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ORIGINAL ARTICLE

Effect of processing treatment on nutritional properties and phytochemical contents of aonla (*Emblica officinalis*) juice

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Abstract The present study was undertaken to evaluate physico-chemical composition and to study the effect of processing on phytochemical contents and nutritional components of anola juice prepared from Banarasi cultivar. Aonla juice pasteurized at 90 °C for 1 min showed better retention of phytochemicals as well as sensory characteristics. Methanol was used as a solvent for extraction of phytochemicals and reversed phase high performance liquid chromatography was performed to identify and quantify the phytochemical contents in juice extract. The pasteurized juice extract contained gallic acid, ethyl gallate, ellagic acid and quercetin 79.12, 0.29, 112.11 and 1.32 mg/100 g, respectively. Ascorbic acid content in juice extract was 155.04 mg/100 g. The storage study of aonla juice was conducted at refrigeration (4 °C) and ambient condition (25–40 °C).

Keywords Juice · Phytochemicals · Sensory · Pasteurization · Ascorbic acid

Introduction

Owing to nutritional, commercial and therapeutic significance, aonla is gaining popularity all over the world (Goyal et al. 2007). Aonla is a rich source of ascorbic acid, polyphenol, flavonoid and tannin (Jain and Khurdiya 2004; Baliga and Dsouza 2011). Because of these properties it is used in cosmetic, pharmaceutical and processing industries. Aonla is one of the underutilized fruit having enormous potential in world market and needs to be popularized. It is an important part of Ayurvedic and Unani system of medicine.

Aonla juice is a potential source of polyphenolic compounds which are helpful in the treatment against health disorders like gastric disorders, diabetes, skin problems, blood pressure and also lower down ageing etc. (Singh et al. 1993). Free and bound phenolic in aonla are responsible for higher antioxidant activity i.e. 4–10 fold higher than turmeric because of the higher polyphenol content in aonla. Owing to these valuable properties aonla fruit and juice have extensively been used in Ayurvedic system of medicine (Pathak et al. 2003). Direct consumption of aonla juice has various health benefits. It has also potential for blending with beverages. However, storage conditions adversely affect the appearance (browning), nutritional and sensory characteristics of aonla juice especially during summer (Singh 2004). Therefore, pasteurization of juice is required to reduce or diminish microbial load.

Aonla fruit is highly acidic and astringent in nature due to which table value of aonla fruit is very limited. Aonla has immense potential in processed form (Nayak et al. 2012). Therefore, there is interest in the production of value added aonla products Therefore, in the present study an attempt was made to prepare aonla juice to observe the effect of processing treatments on phytochemicals using RP-HPLC.

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Materials and methods

Aonla juice preparation and processing

Fresh aonla fruits of variety Banarasi were used for juice extraction. Washing of healthy fruits was done under running tap of water for 5 min to remove adhered dust and to reduce microbial load over the surface. Fruits were cut into pieces and then extraction of juice was done using electric juicer (centrifugal force). Juice was filtered through muslin cloth and was divided into three lots. One lot was pasteurized (90 °C for 1 min), the second lot was preserved with KMS (500 ppm) (potassium metabisulphite) without heat treatment and the third lot was kept as control without any treatment. Pasteurization temperature was selected on the basis of previous work (Bhattacherjee et al. 2011). Juice was stored at room temperature (20–35 °C, 30–70% RH) as well as at refrigerated temperature (4 °C). Various physico-chemical characteristics along with polyphenol content of juice were evaluated periodically during the storage period.

Phytochemical analysis of aonla juice

Phytochemicals contents were determined using RP-HPLC (reversed phase high performance liquid chromatography) using method of Sawant et al. (2011) with some modifications. Methanolic extract of aonla juice was injected into RP-HPLC and quantification of individual phytochemical was done using peak area of standard and sample. Data was reported in mg/100 g of sample.

Physico-chemical analysis of juice during storage

Titratable acidity was estimated by the method of AOAC (2005) (967.21). Diluted aonla extract was titrated against 0.1 N sodium hydroxide using phenolphathlein as indicator. The analysis was performed in triplicate (n = 3). Titratable acidity was reported as citric acid (%).

Total soluble solids of the aonla fruits were determined at ambient temperature using portable hand-held refractometer and the pH value was measured using a digital pH meter.

