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Storability Studies of Aonla (*Emblica officinalis* Gaertn.) Syrup

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With a view to develop value added products, from aonla cultivar NA-7, syrup was prepared under different treatments. The prepared syrup was kept at ambient condition for storage study. The syrup remained acceptable upto 240 days at ambient condition. The syrup prepared from T-3 (35 per cent juice, 65 per cent TSS and 1.3 per cent acidity) recorded maximum organoleptic score than other recipe treatments. The biochemical composition in aonla syrup prepared from T-6 (50 per cent juice, 65 per cent TSS and 1.3 per cent acidity) had the maximum retained acidity, TSS, total sugar, reducing sugar than rest of the treatments and their increasing trend with advancement of storage period upto 240 days was recorded under ambient condition. On the other hand, the syrup prepared with T-6 (50 per cent juice, 65 per cent TSS and 1.3 per cent acidity) had maximum ascorbic acid, non-reducing sugar and organoleptic score and these traits showed decreasing trend with increasing storage period upto 240 days under ambient condition. The syrup prepared from T-3 (35 per cent juice, 65 per cent TSS and 1.3 per cent acidity) had the maximum benefit: Cost ratio, high sensory evaluation score and high nutritional quality.

Key words: Indian gooseberry, syrup preparation, biochemical composition, microbial examination and organoleptic evaluation

Aonla also known as Indian gooseberry (*Emblica officinalis* Gaertn.) is adapted to dry region and salt affected soils. The fruit is found growing wild or in cultivated form in different parts of the country. It can be grown easily on calcareous and slightly saline as well as alkaline soils where other fruit crops do not thrive well. Aonla fruits are the richest source of ascorbic acid among fruits except Barbados cherry. The presence of polyphenols or leucoanthocynins owes a lot to the stability of ascorbic acid. The gallic acid present in aonla fruit has antioxidant property. The fruit is in use as pickle, candy and several other nutritional and medicinal products but its use is limited. In view of health benefits, there is need to make the fruits more and more amenable to value added products. The attempt was made to convert aonla to various value added products will be helpful in alleviating distress sale of the aonla fruits often observed in the market during December-February when the harvesting reaches the peak. With such intent the present investigation was carried out to study the suitability of aonla variety for syrup making.

Materials and Methods

The present investigation was carried out at the Department of Horticulture, College of Agriculture, SKRAU, Bikaner (Rajasthan) during 2006-07. Fully mature fruits were selected for the preparation of aonla syrup. The fruits were washed in running water to remove dirt and dust particles. The seeds were removed and cut into small piece by using Hand Carrot Crusher. The slices were blended by adding necessary amount of warm water in a waring blender. The whole mass was obtained in the form of fine aonla fruit juice. After juice extraction required quantity of juice i.e., 25, 30, 35, 40, 45 and 50 per cent were taken for study as per the proposed investigations. Calculated amount of sugars and citric acid were added to the juice to adjust the total soluble solids to 65 per cent and acidity to 1.3 per cent in the final products. Thus, six treatment recipes; (T-1: 25 per cent juice, 65 per cent TSS and 1.3 per cent acidity, T-2: 30 per cent juice, 65 per cent TSS and 1.3 per cent acidity, T-3: 35 per cent juice, 65 per cent TSS and 1.3 per cent acidity, T-4: 40 per cent juice, 65 per cent TSS and 1.3 percent acidity, T-5: 45 per cent juice, 65 per cent TSS and 1.3 per cent acidity and T-6: 50 per cent juice, 65 per cent TSS and 1.3 per cent acidity) were used for the study. The volume of the final products taken for the study was 7.0 litres for each treatment, with three replications. The prepared syrup was filtered by sieving through a muslin cloth to obtain a product of uniform consistency. The product (7.0 litres) was filled in hot, sterilized bottles of 250 ml capacity and corked airtight. The filled bottles were pasteurized

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in an autoclave at a temperature of 100°C for 15 minutes. The syrup bottles were kept at room temperature for storage studies. Samples were drawn out at monthly interval and analyzed for their biochemical quality constituents till the acceptability of the product. The physico-chemical composition viz., TSS was determined by Hand Refractrometer, while total sugar, reducing sugar, acidity, ascorbic acid and microbial counts were estimated as per standard method as suggested by Ranganna (1997). Non-reducing sugar was determined by subtracting the value of reducing sugar from total sugar. The organoleptic evaluation was done by using 9 point Hedonic scale (Amerine *et al.,* 1965). Microbial population in terms of bacteria, yeast and mould counts were also studied as per method as suggested by Ranganna (1997). The data were statistically analyzed by using completely randomized design with factorial design.

