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Standardization and Evaluation of Physico-Chemical and Sensory properties of Functional Acerola (West Indian Cherry) Beverages

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ABSTRACT: Acerola, a tropical fruit rich in vitamin C and bioactive compounds, faces challenges in preservation and marketability due to its delicate nature. Only limited research has been carried out in this underutilized crop especially in the preparation of acerola-based beverages due to its very seasonal availability and its high perishability. This study attempted to develop and evaluate functional acerola beverages with enhanced physico-chemical and sensory properties. Ready-to-serve beverages were prepared by processing acerola with functional ingredients like aloe vera, chia seeds, ginger, cinnamon, and mint. The beverages were evaluated for their physico-chemical properties and sensory attributes. The results showed significant variations in total soluble solids, pH, titratable acidity, and ascorbic acid content among the different treatments. Sensory evaluation resulted in mint having better taste, aroma, texture and overall acceptability. The findings provide insights into the potential of combining acerola with different ingredients to create functional beverages with desirable sensory attributes, which can contribute to the utilization of this tropical fruit that offer health benefits to consumers.

Keywords: Acerola, Vitamin C, RTS, Physico-chemical properties, sensory attributes.

INTRODUCTION

Human nutrition greatly benefits from beverages made from fruits and vegetables. People from all cultures consume them as healthy food and to slake their thirst. Ready-to-serve (RTS) beverages are gaining popularity in recent times among individuals of all ages. The augmentation of nutraceutical constituents is highly beneficial in the development of enriched functional beverages (Kausar *et al.*, 2016; Khan and Anderson 2003). According to FAO, “fruit juice is the unfermented, but fermentable liquid obtained from the edible part of appropriately mature and fresh fruit or of fruit maintained in ideal conditions by suitable means in accordance with the applicable provisions of the Codex Alimentarius Commission”.

Acerola, (*Malpighia emarginata*) also popularly known as West Indian Cherry or Barbados cherry, is a tropical fruit which belongs to the Malpighiaceae family. In the South Indian states of Tamil Nadu, Kerala, Karnataka, and Maharashtra, the fruit is planted as a garden tree (Singh, 2006). It is recognized as “Super Fruit” (Poletto *et al.*, 2021) as well as “pills of nature’s vitamin” (Belwal *et al.*, 2018) for its extremely rich vitamin C content (1500-4500 mg/ 100g) making it 50-100 times more nutritious than oranges or lemons (Kirker and Newman 2021; Prakash and Baskaran 2018). Apart from vitamin C and small amount of vitamin A, vitamin B complex, protein and minerals, the fruits are also a good source of carotenoids, flavonoids, pectin, pectolytic enzymes and volatile compounds. The fruits also possess anti-fungal properties (Assis *et al.*, 2008; Nunes *et al.*, 2011).

Deterioration of keeping quality of the fruit is the major constraint in acerola cultivation, as the skin of the fruit is very soft and fragile. Due to its delicate and highly perishable nature (shelf life of 2-3 days at room temperature after harvesting), consequent problems in transportation (Rani *et al.*, 2019) and inadequate processing and storage facilities, the fruits are rendered unfit for consumption soon after harvest. It is crucial to quickly process the fruits into value added products in order to reduce the post-harvest loss of this underutilized crop.

Acerola fruits have been exploited for processing into jelly, jam and other products which helps to minimize the post-harvest loss (Thien and Duong 2018). Although several studies on acerola juice are mentioned in the literature, no references so far have reported supplementation of mixed fruit/vegetable extracts with acerola juice. Blending different fruits/ vegetables provides a unique range of nutrients and beneficial ingredients.