Ascorbic acid content was determined by the AOAC (2005) method. Fresh aonla juice was diluted with equal amount of meta-phosphoric acid and titrated rapidly with indo-phenol dye. Similarly, standard ascorbic acid solution and meta-phosphoric acid (blank) solution titrated against the indo-phenol dye.

Total phenolic content were determined according the method of Anesini et al. (2008) with some modifications. Extraction was done with distilled water in boiling water bath. The extract (1 ml) was taken in test tube and to this 0.5 ml of Follin Ciocalteu reagent was added, after 3 min 1 ml of saturated sodium carbonate solution was added and volume was made 10 ml with distilled water. Absorbance was taken at 760 nm after 30 min. Standard curve was prepared using the graded concentration (20–100 ppm) of the gallic acid standard and with reference to the standard curve concentration of total polyphenols was determined as gallic acid equivalent (GAE/kg).

Total sugar content was estimated by the method of Yemm and Will (1954). Extraction of total sugar was carried out using 80% ethanol. Sample extract (0.1 ml) was taken in triplicate in each test tube and anthrone reagent (10 ml) was pipetted in empty test tubes placed in ice-cold water bath. Then early dilutions were added to anthrone reagent and test tubes were placed in boiling water bath for 10 min for colour development. After cooling, absorbance was noted at 625 nm. Standard curve was prepared using the graded concentration of glucose solution (25–250 ppm).

Non enzymatic browning of finished aonla products and stored products was evaluated by method described by Rangana (2004) at regular intervals. Five gram of sample was taken in 25 ml of beakers to it 20 ml of 60% aqueous ethanol was added. Solution was kept overnight and filtration was carried out using filter paper Whatman no.1 (U.S.). Optical density of clear solution was taken at 440 nm using 60% ethanol as blank and browning was reported in terms of absorbance (O.D.) of solution.

Statistical analysis

The data obtained in the present investigation was subjected to statistical analysis of variance (ANOVA) using Duncan test with SPSS 16.0 Software. The data was expressed as mean ± SD.

Results and discussions

Aonla juice extraction and processing

The yield of the juice was 52.85%. The preservation of juice is required for the further processing of juice and for the preparation of aonla based beverages. Nutrient, mineral and vitamins present in aonla juice may serves as a source of food for micro-organism and enzymatic activity which can also deteriorate the quality of juice during storage. Sample of control juice and processed juice were subjected to sensory and physico-chemical analyses.

Analysis of juice

Chemical composition and sensory attributes of aonla juice are presented in Table 1. Addition of KMS at 500 ppm level did not alter acidity, ascorbic acid, TSS (total soluble solid), pH and total polyphenol content. Results were in accordance with the finding of Hiremath et al. (2012). Significant difference ($p < 0.05$) was observed in ascorbic acid, acidity, total sugar, TSS and pH between control and pasteurized aonla juice. Reduction in ascorbic acid content of pasteurized juice might be due to oxidation at high temperature. Browning was higher in pasteurized juice (0.036) compared to control (0.029) and KMS the preserved juice (0.029) sample but the difference was not significant (Table 1) that might be due to browning of juice during heating. A similar trend was reported by Ranote and Bains (1982) in kinnow juice. As depicted in Table 1 no significant difference was observed in colour of juice sample while preserved juice with KMS showed alteration in flavor, taste and OA that might be due to typical taste and smell of KMS.

Effect of processing on phytochemical content

Effect of pasteurization on phytochemical content of aonla juice was studied using RP-HPLC. The pasteurized aonla juice was extracted with methanol solvent as it was found to be the best for the extraction of total polyphenols (Kumari and khatkar 2016). As depicted in Table 2 that ascorbic acid, gallic acid, ethyl gallate, ellagic acid and quercetin in methanolic extract of fresh juice were 168.96, 82.68, 0.31, 118.11 and 1.38 mg/100 g, respectively, while in methanolic extract of pasteurized aonla juice values were 155.04, 79.12, 0.29, 112.11 and 1.32 mg/100 g, respectively (Table 2). A significant difference ($p < 0.05$) was observed in the values of ascorbic acid, gallic acid, ethyl gallate, ellagic acid and quercetin. The changes in gallic acid and ellagic acid were more prominent. A non-significant decrease was observed in gallic acid content at in aonla juice pasteurized at higher temperature (Bhattarcherjee et al. 2011). Similarly, in French cider apple fruit and juice the polyphenolic composition was studied by Guyot et al. (2003) using RP-HPLC (UV–Vis detector).

