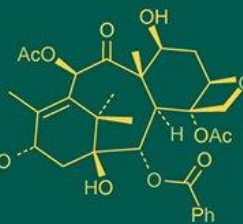
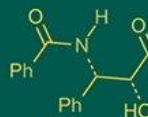


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Effect of sweetening and flavouring materials on quality and storage stability of Aonla (*Phyllanthus emblica* L.) Candy

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Abstract

This study evaluated the influence of different sweetening and flavouring treatments on the quality and storage behaviour of aonla (*Phyllanthus emblica* L.) candy under ambient conditions. A laboratory experiment was conducted during 2025-2026 at the Department of Fruit Science, College of Horticulture and Research Station, Saja-Bemetara, Chhattisgarh. Nine treatment combinations comprising sugar, jaggery and honey syrups at 60 and 70 °Brix, with 1% ginger extract in selected 70 °Brix treatments, were evaluated in a Completely Randomized Design with three replications. Observations were recorded at 0, 30, 60 and 90 days for physical, physico-chemical and sensory attributes. Jaggery syrup at 70 °Brix supplemented with 1% ginger extract (T₈) consistently showed superior performance, recording the highest recovery (68.20-64.60%), highest total soluble solids (71.46-78.83 °Brix), and superior retention of ascorbic acid (248.14-231.52 mg 100 g⁻¹). At 90 days, T₈ recorded 64.60% recovery, 3.70% shrinkage, 78.83 °Brix TSS, 231.52 mg 100 g⁻¹ ascorbic acid, 66.47% total sugar, 41.16% reducing sugar and an overall acceptability score of 22.80/27. Honey syrup at 70 °Brix with ginger (T₉) gave the highest moisture content and texture score at 90 days, while honey syrup at 70 °Brix without ginger (T₆) recorded the highest colour score. Most physical and sensory attributes declined during storage, whereas TSS, titratable acidity, total sugar and reducing sugar generally increased. The findings indicate that T₈ was the most suitable treatment among those tested for producing high-quality aonla candy with good storage stability up to 90 days.

Keywords: Aonla, Indian gooseberry, candy, jiggery, honey, sugar, ginger extract, storage, ascorbic acid, sensory quality

Introduction

Aonla (*Phyllanthus emblica* L.), commonly known as Indian gooseberry, is an important indigenous fruit crop valued for its nutritional, medicinal and processing potential. The fruit is particularly rich in vitamin C and also contains polyphenols, antioxidants, pectin and minerals. Despite these attributes, fresh aonla has limited table-fruit acceptability because of its characteristic acidic and astringent taste and is highly perishable. Processing and value addition therefore provide an opportunity to improve palatability, extend utilization and enhance the economic value of the crop.

Aonla can be processed into candy, murrabba, preserve, pickle, juice, squash, jelly, dried products, powder and other value-added products. Candy preparation uses osmotic movement of soluble solids into fruit tissue and helps balance the natural sourness and astringency. The type and concentration of sweetening material can influence recovery, moisture, soluble solids, sugars, acidity and sensory quality. Natural flavouring materials can further improve consumer appeal. Previous studies cited in the thesis indicate that storage generally results in loss of vitamin C and changes in soluble solids, sugars and sensory attributes.

The present investigation was undertaken to evaluate sugar, jaggery and honey syrups at 60 and 70 °Brix, with or without 1% ginger extract, and to identify the most suitable combination for quality retention and consumer acceptability of aonla candy during ambient storage.

2. Materials and Methods

2.1 Experimental site and design

The experiment was conducted in November 2025 at the Department of Fruit Science, College of Horticulture and Research Station, Saja-Bemetara, MGUVV, Durg, Chhattisgarh. The site is located at approximately 21.71° N latitude, 81.53° E longitude and 282 m above mean sea level. Fresh, mature, healthy and uniform-sized fruits of the local aonla variety were used. The experiment followed a Completely Randomized Design (CRD) with nine treatments and three replications (27 experimental units). Samples were stored in airtight food-grade containers at room temperature and evaluated at 0, 30, 60 and 90 days.

