SHORT COMMUNICATION

Development and storability evaluation of blended beverages prepared from aonla, aloe vera, ginger and lemongrass

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ABSTRACT

An investigation was made to develop a quality blended ready-to-serve beverage prepared from aonla, Aloe vera ginger lemongrass. Standardization of blend combinations based on sensory evaluation revealed that the RTS formulation containing aonla (30%) + Aloe vera (35%) + ginger (25%) + lemon grass (10%) achieved the highest overall acceptability score. During eight weeks of ambient storage, significant physico-chemical changes were observed in the optimized RTS beverage. Total soluble solids increased from 13.0% to 14.6%, acidity rose from 0.24% to 0.35%, reducing sugars increased from 3.13% to 3.85% and total sugars increased from 11.01% to 11.45%, while non-reducing sugars declined from 7.87% to 7.60%. A gradual but statistically significant reduction in vitamin C content was recorded, decreasing from 18.01 to 17.88 mg/100 ml. Sensory evaluation indicated a decline in organoleptic quality during storage; however, the RTS beverage remained acceptable up to eight weeks under ambient conditions.

Keywords: Blended RTS beverage, organoleptic quality, physico-chemical properties, storability

In recent times, global interest in functional beverages has increased, as consumers seek drinks that offer not only basic nourishment but also added health and wellness benefits. This trend is primarily driven by increasing awareness of lifestyle-related disorders, and the recognized role of natural foods in disease prevention and health promotion (Gupta *et al.,* 2011). As a result, ready-to-serve (RTS) herbal and blended beverages have gained popularity due to their convenience, sensory appeal, and incorporation of bioactive compounds derived from medicinal plants. Aonla (*Emblica officinalis* Gaertn.), also known as Indian gooseberry, is considered one of the richest natural sources of vitamin C and is widely recognized for its potent antioxidant, immunomodulatory, and therapeutic properties. It contains important bioactive compounds such as polyphenols, flavonoids, tannins, and ascorbic acid, which contribute to its anti-inflammatory, antidiabetic, hypolipidemic, and hepatoprotective effects (Saroj *et al.,* 2025). Due to its high nutritional value and ability to enhance shelf life and functional quality, aonla is extensively used in the development of functional beverages, including RTS drinks. Its incorporation not only improves the nutritional profile but also contributes to the stability and health-promoting potential of the final product. Aloe vera (*Aloe barbadensis* Miller), often referred

to as the "miracle plant," is rich in more than 75 biologically active constituents, including vitamins, minerals, enzymes, polysaccharides and amino acids. Aloe gel is widely recognized for its anti-inflammatory, digestive, laxative, antioxidant and hydrating properties (Bhowmick, 2019). Due to its high moisture content (about 99.5%) and numerous health-promoting attributes, *Aloe vera* is widely utilized in functional foods and beverages such as juices and health drinks. The presence and enhancement of phytochemical constituents further contribute to improving its therapeutic value for human health (Prisal and Jamal, 2025). Ginger (*Zingiber officinale* Roscoe), is a traditional medicinal spice renowned for its pungent taste and the presence of bioactive compounds, including gingerols and shogaols. These compounds impart antioxidant, anti-inflammatory, digestive, antimicrobial and immune-enhancing effects (White, 2007). Ginger is widely cultivated and consumed in India and has shown potential benefits in reducing digestive disorders, arthritis pain, cholesterol levels and cardiovascular risks. Lemongrass (*Cymbopogon citratus*), is an aromatic medicinal herb rich in citral, which contributes to its antimicrobial, antioxidant, and therapeutic properties. Lemongrass is commonly used in herbal teas and beverages and is known for its antidepressant, analgesic, antipyretic, antiseptic, and carminative effects (Shah *et al.,* 2011). Its pleasant aroma and bioactive profile enhance both sensory quality and functional value in beverage formulations (Premathilake *et al.,* 2018). Our objective of the study is to develop a single RTS beverage blending these four botanicals into offers a synergistic approach to develop a nutritionally enriched, sensory-acceptable, and health-promoting functional drink. Such blended beverages can serve as natural alternatives to synthetic and carbonated drinks while meeting the growing consumer demand for safe, nutritious, and shelf-stable products.

The experiment was carried out during 2024–25 in the Post Graduate Laboratory of the Department of Post-Harvest Management, College of Horticulture and Forestry, Acharya Narendra Deva University of Agriculture & Technology (ANDUAT), Kumarganj, Ayodhya, Uttar Pradesh, India. Fresh aonla (cv. NA-7) and aloe vera (cv. Cimsheel) were collected from the experimental fields/orchards of ANDUAT, Kumarganj, Ayodhya. Ginger (local cultivar, variety not specified) was obtained from the local market. Lemongrass (cv. NLG-84) was procured from Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow, Uttar Pradesh, India. Juices and extracts were prepared using standard processing methods as mentioned below and stored under refrigerated conditions.