The effect of processing on phytochemicals of aonla products was studied by comparing phytochemicals of the particular variety. A significant reduction was observed in the amount of individual phytochemical in pasteurized aonla juice that might be due to loss during heating.

Effect of storage conditions on composition and sensory attributes of aonla juice

Aonla juice without treatment (control), pasteurized (90 °C) and preserved with KMS (500 ppm) was stored at refrigeration (4 °C) and room temperature (20–30 °C). Data pertaining to composition and organoleptic characteristics of aonla juice is presented in Table 3. Control juice sample was spoiled after 2 days due to fungal growth while control stored at refrigeration temperature was found acceptable up to 40 days. Similarly, the pasteurized sample stored at ambient condition was found unacceptable after 60 days while sample stored at refrigeration temperature was acceptable up to 180 days. KMS preserved sample remained acceptable after 6 months storage at both storage condition. A significant ($p < 0.05$) difference was observed in composition of aonla juice among the treatment and as well as at different storage temperature. A decrease was observed in acidity, ascorbic acid and sensory attributes of aonla juice during the storage period in all treatments while an increase was observed in total sugar, TSS, pH and browning. In control sample the acidity and ascorbic acid was reduced from 2.41 to 2.22%, 550 to 530.7 mg/100 g, respectively (Table 1). The preserved sample at room and refrigerated temperature showed a significant reduction in acidity values and ascorbic acid content during storage the period (Table 3). The decrease was more prominent at room temperature compared to refrigeration temperature. A similar trend in acidity and ascorbic acid was observed in orange juice during storage in study by Pareek et al. (2011) and in bael RTS during storage by Singh et al. (2005). Bhattacherjee et al. (2011) also observed reduction in ascorbic acid in pasteurized aonla juice during storage. A decrease in acidity might be due chemical interaction between organic components of juice activated by temperature and enzymatic activity.

The decline in ascorbic acid during storage might be due to an increase in room temperature with storage period involving changes in weather conditions from winter to summer season. An increase in pH was at higher rate of juice stored at room temperature than refrigerated conditions. In pasteurized juice, stored at RT and refrigerated conditions. TSS was increased from 12.55 to 13.45^{0}Brix and 12.45 to 14.85^{0}Brix, respectively and in preserved juice an increase was from 12.80 to 14.85^{0}Brix and 12.85 to 14.65^{0}Brix, respectively. An increase in TSS might be due to hydrolysis of starch into sugars. In the study by Mehta and Bajaj (1983) also reported an increase in TSS of sweet orange and lemon juice. In aonla juice sample an increase was noted in total sugar content during storage. In pasteurized juice at RT and refrigerated temperature an increase was noted from 5.42 to 5.62% and 5.29 to 6.08%, respectively. Similarly, increase was observed in total

