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STUDIES ON PRESERVATIVE-FREE LOW-CALORIE BEVERAGES FROM GUAVA PULP AND AONLA JUICE BLENDS

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ABSTRACT

The present investigation entitled "Studies on preservative-free low-calorie beverages from guava pulp and aonla juice blends" was conducted in the post-harvest technology laboratory of Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya with the objective to develop preservative-free low-calorie beverages and assess the storability of the products. The optimal blend for Ready-to-serve (RTS) and nectar beverages was determined to be 80% guava pulp and 20% aonla juice, which received the highest sensory rating of 'Liked very much' on the Hedonic scale. Assessment of sugar and stevia proportions demonstrated that stevia could successfully substitute 40% of the sugar content in RTS and nectar formulations without compromising palatability. The storage studies indicated substantial alterations in total soluble solids, acidity, reducing sugars, total sugars, and non-enzymatic browning, all of which showed an upward trend. In contrast, ascorbic acid, non-reducing sugars, and organoleptic score showed a downward trend during storage. Hence, it is inferred that the RTS can be stored for up to two months, and nectar can be stored for up to 3 months without impairing the quality of beverages. The results suggest that guava-aonla blends offer a viable alternative for developing health-conscious, preservative-free beverages with extended shelf stability.
Keywords **:** Guava pulp, Aonla juice, Low-calorie beverage, Stevia, Storage stability, Sensory evaluation.

Introduction

Aonla (*Emblica officinalis* Gaertn.), commonly known as 'Indian gooseberry,' is gaining recognition worldwide for its nutritional and therapeutic values, as well as its potential for various value-added products, making it a significant fruit of the 21st century for the beverage industry. The fresh fruit's pulp contains 200 - 900mg/100g of ascorbic acid. Aonla is widely utilized in several Indian systems of medicine, primarily in its fresh or dry form (Agarwal & Chopra, 2004). Due to its high acidity and astringency, the consumption of fresh aonla is limited, necessitating its processing into value-added beverages. Guava (*Psidium guajava* L.), known as the 'Apple of the tropics,' is an excellent source of vitamin C, ranging from 70 to 350 mg/100 g, along with pectin, dietary fiber, and essential minerals such as calcium, phosphorus, and iron (Dhaliwal and Dhillon, 2003). Therefore, due to its high nutritive value, it is an ideal crop for nutritional security. Guava is in great demand as a table fruit and in processing industries (Archana and Siddiqui, 2004). The predominant guava varieties in India include Lucknow-49 and Allahabad Safeda, while Lalit, a high-yielding pink-fleshed variety, is suitable for both fresh consumption and processing. Stevia (*Stevia rebaudiana* Bert.), a herb from the Asteraceae family, contains stevioside, a glycoside that is 150–300 times sweeter than sugar. As a non-caloric natural sweetener, it benefits calorie-conscious consumers and is reported to be safe for human consumption (Geuns, 2003). It serves as a suitable sugar substitute for fruit beverages due to its minimal impact on blood sugar levels. Blending the astringent yet nutritious aonla juice with guava pulp, particularly the Lalit variety, enhances flavour, aroma, and colour while masking astringency. In this context, the formulation of guava-aonla blends represents an innovative approach for developing high-quality, nutritious, and palatable beverages that maximize the health benefits of aonla while improving consumer acceptability.

Materials and Methods

Raw materials

Mature aonla fruits of cultivar Narendra Aonla-7 (NA-7) and ripe guava fruits of cultivar Lalit were procured from the main Experimental Station of the university for the preparation of low-calorie blended RTS and Nectar. The Stevia a natural non-caloric sweetener with a sweetness intensity approximately ten times that of sucrose per gram, was sourced from Jhanil Healthcare Pvt. Ltd., Punjab, while Sugar was purchased from the local market.

Extraction of pulp and juice

Aonla juice was extracted, pasteurized, and stored in sterilized bottles until the final product preparation. The extraction techniques for guava pulp and aonla juice are illustrated in Fig. 1 and Fig. 2, respectively.

