score for flavour was recorded 8.27 in T7 (1Kg papaya slice + sugar syrup @75oB + Ginger extract @5%) and lowest is 7.50 in T0 (1Kg papaya slice + sugar syrup @75oB + Control). Similar results were reported by Hasanuzzaman (2014) in tomato candy and Deepak Singh Rathore [17] in Ber candy.

Taste: The taste has shown decreasing trend during storage and maximum score for taste was recorded 8.27 in T7 (1Kg papaya slice + sugar syrup @75oB + Ginger extract @5%) and lowest is 7.33 in T0 (1Kg papaya slice + sugar syrup @75oB + Control).

Overall acceptability: Overall acceptability has shown decreasing trend during storage and maximum score for overall acceptability was recorded 8.29 in T7 (1Kg papaya slice + sugar syrup @75oB + Ginger extract @5%) and lowest is 7.36 in T0 (1Kg papaya slice + sugar syrup @75oB + Control. The decrease in overall acceptability score may be due to absorption of atmospheric moisture, dilution of sugars and changes in acidity, oxidation of ascorbic acid as well as changes in biochemical constituents of candy. Similar results were reported by Sharma [18] in apple candy.

Table 2. Change in the Total Soluble Solids in ^{0}Brix, Total Titratable acidity and Ascorbic acid (mg/100g) of papaya candies as affected by various treatments

Treatments	TSS (0 Brix)				Acidity (%)				Ascorbic acid (mg/100g)			
	Initial	30 DAS	60 DAS	90 DAS	Initial	30 DAS	60 DAS	90 DAS	Initial	30 DAS	60 DAS	90 DAS
T_0	75.66	75.66	76.66	77.66	0.082	0.082	0.091	0.104	3.44	3.23	3.04	2.82
T_1	76	76.33	77.66	78	0.083	0.083	0.093	0.105	3.55	3.32	3.08	2.83
T_2	76.33	77	78	78.33	0.087	0.088	0.095	0.111	3.61	3.34	3.12	2.84
T_3	77.66	77.66	77.33	79.33	0.087	0.086	0.103	0.11	3.56	3.42	3.14	2.9
T_4	76.66	77	77.66	78	0.086	0.089	0.097	0.111	3.64	3.47	3.1	2.99
T_5	78	78	78.66	79	0.085	0.088	0.099	0.108	3.59	3.46	3.17	2.87
T_6	78	78.66	79.33	80	0.087	0.089	0.097	0.112	3.8	3.61	3.25	3.07
T_7	78	79.33	79.33	80.33	0.091	0.096	0.104	0.113	3.84	3.64	3.28	3.1
T_8	76.66	77.33	78.33	79.33	0.086	0.088	0.1	0.106	3.62	3.39	3.14	2.85
T_9	76.33	77	77.66	78.33	0.088	0.088	0.097	0.111	3.55	3.39	3.21	2.85
F value	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
S Em ±	0.42	0.59	0.49	0.55	0	0	0.01	0.01	0.07	0.08	0.05	0.06
CD 5%	1.27	1.78	1.47	1.66	0	0	0.01	0.01	0.22	0.23	0.14	0.19
CV	0.95	1.31	1.08	1.2	1.98	2.78	3.47	3.03	3.43	3.71	2.48	3.74

Table 3. Change in the Reducing Sugars, Non-Reducing Sugar, Total Sugar and Storage stability of papaya candies as affected by various treatments

Treatments	Reducing Sugar (%)				Non-Reducing Sugar %				Total Sugar %				Shelf-Life
	Initial	30 DAS	60 DAS	90 DAS	Initial	30 DAS	60 DAS	90 DAS	Initial	30 DAS	60 DAS	90 DAS	(days)
T_0	41.21	43.82	47.7	51.97	26.72	27.03	27.69	28	67.93	70.85	75.39	79.97	78
T_1	41.74	44.28	48.28	53.13	27.06	27.36	27.96	28.32	68.8	71.64	76.24	81.45	79
T_2	41.47	44.85	48.31	53.58	27.65	27.78	27.95	28.65	69.12	72.63	76.26	82.23	83
T_3	41.63	44.72	48.45	53.69	27.93	27.96	28.06	28.92	69.56	72.68	76.51	82 61	81
T_4	41.6	44.7	49.28	54.17	27.35	27.65	28.13	28.68	68.95	72.35	76.41	82.85	83
T_5	41.75	44.76	48.69	54.02	27.61	27.94	28.12	29.13	69.36	72.7	76.81	83.15	80
T_6	42.31	46.03	50.02	54.19	28.02	28.19	29.01	29.32	70.52	74.22	79.03	83.51	85
T_7	42.36	46.08	50.06	54.27	28.17	28.65	29.06	29.68	70.53	74.73	79.12	83.95	87
T_8	41.58	45.68	48.93	53.49	27.95	28	28.63	28.56	69.53	73.68	77.56	82.05	79
T_9	41.33	44.64	48.89	53.29	27.56	28.06	28.45	28.55	68.89	72.7	77.34	81.84	83
F value	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	
S Em ±	0.12	0.36	0.29	0.26	0.7	0.16	0.14	0.13	0.38	0.48	0.41	0.59	
CD 5%	0.38	0.99	0.89	0.8	0.16	0.44	0.37	0.34	1.05	1.44	1.25	1.54	
CV	0.52	1.25	1.04	0.85	0.32	0.75	0.54	0.51	1.42	1	0.89	1.16	

