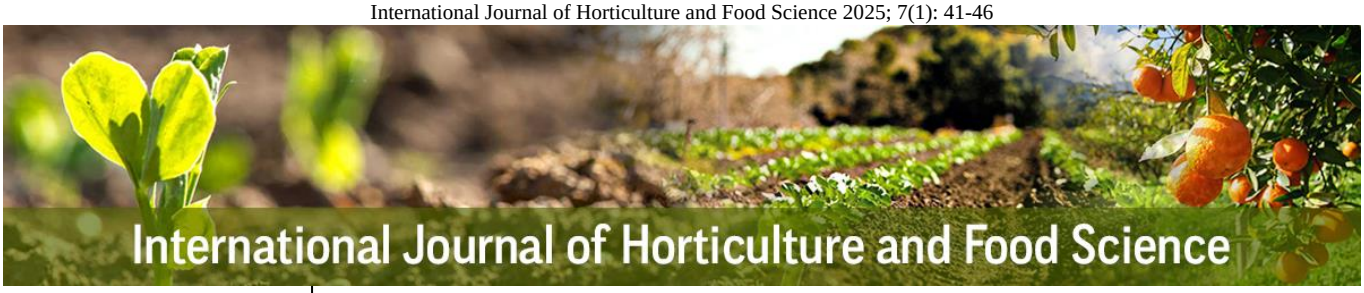

E-ISSN: 2663-1067
P-ISSN: 2663-1075
www.hortijournal.com
IJHFS 2025; 7(1): 41-46
Received: 03-11-2024
Accepted: 06-12-2024

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Effect of processing technique and storage on the ascorbic acid retention & organoleptic characteristics of Amla laddu

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DOI: https://doi.org/10.33545/26631067.2025.v7.i1a.242

Abstract
The amla is a seasonal, acidic and bitter fruit. The present study was undertaken to study the effect of processing technique and storage on the ascorbic acid retention and organoleptic characteristics of laddu prepared from amla. Four varieties of amla *viz.*, Kanchan, Krishna, NA-7 and Gujarat-1 were used to prepare laddu. The physicochemical and nutritional composition of the laddu were analyzed. These products were stored for 30 days period and retention of nutrients during storage period was recorded. The significant increase was observed in reducing sugar and total sugar content of different varieties under different storage conditions. The highest value for reducing sugar (44.60%), total sugar (66.27%) were observed in the Krishna laddu, while the lowest in the laddu prepared from Gujarat-1. Moisture, fiber, acidity, texture, ascorbic acid and non-reducing sugar were significantly decreased as the period storage increased. The highest moisture was observed in the laddu made from Gujarat-1 variety (22.73%) and the lowest in the Krishna variety (14.70%). Fiber content was observed in the *laddu* highest and lowest in Krishna (4.51%) and Kanchan (3.44%), respectively. The highest and lowest acidity was noticed in the Gujarat-1 laddu (2.40%) and Krishna laddu (2.01%). The highest and lowest non-reducing sugar was observed in the Krishna laddu (21.67%) and Gujarat-1 laddu (18.95%). Krishna and Kanchan laddu exhibited the highest (256.22 mg%) and showed the lowest (216.44 mg%) ascorbic acid. The highest score for organoleptic parameters were found for the laddu made from Krishna followed by NA-7, Gujarat-1 and Kanchan variety.

