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STANDARDIZATION OF LOW-CALORIE BEVERAGE PREPARED FROM AONLA JUICE BLENDED WITH ALOE VERA AND GINGER

Karma Beer, Abha Singh* and Alok Kumar Gupta

Central Institute for Subtropical Horticulture, Lucknow - 226 101, Uttar Pradesh, India.

*Corresponding author E-mail : singhabha21@yahoo.co.in

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ABSTRACT

This study aimed to investigate the optimal blending combination of aonla, aloe vera, and ginger extract to address the astringency and browning issue in aonla juice during storage. The browning effect in aonla juice can be mitigated by blending it with aloe vera and ginger extract, resulting in a novel healthy drink with excellent color and flavor. To achieve this, we examined the effect of blending on the biochemical parameters *viz*. TSS, acidity, ascorbic acid and juice color (L^*, a^*, b^*) and organoleptic parameters (color, flavor and bitterness) of the resulting beverage. Our results showed significant variations in TSS, acidity, and ascorbic acid among the treatments during the storage period. After end of storage period the acceptable value of TSS was observed in T_3 (6.20 °B), while the lowest acidity was recorded in T_2, followed by the control (T_0). The retention of ascorbic acid was highest in the control, followed by T_3, during the three months of storage. The blended juice exhibited excellent color and overall acceptability, with the best flavor and bitterness acceptability reported in T_3. These findings suggest that blending aonla juice with aloe vera and ginger can effectively address the browning issue and produce a high-quality, healthy beverage with excellent color, flavor and nutritional properties. This study provides valuable insights for the industry to develop novel healthy drinks with enhanced shelf life and consumer acceptability.

Key words : Aonla, Beverage, TSS, Ascorbic acid, Ginger.

Introduction

Aonla (*Emblica officinalis*), also known as Indian gooseberry, is a deciduous tree species native to India, belonging to the family Phyllanthaceae. The fruit is a rich source of various bioactive compounds, including ascorbic acid (vitamin C), calcium, lysine, minerals, methionine, nicotinic acid, phosphorus, riboflavin and tryptophan. Aonla has been reported to exhibit immunomodulatory effects against multiple diseases and is extensively utilized in Ayurveda, a traditional system of medicine (Bhagat, 2014). The juice of Aonla is considered a potent anti-inflammatory agent and its high ascorbic acid content confers antioxidant properties. While consuming raw aonla fruit is considered beneficial for human health, its low palatability due to inherent high astringency limits its culinary value. Aonla juice is a preferred product due to its ease of digestibility, high refreshment value, thirst-quenching properties, appetite-enhancing qualities and nutrient-rich composition, making it a superior beverage. However, storage conditions, especially during summer, can adversely impact the appearance (browning), nutritional content and sensory characteristics of aonla juice due to enzymatic browning reactions and degradation of bioactive compounds. This beverage is devoid of synthetic preservatives and is nutritionally enriched with Aloe vera and Ginger extract, making it a valuable nutri-suppliments for regions with high malnutrition rates, where adequate nutritional supplementation is crucial. According to Dechiya and Dhawan (2001), Aonla fruits are rich in pectin, iron and calcium with an abundance of these minerals. Now a day's researchers from the entire globe are focusing on developing blended juices, such as combining carrot juice with Aonla juice and Grape juice. This blend exhibits antimicrobial properties, acting as a natural barrier against various microorganisms. However, compatibility issues

have hindered the widespread acceptance of these blends. Nevertheless, existing prepared blended juice demonstrates significant improvements over earlier formulations in terms of taste, flavor, and color (Eshun, 2003).

The fruit is rich in antioxidants due to the presence of gallotannic acid. Despite efforts to commercialize nutraceutical drinks made from pure aonla juice, the beverages developed from aonla juice alone have not gained popularity due to their highly acidic and astringent taste. To address this, the present beverage has been formulated according to consumer preferences and industry processing requirements, making it easily adoptable by the industry. Previous research has explored blending aonla juice with other fruit juices for beverage preparation with preservative (Deka and Setho, 2001; Jain and Khurdiya, 2004). However, the resulting beverages have been compromised by browning during storage, which has hindered their ability to meet quality standards (Garg *et al*., 2008).

