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PERFORMANCE EVALUATION OF FLAVORED LADOO PREPARED FROM DIFFERENT CULTIVARS OF AONLA (*EMBLICA OFFICINALIS* GAERTN.)

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ABSTRACT
Fresh fruit of aonla cv. *NA-7* recorded highest fruit weight, pulp-stone ratio, moisture, reducing & total sugars, ascorbic acid, ash, iron and phosphorus contents of 40.0 g, 20.97 %, 87.0 %, 2.20 %, 8.54 %, 756 mg 100 g^{-1}, 0.78 %, 1.14 mg 100 g^{-1} and 19.2 mg 100 g^{-1}, respectively followed by cv. *Banarsi* and desi. Before making *ladoo*, fruits were washed with plain water and then blended with sugar/raw sugar. The blended mass was heated upto 70 ^{0}Brix and thereafter ginger and cardamom flavours were added to it. The flavoured mass was then cooled at room temperature and small balls of *ladoos* were made. In the freshly prepared *ladoo* the highest reducing sugar (33.40 %), total sugar (43.60 %), ascorbic acid (145.30 mg 100 g^{-1}), ash (0.34 %), iron and phosphorus (0.93 & 16.60 mg 100 g^{-1}) was found in T_3 (NA-7 + Cardamom + Refined Sugar), while as the lowest values were recorded in T_{12} (Desi + Ginger + Raw Sugar). Sensory evaluation of flavoured *ladoo* revealed that the highest score of colour (8.50), texture (8.10), flavour (8.20), taste (8.50) and overall acceptability (8.28) was recorded in T_3 (NA-7 + cardamom + refined sugar).

INTRODUCTION

Aonla or Indian gooseberry (*Emblica officinalis* G) is one of the most important traditional and under-utilized fruits of Indian sub-continent origin, having immense potential for cultivation on marginal and waste lands (Pareek and Kaushik, 2012). Total area and production under aonla cultivation in India is 110 thousand hectares and 1282 thousand tonnes, respectively (Anonymous, 2014). However, in J&K state, present area under aonla cultivation is about 993.83 hectares with an annual production of 1065.24 million tonnes (Anonymous, 2015). Besides India, naturally growing aonla trees are also found in different parts of the world *viz.,* Sri Lanka, Cuba, Puerto Rico, China, Thailand and Japan (Bakshi *et al.*, 2015).

Aonla is one of the oldest Indian fruits and considered as 'Wonder fruit for health' because of its unique qualities. Aonla is also rich in vitamins and minerals like phosphorus, iron, calcium, carotene and vitamin B complex. Every 100 g of aonla contains nearly 700-750 mg of vitamin C. The fruit is used as an antiscorbic, diuretic and laxative (Singh and Pathak, 1987), hence used for treating common cold, gastric troubles, acidity and scurvy (Tandon *et al*., 2003). Aonla helps in curing a number of ailments like fever, anemia, indigestion, constipation, liver disorder, piles, heart complaints and urinary problems. It is the most preferred in the treatment of skin, hair loss, diabetes, *etc*. (Sundari *et al.,* 2013). Aonla is not consumed as fresh in its raw due to its highly acidic and astringent taste. It is, therefore, processed into various value added products, *viz*., preserve (Damame *et al.,* 2002), candy (Nayak *et al*., 2012), juice (Jain and Khurdiya, 2005), pickle (Premi *et al*., 1999), supari (Singh *et al.,* 2012), slices (Singh *et al*., 2015), powder (Pareek and Kaushik, 2012) *etc.*

Various types of traditional *ladoos* are prepared from multi-grains and flours. Multi-grain *ladoo* is galactogouge and nutritionally rich product. It is prepared with varied kinds of flour, nuts, functional food '*dink*' and *ghee*. The product provides good amounts of biological proteins, functional property, vitamins, minerals and adequate fiber and has a good satiety value (Naidu *et al*., 2013). The different types of products from aonla had been made so far; but work on Aonla *ladoo* is very less under sub-tropical conditions of Jammu. Therefore, keeping the above facts in view, the present study was aimed to develop a new value added product flavoured *ladoo* from different cultivars of aonla with the objectives of assessing the best suited cultivars of aonla for preparation of flavoured *ladoo* and to study its physico-chemical and sensory attributes.