Aloe vera, also known as heavens blessing (Masood *et al.,* 2021) belongs to Aloaceae family and has antifungal, wound healing, anti-inflammatory, hypoglycemic, anticancer, and immunomodulatory properties. Aloe vera gel has a bitter taste when consumed raw and can be made palatable by blending with fruit juices (Kausar *et al.*, 2016). Chia seed (*Salvia hispanica*) is an annual herb, that produces black or white seeds (Ixtaina *et al*., 2008). Chia seeds are a source of vitamins, minerals and possess antioxidant compounds (Marcinek and Krejpcio 2017) which when soaked in water create a gelatinous substance that absorbs up to 12 times their weight of water. Because they lack any flavor or aroma of their own, these seeds can be easily incorporated in any food or dish (Suri *et al*., 2021).

Ginger (*Zingiber officinale*) is a valued spice with medicinal properties, used to treat arthritis, ulcers, heart attack and stroke. It is an aromatic tuber crop with volatile oils (Chandra *et al*., 2018). The flavorful and intensely spicy scent of ginger enables food technologists to create a variety of soft drinks, including ginger cocktails, cordials, carbonated beverages, etc. (Pruthi *et al*., 1984). Mint (*Menta piperita* L.), which is well known for its medical benefits, is also a great source of polyphenols. It contains plenty of antioxidants, polyphenols and flavanoids that aid with digestion and immunity. Herbal medicine and most cuisines, frequently employ the herb cinnamon (*Cinnamomum verum*). The herb possesses anti-allergy, antiviral, antimicrobial, and antioxidant effects and aid with numerous therapies for diabetes and heart disease (Yaseen and Mohammed 2020).

The present study aimed to produce an acerola-aloe vera RTS beverage with chia seeds and added extracts of ginger, mint and cinnamon. The study also assessed the physico-chemical parameters and sensory attributes of the three different acerola-aloe vera RTS functional beverages.

MATERIALS AND METHODS

The experiment was conducted in the Food Processing Technology Laboratory of the School of Agricultural Sciences, Karunya Institute of Technology and Sciences (KITS), during 2022-2023. The fully ripe, red-colored acerola (*Malpighia emarginata*) fruits were harvested from the North farm, KITS.

A. Fruit selection, extraction and processing

The leaves and peduncles, immature, insect affected and deteriorated fruits were removed, and the selected fruits were washed under running tap water and were sanitized in peracetic acid solution (1%) at 5ºC for 10 min (Silveira *et al.,* 2013). After washing the fruit, the pulp was extracted manually, and the seeds were removed. After depitting, the extracted pulp was used for further processing. The pulp was weighed using weighing balance and added an adequate amount of water and brought to boil at 100ºC for 10 minutes. The juice was filtered using muslin cloth after cooling.

B. Processing of aloe vera

Fresh aloe vera leaves of good quality were harvested from the Medicinal garden, KITS; the yellow fluid discharges of the leaves were washed thoroughly in running tap water prior to processing. A sharp knife was used to separate the aloe vera gel from the leaves. The gel was pasteurized at 100°C for 20 minutes after being blended in a juicer and filtered through muslin cloth (Kausar *et al*., 2016).

C. Processing of chia seeds

Chia seeds were procured from local sources. 0.2% chia seeds were taken and hydrated in water at room temperature for 2hrs.