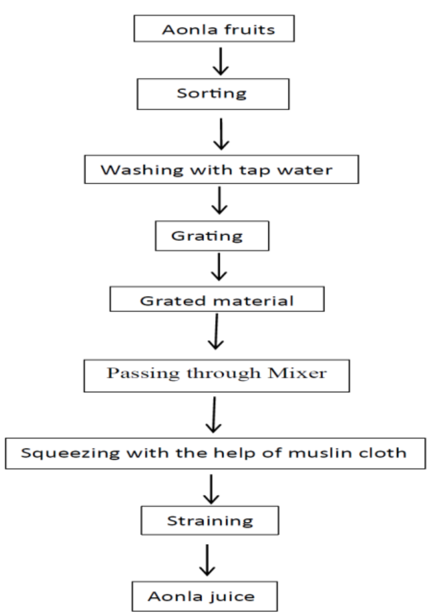

Fig. 1: Flow sheet for extraction of juice from aonla fruits

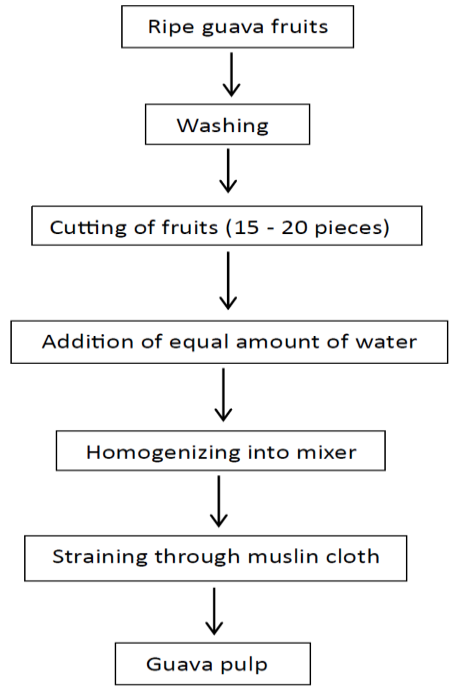

Fig. 2: Flow sheet for extraction of pulp from guava fruits

Standardization of blends for RTS and nectar

The following ratios of aonla juice and guava pulp were evaluated to standardize the blend for the development of quality RTS and nectar.

Standardization of blends for RTS

T_1 - 00% guava pulp adjusted to 0.25 % acidity and 13 % TSS.
T_2 - 00% aonla juice adjusted to 0.25 % acidity and 13 % TSS.
T_3 - 0% guava pulp + 20% aonla juice adjusted to 0.25 % acidity and 13 % TSS.
T_4 - 0% guava pulp + 40% aonla juice adjusted to 0.25 % acidity and 13 % TSS.
T_5 - 40% guava pulp + 60% aonla juice adjusted to 0.25 % acidity and 13 % TSS.
T_6 - 0% guava pulp + 80% aonla juice adjusted to 0.25 % acidity and 13 % TSS.

Standardization of blends for Nectar

T_1 - 100% guava pulp adjusted to 0.3 % acidity and 14 % TSS.
T_2 - 100% aonla juice adjusted to 0.3 % acidity and 14 % TSS.
T_3 - 80% guava pulp + 20% aonla juice adjusted to 0.3 % acidity and 14 % TSS.
T_4 - 60% guava pulp + 40% aonla juice adjusted to 0.3 % acidity and 14 % TSS.
T_5 - 40% guava pulp + 60% aonla juice adjusted to 0.3 % acidity and 14 % TSS.

T_6 - 20% guava pulp + 80% aonla juice adjusted to 0.3 % acidity and 14 % TSS.

Preparation of RTS and Nectar

Three litres of RTS (10% blend, 13% TSS, 0.25% acidity) and nectar (20% blend, 14% TSS, 0.3% acidity) were prepared per treatment and evaluated organoleptically using a 9-point hedonic scale by a panel of judges. The results determining the optimal guava pulp and aonla juice combination for preparation of preservative-free, low-calorie blended RTS and nectar are presented in Table 1 and 2.

Evaluation of sugar and stevia ratio

Using the optimal blend of guava pulp and aonla juice, the following ratios of sugar and stevia were evaluated through organoleptic testing to identify the best combination (Table 3 & 4). Subsequently, five litres of each low-calorie RTS and nectar were prepared by combining measured quantities of sugar, stevioside, pulp, citric acid, and water for storage studies (Fig. 3).

