



EFFECTS OF FLAVOUR INCORPORATION ON QUALITY AND SHELF LIFE OF LADOO PREPARED FROM THREE CULTIVARS OF AONLA (*Emblica officinalis* Gaertn.)

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ABSTRACT

The present study was aimed to develop flavoured laddoo from various cultivars of aonla and to assess the best suited cultivar and their changes in its chemical composition and sensory properties during storage. Well matured aonla (*Emblica officinalis* Gaertn.) fruits (cv. *Banarsi*, *NA-7* and *Desi*) were selected, washed, steamed, de-stoned, pulped and blended with raw (jaggery)/refined sugar. The blended mass was heated upto 70°Brix and then ginger and cardamom (8 g kg⁻¹ pulp) flavours were added to it. The flavoured mass was cooled at room temperature and small laddoo balls prepared. The laddoos were then stored in pet boxes for 3 months to assess the changes in physicochemical and sensory characteristics. Maximum mean moisture (21.6%) and browning (0.14 OD at 440 nm) were found in cv. *Desi* supplemented with ginger and raw sugar. The highest mean ascorbic acid, iron and phosphorus contents of 128.9, 0.88 and 14.8 mg 100 g⁻¹, respectively, were noticed in flavoured laddoo prepared from cv. *NA-7* supplemented with cardamom and refined sugar. An increasing trend in moisture and browning and decreasing trend in ascorbic acid, phosphorus and iron was observed during 3 months storage. On the basis of sensory evaluation (colour, texture, flavour and taste), aonla cv. *NA-7* laddoo supplemented with cardamom and refined sugar was found the best treatment having good shelf life and can be kept for more than 90 days without any adverse effect on its quality attributes.

Key words: Aonla, refined sugar, raw sugar, laddoo, ascorbic acid

INTRODUCTION

Aonla (*Emblica officinalis* Gaertn), popularly known as the Indian gooseberry, is a small sized minor subtropical fruit and grown widely along the hillsides and sub-mountainous areas of North India. The fruit being acrid, cooling, refrigerant, diuretic and laxative is used for treating chronic dysentery, bronchitis, diabetes, fever, diarrhea, jaundice, dyspepsia and coughs (Bhosale *et al.*, 2000). It is highly nutritive and one of the rich sources of ascorbic acid. It contains 500-1500 mg ascorbic acid 100 g⁻¹ pulp. The gallic acid present in aonla fruit has antioxidant properties (Shekhawat *et al.*, 2014). The total area under aonla crop and production in India is about 91,120 ha and 9,89,140 metric tonnes, respectively (Anonymous, 2017). The major aonla producing states in India are Rajasthan, Uttar Pradesh, Gujarat, Tamil Nadu, Maharashtra, Andhra Pradesh, Karnataka and Bihar. However, in Jammu and Kashmir state, area under aonla is about 1970 ha with an annual production of 3280 metric tonnes (Anonymous, 2017). The fruit is extensively used in the preparation of Ayurvedic and Unani medicines like *Chyavanprash*, which promotes health and longevity (Rajkumar *et al.*, 2001).

Due to acidic and astringent taste, the fresh consumption of aonla fruit is less and hence various products like preserve, segments-in-syrup, candy, squash, juice, powder, *etc.* are prepared from the fruits. *Laddos* are sphere-shaped sweets originated in the Indian subcontinent. *Laddos* are made of flour, ghee/butter/oil and sugar with other ingredients that vary by recipe like chopped nuts or dried raisins. The dried products save energy, money and space in packaging, storage and transportation. Plain aonla candies have now been fused with other richly valuable and effective herbs like tulsi, mint, *etc.* Herbal inclusion not only gives a new flavour but also enriched the candy with more medicinal qualities (Nayak *et al.*, 2012). Moreover, there is always a demand from the consumers all over the world for new nutritious and delicately flavoured products; hence the present study was focused on flavour incorporation in *laddoo* prepared from various cultivars of aonla.