Earlier, researchers have explored the possibilities of utilizing aonla fruit for the preparation of juice and beverages (Singh and Kumar, 1995). Although, aonla fruit juices and beverages prepared from them have poor consumer acceptance, this beverage has been standardized to improve the nutritional quality and consumer acceptance of aonla juice. It has been reported that blending improves the vitamin and mineral contents (De Carvalho *et al*., 2007). The Aloe vera leaf contains minerals like calcium, copper, selenium, magnesium, manganese, potassium, sodium, zinc, amino acids, vitamins and enzymes. Aloe vera is widely appreciated as a natural product due to its medicinal and therapeutic properties. When Aloe vera juice is used in food products, it enhances the quality and nutritional status of the prepared beverage, such as the production of ready-to-serve drinks. Aloe vera can be used to fight against acquired immune deficiency syndrome and is also useful in curing various diseases like tumors, liver complaints, jaundice, and ulcers. The food industry is increasingly focusing on aloe vera products due to their medicinal properties, leading to the incorporation of aloe vera extract as a supplement in the production of functional foods (Lopez *et al*., 2017). Hence, aloe vera was chosen to be incorporated into the aonla juice to obtain the best quality healthy drink. Blended drinks are a good option for developing new products that provide taste, nutrition and medicinal properties. Ginger extract contains several antioxidant compounds, such as gingerol and shogaol, which have antimicrobial activity against food spoilage organisms and improve shelf life (Singh *et al*., 2008). Additionally, ginger is used to enhance the aroma and taste, as reported by Kikuzaki *et al*. (1991). There is a great potential to create an excellent quality health drink that combines aloe vera and ginger, offering both taste and nutritional benefits. The blending of aonla juice with ginger and aloe vera is a novel beverage; the work related to this is very limited.

Materials and Methods

Freshly harvested mature Aonla fruits of cv. Chakaiya were procured from the experimental farm of the ICAR-Central Institute for Subtropical Horticulture, Lucknow. After sorting, healthy fruits were washed for 10 minutes under running tap water to remove dust and microbial load adhering to the surface.

Juice extraction : The fruits were crushed by a hydraulic press (Bajaj Machining, New Delhi, India) at a pressure of 1500 pounds per square inch. Then, it was filtered and pasteurized at 90°C for 2 minutes and stored under ambient conditions (25-26°C, 85-90% RH). The ascorbic acid content, acidity, TSS, and color (L^*, a^*, b^*) values were analyzed in the juice during storage. Juice extracts from fresh aloe vera leaves and healthy ginger rhizomes were also prepared thoroughly using a mixture grinder (Phillips, 1.5 HP, 2800 rpm, 230V) and stored at ambient conditions (25-26°C, 85-90% RH).

Treatment details : Different formulations were prepared by blending Aloe vera (2.5, 5.0%), Ginger extract (1.0, 2.5, 5.0, 7.5, 10.0%) and Aonla juice (25.0, 30.0%) in varied proportions without any significant decline in the overall acceptability of the product. The control sample (T_0) consisted of only aonla juice-based beverage, with standard specifications of aonla juice (30%), no added sugar, and acidity (1.2-1.5%). The beverages prepared from different blends contained three different proportion (Aloe-Ginger-Aonla) with constant TSS and acidity in each consecutive formulation, namely: T_1 (5.0-1.0-25%), T_2 (5.0-2.5-25%), T_3 (5.0-5.0-30%), T_4 (5.0-7.5-25%), T_5 (5.0-7.5-30%), T_6 (5.0-10-30%). The beverages were prepared according to the standard method and specifications proposed by FSSAI-2006. The most acceptable blend was selected based on sensory evaluation by staff members.

Physiochemical analysis

TSS : A handheld refractometer (ATAGO-S-28E model) was used to estimate total dissolved solids (TSS), and values were expressed as degrees Brix (°B). Analyses were repeated three times.