Results and Discussion

Biochemical changes

The biochemical composition of the syrup showed (Table 2) increasing trend with of storage period till 240 days at ambient condition. At the end of the storage period, the syrup had maximum TSS (66.00 °Brix), acidity (1.79 %), total sugar (62.51 %)

Table 1. Chemical composition of fruits different aonla cv. NA-7 at harvest

Character/ Cultivar	TSS (°Brix)	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)	Acidity (%)	Ascorbic acid (mg/100 g)	TSS / acidity ratio
NA-7	14.16	3.12	2.05	1.07	2.06	765.74	6.87

and reducing sugar (38.07 %) was recorded under T-6 (50 per cent juice, 65 per cent TSS and 1.3 per cent acidity) while, minimum levels of TSS (65.66 °Brix), acidity (1.59%), total sugar (61.15%) and reducing sugar (29.99%) were recorded with the T-3 (35 per cent juice, 65 per cent TSS and 1.3 per cent acidity). The increased level of attributes may be due to formation of organic acids by ascorbic acid degradation as well as progressive decrease in the astringent and polyphenolic compounds and pectic substances. The increased TSS in syrup with increased of storage period may be due to conversion of left over polysaccharides into soluble sugars. The increase in reducing sugar as well as total sugar corresponded to the increase in total soluble solids (TSS) and ultimate decrease in non-reducing sugar in syrup with increasing storage period. The increased level of total sugars might be due to conversion of starch and pectin into simple sugars. Similar findings were also reported in the beverage of aonla (Jain *et al.,* 2006; Lal, 2006 and Jain *et al.,* 2007). Further, TSS / acidity ratio, pH, ascorbic acid and non-reducing sugars decreased with increasing storage period irrespective of treatments used. However, at the end of storage, the syrup with T-3 (35 per cent juice, 65 per cent TSS and 1.3 per cent acidity) maintained a higher status of ascorbic acid (85.94 mg/100 ml), pH (2.09), TSS/ acidity (43.20) and non-reducing sugar (31.16 %). While, minimum level of ascorbic acid (54.92 mg/ 100 ml) pH (1.81), TSS/acidity (39.99) and non-reducing sugar (14.27 %) was recorded with the T-6 (50 per cent juice, 65 per cent TSS and 1.3 per cent acidity). Such observations might be due to oxidation or irreversible conversion of L-ascorbic acid into dehydro ascorbic acid in the presence of enzyme ascorbic acid oxidase (ascorbinase) with oxygen available through trapping or residual oxygen in the glass bottles. The increased acidity and TSS of all the treatments with increasing storage period had a corresponding decrease in pH value. The reduction in pH could be attributed to simultaneous increase in acidity and TSS of syrup irrespective of their storage periods. Similar findings have been reported by (Mehta and Rathore, 1976; Tripathi *et al.,* 1988; Sethi 1993; Prasad and Mali 2000; Prasad and Mali 2003; Jain *et al.,* 2006; Choudhary *et al.,* 2006; Lal, 2006; Jain *et al.,* 2007 and Choudhary and Dikshit 2007) in various processed products.