MATERIALS AND METHODS

The study was conducted in the Division of Food Science & Technology, SKUAST-J, Udhewalla

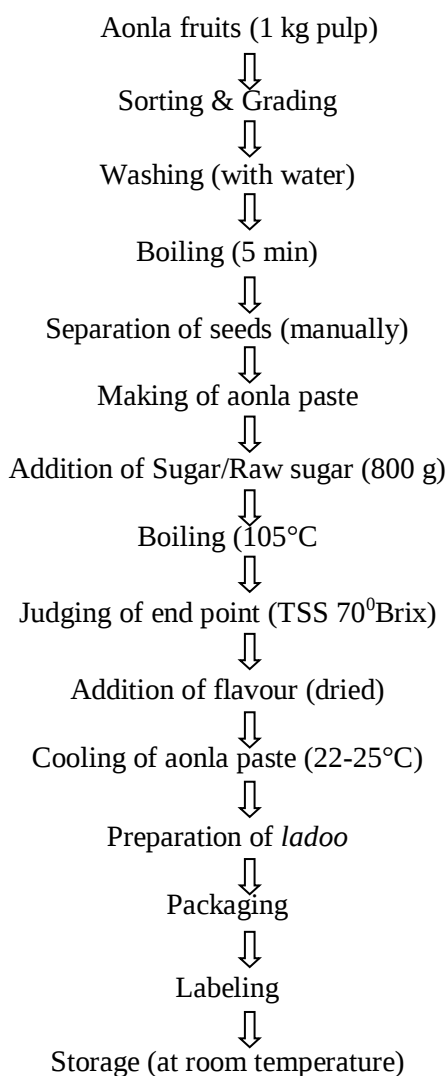


Fig. 1: Flow chart for the preparation of aonla *laddoo*

(J&K) in the year 2014-2015. The flow sheet for making aonla *laddoo* is given in Fig. 1. The defective and injured aonla fruits were sorted out and selected fruits were thoroughly washed with fresh water and steamed. Stones were removed and segments crushed into paste. Refine/ raw sugar was added to paste and cooked till final consistency of 70°Brix was obtained. After adding flavour, the mass was cooled and *laddos* were made and packed into PET (polyethylene terephthalate) boxes for further study. The treatments comprised of fruits of three aonla cultivars viz., *Banarsi*, *NA-7* and *Desi*, each supplemented with either cardamom + refined sugar or ginger + refined sugar or cardamom + raw sugar or ginger + raw sugar. Thus, the total treatment combinations taken were twelve with each treatment replicated three times. The experiment was laid out in a factorial completely randomized design. The chemical analysis of fruit product (*laddoo*) was conducted for moisture, browning, ascorbic acid, phosphorus and iron (Ranganna 1986, AOAC, 2000, 2002). The product was organoleptically evaluated by a semi-trained panel using 9-point hedonic rating (Amerine *et al.*, 1965). The data was subjected to statistical analysis for analysis of variance using standard methods (Cochran and Cox, 1985).

RESULTS AND DISCUSSION

Moisture

An increase in moisture content was observed during the storage period. After one month's storage, the highest moisture content of 21.42% was found in *ladoos* prepared from cv. *Desi* supplemented with ginger and raw sugar while lowest moisture (20.63%) was observed in treatment cv. *NA-7* supplemented with cardamom and refined sugar. After 3 months storage, the highest moisture content of 22.38% was found in treatment cv. *Desi* supplemented with ginger + raw sugar and lowest (21.65%) in treatment cv. '*NA-7*' treated with cardamom + refined sugar. The mean values of storage period showed an increase from initial value of 20.44 to 22.09% after 3 months storage. The interaction effect between treatment and storage was significant (Table 1). Tripathi *et al.* (1988) also noticed an increase in moisture content in aonla preserve. The increase in moisture content might be due to the high humidity in external environment. The product might have absorbed the moisture from external environment or due to the chemical changes such as browning reactions (Mir and Nath, 1993). Navale *et al.* (2014) also reported an increase in the moisture content in wood apple *burfi*.