Keywords: Amla, laddu, nutritional composition, storage period, organoleptic evaluation

1. Introduction
Amla (Indian gooseberry) is one of the oldest Indian fruits and it is thought to have its origin in India. Amla (*Emblica officinalis* Gaertn.) or Indian gooseberry is a minor sub-tropical deciduous tree belonging to the family '*Euphorbiaceae.*' It is also known by other names such as amlaki, amali, ambali, aonla, amalakanu and nelli in different parts of India (Bajpai and Shukla, 1985) [10]. 100 g edible portion of amla provides 81.8 g moisture, 13.4 g carbohydrates, 3.4 g fibre, 0.5 g protein, 0.1 g fat, 0.05 g calcium, 20 mg phosphorus, 1.2 mg iron, 0.2 mg niacin, 0.03 mg thiamine, 0.01 mg riboflavin, 9 mg beta carotene, 58 kcal energy and 600 mg ascorbic acid, 5.0 mg sodium and 225 mg potassium (Swaminathan, 1990 and Gopalan *et al*., 2004) [27]. Indian gooseberries are very rich in anti-oxidants and abundant in vitamin C. Dharmananda (2003) reported a vitamin C content of 625 mg per 100 g of fruit.

Aonla fruit has high medicinal value among indigenous fruits of India. It is valued as an antiscorbutic, diuretic, laxative antibiotic and acidic cooling refrigerant (Singh *et al.*, 1993). Aonla fruit is the main ingredient in *chyavanprash* and is one of the three ingredients in *triphala* used in the treatment of biliousness, constipation and enlarged liver (Singh *et al.*, 1993). Aonla is extensively used in Ayurvedic and Unani systems of medicine in the form of preserve or after drying. In the form of preserve, it is thought to have synergetic action and is recommended with certain Unani medicines. Its beneficial role has been ascribed to the presence of anthracin and phenols. Listed cures include imparting of energy to the heart, brain and liver as well as stopping diarrhoea and giddiness (Jain *et al.*, 1983) [39]. Amla, with its high vitamin C content, is considered valuable in diabetes.

The demand for Aonla fruit and its products is increasing mainly due to the presence of Vitamin – C, phenolic compound and fibre. These nutritional elements have association with the prevention of several diseases like cancer, coronary heart disease, viral hepatitis, gastritis (Bensimon and Kiwi, 1991) [15]. Amla is being processed in to variety of products like Chyavanprash (Anon, 1966) [3], pickle (Chundawat and Sharma, 1978) [19], murrabba (Jain *et al*., 1983) [39], dried flakes and brine preserves (Naik and Chundawat, 1996) [19] and blended beverage (Rajguru, 2008). Thus, the present study has been planned to develop and conduct storage study of Aonla *ladu* with the following objectives.

- To evaluate physico-chemical changes of Aonla *ladu* as influenced by different Aonla cultivars.
- To study the effect of processing technique on the retention of ascorbic acid in amla products.
- To evaluate the organoleptic properties of the *ladu* immediately after preparation and upon storage.

2. Materials and methods

2.1. Collection of raw materials

All the ingredients required for the preparation of the amla ladu as mentioned in the process except amla fruits were procured from the local market give suitable preliminary treatment it required.

2.2. Preparation of Aonla *Ladu*

Mature and fresh aonla fruits (1.5 kg) were randomly selected. The fruits were thoroughly washed. Then shreded using shredder and the stones were removed. The shredded pulp was collected in a steel vessel. It was strained through fine muslin cloth. Again, the pulp was tied in cotton cloth and steamed for 5 min. in dhokla cooker. The semolina (300 g) was roasted with ghee (50 g) on low flame burner till the brown colour was obtained. Simultaneously, the jaggery syrup was prepared by using ghee (100 g) and jaggery (1 kg) and shreded ginger (50 g) was added in it. The roasted semolina was mixed with jaggery syrup thoroughly. After that, the steamed amla pulp was added to the syrup and mixed properly on low flame burner for few minutes. The whole content was then cooled slightly and rolled out in the form of *ladu*. The *ladu* then sprinkled with poppy seeds (*Khus-Khus*). The *ladus* were used for chemical analysis, organoleptic study and storage study. For storage study, the *ladus* were packed in polythene bags and stored at room temperature.

2.3. Organoleptic study of aonla *ladu*

The sensory evaluation of the number of treatments of the different Aonla *ladu* in terms taste, colour/appereance, texture and overall acceptability were carried out (during 0 day, 15 days and 30 days) adopting the standard procedure as described by Ranganna (1999).