Table 1 Effect of storage on composition of juice

Treatment	Parameters	Acidity (%)	Ascorbic acid (mg/100 g)	pH	TSS (^{0}Brix)	Total polyphenol (%)	Total sugar (%)	Browning O.D. 440
0 Day								
Control	RT	2.35 ± 0.01^{a}	550.25 ± 1.06^{ab}	2.43 ± 0.04^{a}	12.85 ± 0.03^{a}	3.22 ± 0.02^{a}	5.87 ± 0.05^{a}	0.029 ± 0.01^{a}
	REF	2.41 ± 0.02^{aA}	550.5 ± 0.43^{aA}	2.40 ± 0.02^{aC}	12.85 ± 0.07^{aB}	3.31 ± 0.09^{aA}	5.79 ± 0.01^{bB}	0.028 ± 0.02^{aA}
Pasteurised	RT	2.15 ± 0.10^{bA}	530 ± 0.71^{dA}	2.18 ± 0.04^{bC}	12.55 ± 0.10^{bB}	3.21 ± 0.01^{cdA}	5.42 ± 0.02^{cC}	0.036 ± 0.01^{aD}
	REF	2.13 ± 0.04^{bA}	$532. \pm 0.65^{cA}$	2.22 ± 0.05^{bH}	12.45 ± 0.06^{bH}	3.08 ± 0.03^{dA}	5.29 ± 0.02^{dH}	0.037 ± 0.01^{aJ}
Preserved	RT	2.32 ± 0.04^{aA}	548.5 ± 0.71^{bA}	2.41 ± 0.02^{aH}	12.80 ± 0.00^{aH}	3.21 ± 0.01^{abcA}	5.80 ± 0.03^{bG}	0.029 ± 0.01^{aJ}
	REF	2.35 ± 0.07^{aA}	550.85 ± 0.50^{aA}	2.43 ± 0.01^{aH}	12.85 ± 0.07^{aE}	3.20 ± 0.05^{bcA}	5.81 ± 0.05^{bE}	0.029 ± 0.00^{aH}
40 Days								
Control	REF	2.22 ± 0.03^{aB}	530.7 ± 0.99^{aC}	2.64 ± 0.02^{aA}	13.65 ± 0.07^{aA}	3.13 ± 0.02^{abA}	5.87 ± 0.03^{aA}	0.040 ± 0.01^{cA}
Pasteurised	RT	1.98 ± 0.04^{bB}	498.05 ± 0.35^{eC}	2.41 ± 0.02^{bA}	13.25 ± 0.07^{bA}	3.16 ± 0.01^{aAB}	5.52 ± 0.02^{bB}	0.055 ± 0.01^{aB}
	REF	2.03 ± 0.01^{bB}	515.9 ± 0.85^{dB}	2.36 ± 0.04^{bF}	13.15 ± 0.04^{bF}	3.02 ± 0.03^{cB}	5.44 ± 0.02^{bG}	0.045 ± 0.01^{bH}
Preserved	RT	2.19 ± 0.01^{aB}	520.9 ± 0.85^{cC}	2.62 ± 0.03^{aF}	13.55 ± 0.10^{aF}	3.02 ± 0.01^{cC}	5.89 ± 0.06^{aFG}	0.042 ± 0.01^{cH}
	REF	2.24 ± 0.02^{aB}	524.5 ± 0.99^{bC}	2.63 ± 0.01^{aF}	13.65 ± 0.9^{aD}	3.10 ± 0.02^{bC}	5.84 ± 0.04^{aE}	0.036 ± 0.01^{dG}
80 Days								