Ascorbic acid

The highest ascorbic acid content of 134.5 mg 100 g⁻¹ was recorded in *ladoos* prepared from cv. *NA-7* supplemented with cardamom and refined sugar, followed by cv. *NA-7* supplemented with ginger and refined sugar. The lowest ascorbic acid value of 110.2 mg 100 g⁻¹ was found in cv. *Desi* supplemented with ginger and raw sugar after 1 month's storage. After 3 months storage, the ascorbic acid content decreased with maximum value (112.35 mg 100 g⁻¹) recorded in cv. *NA-7* supplemented with cardamom + refined sugar and minimum (87.3 mg 100 g⁻¹) in cv. *Desi* treated with ginger + raw sugar. The treatment, storage as well as their interactions were significant. The mean values of ascorbic acid decreased from initial levels of 133.59 to 100.16 mg 100 g⁻¹ during 3 months storage (Table 2). Ascorbic acid being most sensitive to heat is oxidized quickly in presence of oxygen hence it might have been destroyed during processing and subsequently during storage (Priya and Khatkar (2013). The loss in ascorbic acid during storage is also supported by Nayak *et al.* (2012) in aonla candy and Kuchi *et al.* (2014) in guava jelly bar.

Table 1: Effect of treatments and storage period on moisture content (%) of flavoured aonla ladoo

Treatments	Storage period (months)				Mean
	0	1	2	3	
<i>cv. Banarsi</i>					
Cardamom + refined sugar	20.30	20.78	21.43	22.16	21.16
Ginger + refined sugar	20.35	20.81	21.56	22.07	21.19
Cardamom + raw sugar	20.60	21.18	21.58	22.24	21.40
Ginger + raw sugar	20.70	21.23	21.79	22.12	21.46
<i>cv. NA-7</i>					
Cardamom + refined sugar	20.20	20.63	21.25	21.65	20.93
Ginger + refined sugar	20.25	20.75	21.42	21.72	21.03
Cardamom + raw sugar	20.30	20.84	21.48	22.03	21.16
Ginger + raw sugar	20.30	20.86	21.52	22.05	21.18
<i>cv. Desi</i>					
Cardamom + refined sugar	20.40	20.81	21.46	22.15	21.20
Ginger + refined sugar	20.42	20.63	21.48	22.28	21.20
Cardamom + raw sugar	20.76	21.38	21.83	22.32	21.57
Ginger + raw sugar	20.80	21.42	21.93	22.38	21.63
Mean	20.44	20.94	21.56	22.09	
CD _{0.05}	Treatment (T) = 0.11, Storage (S) = 0.06, T x S = 0.23				

Table 2: Effect of treatments and storage period on ascorbic acid (mg 100 g⁻¹) and browning (OD at 440 nm) of flavoured aonla *laddoo*