MATERIALS AND METHODS

Fully matured fruits of aonla were procured from Rainfed Research Sub-Station for Sub-Tropical Fruits (RRSS), SKUAST-J, Raya, Samba (J&K) and were taken to Food Processing and Training Centre (FPTC) of Division of Food Science and Technology, Sher-e-Kashmir University of Agricultural Science and Technology (SKUAST) of Jammu, Udheywalla campus during the year 2014-15. Total no. of treatment combinations were twelve with three replications (Table 1) and the experiment was designed complete randomly. The aonla fruits

were washed under tap water to remove the adhering dust and reduce the surface microflora and then steamed. Stones were removed from the aonla fruits and then segments were crushed into paste. Paste was blended with sugar/raw sugar and then blended mass was heated till final consistency of 70 ^{0}Brix was obtained; after that flavours; *i.e* ginger and cardamom was added. The flavoured mass was cooled at room temperature and *ladoos* were made and packed (Fig 1). The physical analysis of fruit like weight was determined by taking mean weight of 10 fruits by using a digital electronic balance (Indosaw805CH) and results were expressed in grams. Pulp/ Stone ratio was calculated by dividing mean pulp weight with mean weight of fruit.

The chemical analysis of fruit and product (*ladoo*) was conducted for moisture (%), total soluble solids (^{0}Brix), titratable acidity (%), reducing sugar (%), total sugar (%), ascorbic acid (mg 100 g^{-1}), browning (OD at 440 nm), tannin (mg 100 g^{-1}), ash (%), iron (mg 100 g^{-1}) and phosphorus (mg 100 g^{-1}). Titratable acidity, reducing, total sugar and browning were determined by using the standard procedures of Rangana (1986). Ascorbic acid by using 2, 6-dichlorophenol indophenol dye and tannins was determined by using the standard procedures of Ruck, 1969. Total soluble solids (TSS), moisture, ash and minerals were determined as per standard procedures given by Saini *et al.,* 2001. The aonla *laddo* were evaluated for sensory attributes by a panel of 7-8 semi-trained judges, as described by Amerine *et al*. (1965) using a 9 point Hedonic scale system for different parameters like colour, texture, flavour, taste and overall acceptability. The mean values of 7-8 semi-trained judges were considered for evaluating the quality. The data obtained was analyzed statistically to determine statistical significance of treatments. Completely Randomized Design (CRD) was used to test the significance of results (Gomez and Gomez, 1984).

Table 1: Details of the treatments of aonla *ladoo*

Treatments	Details
T_1	Banarsi + Cardamom + Refined Sugar
T_2	Banarsi + Ginger + Refined Sugar
T_3	NA-7 + Cardamom + Refined Sugar
T_4	NA7 + Ginger + Refined Sugar
T_5	Desi + Cardamom + Refined Sugar
T_6	Desi + Ginger + Refined Sugar
T_7	Banarsi + Cardamom + Raw Sugar
T_8	Banarsi + Ginger + Raw Sugar
T_9	NA-7 + Cardamom + Raw Sugar
T_{10}	NA-7 + Ginger + Raw Sugar
T_{11}	Desi + Cardamom + Raw Sugar
T_{12}	Desi + Ginger + Raw Sugar

RESULTS AND DISCUSSION

Various cultivars of aonla fruit differed with respect to the weight of fresh fruit. However, maximum average fresh fruit weight (40.0 g) of aonla was possessed by cultivar *NA-7* followed by *Banarsi* and Desi cultivars with an average fresh fruit weight to the tune of 35.0 and 10.0 g, respectively. Singh *et al*. (2015) reported similar results for *Banarsi* and *Desi* cultivars and Nayak *et al*. (2012) recorded maximum fruit weight in cv. *NA-7* of aonla fruit. The difference in average fruit weight might be due to varietal characteristics and agro-climatic conditions in which they are growing. The highest pulp-stone ratio 20.97 was recorded in cv. *NA-7* as a result of smaller sized stone inside the fruit and the lowest value of 8.52 was observed in cv. Desi. This result is in conformity with the results of Singh *et al*. (2009) and Kumar *et al*. (2011) who have reported minimum pulp-stone ratio (12.40) in desi cultivar and 16.65 in *NA-7* cultivar. Teotia *et al.,* 1968 reported that the fibre intensity varied from slightly fibrous to highly fibrous and little variation existed in stone percentage of aonla cultivars. Moisture content of different aonla cultivars ranged from 82 to 87.0 per cent which might be possibly due to the difference in genetic characters of cultivars, soil, cultural and climatic conditions. Pathak *et al*. (2003) also reported moisture content in various aonla cultivars in the range of 85.2 to 87.7 per cent. Among the three cultivars under study, Desi had maximum TSS (11.2 ^{0}Brix) which was followed by *Banarsi* (9.1 ^{0}Brix) and *NA-7* (8.0 ^{0}Brix) cultivars. The variability in TSS content may be due to different cultivars and climatic conditions. Maximum TSS (13.7 ^{0}Brix) was also reported by Singh *et al*. (2012) in Desi as compared to the other cultivars. Maximum acidity to the tune of 2.7 % was found in Desi cultivar followed by cv. *Banarsi* (2.1 %) and *NA-7* (1.90 %). Singh *et al*. (2015) also reported higher acidity in Desi cultivar as compared to the other

