Original Research Article

Standardization, Physico-Chemical and Organoleptic Evaluation of Value added Ready-To-Serve (RTS) Beverage from Starfruit

ABSTRACT

The present study was carried out to develop a ready-to-serve (RTS) beverage from starfruit value added with ginger, mint, aloe vera, lemon grass, basil and rosemarywith the objective of assessing the physico-chemical and organoleptic properties. The experiment was laid out in randomized block design (RBD) with seven treatments and three replications. Based on the results of assessment, it has been concluded that treatment T_1 (Starfruit Juice + Ginger Juice 2%) performed best in terms of physico-chemical properties *viz.* pH, acidity, TSS, vitamin C, reducing sugar and total sugar. On the basis of sensory evaluation, treatment T_1 (Starfruit juice + Ginger Juice 2%) was found most acceptable in terms of organoleptic properties *viz.* colour, taste, flavour and overall acceptability.

Keywords:Beverage, Organoleptic properties, Physico-chemical properties, Starfruit,

INTRODUCTION

The star fruit of carambola (*Averrhoa carambola* L.) is an attractive fruit of family *Oxalidaceae*, also known as 'Golden Star'. The fruit, which is mostly consumed fresh or as juice, is rich in vitamins A and C along with iron and fiber. The ripe fruit may be processed into fermented or unfermented drinks, jam and jelly etc. (Patil *et al.*, 2010). The fruit contains huge variety of bio-active components such as antioxidants, minerals, total phenolics, and dietary fibers. It is also a good source of potassium, copper, as well as folate and panthothenic acid (Manda *et al.*, 2012). Yet, the lack of technical knowledge for its further processing has rendered its potentials unutilized which make it the most overlooked fruit for extracting essential therapeutic uses in the entire region (Mishra, 2000). Therefore, transportation, handling and, processing within a short span are major concerns in commercial scale processing (Rayaguru, 2008). The physical appearance of the star fruit is green, yellowish green, unripe, semi-ripe, ripe which has sour and fruity smell with perishable properties (Shirsat and Thakor, 2014;Khader, V., & Maheswari, 2014; Nisarga et al., 2023).

Ready to serve drink is popular among every age group because of their refreshing nature and

taste. In recent years, there has been a growing interest in using herbal products as dietary adjuncts in the food industry. Functional beverages are one of its kinds which are tapping into consumer interest in health and wellness. People are now more health conscious and they want all good benefits in one drink. The demand for soft drinks always has an increasing trend and there is a great scope for development of value added beverages by utilizing nutritious food with medicinal properties. Therapeutic beverage sector has been reported to be the fastest growing segment in the soft drink industry sector (Roberts, 2009). There is a growing demand for health drinks based on indigenous fruits. Ready-to-serve (RTS) is a type of beverage containing at least 10% fruit juice besides less than 0.3% acid according to the FPO Standard. It is normally not diluted before serving and hence known as RTS beverage (Behera *et al.,* 2017).

Ginger is an ancient medicinal as well as spicy plant belonging to Zingiberaceae family and botanically known as *Zingiber officinale* Rosc. Since a very long time ginger is known for its medicinal values as a digestive aid, spiritual beverage, aphrodisiac, antiemetic, anticancer, anti-oxidant, anti-inflammatory and immune stimulating properties (Malhotra and Singh, 2003). Mint has been reported to have pharmacological effect such as antimicrobial, anti-inflammatory, antispasmodic, antituesive, anticancer and analgesic (Raghavan, 2006). The functional properties and therapeutic benefits of Aloe Vera are known worldwide. It is a source of active substances including vitamins, minerals, enzymes, sugar, anthraquinones of phenolic compounds, lignin, saponins, sterols, amino acids and salicylic acid (Pugh *et al.,* 2001). Lemongrass is well-known for its antioxidant, anti-microbial, anti-inflammatory, anti-hypertensive, anti-diabetic, anti-mutagenicity, anxiolytic properties, and for its hypoglycemic and hypolipidemic activities (Kiani *et al.,* 2022). Basil has been found to show effectiveness against many fungal, viral, bacterial and protozoal infections. Basil juice is an effective medicine for inflamed eyes and night blindness, which is often caused by vitamin A deficiency (Grieve and Marshall, 1982; Boggia *et al*., 2015; Hosseini-Parvar *et al*., 2015). Rosemary, has been used in folk medicine to alleviate several diseases including headache, dysmenorrhea, stomachache, epilepsy, rheumatic pain, spasms, nervous agitation, improvement of memory, hysteria, depression, as well as physical and mental fatigue (Duke, 2000; Heinrich *et al.*, 2006).