Treatments (T)	Ascorbic acid (mg 100 g ⁻¹)					Browning (OD at 440 nm)				
	Storage period in months (S)									
	0	1	2	3	Mean	0	1	2	3	Mean
<u>cv. Banarsi</u>										
Cardamom + refined sugar	143.40	132.65	121.50	110.30	126.96	0.03	0.06	0.09	0.13	0.07
Ginger + refined sugar	142.20	131.40	120.20	109.20	125.75	0.04	0.07	0.10	0.14	0.08
Cardamom + raw sugar	133.50	122.30	110.50	101.25	128.93	0.06	0.10	0.14	0.19	0.06
Ginger + raw sugar	132.30	120.50	109.70	98.20	127.70	0.07	0.11	0.15	0.20	0.07
<u>cv. NA-7</u>										
Cardamom + refined sugar	145.30	134.50	123.60	112.35	107.82	0.02	0.05	0.08	0.11	0.11
Ginger + refined sugar	144.10	133.20	122.10	111.40	106.12	0.03	0.06	0.09	0.12	0.12
Cardamom + raw sugar	135.00	124.20	113.30	102.45	117.38	0.05	0.08	0.11	0.14	0.12
Ginger + raw sugar	134.00	122.20	111.60	101.20	115.17	0.06	0.09	0.12	0.15	0.13
<u>cv. Desi</u>										
Cardamom + refined sugar	124.30	113.20	102.50	91.30	118.73	0.07	0.10	0.13	0.16	0.09
Ginger + refined sugar	123.20	112.00	100.80	88.50	117.25	0.08	0.11	0.14	0.17	0.10
Cardamom + raw sugar	122.50	111.30	99.65	88.50	105.48	0.08	0.12	0.15	0.20	0.13
Ginger + raw sugar	121.30	110.20	98.60	87.30	104.35	0.09	0.13	0.17	0.21	0.14
Mean	133.59	122.30	111.17	100.16		0.05	0.09	0.12	0.15	
CD _{0.05}	T = 0.11, S = 0.06, T x S = 0.22					T = 0.02, S = 0.01, T x S = ns				

Browning

Flavoured *laddoo* prepared from different cultivars of aonla showed a significant increase in non-enzymatic browning during storage (Table 2). After one month's storage, the minimum non-enzymatic browning of 0.05 (OD at 440 nm) was observed in cv. NA-7 supplemented with cardamom and refined sugar, followed by 0.06 (OD at 440 nm) in treatment cv. NA-7 supplemented with ginger + refined sugar and cv. Banarsi treated with cardamom + refined sugar. After 3 months storage, the minimum browning of 0.11 (OD at 440 nm) was recorded in cv. NA-7 supplemented with cardamom + refined sugar, whereas the maximum non-enzymatic browning of 0.21 (OD at 440 nm) was found in cv. Desi treated with ginger + raw sugar. The effect of treatment and storage period interactions were non-significant. The observed increase might be due to the oxidation of phenols and ascorbic acid in Millard types of browning reactions involving sugars and amines which resulted into the formation of brown pigments or melanoidins (Fenemma, 1976). The other possible reason for increase in non-enzymatic browning during storage might be the trapping of oxygen in pet boxes. Dwivedi *et al.* (2015) found a gradual increase in browning of blended bael and aonla leather during storage.

Iron

The iron content of flavoured aonla *laddoo* was significantly affected by different treatment combinations (Table 3). Aonla cv. NA-7 supplemented with cardamom and refined sugar recorded highest iron content of 0.90 mg 100 g⁻¹; whereas lowest value (0.68 mg 100 g⁻¹) was observed in cv. Desi supplemented with ginger and raw sugar after one month's storage. After 3 months storage, the maximum iron content of 0.84 mg 100 g⁻¹ was observed in cv. NA-7 supplemented with cardamom + refined sugar; while the lowest iron content of 0.62 mg 100 g⁻¹ was observed in cv. Desi treated with ginger + raw sugar. Iron content showed a decreasing trend in all the treatments over a storage period of 3 months. The highest iron content (0.88 mg 100 g⁻¹) was recorded in cv. NA-7 supplemented with cardamom + refined sugar; whereas the lowest iron content (0.66 mg 100 g⁻¹) in storage means was found in cv. Desi treated with ginger + raw sugar. Similar results have been reported by Sharma (2012) in value addition of *jamun*.