Acidity : Grind the sample completely using a mixer grinder. Weigh 5 g (± 0.1 g) of the sample and add 45 mL of purified water in a suitable container at room temperature. Mix thoroughly and filter it through muslin cloth. Take a 10 mL sample in a conical flask, add 4-5 drops of phenolphthalein indicator, and titrate immediately

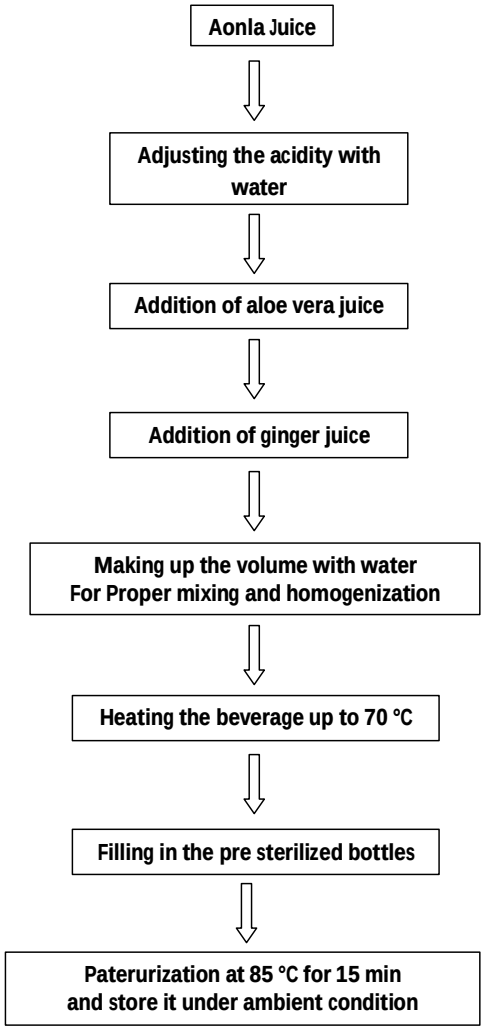

Fig. 1 : Flowchart for the preparation of Aonla juice blended with *Aloe vera* and ginger.

with a standard 0.1 N sodium hydroxide solution until the first permanent pale pink color appears.

Ascorbic acid : Ascorbic acid in the juice and powder was estimated using the titrimetric method with 2, 6-dichlorophenol indophenol dye solution and polyphenols content was estimated using the phenol reagent method of Folin and Ciocaltu (Ranganna, 2000).

Sensory evaluation : Sensory evaluation was performed by 10 panelists consisting of trained and semi-trained staff members have individually coded samples for three sequential sessions consisting of all the mixed treatments to give their views on colour, flavour and overall acceptability using a 9-point hedonic scale consisting of dislike extremely =1, dislike very much = 2, dislike moderately= 3, dislike slightly = 4, neither like nor dislike = 5, like slightly = 6, like moderate = 7, like very much = 8 and like extremely = 9 (Larmond, 1977).

Color (L^*, a^*, b^*) : The juice colors were measured using the handy color meter (3nh.com Model CR4). The degree of browning was indicated by a change in the color values (L^*, a^*, b^*).

Statistical analysis : During this study, a Completely Randomized Design (CRD) was employed as the research design. To identify notable differences ($P < 0.05$) among the element means, one-way and two-way analysis of variance (ANOVA) were conducted, depending on the nature of the data. Subsequently, Tukey's HSD (Honestly Significant Difference) test was utilized to compare means within the ANOVA results.