Preparation of juice/extract from individual ingredients

Aonla (juice): Fresh, mature, and disease-free aonla fruits were washed thoroughly in potable water. The fruits were blanched in boiling water for 5 minutes to reduce astringency, followed by deseeding. The pulp was extracted using a pulper and filtered through muslin cloth to obtain clear aonla juice.

Aloe vera (gel): Fresh aloe vera leaves were washed and the outer green rind was carefully removed using a sterile knife. The transparent inner gel was scooped out, washed to remove latex (aloin), and homogenized in a blender to obtain uniform aloe vera gel.

Ginger (extract):
Fresh ginger rhizomes were washed, peeled, and grated. The grated material was crushed and pressed through muslin cloth to obtain ginger extract (juice).

Lemongrass (extract):
Fresh lemongrass leaves were washed, chopped into small pieces, and subjected to hot water extraction (boiling in water for 10–15 minutes). The extract was then filtered through muslin cloth to obtain clear lemongrass extract.

Preparation of RTS beverages

Ready-to-serve (RTS) beverages were prepared by blending aonla juice, aloe vera gel, ginger extract, and lemongrass extract in different proportions as per treatments. The total fruit/herbal content was maintained at 10%, with total soluble solids (TSS) adjusted to 10–15% using sugar syrup, and acidity maintained at 0.3–0.5% using citric acid. Potassium metabisulphite (KMS) was added at 100 ppm as preservative.

The prepared blends were thoroughly mixed, filtered, filled into pre-sterilized glass bottles, sealed, pasteurized at 85–90°C for 15 minutes, cooled to room temperature, and stored under refrigerated conditions for further analysis.

Treatment details

T_1: Aonla juice (10%) + Aloe vera gel (75%) + Ginger extract (5%) + Lemongrass extract (10%)

T_2: Aonla juice (15%) + Aloe vera gel (65%) + Ginger extract (10%) + Lemongrass extract (10%)

T_3: Aonla juice (20%) + Aloe vera gel (55%) + Ginger extract (15%) + Lemongrass extract (10%)

T_4: Aonla juice (25%) + Aloe vera gel (45%) + Ginger extract (20%) + Lemongrass extract (10%)

T_5: Aonla juice (30%) + Aloe vera gel (35%) + Ginger extract (25%) + Lemongrass extract (10%)

Total soluble solids: The Total Soluble Solids of aonla juice, aloe vera gel (filtered), ginger extract, and lemongrass aqueous extract was measured using a hand refractometer (Erma Inc., Tokyo, Japan) with ranges of 0–32%, 28–62% and 58–92%. The TSS readings taken at ambient temperature were corrected to 20°C using a reference table and the average value for each sample was expressed as a percentage of TSS, following the method outlined by Ranganna (2010).

Acidity: Acidity of the each crop extract was measured using a titration method. Aonla juice (5 mL), aloe vera gel (5 g, homogenized and filtered), ginger extract (5 mL), and lemongrass extract (5 mL) were each diluted to 100 mL with distilled water. A 5 ml aliquot was then titrated with N/10 NaOH using phenolphthalein as an indicator until a pink endpoint was reached. The acidity was calculated and expressed as anhydrous citric acid per 100 g or 100 ml of the sample.

$$\text{Acidity}(\%) = \frac{\text{Titrated value} \times 0.1 \times \text{Volume made up} \times 64 \times 100}{\text{aliquat taken} \times \text{weight of sample taken} \times 1000}$$

Ascorbic acid: Ascorbic acid content was determined by the 2,6-dichlorophenol indophenol dye method (Ranganna, 2010). Aonla juice (5 mL), aloe vera gel (5 g, homogenized), ginger extract (5 mL), and lemongrass extract (5 mL) were each diluted to 50 mL with 3% metaphosphoric acid solution. A 5 mL aliquot was then titrated with the dye until a light pink color persisted for 15 seconds. The ascorbic acid content was calculated and expressed as mg per 100 mL or per 100 g of the sample.

$$\text{Vitamin C} = \frac{\text{Titrated value} \times \text{Dye factor} \times \text{Volume made up} \times 100}{\text{Aliquat Taken} \times \text{Wt.of sample taken}}$$