2.2 Treatment combinations

Treatment	Sweetening material	Final °Brix	Flavouring
T ₁	Aonla + sugar syrup	60	—
T ₂	Aonla + sugar syrup	70	—
T ₃	Aonla + jaggery syrup	60	—
T ₄	Aonla + jaggery syrup	70	—
T ₅	Aonla + honey syrup	60	—
T ₆	Aonla + honey syrup	70	—
T ₇	Aonla + sugar syrup	70	1% ginger extract
T ₈	Aonla + jaggery syrup	70	1% ginger extract
T ₉	Aonla + honey syrup	70	1% ginger extract

2.3 Candy preparation

Selected fruits were washed, uniformly pricked and blanched in boiling water for 5-8 minutes, followed by cooling and segmentation. Stones were removed. Sugar, jaggery and honey syrups were prepared at the required concentrations. For T₇, T₈ and T₉, 1% fresh ginger extract was incorporated. Aonla segments were syruped with daily

adjustment of syrup concentration until the required final Brix was achieved. The drained segments were dried in a hot-air oven at 55-60 °C, packed in clean airtight food-grade containers and stored at room temperature.

2.4 Observations and statistical analysis

Physical observations included recovery, candy weight and shrinkage. Physico-chemical observations included titratable acidity, pH, moisture content, total soluble solids (TSS), ascorbic acid, total sugar, reducing sugar and non-reducing sugar. Sensory evaluation covered colour, texture and flavour using a 9-point hedonic scale; overall acceptability was expressed as the combined score of these three attributes (maximum 27). Ascorbic acid was estimated by the 2,6-dichlorophenol indophenol dye titration method, while sugars were estimated by the Lane and Eynon method. Data were analysed by ANOVA appropriate for CRD, with treatment effects tested at the 5% probability level; SE(m) and critical difference (C.D.) were used where applicable.

3. Results and Discussion

3.1 Physical quality

Recovery declined progressively during storage in all treatments. T₈ recorded the highest recovery throughout, from 68.20% at preparation to 64.60% after 90 days, whereas T₅ recorded the lowest value at 90 days (57.90%). Candy weight also declined with storage. At 90 days, T₈ retained 96.30 g from an initial 100 g, compared with 91.50 g in T₃. Shrinkage increased with storage; T₈ had the lowest shrinkage at 90 days (3.70%), while T₃ had the highest (8.50%). The superior physical retention in T₈ was associated in the thesis with the combined effect of 70 °Brix jaggery syrup and 1% ginger extract.

Table 1: Effect of different sweetening and flavouring materials on recovery (%) of aonla candy during different storage days

Trt.	Description	0 days	30 days	60 days	90 days
T ₁	Aonla + Sugar syrup (60 °Brix)	65.20	64.10	62.85	61.40
T ₂	Aonla + Sugar syrup (70 °Brix)	67.45	66.30	65.05	63.80
T ₃	Aonla + Jaggery syrup (60 °Brix)	63.80	62.55	61.20	59.95
T ₄	Aonla + Jaggery syrup (70 °Brix)	66.10	64.92	63.70	62.45
T ₅	Aonla + Honey syrup (60 °Brix)	61.90	60.60	59.25	57.90
T ₆	Aonla + Honey syrup (70 °Brix)	64.35	63.10	61.80	60.55
T ₇	Sugar syrup (70 °Brix) + 1% ginger extract	67.00	65.85	64.60	63.30
T ₈	Jaggery syrup (70 °Brix) + 1% ginger extract	68.20	67.10	65.90	64.60
T ₉	Honey syrup (70 °Brix) + 1% ginger extract	65.10	63.95	62.60	61.25
	SE(m)±	0.099	0.115	0.106	0.098
	C.D. at 5%	0.296	0.345	0.318	0.294

Table 2: Effect of different sweetening and flavouring materials on weight of candy (g) of aonla candy during different storage days