Results and Discussion

Effect of aloe vera and ginger extract on physicochemical parameters in aonla juice based RTS beverage : The effects of adding aloe vera extract and ginger extract on Total Soluble Solids (TSS), titratable acidity, and ascorbic acid are presented in Table 1. TSS is a important quality parameter for fruit beverages, and maintaining a stable TSS throughout storage is challenging. However, minimal fluctuations can result in a product that is organoleptically acceptable. The initial TSS value in the control sample (T_0) was significantly low (5.05 °Brix) due to the presence of only aonla juice, which was adjusted by water. During storage, the TSS value significantly increased to 5.20, 5.74 and 6.45°Brix in the 1st, 2nd and 3rd months, respectively. A similar trend was observed in treatment T_1, where the TSS value increased to 5.05, 5.62 and 6.31 °Brix during the same period. The TSS significantly changed during storage in all treatments, which can be attributed to hydrolytic changes in carbohydrates, as reported by Kishore *et al*. (2011). This increase in TSS is consistent with the conversion of polysaccharides into soluble sugars and the formation of water-soluble pectin from proto-pectin, as reported by Bal *et al*. (2014). The observed increase in TSS during storage is also in agreement with previous studies conducted by Gaikwad *et al*. (2013) and Sasi *et al*. (2013). The increase in sugar content in the beverage can be attributed to the hydrolysis of polysaccharides, such as starch, cellulose, and pectin, which are converted into monosaccharides. This breakdown of complex carbohydrates into simpler sugars likely contributed to the elevated sugar levels observed in the beverage during storage.

Titratable acidity plays a crucial role in the sensory acceptance of fruit-based beverages, such as Ready-to-Serve (RTS) drinks. In the control treatment, titratable acidity was found to be 1.86%, 1.69%, and 1.54% during the 1st, 2nd and 3rd months of storage, respectively, which was the highest among all treatments. In contrast, the minimum acidity was recorded in T_2 as 1.26%, 1.15%, and 1.04% during the same storage periods. A decrease in acidity was observed in all treatments by the end of

Table 1 : Effect of treatment on TSS (°B), acidity and ascorbic acid of blended RTS beverage during storage.

	Month	T_0	T_1	T_2	T_3	T_4	T_5	T_6
TSS	1st	5.20a ± 0.42	5.09a ± 0.41	4.888adb± 0.4	4.992ab ± 0.41	5.091a ± 0.41	4.576d± 0.37	4.68cd ± 0.38
	2nd	5.74a± 0.47	5.62ab ± 0.44	5.39bc ± 0.42	5.51bc ± 0.42	5.62ab ± 0.44	5.05cd ± 0.42	5.16cd ± 0.42
	3rd	6.45 a± 0.51	6.32a ± 0.52	6.07ab ± 0.52	6.20ab ± 0.51	6.31a ± 0.51	5.68c± 0.51	5.81c ± 0.51
Acidity	1st	1.86c ± 0.15	2.40a ± 0.21	1.26d ± 0.1	2.01ab ± 0.16	1.87abc ± 0.16	1.88abc ± 0.16	1.99 ab± 0.16
	2nd	1.698b ± 0.14	2.19a ±0.19	1.15c ± 0.14	1.83ab± 0.11	1.70b ± 0.08	1.71b± 0.13	1.81 ab±0.11
	3rd	1.54bc ± 0.12	1.998a ± 0.1	1.04 c± 0.1	1.66b ± 0.11	1.55bc ± 0.11	1.56bc ± 0.11	1.64b ± 0.1
Ascorbic acid	1st	380.26 a± 30.92	236.22b ± 19.21	164.84c ± 13.4	115.23d ± 9.37	119.87d ± 9.75	114.10d ± 9.28	100.16 d± 8.19
	2nd	265.03 a± 21.55	115.23c ± 9.37	157.80 b ± 12.83	109.32 c± 8.89	110.59c ± 8.99	106.91c ± 8.69	107.25c ± 11.27
	3rd	152.51 a± 10.77	105.3 1b± 8.56	147.89 a± 12.02	106.51b± 8.66	105.87b± 8.61	106.86b± 8.69	95.47c ± 7.76

the storage period. This change in titratable acidity is consistent with previous reports, such as the study by Alkuraieef and Al-Juhani (2022), which observed a similar trend in pomegranate juice stored for 72 hours.