Pasteurised	REF	1.81 ± 0.03^{bD}	497.80 ± 0.71^{bD}	2.48 ± 0.03^{bE}	13.45 ± 0.05^{cE}	2.96 ± 0.10^{bC}	5.61 ± 0.03^{bE}	0.057 ± 0.01^{aF}
Preserved	RT	1.87 ± 0.04^{bD}	498.9 ± 0.57^{bE}	2.69 ± 0.02^{bE}	14.15 ± 0.09^{aD}	2.96 ± 0.02^{bDE}	6.05 ± 0.06^{aE}	0.064 ± 0.02^{aF}
	REF	2.03 ± 0.01^{aC}	505.75 ± 0.64^{aE}	2.71 ± 0.02^{aDE}	13.85 ± 0.06^{bD}	3.07 ± 0.12^{aDE}	6.03 ± 0.04^{aCD}	0.048 ± 0.01^{aE}
120 Days								
Pasteurised	REF	1.77 ± 0.03^{bDE}	475.55 ± 0.49^{bF}	2.71 ± 0.02^{aC}	14.10 ± 0.06^{bC}	2.93 ± 0.08^{bCD}	5.81 ± 0.06^{cC}	0.068 ± 0.01^{bD}
Preserved	RT	1.73 ± 0.04^{cEF}	476 ± 0.57^{bG}	2.82 ± 0.02^{bCD}	14.55 ± 0.07^{aB}	2.91 ± 0.02^{bFG}	6.19 ± 0.05^{aCD}	0.098 ± 0.01^{aD}
	REF	1.97 ± 0.02^{aC}	489.05 ± 0.68^{aG}	2.78 ± 0.01^{bC}	14.35 ± 0.21^{abBC}	3.03 ± 0.11^{aF}	6.07 ± 0.16^{bC}	0.058 ± 0.01^{cC}
160 Days								
Pasteurised	REF	1.66 ± 0.02^{bF}	460.1 ± 0.43^{aH}	2.85 ± 0.01^{bAB}	14.60 ± 0.14^{aB}	2.87 ± 0.07^{aE}	5.99 ± 0.09^{cB}	0.079 ± 0.01^{bB}
Preserved	RT	1.59 ± 0.04^{bG}	461.35 ± 0.70^{aH}	2.88 ± 0.02^{aB}	14.75 ± 0.07^{aAB}	2.80 ± 0.02^{bH}	6.29 ± 0.08^{aAB}	0.130 ± 0.01^{aB}
	REF	1.83 ± 0.03^{aD}	465.85 ± 0.78^{aI}	2.82 ± 0.01^{bAB}	14.55 ± 0.06^{aA}	2.92 ± 0.04^{aH}	6.16 ± 0.06^{bB}	0.070 ± 0.01^{cAB}
180 Days								
Pasteurised	REF	1.51 ± 0.04^{bG}	451.35 ± 1.06^{bI}	2.88 ± 0.02^{bA}	14.85 ± 0.04^{aA}	2.79 ± 0.06^{bF}	6.08 ± 0.11^{bA}	0.082 ± 0.01^{bA}
Preserved	RT	1.49 ± 0.02^{bH}	448.95 ± 0.64^{bI}	2.96 ± 0.02^{aA}	14.85 ± 0.09^{aA}	2.73 ± 0.02^{cI}	6.33 ± 0.03^{Aa}	0.136 ± 0.01^{aA}
	REF	1.71 ± 0.10^{aE}	460.75 ± 0.75^{aJ}	2.84 ± 0.01^{bA}	14.65 ± 0.03^{aA}	2.85 ± 0.9^{aI}	6.25 ± 0.06^{aA}	0.073 ± 0.01^{cA}