2.4. Analysis of physicochemical parameters

All the proximate contents were analyzed by following standard AOAC methods (2007). Acidity was determined as per method described by the Ranganna (1979). The mineral contents were determined by using AAS. The ascorbic acid in the *ladu* was determined titrimetrically using 2, 6-dichlorophenol indophenol dye by the method described by Ranganna (1979). The total sugar content was determined by the phenolsulphuric method described by Dubois *et al.* (1956). The reducing sugar was determined by the Nelson Somyogi method described by Somyogi (1952).

2.5. Texture analysis of developed product

The hardness of the amla *ladu* was measured with the use of '*texture analyzer'* (Stable micro system, UK) *(TA-XT2i)* by using the preset settings (Pre-Test Speed: 1.05 mm/s, Test Speed: 2.00 mm/s, Post-Test Speed: 10.0 mm/s, Distance: 5 mm, Trigger Force Auto: 25 g, Data Acquisition Rate: 500 pps). The reading of maximum force (i.e. highest peak) was recorded, when the amla *ladu* fractured into two major pieces. Force following this point was substantially reduced as the knife continues to penetrate through smaller broken pieces. The variation in the observation recorded for different sample (*ladu*) properties.

2.6. Statistical analysis

The experiment was carried out under the Factorial Completely Randomized Design (FCRD). The data obtained for each characteristic were subjected to statistical analysis as per the procedure discussed by Panse and Sukhatme (1978).

3. Results and discussion

3.1. Organoleptic parameters of developed product

It was observed that the differences in taste score of Aonla Ladu due to various treatments were significantly varied at 0 days, 15 days and 30 days. However, there has been a significant decrease in taste acceptance score for amla *ladu*. The Aonla *Ladu* was found to be higher and acceptable score for the Krishna from (34.31) for 0 days to (29.76) for 30 days which slightly decline in values like NA-7 (from 33.30 to 29.40) followed by Gujarat-1 and Kanchan. Further, it was also observed from the result that the taste score of the Aonla *Ladu* decreased with increase in the storage period. However, Krishna variety and NA-7 was noticed maximum taste score acceptable during all the storage period as compared to all other varieties. Similar findings were reported by Sahu *et al.*, (2010) [25].

It was observed that the differences in colour/appereance of amla ladu due to various treatments were significantly varied at 0 days, 15 days and 30 days. However, there has been a significant decrease in colour/appereance acceptance score for amla *ladu*. The amla *ladu* were found to be acceptable and the score was higher for the Krishna variety from (34.32) for 0 days to (28.46) for 30 days, which was a slightly decline in values were observed in the NA-7 variety (from 32.95 to 26.26) followed by Gujarat-1 and Kanchan. Further, it is also observed from the result that the colour/appereance score of the amla *ladu* decreased with the increase in the storage period. However, Krishna variety and NA-7 were having maximum colour/appereance score which was acceptable during all the storage period as compared to other varieties. The color evaluation showed that color of the Aonla preserve decrease with storage period in all treatments. Similar findings were observed by Bhagwan (1992), Sharma (2000).