T_1 - 100% sugar
T_2 - 100% stevia
T_3 - 80% sugar + 20% stevia
T_4 - 60% sugar + 40% stevia
T_5 - 40% sugar + 60% stevia
T_6 - 20% sugar + 80% stevia

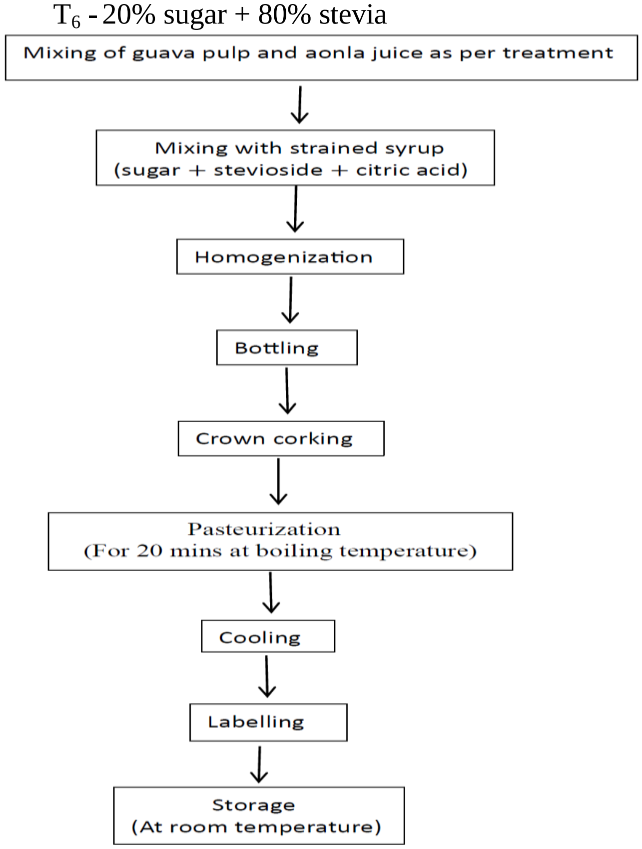

Fig. 3: Flow sheet for preparation of preservative-free low-calorie guava pulp and aonla juice blended RTS and nectar

Storage studies

Five litres of RTS and nectar from each selected treatment were prepared, filled into 200 ml RTS bottles with a 2 cm headspace, crown-corked, pasteurized, and stored at ambient temperature for storage studies. Observations were systematically recorded at monthly intervals to assess changes in TSS, acidity, ascorbic acid (AOAC, 2000), sugars (Lane & Eynon, 1923), non-enzymatic browning (Rangana, 2010), and organoleptic quality (Amerine *et al*., 1965). The TSS of the beverages was measured using a hand refractometer, with readings corrected to 20°C. Acidity was estimated by titrating a known sample quantity against 0.1N NaOH using phenolphthalein as an indicator, with the endpoint marked by the appearance of pink colour. Ascorbic acid content was analysed by diluting the sample in metaphosphoric acid and titrating against a 2,6-Dichlorophenol indophenol dye solution, with the endpoint indicated by the appearance and persistence of a pink colour. Reducing and non-reducing sugars were estimated using Fehling's A and B solutions, titrating the aliquot against a 1% dextrose solution with methylene blue as an indicator. Total sugars were calculated as the sum of reducing and non-reducing sugars. Non-enzymatic browning was assessed by measuring optical density at 440 nm using a UV spectrophotometer. Organoleptic evaluation of colour, flavour, and texture was conducted by a semi-trained panel using a 9-point Hedonic scale. The experiments were conducted with three replications to ensure the reliability of the findings. Statistical analysis of the data was performed using the methodology outlined by (Panse & Sukhatme, 1989), employing a completely randomized design (CRD) for rigorous evaluation of treatment effects.

Results and Discussion

Standardization of blends for RTS and nectar

In the present study, treatment no. 3, comprising 80% guava pulp and 20% aonla juice, was identified as the most preferred combination for both RTS and nectar, based on organoleptic evaluation by a panel of judges, with hedonic scores of 8.56 and 8.75, respectively, and a rating of "Liked very much"(Table 1 & 2). Similarly, (Byanna *et al*., 2012) optimized an RTS beverage with a 50:50 sweet orange–pomegranate juice blend, while (Sree *et al*., 2015) reported 60:40 as the most acceptable ratio. (Mahnoori *et al*., 2020) found a 75:25 litchi–beetroot blend optimal for taste and colour for RTS.