Trt.	Description	0 days	30 days	60 days	90 days
T ₁	Aonla + Sugar syrup (60 °Brix)	100.00	97.45	94.10	92.30
T ₂	Aonla + Sugar syrup (70 °Brix)	100.00	98.20	95.82	94.10
T ₃	Aonla + Jaggery syrup (60 °Brix)	100.00	96.80	93.22	91.50
T ₄	Aonla + Jaggery syrup (70 °Brix)	100.00	97.60	94.70	92.90
T ₅	Aonla + Honey syrup (60 °Brix)	100.00	98.75	96.40	94.82
T ₆	Aonla + Honey syrup (70 °Brix)	100.00	99.10	97.20	95.60
T ₇	Sugar syrup (70 °Brix) + 1% ginger extract	100.00	98.92	96.80	95.20
T ₈	Jaggery syrup (70 °Brix) + 1% ginger extract	100.00	99.40	97.90	96.30
T ₉	Honey syrup (70 °Brix) + 1% ginger extract	100.00	98.30	96.10	94.40
	SE(m)±	NS	0.110	0.115	0.115
	C.D. at 5%	NS	0.329	0.346	0.346

Table 3: Effect of different sweetening and flavouring materials on shrinkage (%) of aonla candy during different storage days

Trt.	Description	0 days	30 days	60 days	90 days
T ₁	Aonla + Sugar syrup (60 °Brix)	0.00	2.55	5.90	7.70
T ₂	Aonla + Sugar syrup (70 °Brix)	0.00	1.80	4.15	6.20
T ₃	Aonla + Jaggery syrup (60 °Brix)	0.00	3.20	6.75	8.50
T ₄	Aonla + Jaggery syrup (70 °Brix)	0.00	2.40	5.30	7.10
T ₅	Aonla + Honey syrup (60 °Brix)	0.00	1.25	3.60	5.15
T ₆	Aonla + Honey syrup (70 °Brix)	0.00	0.90	2.80	4.40
T ₇	Sugar syrup (70 °Brix) + 1% ginger extract	0.00	1.05	3.20	4.80
T ₈	Jaggery syrup (70 °Brix) + 1% ginger extract	0.00	0.60	2.10	3.70
T ₉	Honey syrup (70 °Brix) + 1% ginger extract	0.00	1.40	3.90	5.60
	SE(m)±	NS	0.01	0.02	0.01
	C.D. at 5%	NS	0.04	0.06	0.03

Table 4: Effect of different sweetening and flavouring materials on titratable acidity (%) of aonla candy during different storage days

Trt.	Description	0 days	30 days	60 days	90 days
T ₁	Aonla + Sugar syrup (60 °Brix)	0.64	0.59	0.51	0.50
T ₂	Aonla + Sugar syrup (70 °Brix)	0.77	0.75	0.70	0.68
T ₃	Aonla + Jaggery syrup (60 °Brix)	1.24	1.16	1.11	0.98
T ₄	Aonla + Jaggery syrup (70 °Brix)	1.31	1.21	1.14	1.01
T ₅	Aonla + Honey syrup (60 °Brix)	1.44	1.56	1.59	1.65
T ₆	Aonla + Honey syrup (70 °Brix)	1.49	1.51	1.54	1.60
T ₇	Sugar syrup (70 °Brix) + 1% ginger extract	0.71	0.69	0.64	0.62
T ₈	Jaggery syrup (70 °Brix) + 1% ginger extract	1.56	1.59	1.61	1.68
T ₉	Honey syrup (70 °Brix) + 1% ginger extract	1.38	1.26	1.18	1.18
	SE(m)±	0.01	0.01	0.01	0.01
	C.D. at 5%	0.02	0.02	0.02	0.02

Table 5: Effect of different sweetening and flavouring materials on pH of aonla candy during different storage days