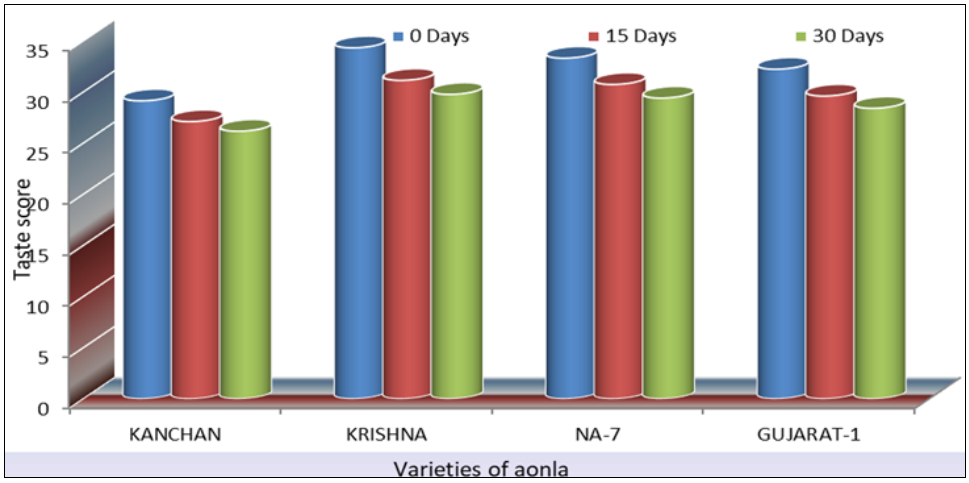

Fig 1: Taste scores of different Amla varieties

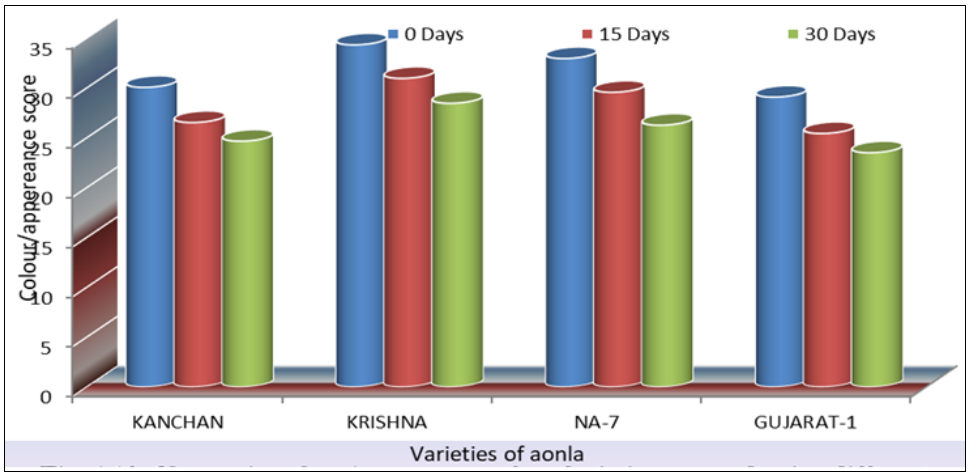

Fig 2: Colour/appearance scores of different amla varieties

It was observed that the differences in texture score of Aonla Ladu due to various treatments were significantly varied at 0 days, 15 days and 30 days. The amla *ladu* were found to be acceptable and the score was higher for the Krishna variety *ladu* from (16.57) for 0 days to (14.66) for 30 days. A slight decline in the values for the *ladu* prepared from NA-7, Gujarat-1 and Kanchan were also observed. Further, it is also observed from the result that the texture score of the aonla *Ladu* decreased with increase in the storage period. However, Krishna variety and NA-7 were having maximum texture score which was acceptable during all the storage period as compared to other varieties.