Reducing sugars: Reducing sugars were estimated by the Fehling's titration method (Ranganna, 2010). For aonla, 5 g of fresh pulp was crushed with distilled water, filtered through muslin cloth, and the volume was made up to 100 mL. In the case of aloe vera, 5 g of homogenized gel was diluted with distilled water, filtered to remove mucilage, and the volume was adjusted to 100 mL. Ginger extract (5 mL) was similarly diluted to 100 mL with distilled water. For lemongrass, 5 mL of the aqueous extract obtained after boiling and filtration was taken and diluted to 100 mL. Suitable aliquots (5 mL for fresh samples and 2 mL for RTS beverages) were titrated against Fehling's solutions A and B using methylene blue as an indicator under boiling conditions until the appearance of a brick-red precipitate. The reducing sugar

content was calculated and expressed as percentage.

$$\text{Reducing sugars (\%)} = \frac{\text{mg of Inverted sugar} \times \text{Dilution} \times 100}{\text{Titre value} \times \text{wt of sample} \times 100}$$

Total sugars: Total sugars were estimated following the Lane and Eynon method as described by Ranganna (2010). Aonla juice (5 mL), aloe vera gel (5 g, homogenized and filtered), ginger extract (5 mL), and lemongrass extract (5 mL) were each diluted to 100 mL with distilled water. An aliquot of the sample was hydrolyzed with dilute hydrochloric acid to convert non-reducing sugars into reducing sugars, followed by neutralization with sodium hydroxide using phenolphthalein as an indicator. The hydrolyzed sample was then titrated against Fehling's solutions A and B using methylene blue as an indicator under boiling conditions until a brick-red endpoint was obtained. The total sugar content was calculated and expressed as percentage of total sugars in the sample.

Organoleptic quality: The organoleptic quality of the RTS beverages was assessed by semi-trained panelists using a 9-point Hedonic Rating Scale, evaluating attributes such as color, flavor, and texture, with the mean scores representing the overall quality (Amerine *et al.,* 1965).

Point Hedonic Scale for organoleptic test

Organoleptic score	Rating
9	Extremely liked
8	Very much liked
7	Moderately liked
6	Slightly liked
5	Neither liked nor disliked
4	Slightly disliked
3	Moderately disliked
2	Very much disliked
1	Extremely disliked

The organoleptic assessment was performed by a panel of semi-trained judges who evaluated of color, flavor and overall acceptability using a 9-point hedonic rating scale (Amerine *et al.,* 1965).

Experiment was conducted with five replications under Completely Randomized Design. Data were analyzed statistically using Statistical Package for Social Sciences (IBM-SPSS) Version 23.0, following the procedures by Panse (1985).

Chemical composition of aonla juice, aloe vera gel, ginger extract, and lemongrass extract showed significant variation in TSS, acidity, sugar fractions and vitamin C (Table 1). Aonla juice had the highest TSS (9.30%), acidity (1.65%), reducing sugar (5.00%), total sugars (8.52%) and vitamin C (580.01 mg/100 g) while aloe vera had the lowest TSS (1.75%), acidity (0.22%), sugars (1.62% total) and vitamin C (2.62 mg/100 g). Ginger and lemongrass exhibited moderate values. The higher TSS, sugars, acidity and vitamin C in aonla make it ideal for blended beverages, enhancing flavor, sweetness and nutritional value whereas aloe vera and lemongrass mainly contribute moisture and aroma. These results align with previous studies (Baliga *et al.,* 2011; Pathak, 2013).

Table 2 presents the impact of various blend combinations of aonla, aloe vera, ginger juices and lemongrass extract on the organoleptic quality of RTS beverages. Overall acceptability scores ranged from 7.12 to 8.14, indicating all formulations were acceptable to highly acceptable. Blend 5 (30% aonla, 35% aloe vera, 25% ginger, 10% lemongrass, 15% sugar) scored highest (8.14, "Liked Very Much"), likely due to a balanced mix of acidity, bitterness, pungency, and aroma. Blend 3 (20% aonla, 55% aloe vera, 15% ginger, 10% lemongrass, 15% sugar) scored lowest (7.12), possibly due to excess aloe vera causing a bitter aftertaste. Sensory scores increased with higher aonla and ginger

content and lower aloe vera, suggesting positive flavor contributions from aonla and ginger. The SE.m was 0.02 and CD at 5% was 0.07, confirming that the difference of 1.02 between the highest and lowest scores was statistically significant. These findings align with previous studies showing that appropriate blending of aonla improves acceptability, while excessive aloe vera may reduce palatability (Singh *et al*., 2014; Lawless and Heymann, 2010).

Table 3 shows the changes in physicochemical characteristics of the Blend 5 (T_5) (30% aonla, 35% aloe vera, 25% ginger, 10% lemongrass, 15% sugar) RTS beverage during the 8-week storage period. A gradual increase in total soluble solids (TSS) was observed from 13.0% at 0 week to 14.6% after 8 weeks of storage. This increase may be attributed to the hydrolysis of polysaccharides, sugar inversion, breakdown of complex carbohydrates and organic acids, as well as moisture loss, which leads to a higher concentration of soluble solids. Similar increases in TSS during storage have been reported by Ranganna (2014), Kumar *et al*. (2020) and Kumari *et al.* (2025). Statistical analysis confirmed that the increase was significant (CD at 5% = 0.52), with low experimental error (SE ± 0.17), indicating reliable and precise results.