Trt.	Description	0 days	30 days	60 days	90 days
T ₁	Aonla + Sugar syrup (60 °Brix)	3.56	3.50	3.47	3.40
T ₂	Aonla + Sugar syrup (70 °Brix)	3.67	3.57	3.54	3.47
T ₃	Aonla + Jaggery syrup (60 °Brix)	3.28	3.33	3.40	3.45
T ₄	Aonla + Jaggery syrup (70 °Brix)	3.33	3.39	3.47	3.52
T ₅	Aonla + Honey syrup (60 °Brix)	3.23	3.29	3.37	3.42
T ₆	Aonla + Honey syrup (70 °Brix)	3.28	3.34	3.42	3.48
T ₇	Sugar syrup (70 °Brix) + 1% ginger extract	3.64	3.71	3.66	3.58
T ₈	Jaggery syrup (70 °Brix) + 1% ginger extract	3.18	3.24	3.33	3.38
T ₉	Honey syrup (70 °Brix) + 1% ginger extract	3.74	3.81	3.91	3.92
	SE(m)±	0.01	0.01	0.01	0.01
	C.D. at 5%	0.04	0.02	0.02	0.02

Table 6: Effect of different sweetening and flavouring materials on moisture (%) of aonla candy during different storage days

Trt.	Description	0 days	30 days	60 days	90 days
T ₁	Aonla + Sugar syrup (60 °Brix)	22.40	20.10	17.85	15.60
T ₂	Aonla + Sugar syrup (70 °Brix)	21.80	19.65	17.20	15.10
T ₃	Aonla + Jaggery syrup (60 °Brix)	23.10	20.80	18.40	16.20
T ₄	Aonla + Jaggery syrup (70 °Brix)	22.60	20.20	17.90	15.70
T ₅	Aonla + Honey syrup (60 °Brix)	24.80	22.90	21.10	19.30
T ₆	Aonla + Honey syrup (70 °Brix)	25.40	23.80	22.10	20.40
T ₇	Sugar syrup (70 °Brix) + 1% ginger extract	23.90	22.10	20.30	18.60
T ₈	Jaggery syrup (70 °Brix) + 1% ginger extract	24.20	22.40	20.70	18.90
T ₉	Honey syrup (70 °Brix) + 1% ginger extract	26.10	24.60	23.10	21.60
	SE(m)±	0.06	0.06	0.06	0.06
	C.D. at 5%	0.17	0.18	0.18	0.17

Table 7: Effect of different sweetening and flavouring materials on total soluble solids (°Brix) of aonla candy during different storage days

Trt.	Description	0 days	30 days	60 days	90 days
T ₁	Aonla + Sugar syrup (60 °Brix)	59.38	59.96	59.68	61.10
T ₂	Aonla + Sugar syrup (70 °Brix)	69.91	69.83	69.60	71.20
T ₃	Aonla + Jaggery syrup (60 °Brix)	60.60	62.00	63.20	66.16
T ₄	Aonla + Jaggery syrup (70 °Brix)	70.76	72.15	73.25	76.42
T ₅	Aonla + Honey syrup (60 °Brix)	60.70	62.10	63.30	66.26
T ₆	Aonla + Honey syrup (70 °Brix)	70.86	72.35	73.55	76.82
T ₇	Sugar syrup (70 °Brix) + 1% ginger extract	69.27	70.11	70.29	73.40
T ₈	Jaggery syrup (70 °Brix) + 1% ginger extract	71.46	72.35	73.75	78.83
T ₉	Honey syrup (70 °Brix) + 1% ginger extract	68.37	69.92	69.60	71.27
	SE(m)±	0.34	0.13	0.13	0.15
	C.D. at 5%	1.01	0.37	0.37	0.46

Table 8: Effect of different sweetening and flavouring materials on ascorbic acid (mg 100 g⁻¹) of aonla candy during different storage days

Trt.	Description	0 days	30 days	60 days	90 days
T ₁	Aonla + Sugar syrup (60 °Brix)	211.26	199.46	183.21	173.09
T ₂	Aonla + Sugar syrup (70 °Brix)	238.79	221.07	211.78	210.63
T ₃	Aonla + Jaggery syrup (60 °Brix)	226.24	220.68	209.11	204.81
T ₄	Aonla + Jaggery syrup (70 °Brix)	222.84	220.78	204.34	192.91
T ₅	Aonla + Honey syrup (60 °Brix)	239.36	233.45	225.93	219.31
T ₆	Aonla + Honey syrup (70 °Brix)	241.06	243.10	231.31	226.52
T ₇	Sugar syrup (70 °Brix) + 1% ginger extract	230.91	221.82	214.42	210.97
T ₈	Jaggery syrup (70 °Brix) + 1% ginger extract	248.14	240.03	236.31	231.52
T ₉	Honey syrup (70 °Brix) + 1% ginger extract	245.87	231.15	220.86	215.67
	SE(m)±	0.48	0.24	0.23	0.23
	C.D. at 5%	1.44	0.71	0.70	0.69