D. Preparation of Acerola- aloe vera RTS beverage with different plant extracts

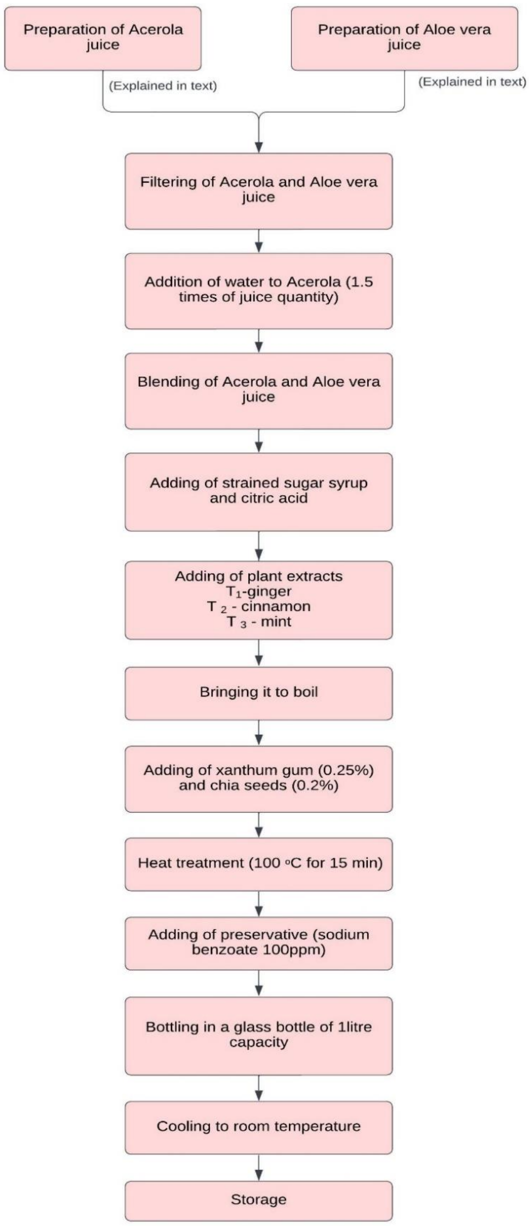

Fig. 1. Flow chart of preparation of Acerola- Aloe vera RTS beverages with different plant extracts.

E. Physio-chemical evaluation

pH was determined using digital pH meter (model-LT-501); total soluble solids was determined using digital refractometer (model-HI96801) and was expressed as °Brix; titratable acidity was determined by 0.1% N NaOH titrating solution and expressed as % citric acid (Ranganna, 1979); total sugar was determined by anthrone method and absorbance was read at 6200 nm using spectrophotometer (model- KLUV-2100) (Plummer, 1990); reducing sugar was determined by dinitrosalicylic acid method and absorbance was read at 600 nm spectrophotometer (Miller, 1972); Ascorbic acid was determined by volumetric method using 2,6-dichloro indophenol dye (Sadasivam and Balasubramanian 1987). Suspension stability was determined by following the method given by Ranganna and Raghuramaiah (1970) and viscosity was determined with a brook field viscometer.

F. Sensory evaluation

Using a 7-point hedonic scale, sensory evaluation of Acerola-Aloe vera RTS drink was conducted using 25 respondents. The wines were evaluated for their color, flavor, taste, appearance, and overall acceptability.

G. Statistical Analysis

The experiment followed a completely randomized design (4 treatments and 4 replications thus n=16). To establish the statistical significance of treatments, the data was statistically analyzed using the analysis of variance technique (ANOVA). Lest Significant Difference test (LSDt) was used to determine mean separation.

Sensory response of consumer	Values in hedonic scale
Dislike very much	1
Dislike moderately	2
Dislike slightly	3
Neither like nor dislike	4
Like slightly	5
Like moderately	6
Like very much	7

RESULTS AND DISCUSSION

A. Physico-chemical evaluation

The results of the physico-chemical analysis of the Acerola-Aloe vera juice with 3 extracts (ginger, cinnamon, and mint) are presented in Table 1. The total soluble solids (TSS) content varied significantly among the treatments. The T3 (Acerola + aloe vera + mint) had the highest mean TSS value of 32.14 °Brix, indicating a higher sugar content in the juice. The TSS values for the other treatments ranged from 27.33 to 28.93 °Brix. A study conducted in beetroot RTS using mint extract had the highest mean TSS value compared to ginger and holy basil extracts (Varshini *et al.*, 2022). The pH for the various treatments ranged from 3.36 to 3.86. Treatment T0 (Acerola + aloe vera) had the lowest pH value, while Treatment T1 (Acerola + aloe vera + ginger) had the highest pH value. The treatments differed significant for the pH values. The juice with ginger extract has the highest pH value, according to Hariharan and Mahendran (2016), who also reported that pH value decreases with increase in acidity.