A significant increase in acidity (%) of the RTS beverage was also recorded during storage, rising from 0.24% at 0 weeks to 0.35% after 8 weeks. This increase is likely due to polysaccharide hydrolysis, degradation of organic compounds, biochemical reactions, and conversion of residual sugars into organic acids. While the gradual rise within permissible limits may enhance shelf life and microbial stability, excessive acidity could influence sensory quality. Statistical analysis confirmed that the increase was significant, with SE.m ± 0.01 and CD at 5% of 0.03, indicating that storage duration had a pronounced effect on beverage acidity.

The vitamin C content (mg/100 ml) of the blended beverage showed a gradual decline during storage, decreasing slightly from 18.01 mg/100 ml at 0 week to 17.88 mg/100 ml by the 7th and 8th weeks. The overall reduction during the storage period was only 0.13 mg/100 ml, indicating good retention of ascorbic acid. The SE.m (±0.014) and CD at 5% (0.041) indicated that changes up to 3 weeks were statistically non-significant, with a noticeable decrease ($p \leq 0.05$) observed from the 4th week onwards. The relatively stable vitamin C levels during later storage suggest a slower degradation rate. The minor loss of vitamin C may be attributed to oxidative degradation of ascorbic acid; however, the presence of acidic ingredients such as *Phyllanthus emblica* (aonla), *Cymbopogon citratus* (lemongrass), and *Zingiber officinale* (ginger), along with added citric acid and preservatives, likely contributed to maintaining vitamin C stability during storage.

The reducing sugar content (%) of the RTS beverage showed a significant and progressive increase during storage, rising from 3.13% at 0 week to 3.85% after 8 weeks, with a steady rise throughout the storage period and a more pronounced increase during the later stages. Statistical analysis indicated that differences among storage intervals were significant at the 5% level (CD = 0.14), and the low SE.m (±0.04) confirms the reliability of the data.

It was concluded that Aonla juice was found nutritionally superior, with high TSS, acidity, sugars, and vitamin C, making it an ideal base for RTS beverages. The most acceptable blend was 30% aonla, 35% aloe vera, 25% ginger, 10% lemongrass, and 15% sugar. Over 8 weeks, TSS, acidity, and reducing sugars increased, non-reducing sugars decreased, and vitamin C remained largely stable, indicating good nutrient retention during storage.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal

relationships that could have appeared to influence the work reported in this paper.

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Table 1: Chemical composition of aonla, aloe vera, ginger and lemongrass juices

Sl. No.	Chemical attributes	Mean Values			
		Aonla juice	Aloe vera juice	Ginger juice	Lemongrass juices
1	T.S.S (%)	9.30	1.75	2.22	2.25
2	Acidity (%)	1.65	0.22	0.30	0.50
3	Reducing sugars (%)	5.00	0.42	0.59	0.14
5	Total sugars (%)	8.52	1.58	1.82	3.80
6	Vitamin C (mg/100gm)	580.01	2.62	1.85	1.67

Table 2: Organoleptic evaluation of RTS beverages prepared from various blend combinations of extracts

Blend combination (Treatment No.)	Different combination of blends					Organoleptic quality	
	Aonla juice (%)	Aloe vera juice (%)	Ginger juice (%)	Lemon grass extract (%)	Sugars (%)	Score	Rating
T_1	10	75	5	10	15	7.40	LV
T_2	15	65	10	10	15	7.18	LV
T_3	20	55	15	10	15	7.12	LVM
T_4	25	45	20	10	15	7.90	LVM
T_5	30	35	25	10	15	8.14	LVM
(SEm ±)						0.02	
(CD 5%)						0.07	

Table 3: Variations in physicochemical characteristics of the RTS formulation (T□) comprising aonla (30%), aloe vera (35%), ginger (25%) and lemongrass (10%) during storage

Storage duration (weeks)	Total soluble solids (%)	Acidity (%)	Vitamin C (mg/100 ml)	Reducing sugars (%)
0	13.0	0.24	18.01	3.13
1	13.3	0.25	17.99	3.18
2	13.5	0.26	17.97	3.25
3	13.6	0.27	17.963	3.35
4	13.7	0.29	17.93	3.46
5	13.9	0.30	17.91	3.52
6	14.0	0.32	17.90	3.70
7	14.3	0.33	17.88	3.80
8	14.6	0.35	17.88	3.85
SEm ±	0.17	0.01	0.014	0.04
CD 5%	0.52	0.03	0.041	0.14