Table 9: Effect of different sweetening and flavouring materials on total sugar (%) of aonla candy during different storage days

Trt.	Description	0 days	30 days	60 days	90 days
T ₁	Aonla + Sugar syrup (60 °Brix)	58.00	59.50	61.15	61.76
T ₂	Aonla + Sugar syrup (70 °Brix)	58.97	58.25	63.56	64.30
T ₃	Aonla + Jaggery syrup (60 °Brix)	57.20	59.50	60.55	61.20
T ₄	Aonla + Jaggery syrup (70 °Brix)	58.50	57.54	62.03	62.50
T ₅	Aonla + Honey syrup (60 °Brix)	56.40	62.02	59.96	61.70
T ₆	Aonla + Honey syrup (70 °Brix)	57.20	60.06	60.96	61.20
T ₇	Sugar syrup (70 °Brix) + 1% ginger extract	59.85	60.06	62.26	63.31
T ₈	Jaggery syrup (70 °Brix) + 1% ginger extract	60.82	59.17	64.72	66.47
T ₉	Honey syrup (70 °Brix) + 1% ginger extract	58.00	59.37	61.15	62.30
	SE(m)±	0.14	0.16	0.15	0.16
	C.D. at 5%	0.41	0.46	0.44	0.49

Table 10: Effect of different sweetening and flavouring materials on reducing sugar (%) of aonla candy during different storage days

Trt.	Description	0 days	30 days	60 days	90 days
T ₁	Aonla + Sugar syrup (60 °Brix)	30.15	31.15	32.70	35.11
T ₂	Aonla + Sugar syrup (70 °Brix)	32.10	34.10	36.10	38.76
T ₃	Aonla + Jaggery syrup (60 °Brix)	28.49	30.00	31.31	33.11
T ₄	Aonla + Jaggery syrup (70 °Brix)	30.91	32.42	34.11	35.96
T ₅	Aonla + Honey syrup (60 °Brix)	32.30	33.85	35.45	37.16
T ₆	Aonla + Honey syrup (70 °Brix)	30.11	31.25	32.14	33.96
T ₇	Sugar syrup (70 °Brix) + 1% ginger extract	31.26	33.14	35.94	37.71
T ₈	Jaggery syrup (70 °Brix) + 1% ginger extract	35.67	37.45	39.25	41.16
T ₉	Honey syrup (70 °Brix) + 1% ginger extract	32.66	34.26	36.15	40.26
	SE(m)±	0.12	0.13	0.13	0.15
	C.D. at 5%	0.37	0.39	0.40	0.45

Table 11: Effect of different sweetening and flavouring materials on non-reducing sugar (%) of aonla candy during different storage days

Trt.	Description	0 days	30 days	60 days	90 days
T ₁	Aonla + Sugar syrup (60 °Brix)	26.46	26.94	27.03	25.31
T ₂	Aonla + Sugar syrup (70 °Brix)	25.53	22.95	26.09	24.26
T ₃	Aonla + Jaggery syrup (60 °Brix)	25.74	27.37	27.38	25.88
T ₄	Aonla + Jaggery syrup (70 °Brix)	26.21	23.87	26.53	25.22
T ₅	Aonla + Honey syrup (60 °Brix)	22.90	26.76	23.29	23.32
T ₆	Aonla + Honey syrup (70 °Brix)	23.89	20.63	24.20	24.04
T ₇	Sugar syrup (70 °Brix) + 1% ginger extract	27.16	25.58	25.01	24.32
T ₈	Jaggery syrup (70 °Brix) + 1% ginger extract	27.27	28.03	27.78	26.69
T ₉	Honey syrup (70 °Brix) + 1% ginger extract	24.07	23.85	23.75	20.94
	SE(m)±	0.03	0.04	0.03	0.03
	C.D. at 5%	0.08	0.12	0.08	0.09