Organoleptic evaluation

The organoleptic evaluation of the aonla syrup prepared in six treatments subjecting them to ambient storage condition was carried out at 30 days interval by a panel members. The aonla syrup prepared using T-3 (35 per cent juice, 65 per cent TSS and 1.3 per cent acidity) showed the highest score (9.00) at the end of storage period. The sensory mean score for each attribute was the highest on the first day of, which decreased with increasing period of storage. There are many extrinsic and intrinsic factors which determine the storage stability of products and temperature plays an important role among them. There are certain biochemical changes which occur at low pH and high temperature that leads to formation of brown pigments and produces off flavour in the beverages. The other possible reasons for this phenomenon may be the inactivation of enzymes by preservative action on the treatments and protective action of ß-carotene against non-enzymatic browning. Panelists also recorded a considerable loss of flavour in aonla beverage upon prolonged storage. This may be due to degradation of flavour constituents and unstable nature of volatile substances with advancement of storage time. The present findings are in accordance with the view of Jain *et al.* (2006), Lal (2006), Jain *et al.* (2007), Jain and Khurdyia (2007) and Premi *et al.,* (1999) as observed by them in various aonla products.

Table 2. Effect of different recipe treatments on biochemical changes with advancement of storage period (days) under ambient condition

	TSS (°Brix)									Acidity (%)								
Storage / Recipe	0	30	60	90	120	150	180	210	240	0	30	60	90	120	150	180	210	240
T-1	65.01	65.01	65.01	65.01	65.09	65.15	65.40	65.53	65.82	1.30	1.37	1.38	1.40	1.42	1.44	1.49	1.53	1.62
T-2	65.01	65.01	65.01	65.01	65.07	65.10	65.35	65.46	65.77	1.30	1.36	1.37	1.39	1.40	1.41	1.46	1.51	1.57
T-3	65.01	65.01	65.01	65.01	65.03	65.05	65.30	65.39	65.66	1.30	1.35	1.35	1.36	1.38	1.39	1.44	1.48	1.52
T-4	65.01	65.01	65.01	65.03	65.13	65.18	65.44	65.58	65.89	1.30	1.38	1.40	1.42	1.44	1.47	1.52	1.59	1.67
T-5	65.01	65.01	65.01	65.05	65.17	65.21	65.49	65.65	65.94	1.30	1.39	1.41	1.43	1.46	1.49	1.54	1.62	1.74
T-6	65.01	65.01	65.01	65.06	65.22	65.26	65.53	65.71	66.00	1.30	1.40	1.42	1.44	1.48	1.51	1.56	1.66	1.79
Mean	65.01	65.01	65.01	65.03	65.12	65.16	65.42	65.55	65.85	1.30	1.37	1.39	1.41	1.43	1.45	1.50	1.56	1.65
CD5%	NS	NS	NS	NS	0.009	0.008	0.009	0.009	0.009	NS	NS	NS	NS	0.009	0.009	0.010	0.009	0.009
	TSS / acidity ratio									Organoleptic score								
Storage / Recipe	0	30	60	90	120	150	180	210	240	0	30	60	90	120	150	180	210	240
T-1	48.15	47.45	47.11	46.43	45.84	45.24	43.89	42.28	40.63	8.86	8.79	8.73	8.70	8.66	8.49	8.22	7.77	7.18
T-2	48.15	47.80	47.45	46.77	46.48	46.17	44.76	43.35	41.89	8.92	8.82	8.79	8.75	8.71	8.55	8.29	7.82	7.24