Table 1: Organoleptic quality of different combinations of guava pulp and aonla juice ratio for the preparation of low-calorie blended RTS:

Treatment No.	Guava pulp + aonla juice ratio	Organoleptic quality	
		Score	Rating
T_1	100% guava pulp	8.74	LVM
T_2	100% aonla juice	6.49	LS
T_3	80% guava pulp + 20% aonla juice	**8.56**	LVM
T_4	60% guava pulp + 40% aonla juice	7.69	LM
T_5	40% guava pulp +60% aonla juice	7.45	LM
T_6	20% guava pulp + 80% aonla juice	6.62	LS

LVM - Liked very much, LM - Liked Moderately, LS - Liked slightly

Table 2: Organoleptic quality of different combinations of guava pulp and aonla juice ratio for the preparation of low-calorie blended Nectar:

Treatment No.	Guava pulp + aonla juice ratio	Organoleptic quality	
		Rating	Score
T_1	100% guava pulp	8.82	LVM
T_2	100% aonla juice	6.40	LS
T_3	80% guava pulp + 20% aonla juice	**8.75**	LVM
T_4	60% guava pulp + 40% aonla juice	7.70	LM
T_5	40% guava pulp +60% aonla juice	7.52	LM
T_6	20% guava pulp + 80% aonla juice	6.63	LS

LVM - Liked very much, LM - Liked moderately, LS - Liked slightly

Standardization of sugar and stevia ratio

In the present study, treatment no. 4, consisting of a 60% sugar and 40% stevia ratio, received the highest organoleptic score and was rated as "Liked very much" compared to other formulations (Table 3 & 4). This combination was identified as the most suitable for the preparation of low-calorie blended RTS and nectar. (Tadhani and Subhash, 2012) reported successful sugar replacement with stevioside at 50% & 75% in tea and coffee, and 80% (stevioside) and 60% (stevia leaf extract) in lemon juice.

Table 3: Organoleptic quality of different sugar and stevia ratio for the preparation of low-calorie blended RTS:

Treatment No.	Best blending ratio	Sugar + stevia ratio	Organoleptic quality	
			Score	Rating
T_1	80 % guava pulp + 20 % aonla juice	100% sugar	8.54	LVM
T_2	80 % guava pulp + 20 % aonla juice	100% stevia	6.35	LS
T_3	80 % guava pulp + 20 % aonla juice	80% sugar + 20% stevia	7.72	LM
T_4	80 % guava pulp + 20 % aonla juice	60% sugar + 40% stevia	**8.40**	LVM
T_5	80 % guava pulp + 20 % aonla juice	40% sugar + 60% stevia	7.45	LM
T_6	80 % guava pulp + 20 % aonla juice	20% sugar + 80% stevia	6.54	LS

LVM - Liked very much, LM - Liked moderately, LS - Liked slightly

Table 4: Organoleptic quality of different sugar and stevia ratio for the preparation of low-calorie blended nectar:

Treatment No.	Best blending ratio	Sugar + stevia ratio	Organoleptic quality	
			Score	Rating
T_1	80 % guava pulp + 20 % aonla juice	100% sugar	8.68	LVM
T_2	80 % guava pulp + 20 % aonla juice	100% stevia	6.30	LS
T_3	80 % guava pulp + 20 % aonla juice	80% sugar + 20% stevia	7.79	LM
T_4	80 % guava pulp + 20 % aonla juice	60% sugar + 40% stevia	**8.59**	LVM
T_5	80 % guava pulp + 20 % aonla juice	40%sugar +60% stevia	7.53	LM
T_6	80 % guava pulp + 20 % aonla juice	20% sugar + 80% stevia	6.42	LS