Table 3: Effect of treatments and storage period on iron content (mg 100 g⁻¹) and phosphorus (mg 100 g⁻¹) of flavoured aonla laddoo

Treatments (T)	Iron content (mg 100 g ⁻¹)					Phosphorus (mg 100 g ⁻¹)				
	Storage period (months)									
	0	1	2	3	Mean	0	1	2	3	Mean
<u>cv. Banarsi</u>										
Cardamom + refined sugar	0.84	0.81	0.78	0.75	0.79	15.30	14.22	13.40	12.63	13.88
Ginger + refined sugar	0.81	0.78	0.75	0.72	0.76	15.24	14.13	13.34	12.56	13.81
Cardamom + raw sugar	0.82	0.76	0.76	0.73	0.88	15.05	14.20	13.38	11.60	14.83
Ginger + raw sugar	0.79	0.78	0.73	0.70	0.84	15.06	14.11	13.32	11.53	14.76
<u>cv. NA-7</u>										
Cardamom + refined sugar	0.93	0.90	0.87	0.84	0.71	16.60	15.35	14.23	13.15	13.43
Ginger + refined sugar	0.89	0.86	0.83	0.80	0.68	16.53	15.27	14.17	13.08	13.36
Cardamom + raw sugar	0.79	0.77	0.76	0.75	0.76	15.30	15.23	14.21	12.11	13.55
Ginger + raw sugar	0.82	0.77	0.76	0.74	0.75	15.10	15.05	14.15	12.05	13.50
<u>cv. Desi</u>										
Cardamom + refined sugar	0.76	0.73	0.70	0.67	0.76	14.84	13.92	12.96	12.02	14.21
Ginger + refined sugar	0.73	0.70	0.67	0.64	0.77	14.76	13.85	12.90	11.96	14.08
Cardamom + raw sugar	0.74	0.71	0.68	0.65	0.69	13.80	13.90	12.94	10.98	12.90
Ginger + raw sugar	0.71	0.68	0.65	0.62	0.66	13.72	13.83	12.88	10.93	12.84
Mean	0.80	0.77	0.74	0.71		15.10	14.42	13.49	12.05	
CD _{0.05}	Treatment (T) = 0.10, Storage (S) = 0.05, T x S = 0.22					T = 0.11, S = 0.06, T x S = 0.23				

Phosphorus

During different storage periods, the phosphorus content significantly decreased from initial level of 15.10 to 14.42 and thereafter to 12.05 mg 100 g⁻¹ (Table 3). After 2 months storage, the highest phosphorus content of 14.23 mg 100 g⁻¹ was found in cv. NA-7 supplemented with cardamom and refined sugar and lowest (12.88 mg 100 g⁻¹) in cv. Desi treated with ginger + raw sugar. After 3 months storage, the maximum and minimum phosphorus contents of 13.15 and 10.93 mg 100 g⁻¹, respectively, was observed in cv. NA-7 treated with cardamom + refined sugar and cv. Desi treated with ginger + raw sugar. The storage mean of treatment (cv. NA-7 treated with cardamom + refined sugar) recorded highest phosphorus content of 14.83 mg 100 g⁻¹ which was closely followed by cv. NA-7 treated with ginger + refined sugar (14.76 mg 100 g⁻¹); whereas the lowest phosphorus content of 12.84 mg 100 g⁻¹ was observed in cv. Desi treated with ginger + raw sugar (Table 3). The findings were supported by Gupta (2007) in case of osmo-dehydrated *ber*, Sharma (2005) in case of blended guava and papaya beverage and Sharma (2012) in case of value addition of *jamun* fruit.

Colour

The colour score of flavoured aonla laddoo decreased during entire storage period (Table 4). After 1 month's storage, maximum score of 8.3 was observed in cv. NA-7 supplemented with cardamom and refined sugar; whereas minimum score of 5.30 was found in cv. Desi supplemented with ginger and raw sugar. After 3 months storage, the scores decreased to 7.90 in cv. NA-7 supplemented with cardamom + refined sugar and 5.05 in cv. Desi treated with ginger + raw sugar. The highest overall mean score of 8.18 was found in cv. NA-7 treated with cardamom + refined sugar and the lowest score of 5.5 in cv. Desi treated with ginger + raw sugar. During storage period, a decreasing trend was observed in mean score a from 7.04 to 6.36 after three months storage period. The treatments and storage mean interactions significantly differed. The decrease in appeal for colour was probably due to browning reactions occurring in the product. Domale *et al.* (2008) also noticed a decreasing trend in scores for colour in aonla toffee during storage period. Shakir *et al.* (2009) noticed a decreasing trend in scores for colour in apple-pear mixed fruit jam during storage.