The range of the titratable acidity, measured as a percentage of citric acid, was 0.41% to 0.45%. The highest titratable acidity was found in treatment T_2 (Acerola + aloe vera + cinnamon), whereas the lowest was found in treatment T_1 (Acerola + aloe vera + mint). However, there was no significant difference in the titratable acidity across the regimens. Chandra *et al*. (2018) evaluated various formulations of RTS from a blend of awala, aloe vera, mint, and ginger, the plant extracts (ginger, mint, and cinnamon) and found that the treatments did not have differences in the TA. The amount of ascorbic acid in the juice, which is a measure of its vitamin C content, significantly varied between the treatments.

Table 1a: Physico-chemical analysis of Acerola – Aloe vera juice with different flavors.

Treatment	TSS (°Brix)	pH	Titratable acidity (% citric acid)	Ascorbic acid(mg/100ml)
T_0	27.33^a	3.36^a	0.42^a	328.35^a
T_1	28.53^b	3.86^c	0.43^{ab}	210.99^b
T_2	28.93^c	3.45^{ab}	0.45^b	471.62^c
T_3	32.14^d	3.48^b	0.41^a	362.36^d
CD at (5%)	0.24	0.11	0.02	1.02

(T_0- Acerola+ aloe vera, T_1- Acerola+ aloe vera+ ginger, T_2- Acerola+ aloe vera+ cinnamon and T_3- Acerola+ aloe vera+ mint; a-d superscript letters in data indicates significant difference between treatments (p≤0.05).

Table 1b: Physico-chemical analysis of Acerola – Aloe vera RTS beverage with flavors.

Treatment	Total sugar (%)	Reducing sugar (%)	Suspension stability (%)	Viscosity (cps)
T_0	24.15^a	9.44^a	39.30^a	7.57^{ab}
T_1	25.49^b	10.62^b	39.57^b	7.71^{bc}
T_2	25.72^b	10.53^b	39.71^c	7.75^c
T_3	30.72^c	12.72^c	39.63^b	7.43^a
CD at (5%)	1.02	0.5	0.07	0.16

(T_0- Acerola + aloe vera, T_1- Acerola + aloe vera+ ginger, T_2- Acerola + aloe vera + cinnamon and T_3- Acerola + aloe vera + mint; a- d superscript letters in data indicates significant difference between treatments (p≤0.05).

The mean ascorbic acid content of treatment T_2 (Acerola + aloe vera + cinnamon) was 471.62 mg/100 ml, while that of treatment T_1 (Acerola + aloe vera + ginger) was 210.99 mg/100 ml. According to Chandra *et al*. (2018); Kausar (2020), aloe vera and various plant extracts alter the Ascorbic acid content.

The total sugar content of the juice ranged from 24.15% to 30.72%, with treatment T_3 (Acerola + aloe vera + mint) having the highest value. The reducing sugar content followed a similar trend, with treatment T_3 having the highest value of 12.72%. The differences in total sugar and reducing sugar content among the treatments were statistically significant. Compared to the other plant extracts, mint had the highest total sugar and reducing sugar in development and standardization of ready to serve (RTS) beetroot drink.

The suspension stability and viscosity of the juice, which contribute to its mouthfeel and texture, did not vary significantly among the treatments. The suspension stability values ranged from 39.30% to 39.71%, and the viscosity values ranged from 7.43 to 7.75. According to Sobini *et al.* (2022) in palmyra RTS drink the stability and turbidity of RTS were markedly improved by applying homogenization and increasing the xanthan gum concentration. The viscosity and suspension properties of the RTS were enhanced by the concentration of xanthan gum. The viscosity was reduced with prolonged storage days.