Table 4. Change in the colour and appearance, Texture, Flavour of papaya candies as affected by various treatments

Treatments	Colour				Texture				Flavour			
	Initial	30 DAS	60 DAS	90 DAS	Initial	30 DAS	60 DAS	90 DAS	Initial	30 DAS	60 DAS	90 DAS
T_0	8	7.6	7.05	6.8	7.5	7.4	7.06	7	7.8	7.73	7.63	7.5
T_1	8.23	8.16	7.2	7.3	7.76	7.53	7.4	7.33	8.11	8.1	8.03	7.63
T_2	8.2	8.19	7.36	7.6	8.1	7.73	7.7	7.53	8.19	8.1	8.09	7.73
T_3	8.21	8.2	7.5	7.66	8.06	7.83	7.56	7.5	8.2	8.2	8.19	7.66
T_4	8.22	8.21	7.53	7.6	8.11	7.96	7.73	7.63	8.22	8.21	8.2	7.83
T_5	8.21	8.2	7.33	7.6	8.16	8.12	7.83	7.66	8.28	8.28	8.27	7.83
T_6	8.27	8.25	8.1	8.2	8.22	8.21	8.19	8.16	8.29	8.29	8.28	8.21
T_7	8.3	8.29	8.28	8.27	8.3	8.3	8.29	8.27	8.3	8.3	8.29	8.27
T_8	8.22	8.22	7.8	7.86	8.19	8.1	7.96	7.73	8.24	8.23	8.22	8.2
T_9	8.26	8.21	7.7	7.76	8.2	7.93	7.76	7.73	8.16	8.1	7.96	7.86
F value	S	S	S	S	S	S	S	S	S	S	S	S
S Em ±	0.25	0.21	0.2	0.18	0.18	0.17	0.12	0.1	0.19	0.17	0.15	0.11
CD 5%	0.68	0.6	0.57	0.48	0.47	0.45	0.3	0.28	0.51	0.46	0.38	0.28
CV	5.01	3.91	3.89	2.89	3.19	3.11	2.34	3.28	3.41	3.36	2.31	2.02

Table 5. Change in the Taste and Overall Acceptability of papaya candies as affected by various treatments

Treatments	Taste				Overall Acceptability			
	Initial	30 DAS	60 DAS	90 DAS	Initial	30 DAS	60 DAS	90 DAS
T_0	7.73	7.66	7.6	7.33	7.63	7.53	7.46	7.36
T_1	7.8	7.73	7.66	7.5	7.93	7.86	7.76	7.7
T_2	7.8	7.76	7.63	7.56	8.13	8.11	8	7.8
T_3	7.97	7.9	7.8	7.63	8.13	8.1	8.06	7.83
T_4	8.03	8	7.93	7.9	8.16	8.15	8.13	7.96
T_5	8	7.93	7.76	7.7	8.23	8.23	8.2	8.18
T_6	8.26	8.25	8.19	8.12	8.27	8.27	8.26	8.24
T_7	8.3	8.29	8.28	8.27	8.3	8.3	8.29	8.29
T_8	8.24	8.2	8.12	8.11	8.24	8.23	8.22	8.2
T_9	8.25	8.2	8.05	8	8.25	8.24	8.23	8.1
F value	S	S	S	S	S	S	S	S
S Em ±	0.17	0.15	0.14	0.12	0.19	0.16	0.15	0.13
CD 5%	0.49	0.42	0.38	0.33	0.57	0.47	0.43	0.37
CV	2.93	2.86	2.83	2.76	3.88	3.13	2.89	2.58

Fig. 1. Cutting of papaya

Fig. 2. Blanching of papaya slices

Fig. 3. Drying of papaya candy

Fig. 4. Papaya candy after drying

4. CONCLUSION

Based on present investigation, it is concluded that treatment T7 (1Kg papaya slice + sugar syrup @75oB + Ginger extract @5%) was best in terms of best recipe with value addition for preparation of papaya candy. The same treatment T7 (1Kg papaya slice + sugar syrup @75oB + Ginger extract @5%) was again found best in terms of Quality, Storage stability and maximum B:C ratio.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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