Table 4: Effect of treatments and storage period on colour and texture of flavoured aonla laddoo

Treatments	Colour					Texture				
	Storage period (months)									
	0	1	2	3	Mean	0	1	2	3	Mean
<u>cv. Banarsi</u>										
Cardamom + refined sugar	8.00	7.90	7.60	7.20	7.68	8.00	7.70	7.35	7.00	7.51
Ginger + refined sugar	7.90	7.65	7.25	6.65	7.36	7.50	7.12	6.92	6.75	7.07
Cardamom + raw sugar	7.45	7.00	6.80	6.30	8.18	6.95	6.72	6.55	6.45	7.70
Ginger + raw sugar	7.40	7.20	7.00	6.60	7.70	6.70	6.60	6.40	6.30	7.59
<u>cv. NA-7</u>										
Cardamom + refined sugar	8.50	8.30	8.00	7.90	6.11	8.10	7.63	7.83	7.38	6.38
Ginger + refined sugar	8.10	7.90	7.60	7.20	6.50	8.01	7.51	7.44	7.22	6.25
Cardamom + raw sugar	7.60	7.40	7.10	6.90	6.89	7.10	6.95	6.60	6.45	6.67
Ginger + raw sugar	7.50	7.30	6.50	6.00	7.05	7.00	6.75	6.50	6.10	6.50
<u>cv. Desi</u>										
Cardamom + refined sugar	7.00	6.00	6.00	5.45	7.25	6.60	6.40	6.30	6.20	6.78
Ginger + refined sugar	7.00	6.70	6.40	5.90	6.83	6.50	6.30	6.20	6.00	6.59
Cardamom + raw sugar	6.00	5.90	5.70	5.25	5.71	5.40	5.25	5.15	5.05	5.21
Ginger + raw sugar	6.50	5.30	5.15	5.05	5.50	5.38	5.20	5.08	5.02	5.17
Mean	7.41	7.04	6.75	6.36		6.93	6.67	6.52	6.32	
CD _{0.05}	Treatment (T) = 0.05, Storage (S) = 0.05, T x S = 0.09					T = 0.05, S = 0.05, T x S = 0.09				

Texture

The maximum score of texture (7.63) was recorded in cv. NA-7 supplemented with cardamom and refined sugar and minimum of 5.20 in cv. Desi treated with ginger and raw sugar after 1 month's storage (Table 4). After 3 months storage, the texture score decreased to 7.38 in cv. NA-7 treated with cardamom + refined sugar and 5.02 in cv. Desi treated with ginger + raw sugar. Mean value of treatments varied significantly with highest mean score (7.7) registered in cv. NA-7 supplemented with cardamom and refined sugar and lowest (5.17) in cv. Desi supplemented with ginger and raw sugar. During storage period, there was decrease in mean score from 6.67 after 1 month's storage to 6.32 after 3 months storage. The change observed in texture during storage may be attributed to the degradation of pectin materials in fruits and also due to moisture pickup by the products. Shobha and Bharati (2007) reported a decrease in scores for texture in ber *burfi* during storage period. Similar results have been reported by Nayak *et al.* (2012) in case of flavoured aonla candy and Patel and Kushwaha (2014) in case of aonla preserve during storage period.