T-3	48.15	48.15	48.15	47.80	47.12	46.80	45.34	44.18	43.20	9.00	8.96	8.91	8.86	8.82	8.64	8.36	7.89	7.30
T-4	48.15	47.11	46.43	45.79	45.23	44.34	43.05	41.24	39.45	8.81	8.73	8.68	8.65	8.61	8.43	8.16	7.72	7.13
T-5	48.15	46.77	46.11	45.49	44.64	43.76	42.52	40.52	37.89	8.77	8.68	8.63	8.58	8.56	8.37	8.09	7.67	7.07
T-6	48.15	46.43	45.78	45.18	44.07	43.22	42.01	39.58	36.87	8.72	8.62	8.57	8.53	8.51	8.31	8.01	7.60	7.01
Mean	48.15	47.28	46.84	46.24	45.56	44.92	43.59	41.86	39.99	8.85	8.77	8.71	8.68	8.64	8.46	8.19	7.74	7.15
CD5%	NS	NS	0.010	0.010	0.020	0.009	0.010	0.010	0.010	NS	NS	0.010	0.010	0.015	0.010	0.015	0.010	0.015
	Total sugar (%)									pH								
Storage / Recipe	0	30	60	90	120	150	180	210	240	0	30	60	90	120	150	180	210	240
T-1	60.69	60.89	60.99	61.12	61.25	61.31	61.42	61.54	61.69	2.59	2.42	2.34	2.20	2.16	2.12	2.06	2.02	1.97
T-2	60.38	60.59	60.72	60.85	60.98	61.04	61.17	61.31	61.45	2.63	2.48	2.39	2.26	2.20	2.17	2.12	2.07	2.00
T-3	60.13	60.35	60.48	60.51	60.65	60.76	60.89	60.99	61.15	2.67	2.53	2.46	2.34	2.28	2.24	2.19	2.12	2.09
T-4	60.93	61.41	61.29	61.41	61.55	61.62	61.74	61.86	61.99	2.54	2.37	2.27	2.14	2.12	2.06	2.00	1.97	1.92
T-5	61.29	61.49	61.59	61.65	61.79	61.87	61.99	62.12	62.29	2.50	2.32	2.22	2.09	2.07	2.00	1.94	1.92	1.88
T-6	61.62	61.83	61.92	61.99	62.10	62.16	62.24	62.38	62.51	2.46	2.27	2.18	2.03	2.02	1.94	1.88	1.85	1.81
Mean	60.84	61.09	61.17	61.25	61.39	61.46	61.57	61.70	61.85	2.56	2.39	2.31	2.18	2.14	2.09	2.03	1.99	1.94
CD 5 %	0.012	0.020	0.015	0.018	0.018	0.020	0.014	0.021	0.020	0.010	NS		NS	0.010	0.010	0.009	0.009	0.009
	Ascorbic acid (mg/100 ml)									Bacterial counts (X 10^{-3} cfu/ml)								
Storage / Recipe	0	30	60	90	120	150	180	210	240	0	30	60	90	120	150	180	210	240
T-1	152.94	150.01	147.69	143.73	140.02	128.25	112.68	85.68	72.74	0.00	0.12	0.13	0.14	0.24	0.26	0.28	0.37	0.43
T-2	154.93	152.23	150.15	147.01	143.03	133.92	119.94	92.17	79.99	0.00	0.10	0.11	0.12	0.21	0.23	0.25	0.33	0.38
T-3	158.99	154.95	153.28	151.15	145.15	139.99	126.15	99.07	85.94	0.00	0.07	0.08	0.10	0.17	0.20	0.21	0.26	0.32
T-4	150.89	147.97	143.94	140.71	135.74	122.72	104.94	79.63	67.67	0.00	0.14	0.15	0.17	0.27	0.30	0.32	0.42	0.48
T-5	147.84	144.99	140.92	137.92	132.15	118.73	97.76	73.94	60.99	0.00	0.17	0.18	0.20	0.31	0.33	0.36	0.47	0.53
T-6	142.82	142.15	138.15	134.73	129.74	113.67	92.94	68.15	54.92	0.00	0.18	0.20	0.22	0.35	0.36	0.39	0.52	0.59
Mean	151.40	148.72	145.68	142.54	137.64	126.21	109.07	83.11	70.37	0.00	0.13	0.14	0.16	0.26	0.28	0.30	0.39	0.45
CD 5 %	0.903	0.903	0.931	0.932	0.932	0.906	0.903	0.931	0.932	NS	0.01	0.01	0.02	0.03	0.01	0.02	0.01	0.02
	Non-reducing sugar (%)									Yeast counts (X 10^{-3} cfu/ml)								
Storage / Recipe	0	30	60	90	120	150	180	210	240	0	30	60	90	120	150	180	210	240
T-1	38.54	37.73	36.27	35.16	34.28	33.20	31.74	29.80	26.53	0.00	0.08	0.13	0.18	0.24	0.27	0.32	0.38	0.43