Table 2: Physico-chemical characteristics of different aonla cultivars

S. No.	Attributes	Cultivars		
		Banarsi	NA-7	Desi
1	Fruit weight (g)	35	40	10
2	Pulp:stone ratio (g)	20.6	20.97	8.52
3	Moisture (%)	86.4	87	82
4	Total soluble solids (^{0}Brix)	9.1	8	11.2
5	Titratable Acidity (%)	2.1	1.9	2.7
6	Reducing sugar (%)	1.35	2.2	1.1
7	Total sugar (%)	8.26	8.54	7.4
8	Ascorbic Acid (mg 100 g^{-1})	647	756	532
9	Tannins (mg 100 g^{-1})	2.12	0.98	2.36
10	Ash (%)	0.75	0.78	0.7
11	Minerals:			
	(i) Iron (mg 100 g^{-1})			
	(ii) Phosphorus (mg 100 g^{-1})	1.09	1.14	1.04
		18.8	19.2	18.3

Table 3: Physico-chemical composition of freshly prepared flavoured aonla *ladoo*

Treatments	Moisture (%)	TSS (^{0}Brix)	Acidity (%)	Reducing Sugar (%)	Total Sugar (%)	Ascorbic Acid (mg 100 g^{-1})	Browning (OD at440 nm)	Tannin (mg 100 g^{-1})	Ash (%)	Iron (mg 100 g^{-1})	Phosp horus (mg 100 g^{-1})
T_1 (Banarsi + Cardamom + Refined Sugar)	20.30	70.10	0.21	32.30	42.50	143.40	0.03	0.62	0.29	0.84	15.30
T_2 (Banarsi + Ginger + Refined Sugar)	20.35	70.10	0.22	31.20	41.30	142.20	0.04	0.63	0.29	0.81	15.24
T_3 (NA-7 + Cardamom + Refined Sugar)	20.20	70.20	0.18	33.40	43.60	145.30	0.02	0.58	0.34	0.93	16.60
T_4 (NA7 + Ginger + Refined Sugar)	20.25	70.20	0.19	32.60	42.65	144.10	0.03	0.59	0.33	0.89	16.53
T_5 (Desi + Cardamom + Refined Sugar)	20.40	70.00	0.23	25.00	36.60	124.30	0.07	0.64	0.20	0.76	14.84
T_6 (Desi + Ginger + Refined Sugar)	20.42	70.00	0.24	24.30	35.65	123.20	0.08	0.66	0.19	0.73	14.76
T_7 (Banarsi + Cardamom + Raw Sugar)	20.60	70.00	0.24	26.20	38.30	133.50	0.06	0.67	0.25	0.82	15.05
T_8 (Banarsi + Ginger + Raw Sugar)	20.70	70.00	0.25	25.50	37.35	132.30	0.07	0.68	0.23	0.79	15.06
T_9 (NA-7 + Cardamom + Raw Sugar)	20.30	70.10	0.19	27.50	39.25	135.00	0.05	0.60	0.28	0.79	15.30
T_{10} (NA-7 + Ginger + Raw Sugar)	20.30	70.10	0.20	26.30	38.60	134.00	0.06	0.61	0.27	0.82	15.10
T_{11} (Desi + Cardamom + Raw Sugar)	20.76	70.00	0.26	24.20	35.35	122.50	0.08	0.69	0.18	0.74	13.80
T_{12} (Desi + Ginger + Raw Sugar)	20.80	70.00	0.28	23.10	34.50	121.30	0.09	0.70	0.18	0.71	13.72
CD (5 %)	0.18	0.09	0.03	0.25	0.28	0.23	0.01	0.06	0.05	0.03	0.06