The ascorbic acid content in the juice underwent the most significant change, rapidly decreasing from approximately 380 to 95.47 mg $100g^{-1}$ after three months of storage across all treatments. Interestingly, high temperatures (85°C) had a minimal impact on ascorbic acid content compared to the storage duration. The ascorbic acid content consistently decreased with increasing storage time, with the highest loss observed in the control and the lowest in treatment T_3. This finding supports previous research by Anup *et al*. (2011) suggesting that temperature fluctuations during storage contribute to ascorbic acid degradation. As shown in Table 1, the ascorbic acid content in the blended juice exhibited a gradual to rapid decline across all treatments. Initially, the highest ascorbic acid content was observed in the control (T_0) at 380.26 mg $100g^{-1}$, followed by 265.03 mg $100g^{-1}$ and 152.51 mg $100g^{-1}$ during the 1st, 2nd and 3rd months of storage, respectively. In subsequent treatments, the highest levels of ascorbic acid were reported in T_1 (236.22 mg $100g^{-1}$), T_2 (157.80 mg $100g^{-1}$) and T_2 (147.89 mg $100g^{-1}$) during the same storage period. Similar findings have been reported in other studies, including a bitter gourd-kiwi blend squash (Sharma *et al*., 2016) and a bitter gourd-aonla blend beverage (Sharma and Thakur, 2017), where ascorbic acid content decreased significantly at all storage intervals. Previous research has also shown that aonla juice stored in glass bottles at ambient conditions can retain ascorbic acid (298.4 mg $100g^{-1}$) for up to six months (Damame *et al*., 2002) and osmovac-dehydrated aonla segments stored at low temperatures can maintain maximum ascorbic acid levels for up to six months (Suresh and Sagar, 2009).

Effect of aloe vera and ginger extract on color (L^*, a^*, b^*) value : The colorimetric properties of the prepared beverage were evaluated using 3nh.com color meter model CR4, which measures lightness (L^*), red-green chromaticity (a^*) and yellow-blue chromaticity (b^*), as presented in Table 2. The Control treatment exhibited the highest L^* and b^* values in the 1st, 2nd and 3rd month of storage periods, respectively. The change in L^* value might be due to the change in property of phenolics compounds, the similar kinds of results were reported by Wijessundara *et al*. (2017). In contrast, Treatment T_6 displayed the highest a^* value among all treatments during the same period, deviating from the overall trend observed in the Control treatment. Important sensory factor that affects consumer acceptability is juice color. The color value was significantly impacted by the juice proportion.

Across all treatments, there was some homogeneity in the color parameters (L^*, a^* and b^*). While, the L^* value changes significantly with blending, a^* and b^* values did not differ significantly across all treatments. L^* and b^* values were lowered by the concentration of aonla RTS mixed with ginger and aloe vera liquids. The computed color L^* value was between 41.52, 69.92 and the b^* value was between 48.12 and 73.80. The range of a^* values, which indicate red-green color intensity was reported to be between 10.89 and 32.55 by Seema *et al*. (2014) and Jain and Khurdiya (2004), who find the similar conclusions.

Evaluation of sensory parameters in aonla based RTS beverage : The sensory qualities of aonla juice-based RTS beverages were evaluated using a 9-point hedonic rating test method (Ranganna, 2001). The beverages were formulated by replacing preservatives with aloe vera and ginger to reduce calorie intake without compromising sensory parameters. The sensory evaluation was conducted at 1-month, 2-month, 3-month intervals and the results are presented in Table 3 and Fig. 1. Treatment T_3 consistently scored higher in all sensory parameters, including color, flavor and bitterness acceptability, compared to other treatments. The addition of aloe vera and ginger significantly affected the color and taste of the beverages. Overall acceptability, a crucial sensory attribute, was highest in treatment T_3 (7.37) and lowest in treatment T_0 (4.88) (Fig. 2). These findings align with previous studies on fruit juices and syrups preparation, such as Ladda *et al*. (2016), who successfully formulated a noni-based syrup with Aloe vera and aonla juice, and Bhavya and Vanajalata (2015), who developed a blended RTS beverage with sweet orange and pomegranate juice that remained stable over 3 months. Sridhar *et al*. (2017) also reported consistent results in their study on jamun and guava juice during storage. The prepared product demonstrates remarkable three-month storage stability at ambient temperature and humidity, without any artificial preservatives, while retaining its outstanding quality and adhering to permissible microbial limits. This underscores the product's durability and suitability for distribution and consumption over an extended period.