B. Sensory Analysis

A sensory assessment was performed on the acerola-aloe vera juice treatments made with various flavoring agents. Ten judges assessed the aesthetic appeal of the various treatments based on their taste, color, aroma texture, and overall appeal. In Table 2, the mean ratings for the color, flavor, texture, and overall acceptability of the treatments are displayed.

Table 2: Sensory analysis of Acerola – Aloe vera RTS beverages with different flavors.

Treatments	Appearance	Color	Taste	Aroma	Texture
T_0	6.08^{bc}	5.78^{a}	6.15^{c}	5.25^{a}	5.58^{a}
T_1	6.00^{ab}	6.05^{b}	5.85^{b}	6.00^{ab}	5.53^{a}
T_2	5.88^{a}	6.05^{b}	4.33^{a}	6.23^{b}	5.53^{a}
T_3	6.20^{c}	6.05^{b}	6.55^{d}	6.68^{c}	6.05^{b}
CD at (5%)	0.18	0.26	0.19	0.31	0.40

(T_0- Acerola + aloe vera, T_1- Acerola + aloe vera + ginger, T_2- Acerola + aloe vera + cinnamon and T_3- Acerola + aloe vera + mint; a- d superscript letters in data indicates significant difference between treatments ($p \leq 0.05$).

In terms of appearance of the juice T_3 (6.20) had the highest mean value. Compared to T_0, the other treatments. T_1, T_2 and T_3 has the highest mean values of color. The taste of the juice varied significantly from each other with T_3 (6.55) has the highest mean value while T_2 (4.33) has the lowest mean value similarly T_3 has the great aroma (6.68), texture (6.05) and overall acceptability (6.58) compared to other treatments.

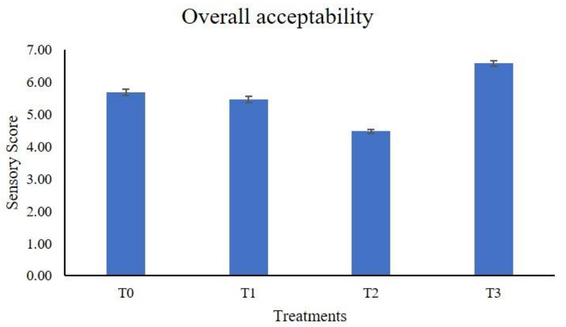

Fig. 2. Overall acceptability of Acerola-Aloe vera RTS beverages with different flavors.

CONCLUSIONS

Awareness on the use of natural foods, health and nutritional supplements following the COVID-19 pandemic has created huge shift in food consumption behavior globally. This has resulted in development of numerous functional foods that improve health leading to several patents. The functional acerola- aloe vera RTS beverages will be a great additional and ideal option for the consumers as acerola are rich in vitamin C and other minerals and vitamins. Additionally, aloe vera, chia seed, ginger, cinnamon and mint help to create an antioxidant rich and refreshing drink.

The combination of these ingredients apart from enhancing taste also provides potential health benefits, such as anti-inflammatory and antioxidant properties, making it a great choice for those looking to improve their overall well-being.

FUTURE SCOPE

The growing interest in natural foods and health-conscious choices will drive the demand for functional acerola- aloe vera RTS offer beverages. Functional beverages like acerola-aloe vera RTS offer health benefits, and research and development efforts are likely to lead to new combinations and formulations of functional ingredients. With globalization of food markets, functional RTS beverages have the potential to reach a wide consumer base globally.

Author contribution. Kirubha. C contributed in conducting the experiments, collecting and analyzing the data, interpreting the results and writing the manuscript. Kezia S helped with the laboratory experimentation. Dr. Satheeshan K.N. and Dr Ranganathan T. V. provided expert guidance, suggestions and critical insights throughout the research. Dr. Jenita Thinakaran contributed in conceptualizing and formulating the research proposal, provided support during experimentation and in correcting earlier drafts of this manuscript.

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Conflict of Interest. None.

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