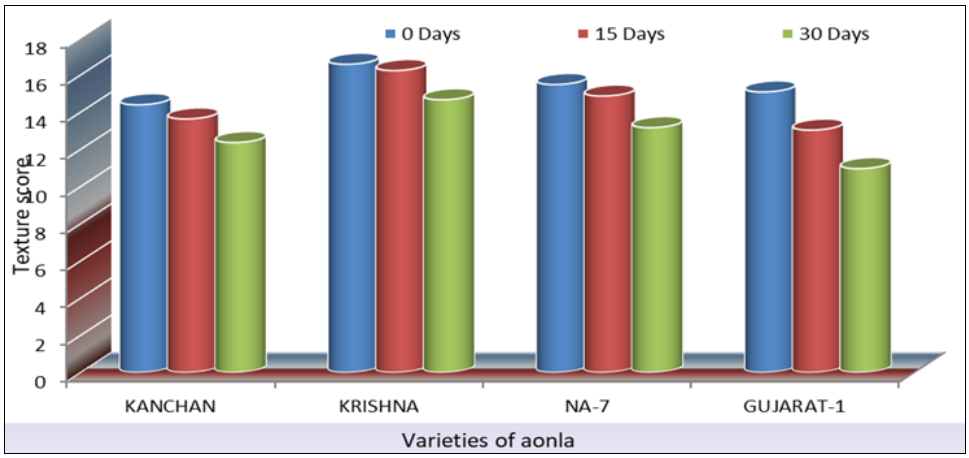

Fig 3: Texture scores of different Amla varieties

It was observed that the Overall acceptability score of Aonla *Ladu* made from different varieties was significantly varied. The amla *ladu* made from Krishna variety had higher acceptable score which ranged from (78.38) for 0 days to (57.46) for 30 days. There was slight decline in the values for the overall acceptability different periods in the *ladu* prepared from other varieties. Further, it is also observed from the result that the Overall acceptability score of the amla *Ladu* decreased with increase in the storage period. However, Krishna variety and NA-7 were having maximum

Overall acceptability score during all the storage period as compared to other varieties.

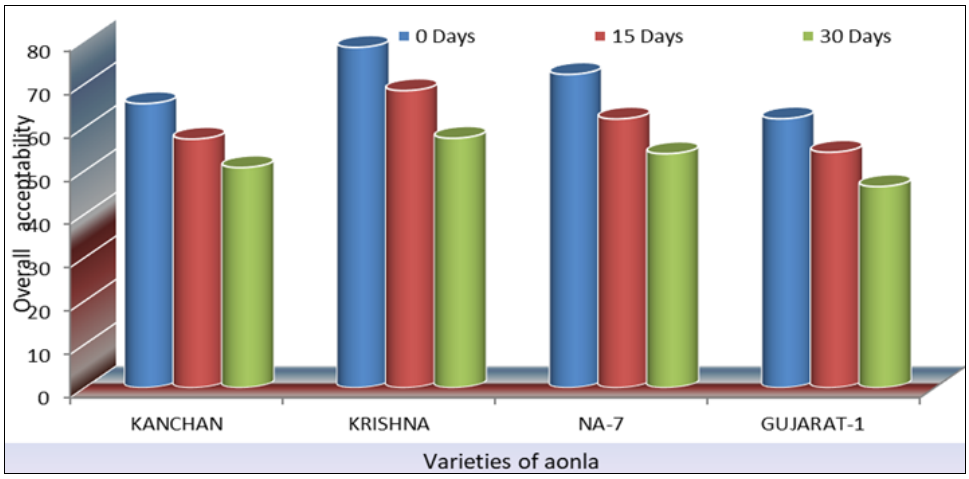

Fig 4: Overall acceptability scores of different amla varieties

3.2. Physicochemical parameters of developed product

The moisture was significantly ($p< 0.05$) varied among different varieties *ladu* under different storage conditions. The highest moisture was observed in the *ladu* made from Gujarat-1 variety (22.73%) while the lowest moisture was observed in the *ladu* made from Krishna variety (14.77%) followed by NA-7 and Kanchan varieties, throughout the entire period of storage. However, the different storage period also showed the significant ($p< 0.05$) decline in moisture content. Thus, the results indicate that the moisture content of the *ladu* varied and also decreased during the storage. Similar results were reported by Naik (1992).

Table 1. Moisture content of aonla *ladu* prepared from different varieties under various storage periods

Among the four varieties of aonla studied, the highest acidity was observed in the *ladu* made from Gujarat - 1 variety (2.40%), while, the lowest acidity was observed in the Krishna variety *ladu* (2.01%) followed by NA-7 and Kanchan. The different storage period also showed the significant ($p< 0.05$) variance in the acidity. Thus, the results indicate that the acidity of the *ladu* significant decreased as the storage period increased on the storage of 30 days. Similar findings were cited by Gajanana *et al.* (2005) [23], Rajguru, (2008) and Reddy *et al.*, (2009) [30].