Currently, the market demand for beverages rich in phenolics and bioactive compounds is on the rise, driven by consumer awareness of their nutritional importance. Aonla fruits, abundant in phenolic compounds and antioxidants, offer a valuable ingredient for beverage development. As consumers increasingly seek clean labels and natural ingredients, the need for preservative-free flavored beverages has become a priority. Our study demonstrates that incorporating aloe vera and ginger juice extract into aonla juice RTS beverages not only enhances

Table 2 : Effect of treatment on color value (L*, a* and b*) of blended of RTS beverage during storage.

Color	Month	T_0	T_1	T_2	T_3	T_4	T_5	T_6
L*	1st	69.92a ± 0.92	66.56ab ± 1.22	56.45bc ± 0.88	54.41bc ± 1.25	53.91bc± 1.13	51.25c ± 1.14	50.96c ± 1.21
	2nd	65.76a ± 0.96	61.96ab ± 1.2	53.94 bc ± 0.8	49.05 c ± 1.24	47.87 c± 1.27	46.35 c± 1.25	43.51 c± 1.12
	3rd	62.40a ± 2.31	60.47 ab± 2.8	57.02abc ± 1.87	53.25bc ± 2.95	48.49c ± 3.13	47.98c ± 3.09	41.52c ± 2.64
a*	1st	10.89c ± 1.04	15.76c ± 1.06	19.89bc ± 1	21.78ab ± 1.13	22.43ab ± 1.08	24.20ab ± 1.11	27.74a ± 1.18
	2nd	12.42c ± 1.07	17.49c ± 0.98	21.15bc ± 1.03	24.20 ab ± 1.13	27.17 ab ± 1.07	30.82ab ± 1.02	32.74 a ± 1.55
	3rd	15.14c ± 2.55	21.23c ± 2.31	23.87bc ± 2.41	29.90 ab± 2.64	31.16 ab± 2.48	31.55 ab± 2.4	32.45a ± 2.55
b*	1st	73.80a± 1.15	70.63ab ± 1.32	69.81ab± 1.1	67.77abc ± 1.4	63.98bc± 1.24	62.51bc ± 1.29	58.36c ± 1.38
	2nd	64.59a ± 1.16	61.14 ab± 1.24	58.23 ab± 1.01	56.83 abc± 1.36	52.20abc ± 1.38	50.06c ± 1.41	48.12c ± 1.27
	3rd	62.5 a± 2.64	60.63ab ± 2.9	56.74 ab ± 2.5	55.18abc ± 3.27	54.63 abc ± 3.14	53.74bc ± 3.15	51.59c ± 3.06

Table 3 : Effect of treatment on colour, flavour and bitterness acceptability of blended RTS beverage during storage.

	Month	T_0	T_1	T_2	T_3	T_4	T_5	T_6
Color	1st	5.13c ± 0.36	5.46bc ± 0.26	5.63 abc± 0.13	6.99 a± 0.37	5.83ab ± 0.29	5.76 ab± 0.54	5.39bc ± 0.31
	2nd	5.31c ± 0.18	5.34c ± 0.10	6.11bc ± 0.11	6.37ab ± 0.20	6.48a ± 0.25	6.04bc ± 0.47	5.81bc ± 0.31
	3rd	5.26c ± 0.15	5.21c ± 0.21	4.88c ± 0.11	6.85a ± 0.26	6.26cb ± 0.35	6.59a ± 0.19	6.60a± 0.16
Flavour	1st	4.18c ± 0.18	5.18 bc± 0.18	5.33 bc± 0.26	7.51a ± 0.26	5.15ac ± 0.14	5.21bc ± 0.29	5.34bc ± 0.245
	2nd	5.26c ± 0.26	5.65b ± 0.11	6.03ab ± 0.03	6.53 a± 0.29	6.03ab ± 0.10	5.91b ± 0.08	6.02ab ± 0.23
	3rd	5.76b ± 0.21	5.92ab ± 0.071	5.39 c± 0.21	7.21a ± 0.18	6.62b ± 0.31	6.00 bc± 0.12	7.00 a± 0.12
Bitterness Acceptability	1st	4.88 c± 0.11	5.50b ± 0.25	5.94ab ± 0.04	7.02a ± 0.051	4.95 c± 0.24	5.36b ± 0.15	5.46 b± 0.34
	2nd	5.01c± 0.12	5.03c ± 0.04	6.11 a± 0.06	6.00ab± 0.13	6.36 a± 0.22	5.92b ± 0.13	6.036ab ± 0.15
	3rd	5.14b ± 0.15	5.08 b± 0.04	5.18b ± 0.25	7.37a± 0.26	6.40ab ± 0.30	6.43 ab± 0.29	6.29ab ± 0.40