T-2	40.14	39.41	37.78	36.86	35.98	34.83	33.46	32.37	28.77	0.00	0.06	0.09	0.13	0.18	0.22	0.26	0.32	0.37
T-3	41.99	41.19	39.80	38.60	37.73	36.68	35.37	34.48	31.16	0.00	0.02	0.05	0.09	0.13	0.17	0.21	0.26	0.28
T-4	36.39	35.47	34.30	33.42	32.56	31.40	30.01	27.88	22.82	0.00	0.11	0.16	0.22	0.29	0.32	0.39	0.45	0.49
T-5	35.05	34.24	32.65	31.69	30.81	29.64	28.20	24.88	19.13	0.00	0.13	0.19	0.26	0.35	0.37	0.44	0.52	0.56
T-6	33.06	32.25	31.01	30.06	29.15	28.00	26.46	22.31	14.27	0.00	0.15	0.22	0.30	0.40	0.42	0.48	0.57	0.63
Mean	37.53	36.71	35.30	34.29	33.42	32.29	30.87	28.62	23.78	0.00	0.09	0.14	0.20	0.26	0.29	0.35	0.42	0.46
CD5%	NS	NS	0.258	0.129	0.519	0.258	0.467	0.519	0.258	NS	0.01	0.02	0.02	0.01	0.01	0.02	0.01	0.03
	Reducing sugar (%)									Mould counts (X 10^{-3} cfu/ml)								
Storage / Recipe	0	30	60	90	120	150	180	210	240	0	30	60	90	120	150	180	210	240
T-1	22.15	23.16	25.72	25.96	26.97	28.11	29.68	31.74	35.17	0.00	0.10	0.16	0.19	0.24	0.29	0.36	0.42	0.47
T-2	20.24	21.18	22.94	23.99	24.99	26.21	27.72	28.94	32.68	0.00	0.07	0.13	0.15	0.18	0.24	0.31	0.37	0.41
T-3	18.13	19.16	20.68	21.91	22.92	24.08	25.52	26.51	29.99	0.00	0.03	0.10	0.12	0.14	0.20	0.24	0.28	0.32
T-4	24.54	25.67	26.99	27.99	28.98	30.22	31.73	33.98	39.18	0.00	0.13	0.20	0.23	0.29	0.33	0.40	0.49	0.53
T-5	26.24	27.25	28.94	29.92	30.99	32.24	33.79	37.24	43.16	0.00	0.17	0.23	0.28	0.33	0.38	0.46	0.53	0.58
T-6	28.62	29.58	30.91	31.93	32.95	34.16	35.78	40.07	48.25	0.00	0.20	0.27	0.30	0.36	0.43	0.50	0.57	0.63
Mean	23.32	24.33	26.03	26.95	27.97	29.17	30.70	33.08	38.07	0.00	0.12	0.18	0.21	0.26	0.31	0.38	0.44	0.48
CD 5 %	0.258	0.258	0.467	0.258	0.467	0.258	0.258	0.467	0.258	NS	0.01	0.02	0.03	0.02	0.02	0.02	0.02	0.03

Microbial examination

The microbial population increased invariably with successive increase of storage period irrespective of treatments used. Minimum bacterial counts ($0.32X10^{-3}$cfu/ml), yeast counts ($0.28X10^{-3}$ cfu/ ml) and mould counts ($0.32X10^{-3}$ cfu/ml) were noted under T-3 (35 per cent juice, 65 per cent TSS and 1.3 per cent acidity). Such finding may be probably due to some undergone contaminations during preparation and examinations.The observations made by (Jain *et al*., 2003 and Baramanray *et al*., 1995) are in consonance to the present finding.

Economics

The maximum Benefit: Cost ratio (2.31:1) in aonla syrup was observed under T-3 (35 per cent juice, 65 per cent TSS and 1.3 per cent acidity) and minimum (1.88:1) under T-6 (50 per cent juice, 65 per cent TSS and 1.3 per cent acidity).

Conclusion

Based on present study, it appears that aonla fruits can be converted to syrup under different treatments of 35 per cent juice, 65 per cent TSS and 1.3 per cent acidity. The shelf life of the product was observed to be 240 days at ambient conditions.

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