Table 4: Sensory evaluation of freshly prepared flavoured aonla *ladoo*

Treatments	Colour	Texture	Flavour	Taste	Overall acceptability
T_1 (Banarsi + Cardamom + Refined Sugar)	8.00	8.00	8.00	8.00	8.05
T_2 (Banarsi + Ginger + Refined Sugar)	7.90	7.50	7.40	7.50	7.50
T_3 (NA-7 + Cardamom + Refined Sugar)	8.50	8.10	8.20	8.50	8.28
T_4 (NA-7 + Ginger + Refined Sugar)	8.10	8.01	8.10	8.12	8.21
T_5 (Desi + Cardamom + Refined Sugar)	7.00	6.60	6.60	6.90	6.82
T_6 (Desi + Ginger + Refined Sugar)	7.00	6.50	6.50	6.50	6.75
T_7 (Banarsi + Cardamom + Raw Sugar)	7.45	6.95	6.90	7.10	7.17
T_8 (Banarsi + Ginger + Raw Sugar)	7.40	6.70	6.62	7.00	7.10
T_9 (NA-7 + Cardamom + Raw Sugar)	7.60	7.10	7.10	7.20	7.18
T_{10} (NA-7 + Ginger + Raw Sugar)	7.50	7.00	7.00	7.20	7.18
T_{11} (Desi + Cardamom + Raw Sugar)	6.00	5.40	6.40	6.40	6.56
T_{12} (Desi + Ginger + Raw Sugar)	6.50	5.38	6.30	6.36	6.50
CD (5 %)	0.20	0.23	0.25	0.18	0.22

cultivars. Variability in titratable acidity was reported by Singh, 1997. The values of reducing and total sugar were found higher in cultivar *NA-7* to the tune of 2.20 and 8.54 per cent, respectively. Patel and Kushwaha (2014) reported the similar results. Mehta *et al.,* 2005 recorded higher values for total and reducing sugars as compared to data obtained in the present study. This might be variation in climatic conditions, maturity stage and varietal characteristics. Aonla is rich in vitamin C and the maximum ascorbic acid (756 mg 100 g^{-1}) was found in cv. *NA-7* which was followed by cv. *Banarsi* (647 mg 100 g^{-1}) and cv. Desi (532 mg 100 g^{-1}). These findings are quite similar with Patel and Kushwaha (2014) who also reported that cv. *NA-7* contained more ascorbic acid to the tune of 733.63 mg 100 g^{-1} as compared to cv. *Kanchan* (512.5 mg 100 g^{-1}). The differences in ascorbic acid content of fruits in the present study and those reported in literature may be attributed to various factors including agro-climatic conditions in which fruts are grown and maturity of fruits (Meghwal and Azam, 2004). The tannin content ranged from 0.98 to 2.36 % in fresh fruits of aonla. The minimum content of tannin was found in cv. *NA-7* followed by cv. *Banarsi*. These findings are in close conformity to those of Nayak *et al*. (2012) who reported 1.81 % tannins in cv. *NA-7*. Ash content was found higher in cv. *NA-7* followed by cvs. *Banarsi* and Desi. The fresh aonla fruit contained mineral content of 1.09, 1.14 and 1.04 mg 100 g^{-1} iron in cv. *Banarsi*, *NA-7* and Desi and 18.8, 19.2 and 18.3 mg 100 g^{-1} phosphorus in cvs. *Banarsi*, *NA-7* and Desi, respectively (Table 2).