Table 2: Acidity (%) of aonla *ladu* prepared from different varieties under various storage periods

DV Mean Table	0 Days	15th Days	30th Days	Variety Mean
KANCHAN	2.24	2.05	1.85	2.04
KRISHNA	2.22	2.00	1.83	2.01
NA-7	2.38	2.21	2.01	2.20
GUJARAT-1	2.60	2.41	2.18	2.40
Day Mean	2.36	2.17	2.97	
Total	78.06		General Mean	2.16

The highest value for the texture was observed in the *ladu* made from Krishna variety (5.03 g force), while, the lowest value was observed in Gujarat -1 variety *ladu* (4.03 g force) followed by NA-7 and Kanchan varieties throughout the highest mean value period of storage. Thus, the result indicated that the significant ($p< 0.05$) decreased value for the texture of the *ladu* under different period of storage.

Table 3: Texture (g force) of aonla *ladu* prepared from different varieties under various storage periods

DV Mean Table	0 Days	15 Days	30 Days	Variety Mean
Kanchan	4.43	4.16	3.80	4.13
Krishna	5.30	5.00	4.80	5.03
Na-7	5.00	4.81	4.60	4.80
Gujarat-1	4.20	4.06	3.83	4.03
Day Mean	4.73	4.51	4.25	
Total	162.05		General Mean	4.50

The highest fiber content was observed in the *ladu* made from Krishna variety (4.51), while, the lowest fiber content was observed in the *ladu* made from Kanchan variety (3.44) followed by NA-7 and Gujarat-1 varieties. The different storage period also showed the significant ($p< 0.05$) decline in fiber content. Thus, the results indicate that the fiber content of the *ladu* varied and also decreased during the storage. Similar results were highlighted by Reddy *et al.*, (2009) [30].

Table 4: Fiber content of aonla *ladu* prepared from different varieties under various storage periods

DV Mean Table	0 Days	15 Days	30 Days	Variety Mean
Kanchan	4.29	3.39	2.63	3.43
Krishna	4.75	4.35	4.44	4.51
Na-7	4.16	4.81	2.92	3.63
Gujarat-1	4.62	4.48	4.03	4.38
Day Mean	4.45	4.01	3.50	
Total	143.70		General Mean	3.99

The ascorbic acid content was varied widely in Aonla *ladu*. However, the Krishna variety *ladu* exhibited the highest (256.22 mg %) ascorbic acid, whereas the Kanchan variety *ladu* showed the lowest (216.44 mg %) ascorbic acid throughout the period of storage. The result indicated showed that there was significantly ($P < 0.05$) decrease in the ascorbic acid content of Aonla *ladu* under different period of storage. Similar findings were reported by Jain *et al.* (2003) [37], Naik (1992), Tripathi *et al.* (1998) [38], Ganatra (2002) [24], Gajanana *et al.*, (2005) [23] and Khurdiya (2002) [36].

Table 5: Ascorbic Acid (mg %) of aonla *ladu* prepared from different varieties under various storage periods

DV Mean Table	0 Days	15 Days	30 Days	Variety Mean
Kanchan	240.66	218.33	190.33	216.44
Krishna	279.51	259.83	229.33	256.22
Na-7	255.16	233.33	200.00	229.50
Gujarat-1	260.00	238.33	210.33	236.22
Day Mean	258.83	237.45	207.50	
Total	8445.55		General Mean	234.55

The highest reducing sugar per cent was observed in the *ladu* made from Krishna variety (44.60%), while, the lowest was observed in the *ladu* made from Gujarat -1 variety (42.18%) followed by NA-7 and Kanchan, irrespective of different storage periods. The different storage period also showed significant ($p< 0.05$) variation in reducing sugar. Thus, the results indicate that the reducing sugar of the *ladu* varied and also increased during the storage of 30 days. Deka *et al*. (2004) [21] reported reducing sugar content range 4.05 to 11.57 mg percentage after six months storage in lime aonla beverage. Damnane *et al.,* (2002) showed a marked increase in reducing sugar in Aonla preserve during storage period of six months. Reddy *et al.,* (2009) [30] observed that an increase the reducing sugar of amla syrup on the storage of 90 days.