Table 12: Effect of different sweetening and flavouring materials on colour score (out of 9) of aonla candy during storage

Trt.	Description	0 days	30 days	60 days	90 days
T ₁	Aonla + Sugar syrup (60 °Brix)	7.80	7.65	7.40	7.10
T ₂	Aonla + Sugar syrup (70 °Brix)	8.20	8.05	7.80	7.50
T ₃	Aonla + Jaggery syrup (60 °Brix)	7.60	7.40	7.20	6.90
T ₄	Aonla + Jaggery syrup (70 °Brix)	7.90	7.70	7.50	7.20
T ₅	Aonla + Honey syrup (60 °Brix)	8.10	7.95	7.70	7.40
T ₆	Aonla + Honey syrup (70 °Brix)	8.40	8.25	8.00	7.70
T ₇	Sugar syrup (70 °Brix) + 1% ginger extract	8.00	7.85	7.60	7.30
T ₈	Jaggery syrup (70 °Brix) + 1% ginger extract	8.30	8.15	7.90	7.60
T ₉	Honey syrup (70 °Brix) + 1% ginger extract	7.80	7.60	7.40	7.10
	SE(m)±	0.03	0.03	0.03	0.03
	C.D. at 5%	0.09	0.09	0.09	0.09

Table 13: Effect of different sweetening and flavouring materials on texture score (out of 9) of aonla candy during storage

Trt.	Description	0 days	30 days	60 days	90 days
T ₁	Aonla + Sugar syrup (60 °Brix)	7.60	7.45	7.20	6.90
T ₂	Aonla + Sugar syrup (70 °Brix)	8.00	7.85	7.60	7.30
T ₃	Aonla + Jaggery syrup (60 °Brix)	7.40	7.20	7.00	6.70
T ₄	Aonla + Jaggery syrup (70 °Brix)	7.70	7.50	7.30	7.00
T ₅	Aonla + Honey syrup (60 °Brix)	7.90	7.75	7.50	7.20
T ₆	Aonla + Honey syrup (70 °Brix)	8.10	7.95	7.70	7.40
T ₇	Sugar syrup (70 °Brix) + 1% ginger extract	7.80	7.65	7.40	7.10
T ₈	Jaggery syrup (70 °Brix) + 1% ginger extract	7.60	7.40	7.20	6.90
T ₉	Honey syrup (70 °Brix) + 1% ginger extract	8.20	8.05	7.80	7.50
	SE(m)±	0.03	0.03	0.03	0.03
	C.D. at 5%	0.09	0.09	0.09	0.09

Table 14: Effect of different sweetening and flavouring materials on flavour score (out of 9) of aonla candy during storage

Trt.	Description	0 days	30 days	60 days	90 days
T ₁	Aonla + Sugar syrup (60 °Brix)	7.70	7.50	7.30	7.00
T ₂	Aonla + Sugar syrup (70 °Brix)	8.10	7.95	7.70	7.40
T ₃	Aonla + Jaggery syrup (60 °Brix)	7.50	7.30	7.10	6.80
T ₄	Aonla + Jaggery syrup (70 °Brix)	7.80	7.60	7.40	7.10
T ₅	Aonla + Honey syrup (60 °Brix)	8.00	7.85	7.60	7.30
T ₆	Aonla + Honey syrup (70 °Brix)	7.70	7.50	7.30	7.00
T ₇	Sugar syrup (70 °Brix) + 1% ginger extract	8.10	7.95	7.70	7.40
T ₈	Jaggery syrup (70 °Brix) + 1% ginger extract	8.30	8.15	7.90	7.60
T ₉	Honey syrup (70 °Brix) + 1% ginger extract	8.20	8.05	7.80	7.50
	SE(m)±	0.03	0.03	0.03	0.03
	C.D. at 5%	0.09	0.09	0.09	0.09