The values are mean ± SD of determinations made in triplicates. Mean values followed by different letters within a same column differ significantly ($p < 0.05$). Small letter denote significant difference among treatment and capital letters for significant difference among storage

RT room temperature, *Ref* refrigerated temperature (4 °C)

Table 2 Effect of processing on phytochemicals in aonla juice

Aonla product	Ascorbic acid (mg/100 g)	Gallic acid (mg/100 g)	Ethyl gallate (mg/100 g)	Ellagic acid (mg/100 g)	Quercetin (mg/100 g)
Fresh juice	168.96 ± 1.23[b]	82.68 ± 0.67[b]	0.31 ± 0.98[b]	118.11 ± 0.45[b]	1.38 ± 0.02[b]
Pasteurised juice	155.04 ± 1.09[a]	79.12 ± 0.76[a]	0.29 ± 0.89[a]	112.11 ± 0.23[a]	1.32 ± 0.03[a]

[a]The values are mean ± SD of determinations made in triplicates. Mean values followed by different letters within a same column differ significantly ($p < 0.05$)

Table 3 Effect of storage on sensory characteristics

Treatment	Parameters	Colour	Flavour	Taste	OA
0 Day					
Control	RT	6.90 ± .14[a]	7.15 ± 0.01[a]	6.90 ± 0.12[b]	6.98 ± 0.11[a]
	REF	6.87 ± 0.04[aA]	7.05 ± 0.07[abA]	6.74 ± 0.03b[cA]	6.89 ± 0.02[abA]
Pasteurised	RT	7.00 ± 0.14[aA]	6.95 ± 0.07[bcA]	6.88 ± 0.04[bcA]	6.94 ± 0.02[abA]
	REF	6.75 ± 0.04[aA]	6.85 ± 0.08[cdA]	7.15 ± 0.10[aC]	6.92 ± 0.04[abA]
Preserved	RT	6.90 ± 0.17[aA]	6.85 ± 0.03[cdAB]	6.75 ± 0.05[bcA]	6.83 ± 0.02[bcA]
	REF	6.74 ± 0.04[aA]	6.78 ± 0.04[dA]	6.70 ± 0.01[cA]	6.73 ± 0.01[cA]
40 Days					
Control	REF	6.67 ± 0.07[cB]	6.65 ± 0.04[abB]	6.53 ± 0.04[cB]	6.62 ± 0.02[bC]
Pasteurised	RT	6.81 ± 0.06[aA]	6.79 ± 0.09[aA]	6.72 ± 0.03[bB]	6.77a ± 0.06[B]
	REF	6.70 ± 0.03[abcA]	6.63 ± 0.02[bBC]	6.83 ± 0.05[aC]	6.72 ± 0.02[aC]
Preserved	RT	6.79 ± 0.06[abAB]	6.75 ± 0.01[abBC]	6.64 ± 0.02b[AB]	6.72 ± 0.02[aB]
	REF	6.67 ± 0.02[cB]	6.64 ± 0.02[bBC]	6.48 ± 0.04[cBC]	6.59 ± 0.01[bC]
80 Days					
Pasteurised	REF	6.58 ± 0.03[aBC]	6.45 ± 0.07[aDE]	6.59 ± 0.01[aDE]	6.54 ± 0.03[aE]
Preserved	RT	6.55 ± 0.06[aCD]	6.44 ± 0.02[aD]	6.44 ± 0.02[abC]	6.47 ± 0.00[bD]
	REF	6.57 ± 0.02[aC]	6.49 ± 0.05[aD]	6.30 ± 0.09[bDE]	6.45 ± 0.02[bE]
120 Days					
Pasteurised	REF	6.39 ± 0.03[aD]	6.27 ± 0.06[aF]	6.30 ± 0.03[aF]	6.32 ± 0.01[aG]
Preserved	RT	6.15 ± 0.07[bE]	6.18 ± 0.08[aE]	6.00 ± 0.03[cE]	6.11 ± 0.04[bF]
	REF	6.47 ± 0.03[aD]	6.30 ± 0.06[aE]	6.18 ± 0.04[bEF]	6.32 ± 0.01[aG]
160 Days					
Pasteurised	REF	6.25 ± 0.05[bE]	6.08 ± 0.05[aGH]	5.97 ± 0.04[aH]	6.09 ± 0.02[aI]
Preserved	RT	5.97 ± 0.04[cFG]	5.92 ± 0.03[bF]	5.71 ± 0.09[bF]	5.86 ± 0.03[aH]
	REF	6.39 ± 0.05[aE]	6.13 ± 0.04[aG]	5.87 ± 0.03[abG]	6.13 ± 0.04[aI]
180 Days					
Pasteurised	REF	6.17 ± 0.03[bF]	6.02 ± 0.02[bH]	5.71 ± 0.08[aI]	5.96 ± 0.03[bJ]
Preserved	RT	5.88 ± 0.06[cG]	5.74 ± 0.07[cG]	5.28 ± 0.10[bG]	5.63 ± 0.03[cI]
	REF	6.34 ± 0.10[aF]	6.11 ± 0.04[aG]	5.82 ± 0.06[aG]	6.09 ± 0.04[aJ]

The values are mean ± SD of determinations made in triplicates. Mean values followed by different letters within a same column differ significantly ($p < 0.05$). Small letter denote significant difference among treatment and capital letters for significant difference among storage period

RT room temperature, *Ref* refrigerated temperature

sugars content in preserved aonla juice (Table 3) that might be due to conversion of polysaccharides into simple sugar (Jain et al. 2003). Total polyphenol contents of aonla juice was not significantly non-significant increased during storage in all treatments. A similar trend was observed in aonla juice sample by Tripathi et al. (1988). An increase in NEB (non enzymatic browning) was higher in juice stored at RT than at refrigerated temperature. In pasteurized juice sample at RT and refrigeration NEB was increased from 0.036 to 0.091 and 0.037 to 0.082, respectively. In aonla

preserved sample stored at RT and refrigeration NEB was increased from 0.029 to 0.136 and 0.029 to 0.073, respectively. Similarly, in the study carried out by Bhattacherjee et al. (2011) an increase in NEB was higher in aonla juice stored at high temperature compared to low temperature. The increase might be due to Maillard reaction contributing to browning and also due to formation of furfural using the ascorbic (Shinoda et al. 2005). A significant decline was observed in sensory attributes such as colour, flavour, taste and overall acceptability of aonla juice with storage period stored at different storage temperature (Table 3). Decrease was more at RT than refrigeration condition. Overall acceptability of pasteurized juice at RT and refrigeration was reduced from 6.94 to 6.35 and 6.92 to 5.96, respectively. A decrease in sensory characteristics might be due to the development of brown colour during NEB.

Conclusion

The finding of the present investigation concluded that aonla juice is a potential source of phytochemicals and ascorbic acid. Gallic acid, ellagic acid, quercetin and ethyl gallate were the main phytochemicals present in aonla juice. Pasteurized aonla juice had better retention of phytochemicals and sensory characteristics during storage. Commercially, it may help in the development of aonla juice based functional beverage.

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