Table 6: Reducing sugar (%) of aonla *ladu* prepared from different varieties under various storage periods

DV Mean Table	0 Days	15 Days	30 Days	Variety Mean
KANCHAN	42.00	43.26	44.23	43.16
KRISHNA	43.26	44.76	45.76	44.60
NA-7	42.30	43.16	44.00	43.15
GUJARAT-1	41.20	42.23	43.13	42.18
Day Mean	42.19	43.35	44.28	
Total	1558.00		General Mean	43.27

The highest non-reducing sugar per cent was observed in the Krishna variety *ladu* (21.67 %), while, the lowest non-reducing sugar per cent was observed in the Gujarat -1 variety *ladu* (18.95%). Thus, result indicated gradually decreased in non-reducing sugar per cent. Reddy *et al.,* (2009) [30] reported the decrease in the non-reducing sugar of amla syrup on the storage of 90 days.

Table 7: Non-reducing Sugar (%) of aonla *ladu* prepared from different varieties under various storage periods

DV Mean Table	0 Days	15th Days	30th Days	Variety Mean
Kanchan	20.50	20.10	19.83	20.14
Krishna	22.00	21.63	21.40	21.67
Na-7	21.00	20.71	20.60	20.77
Gujarat-1	19.26	18.85	18.73	18.95
Day mean	20.69	20.32	20.14	
Total	733.90		General Mean	20.38

The highest total sugar per cent was observed in the *ladu* made from Krishna variety (66.27%), while, the lowest Total sugar per cent was observed in the *ladu* made from Gujarat-1 variety (61.13%) followed by NA-7 and Kanchan irrespective of the different storage periods. The different storage period also showed significant ($P < 0.05$) increase in total sugar. Thus, the results indicate that the total sugar of the *ladu* varied and also increased during on the storage of 30 days. Damnane *et al.,* (2002) reported a marked increase in total sugar on physicochemical changes in Aonla preserve during storage period of six months. Reddy *et al.,* (2009) [30] observed that an increase the Total sugar of amla syrup on the storage of 90 days. Sahu *et al.,* (2010) [25] observed that the Total sugar increased 52.83 % to 56.71 % at the end storage of six months studies in Aonla preserve (murabba) of three cultivars.

Table 8: Total Sugar (%) of aonla *ladu* prepared from different varieties under various storage periods.

DV Mean Table	0 Days	15th Days	30th Days	Variety Mean
Kanchan	62.50	63.36	64.06	63.31
Krishna	65.26	66.40	67.16	66.27
Na-7	63.30	63.88	64.60	63.92
Gujarat-1	60.46	61.08	61.86	61.13
Day mean	62.88	63.68	64.42	
Total	2291.90		General Mean	63.664

4. Conclusion

From the study, it can be concluded that, among the four varieties, Krishna was the most acceptable for the preparation of *ladu*. Nutritional quality of the *ladu* in terms of its main nutrients i.e., ascorbic acid made from Krishna variety was superior and contained the highest Ascorbic acid. The storage period deteriorated the nutritional quality as well as organoleptic characteristics of the *ladu*. The findings of the present study thus, suggest a novel and innovative product of amla having a high nutritive value and also having excellent therapeutic quality. It is suggested that use of amla in the form of *ladu* to increase nutrient intakes for eradicating nutritional deficiencies as vitamin C improves the absorption of important minerals like iron and many other minerals.

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