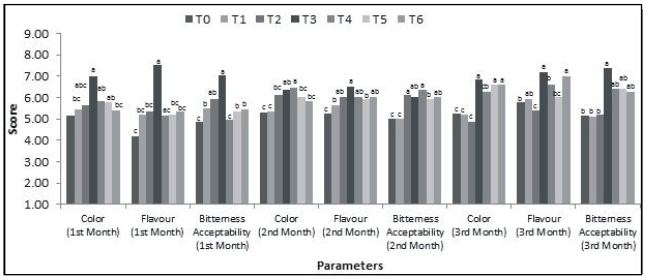

Fig. 1 : Evaluation of sensory parameters in aonla based RTS beverage.

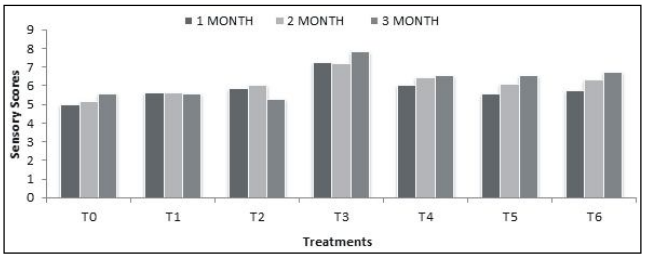

Fig. 2 : Overall acceptibility of sensory evaluation.

the bioactive compound profile but also inhibits enzymatic browning, significantly improving the beverage's color. This results in a healthier, preservative-free option that meets consumer demands for health, taste, and sustainability. By leveraging the potential of aonla and natural extracts, we can make beverages that align with consumer preferences and promote a healthier lifestyle. This product provides a multitude of health benefits, including effective weight management and a reduced risk of lifestyle diseases, such as type II diabetes, hypoglycemia, and cardiovascular diseases. Furthermore, it helps maintain optimal levels of vital nutrients, including essential vitamins, magnesium, and fiber, supporting overall well-being and health.

Conclusion

A recent study highlights the exceptional performance of a novel blend in terms of taste, flavor, acidity, and total soluble solids (TSS), with a remarkable three-month shelf life without preservatives. The pioneering combination of aonla, ginger and aloe vera juices (5.0-5.0-30% ratio) has the potential to transform the beverage industry. This innovative formulation enables the creation of premium, clean-label beverages that align with emerging market trends, prioritizing health, sustainability and taste. Future research should focus on scaling up production, exploring new applications and flavor profiles, and investigating the more health benefits and more nutritional properties of blend, ultimately driving the development of consumer-centric beverages that meet the changing demands of the market.

Authors' contributions

Karma Beer and Abha Singh conceptualized the idea

of the project and accordingly planned the outline of the work. The resource availability was ensured by Karma Beer. Abha Singh collected the relevant data and performed the research experiments in the laboratory. The analysis and drafting of document were done by Karma Beer. The manuscript was edited and accordingly restructured by Abha Singh. Before final submission, both authors have contributed significantly in the review process and proofreading of the manuscript.

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