Table 15: Effect of different sweetening and flavouring materials on overall acceptability (total score out of 27) of aonla candy during storage

Trt.	Description	0 days	30 days	60 days	90 days
T ₁	Aonla + Sugar syrup (60 °Brix)	23.10	22.60	21.90	21.00
T ₂	Aonla + Sugar syrup (70 °Brix)	24.30	23.85	23.10	22.20
T ₃	Aonla + Jaggery syrup (60 °Brix)	22.50	21.90	21.30	20.40
T ₄	Aonla + Jaggery syrup (70 °Brix)	23.40	22.80	22.20	21.30
T ₅	Aonla + Honey syrup (60 °Brix)	24.00	23.55	22.80	21.90
T ₆	Aonla + Honey syrup (70 °Brix)	23.10	22.50	21.90	21.00
T ₇	Sugar syrup (70 °Brix) + 1% ginger extract	23.90	23.45	22.70	21.80
T ₈	Jaggery syrup (70 °Brix) + 1% ginger extract	24.90	24.45	23.70	22.80
T ₉	Honey syrup (70 °Brix) + 1% ginger extract	24.60	24.15	23.40	22.50
	SE(m)±	0.03	0.03	0.03	0.03
	C.D. at 5%	0.09	0.09	0.09	0.09

3.2 Physico-chemical quality

Titrate acidity varied significantly among treatments. T₈ recorded the highest acidity at 0 and 90 days (1.56 and 1.68%, respectively), while T₁ recorded the lowest (0.64 and 0.50%). The thesis attributed the higher acidity in T₈ to better retention of organic acids. pH values showed treatment-specific differences: T₉ recorded the highest pH at 90 days (3.92), whereas T₈ recorded the lowest (3.38). Moisture decreased during storage in all treatments. T₉ retained the highest moisture (21.60% at 90 days), while T₂ had the lowest (15.10%).

TSS increased progressively during storage. T₈ recorded the highest TSS at all observation dates, rising from 71.46 °Brix initially to 78.83 °Brix at 90 days. The thesis associated this increase with moisture loss and concentration of soluble solids. Ascorbic acid declined during storage, but T₈ retained a high level, decreasing from 248.14 to 231.52 mg 100 g⁻¹. At 90 days, T₁ had the lowest ascorbic acid content (173.09 mg 100 g⁻¹). Total and reducing sugars generally increased with storage, with T₈ reaching 66.47% total sugar and 41.16% reducing sugar at 90 days. Non-reducing sugar in T₈ was 26.69% at 90 days.

3.3 Sensory quality

All sensory attributes showed a gradual decline with storage. T₆ recorded the highest colour score throughout storage, decreasing from 8.40 at 0 days to 7.70 at 90 days. T₉ recorded the highest texture score, from 8.20 to 7.50. T₈ recorded the highest flavour score throughout, from 8.30 initially to 7.60 at 90 days. Overall acceptability was highest for T₈ at every storage interval: 24.90, 24.45, 23.70 and 22.80 at 0, 30, 60 and 90 days, respectively. T₃ recorded the lowest overall acceptability at each corresponding interval.

3.4 Overall treatment performance

Among the nine treatment combinations, T₈—Aonla + jaggery syrup at 70 °Brix + 1% ginger extract—showed the most consistent overall performance. At 90 days it had the highest recovery, lowest shrinkage, highest TSS, highest ascorbic acid retention among the treatments reported as best in the thesis, highest total, reducing and non-reducing sugars, highest flavour score and highest overall acceptability. T₆ was superior for colour and T₉ for texture and moisture retention, demonstrating that individual quality attributes may respond differently to the sweetening base.