LVM - Liked very much, LM - Liked moderately, LS - Liked slightly

Biochemical changes during storage

Studies on biochemical changes indicate a gradual increase in TSS during storage, rising from 9.0% to 9.60% in RTS after one month and from 9.0% to 9.70% in nectar after two months of storage under ambient conditions. This uptrend is attributed to polysaccharide and oligosaccharide hydrolysis into soluble sugars. Similar trends have been reported by (Shaheel *et al*., 2015) in blended Karonda RTS and (Goutam *et al*., 2021**)** in blended custard apple nectar. The acidity of beverages increased during storage, rising from 0.25% to 0.27% in RTS after one month and from 0.30% to 0.32% in nectar after two months. This rise is attributed to the degradation of pectic substances and ascorbic acid, leading to organic acid formation. Similarly, an increase in acidity content was observed by (Hariharan, 2016) in ginger-lime RTS and (Charan *et al.*, 2017) in passion fruit nectar. The study revealed a significant decline in ascorbic acid content during storage. In RTS, ascorbic acid decreased from 11.42 mg to 8.65 mg per 100 g, while in nectar, it declined from 12.38 mg to 8.32 mg per 100 g. This reduction is attributed to the oxidation of ascorbic acid into dehydroascorbic acid due to trapped oxygen in glass bottles. These findings align with those of (Chandrakant, 2021) in blended aonla – basil - ginger RTS. Reducing sugars of the beverages found to be increased from 2.10% at initial day to 2.75% at the end of storage in RTS and from 2.55% to 3.15% in nectar. Similar results reported by (Ravinder *et al*., 2012) in blended shatavari nectar and (Rakha *et al.*, 2017) in kiwi fruit nectar. The content of total sugars also increased with the advancement of storage period. It increased from 7.50% to 7.90% in RTS and 7.85% to 8.20% in nectar. Similar results observed by (Malav *et al*., 2014) in orange-aonla-ginger blended RTS. The increase in reducing sugars and total sugars may be due to the conversion of Non reducing sugar to reducing sugar and hydrolysis of polysaccharides into monosaccharides. Conversely, non-reducing sugars demonstrated a continuous decline throughout the storage period. The decrement in the Non reducing sugar may be due to the conversion of Non reducing sugar into reducing sugar. Similar observations reported by (Singh *et al*., 2007) in blended pineapple - guava nectar and (Tiwari and Deen, 2015) in aloe vera - bael RTS. Browning in the beverages showed an increasing trend during storage, with values rising from 0.17 to 0.24 in RTS and from 0.18 to 0.26 in nectar. This increase is attributed to chemical reactions involving nitrogenous compounds with carbohydrates and organic acids, as well as interactions between sugars and organic acids. Similar findings were reported by (Mandal *et al*., 2020) in jamun nectar. The organoleptic value of preservative-free, low-calorie blended RTS and nectar declined over storage, decreasing from 8.5 to 4.6 in RTS and from 8.6 to 4.5 in nectar after the 1st and 2nd months. This deterioration is may be due to undesirable changes occurring during storage. Similar trends were reported by (Afreen *et al*., 2016) in carrot–sour orange blended RTS.

Table 5: Biochemical and organoleptic changes during storage in preservative-free low-calorie RTS

Storage period (months)	TSS (%)	Acidity (%)	Vitamin C (mg/100g)	Reducing sugars (%)	Non reducing sugar (%)	Total sugars (%)	Browning (O.D)	Organoleptic quality	
								Score	Rating
0	9.0	0.25	11.42	2.10	5.40	7.50	0.17	8.5	LVM
1	9.0	0.25	10.80	2.10	5.40	7.50	0.17	8.5	LVM
2	9.21	0.26	9.90	2.34	5.31	7.65	0.20	7.8	LM
3	9.60	0.27	8.65	2.75	5.15	7.90	0.24	4.6	LS
CD(1%)	0.20	NS	0.44	0.22	NS	0.28	0.02		

LVM - Liked very much, LM - Liked moderately, LS - Liked slightly

Table 6: Biochemical and organoleptic changes during storage in preservative-free low- calorie nectar

Storage period (months)	TSS (%)	Acidity (%)	Vitamin C (mg/100g)	Reducing sugars (%)	Non reducing sugar (%)	Total sugars (%)	Browning (O.D)	Organoleptic quality	
								Score	Rating
0	9.0	0.30	12.38	2.55	5.30	7.85	0.18	8.6	LVM
1	9.0	0.30	11.76	2.55	5.30	7.85	0.18	8.6	LVM
2	9.0	0.30	10.82	2.55	5.30	7.85	0.18	8.4	LVM
3	9.25	0.31	9.71	2.78	5.22	8.00	0.22	7.8	LM
4	9.70	0.32	8.32	3.15	5.05	8.20	0.26	4.5	LS
CD(1%)	0.23	NS	0.27	0.30	NS	0.21	0.03		

LVM - Liked very much, LM - Liked moderately, LS - Liked slightly

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Conclusion

The study concludes that aonla can be effectively utilized in combination with guava to formulate palatable, nutritious, and high-quality blended beverages. Additionally, preservative-free, low-calorie RTS and nectar of acceptable quality can be prepared by replacing 40% of sugar with stevia. Based on organoleptic evaluation and browning parameters, it is determined that preservative-free, low-calorie RTS can be stored for up to two months, while nectar remains stable for three months under ambient conditions without significant quality deterioration.

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