The value added beverages can be prepared from blends of different fruits & vegetables and extracts of herbs having medicinal, nutritional and therapeutic values with acceptable palatability. The development of starfruit RTS beverages blended with ginger, mint, aloe

vera, lemon grass, basil, rosemary would provide the opportunities for best use of these perishable raw materials with less post-harvest loss and simultaneously availability of palatable drinks of medicinal values to the consumers. The consumers are becoming health conscious and more careful about their health and fitness subsequently demands for natural beverages with medicinal properties over synthetic one increasing in the market. Considering the aforementioned facts, a ready-to-serve beverage was developed from starfruit, value added with ginger, mint, aloe vera, lemon grass, basil, and rosemary. The objective was to evaluate the physico-chemical properties and sensory acceptability of the starfruit RTS beverage.

MATERIALS AND METHODS

The experiment was conducted in the Post-harvest Technology Laboratory, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India, during the year 2022-2024. The experiment was laid out in Randomized Block Design (RBD) with seven treatments and three replications. The treatments were T_0 (Control), T_1 (Starfruit Juice + Ginger Juice 2%), T_2 (Starfruit Juice + Mint Juice 2%), T_3 (Starfruit Juice + Aloe vera Juice 2%), T_4 (Starfruit Juice + Lemongrass Juice 2%), T_5 (Starfruit Juice + Basil Juice 2%), T_6 (Starfruit Juice + Rosemary Juice 2%).

Formulation of Starfruit RTS Beverage

The six different types of starfruit RTS beverages, along with the control, were prepared in a quantity of 1 litre each. Each batch of 1 litre of starfruit RTS beverages was prepared using 100ml of starfruit juice, 900ml water, 100g sugar, 0.3g citric acid, and 0.1g sodium benzoate. Additionally, for each formulation, 20 ml of flavour juice, including ginger, mint, aloe vera, lemongrass, basil and rosemary was added for value addition.

Methodology for Preparation of Starfruit RTS Beverage

The cleaned starfruits were chopped into small pieces and then processed using a juicer to extract the juice. In a separate container, the RTS beverage was prepared by combining the

freshly extracted starfruit juice with water and sugar in the required proportions. Additionally, each sample of the RTS beverage was flavored by adding ginger, mint, aloe vera, lemon grass, basil, and rosemary juice, respectively. The mixture was stirred thoroughly to ensure proper blending of flavours. The prepared RTS beverage was strained through a double layer muslin cloth to obtain the clarified juice devoid of fibre particles.

Storage of Starfruit RTS Beverage

Starfruit RTS beverages were filled into sterilized glass bottles and plastic bottles and stored at ambient room temperature.

Evaluation of Physico-chemical Properties of Starfruit RTS Beverage

The starfruit RTS beverages were evaluated for various physico-chemical properties like pH, TSS, acidity, vitamin C, reducing sugar and total sugar. The pH content was analyzed by digital pH meter. The TSS content was analyzed by hand refractometer. The acidity content was analyzed by titrationmethod. The Vitamin C content was analyzed by 2, 6-dicholorophenol-inndophenol visual titration method. The reducing sugar and total sugar content was analyzed by lane and eynon method. The recorded data of all samples for different parameters were tabulated and statistically analyzed to find out the most suitable treatment combination in terms of physico-chemical properties.