4. Conclusion

The study demonstrated that sweetening material, syrup concentration and ginger flavouring influenced the physical, physico-chemical and sensory characteristics of aonla candy

during ambient storage. Storage was accompanied by reductions in recovery, candy weight, moisture, ascorbic acid and sensory scores, while TSS, titrate acidity, total sugar and reducing sugar generally increased. The combination of 70 °Brix jaggery syrup with 1% ginger extract (T₈) was the most suitable treatment based on its integrated performance. After 90 days, T₈ maintained 64.60% recovery, 96.30 g candy weight, only 3.70% shrinkage, 78.83 °Brix TSS, 231.52 mg 100 g⁻¹ ascorbic acid and an overall acceptability score of 22.80/27. Therefore, T₈ may be considered a promising formulation for aonla candy and value addition under the experimental conditions used.

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References

1. Association of Official Analytical Chemists. Official Methods of Analysis. 15th ed. Washington, DC: Association of Official Analytical Chemists; 1990.
2. Balaji V, Prasad VM, Saroj PL. Comparative study of varieties, honey coating and storage durations on aonla candy. Indian Journal of Horticulture. 2014;71(1):104-108.
3. Bhattacharjee AK, Dikshit A, Kumar S, Tondon DK. Quality of aonla candy and segment-in-syrup prepared from steep preserved fruits in water. Indian Journal of Natural Products and Resources. 2012;4(1):119-122.
4. Damame SV, Gaikwad RS, Patil SR, Masalkar SD. Vitamin C content of various aonla products during storage. Orissa Journal of Horticulture. 2002;30(1):19-22.
5. Devra NS, Kaushik RA, Meena HR. Standardization and storage study of aonla based blended ready-to-serve beverages. International Journal of Current Microbiology and Applied Sciences. 2017;6(5):1275-1284.
6. Durrani AM, Srivastava PK, Verma S. Development and quality evaluation of honey based carrot candy. Journal of Food Science and Technology. 2011;48(4):502-505.
7. Ghanwat AB, Khandare VS, Syed SJ. Effect of various treatments on physico-chemical composition of Indian gooseberry candy during storage. Journal of

- Pharmacognosy and Phytochemistry. 2019;8(4):2580-2586.
8. Kamble AK, Lavande NS. Solar drying of osmosed aonla flakes for preparation of aonla candy. Journal of Ready to Eat Food. 2014;1(31):120-126.
 9. Kumar PS, Sagar VR. Effect of osmosis on chemical parameters and sensory attributes of mango, guava slices and aonla segments. Indian Journal of Horticulture. 2009;66(1):53-57.
 10. Kumar S, Singh IS. Storage studies of aonla fruit products at ambient temperature. Progressive Horticulture. 2001;33(2):169-173.
 11. Nayak P, Tondon DK, Bhatt DK. Study on changes of nutritional and organoleptic quality of flavoured candy prepared from aonla during storage. International Journal of Nutrition and Metabolism. 2012;4(7):100-106.
 12. Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers. New Delhi: Indian Council of Agricultural Research; 1985.
 13. Pawar GA, Hamid RS, Shams R, *et al.* Recent insights into the morphological, nutritional and phytochemical properties of Indian gooseberry (*Phyllanthus emblica*) for the development of functional foods. Plants. 2024;13(5):574.
 14. Pragati S, Dahiya S, Dhawan SS. Effect of drying method on nutrition composition of dehydrated aonla fruit. Plant Foods for Human Nutrition. 2003;58:921-928.
 15. Priya MD, Khatkar BS. Effect of processing methods on keeping quality of aonla preserve. International Food Research Journal. 2013;20(2):617-622.
 16. Puranik V, Mishra V, Yadav N, Rai GK. Bioactive components retention in processed Indian gooseberry products. Journal of Food Processing and Technology. 2012;3:12.
 17. Sagar VR, Khurdiya DS. Studies on dehydration of fruit products and related quality changes. Reference as cited in the supplied thesis. 1999.
 18. Sethi V, Anand JC. Studies on intermediate moisture products of aonla. Reference as cited in the supplied thesis. 1982.
 19. Singh RK, Pathak RK. Studies on processing suitability of aonla cultivars. Reference as cited in the supplied thesis. 1987.
 20. Tripathi VK, *et al.* Studies on storage quality of aonla candy and related products. Reference as cited in the supplied thesis. 1988.