Flavour

During storage, mean score of flavour decreased from 1 month to 3 months. After 3 months storage flavour score decreased in all the treatments with highest score (7.52) recorded in cv. NA-7 supplemented with cardamom and refined sugar. Mean score of 6.68, 6.51 and 6.36 at 1, 2 and 3 months storage, respectively, (Table 5) indicated a decrease in appeal as far as the flavour of *laddoo* was concerned which may be attributed to various chemical changes and loss of volatiles. Bhattacharjee *et al.* (2013) reported reduction in score for flavour during storage of aonla candy. Patel and Kushwaha (2014) also reported similar results for aonla preserve during storage period.

Taste

The score of taste of flavoured aonla *laddoo* decreased during the entire storage period (Table 5). After 1 month's storage, maximum score of 8.0 was observed in cv. NA-7 supplemented with cardamom and refined sugar and minimum of 5.25 in cv. Desi supplemented with cardamom and raw sugar and ginger and raw sugar. After 3 months storage the taste score decreased to 7.23 in cv. NA-7 treated with cardamom + refined sugar and 5.05 in cv. Desi treated with ginger + raw sugar. However, significant difference was found in the taste scores of flavoured aonla *laddoo* during three

Table 5: Effect of treatments and storage period on flavour and taste of flavoured aonla laddoo

Treatments	Flavour					Taste				
	Storage period (months)									
	0	1	2	3	Mean	0	1	2	3	Mean
<u>cv. Banarsi</u>										
Cardamom + refined sugar	8.00	7.77	7.69	7.50	7.74	8.00	7.50	7.30	7.00	7.45
Ginger + refined sugar	7.40	6.90	6.86	6.73	6.97	7.50	7.00	6.70	6.59	6.95
Cardamom + raw sugar	6.90	6.70	6.40	6.10	7.79	7.10	6.70	6.45	6.30	7.81
Ginger + raw sugar	6.62	6.54	6.38	6.18	7.76	7.00	6.50	6.30	6.20	7.61
<u>cv. NA-7</u>										
Cardamom + refined sugar	8.20	7.90	7.62	7.52	6.24	8.50	8.00	7.50	7.23	6.73
Ginger + refined sugar	8.10	7.79	7.63	7.45	6.25	8.12	7.71	7.41	7.20	6.30
Cardamom + raw sugar	7.10	6.60	6.50	6.20	6.53	7.20	6.87	6.63	6.45	6.64
Ginger + raw sugar	7.00	6.85	6.71	6.57	6.43	7.20	6.50	6.40	6.15	6.50
<u>cv. Desi</u>										
Cardamom + refined sugar	6.60	6.30	6.10	5.95	6.60	6.90	6.75	6.75	6.50	6.79
Ginger + refined sugar	6.50	6.40	6.03	6.05	6.78	6.50	6.30	6.25	6.15	6.56
Cardamom + raw sugar	6.40	5.28	5.17	5.09	5.48	6.40	5.25	5.17	5.10	5.48
Ginger + raw sugar	6.30	5.20	5.12	5.00	5.40	6.36	5.25	5.16	5.05	5.46
Mean	7.09	6.68	6.51	6.36		7.22	6.69	6.50	6.32	
CD _{0.05}	Treatment (T) = 0.05, Storage (S) = 0.04, T x S = 0.08					T = 0.05, S = 0.04, T x S = 0.07				

months storage. Shobha and Bharati (2007) reported decrease in taste scores of ber *burfi* during storage period. A decreasing trend in the scores of taste was also observed by Nayak *et al.* (2012) in flavoured aonla candy during storage period. Bhattacharjee *et al.* (2013) reported reduction in score for taste during storage of aonla candy. Patel and Kushwaha (2014) also noticed similar results for aonla preserve during storage period.

Conclusion: The storability study revealed that aonla *laddoos* prepared in case of cv. NA-7 supplemented with cardamom and refined sugar was found best having good shelf life, followed by cv. NA-7 supplemented with ginger and raw sugar, cv. Banarsi supplemented with cardamom and refined sugar and can be kept for more than 90 days.

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