The treatment means for moisture content in various blends of *ladoo* were statistically non-significant (20.20 to 20.80%). Nayak *et al*. (2012) reported the moisture content values ranging from 16.55 to 16.85 per cent in flavoured aonla candy. The TSS of the freshly prepared flavoured aonla *ladoo* was maintained at 70^0 Brix in all the treatments. A TSS value of 75 ^{0}Brix was also maintained by Nayak *et al*. (2012) while studying the flavoured aonla candy. Treatment T_{12} (desi + ginger + raw sugar) recorded the highest acidity (0.28 %) while the lowest (0.18 %) was observed in T_3 (NA-7 + cardamom + refined sugar). Similar results were also reported by Nayak *et al*. (2012) who showed a treatment wise increasing trend in acidity content from 0.48 to 0.53 per cent in flavoured aonla candy. The highest reducing sugar content of 33.40 % was found in treatment T_3 (NA-7 + cardamom + refined sugar) whereas treatment T_{12} (desi + ginger + raw sugar) recorded the lowest reducing sugar content of 23.10 per cent. The highest and lowest total sugar contents of 43.60 and 34.50 % were observed in T_3 (NA-7 + cardamom + refined sugar) and T_{12} (desi + ginger + raw sugar), respectively. These results were in agreement with the findings of Singh *et al*. (2015) who studied the development of osmo-air dried aonla slices. Nayak *et al*. (2012) reported the reducing and total sugars content ranging from 38.1 to 36.6 and 66.6 to 64.5 per cent in flavoured aonla candy. The highest ascorbic acid content of 145.30 mg

100 g^{-1} was recorded in T_3 (NA-7 + cardamom + refined sugar) which was followed by T_4 (NA-7 + ginger + refined sugar) containing 144.10 mg 100 g^{-1} of ascorbic acid while T_{12} (desi + ginger + raw sugar) recorded the lowest ascorbic acid content of 121.30 mg 100 g^{-1} (Table 3). These findings are in accordance with the findings of Singh *et al*. (2015). The maximum and minimum browning content of 0.09 and 0.02 (OD at 440 nm) was found in T_{12} (desi + ginger + raw sugar) and T_3 (NA-7 + cardamom + refined sugar), respectively. The Similar findings were reported by Nayak *et al*. (2012). Treatment T_{12} (desi + ginger + raw sugar) recorded maximum tannin content of 0.70 mg 100 g^{-1} where as minimum tannin content of 0.58 mg 100 g^{-1} was found in T_3 (NA-7 + cardamom + refined sugar) (Table 2). Similar results had also been reported by Kumar (2005) while studying sustainability of different *ber* products. It is evident from the results that T_3 (NA-7 + cardamom + refined sugar) recorded maximum ash content of 0.34 % where as T_{12} (desi + ginger + raw sugar) was found to contain minimum ash content of 0.18 per cent, respectively. The maximum and minimum iron content to the tune of 0.93 and 0.71 mg 100 g^{-1} was recorded in T_3 (NA-7 + cardamom + refined sugar) and T_{12} (desi + ginger + raw sugar), respectively. Data pertaining to the phosphorus content revealed that the highest phosphorus content of 16.60 mg 100 g^{-1} was recorded in T_3 (NA-7 + cardamom + refined sugar) which was followed by T_4 (NA-7 + ginger + refined sugar) whereas the lowest phosphorus content of 13.72 mg 100 g^{-1} was noticed in T_{12} (desi + ginger + raw sugar) (Table 3).

Maximum colour score of 8.50 was recorded in T_3 (NA-7 + cardamom + refined sugar) followed by T_4 (NA-7 + Ginger + Refined Sugar) and T_1 (Banarsi + Cardamom + Refined Sugar) with the values 8.10 and 8.0, respectively. The treatment T_3 (NA-7 + cardamom + refined sugar) and T_{12} (desi + ginger + raw sugar) recorded highest and lowest scores to the tune of 8.10 and 5.38 in case of texture. The highest score of 8.20 was recorded in T_3 (NA-7 + cardamom + refined sugar) which was followed by T_4 (NA-7 + ginger + refined sugar) having score 8.10 while lowest flavour score of 6.30 was recorded in T_{12} (desi + ginger + raw sugar). The maximum and minimum score of 8.50 and 6.36 was recorded in T_3 (NA-7 + cardamom + refined sugar) and T_{12} (desi + ginger + raw sugar), respectively (Table 4). The overall acceptability was maximum in T_3 (NA-7 + cardamom + refined sugar) and minimum in T_{12} (desi + ginger + raw sugar) having values of 8.28 and 6.50, respectively. Similar results of overall acceptability were also reported by Nayak *et al.,* 2012 in flavoured aonla candy and the values ranged from 8.3 to 7.7.

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