Evaluation of Organoleptic Properties of Starfruit RTS Beverage

The starfruit RTS beverages were tested for sensory evaluation by a panel of five judges to determine colour, taste, flavour, and overall acceptability. The samples were evaluated on a 9-point scale using hedonic rating method. Each sample was evaluated and given a score by the panelists on the scale of 1-9 for each parameter, for each sample. The mean scores of all samples of all the five members were tabulated and statistically analyzed to find out which treatment combination is most acceptable in terms of sensory acceptability.

RESULTS AND DISCUSSION

Physico-chemical Properties of Starfruit RTS Beverage

The nutritional value of starfruit RTS beverage was evaluated by analyzing its physico-chemical properties like pH, TSS, acidity, vitamin C, reducing sugar and total sugar. The data recorded on physico-chemical properties of starfruit RTS beverage have been presented in Table 1.

Effect of different treatments on pH of Starfruit RTS Beverage

Statistical analysis revealed that pH content differed significantly across all treatments. The mean

values of pH ranged from 4.23 to 5.14. The maximum pH content 5.14 was recorded in T_1 (Starfruit Juice + Ginger Juice 2%), while the minimum pH content 4.23 was recorded in T_6 (Starfruit Juice + Rosemary Juice 2%). Similar results were reported by Sasikumar *et al.* (2015) in Ready-to-Serve (RTS) beverage prepared from blend of *aloe vera* and aonla; Behera *et al.* (2017) in Ready-to-Serve (RTS) beverage prepared from residual osmotic solution of starfruit; Hamid *et al.* (2017) in Ready-to-Serve (RTS) beverage prepared from mulberry; Thakur *et al.* (2018) in Ready-to-Serve (RTS) beverage preparedfrom wild aonla.Beverages with lower pH levels exhibited greater stability over time, with reduced rates of spoilage and degradation of sensory attributes. The variations in pH impacted the perception of sweetness, sourness, and overall taste intensity in fruit juices.

Effect of different treatments on Total Soluble Solids of Starfruit RTS Beverage

Statistical analysis revealed that TSS content differed significantly across all treatments. The mean values of TSS content ranged from 9.42 to 10.12°Brix. The The maximum total soluble solids content 10.12°Brix was recorded in T_1 (Starfruit Juice + Ginger Juice 2%), while the minimum total soluble solids content 9.42°Brix was recorded in T_5 (Starfruit Juice + Basil Juice 2%). Similar results were reported bySasikumar *et al.* (2015) in Ready-to-Serve (RTS) prepared from blend of *aloe vera* and aonla; Kharsyntiew*et al.* (2019) in juice prepared from carambola; Das *et al.* (2021) in Ready-to-Serve (RTS) beverage prepared from kinnow and aonla; Deepa and Karetha (2022) in Ready-to-Serve (RTS) beverage prepared from dragon fruit and lime juice. TSS influenced the shelf stability of the RTS beverage. Higher sugar content acted as a preservative by reducing water activity, thereby inhibiting microbial growth and prolonging the beverage shelf life.

Effect of different treatments on Acidity of Starfruit RTS Beverage

Statistical analysis revealed that acidity content differed significantly across all treatments. The mean values of acidity content ranged from 0.11 to 0.38%.The maximum acidity content 0.38% was recorded in T_6 (Starfruit Juice + Rosemary Juice 2%), while minimum acidity content 0.11% was recorded in T_0 (Control). Similar results were reported by Harshitha *et al.* (2016) in Ready-to-Serve (RTS) beverage prepared from mango; Sharma *et al.* (2017) in Ready-to-Serve (RTS) beverage prepared from mango;Hamid *et al.* (2017) in Ready-to-Serve (RTS) beverage prepared from mulberry; Thakur *et al.* (2018) in Ready-to-Serve (RTS) beverage prepared from wild aonla; Bochare*et al.* (2020) in Ready-to-Serve (RTS) beverage prepared from kiwi incorporated with lemongrass.Das *et al.* (2021) in Ready-to-Serve (RTS) beverage prepared from kinnow and aonla; Shagiwal and Deen (2022) in

Ready-to-Serve (RTS) beverage prepared from strawberry, ginger and aloe vera blend; Salaria and Reddy (2022) in Ready-to-Serve (RTS) beverage (RTS) prepared from muskmelon. The moderate acidity levels in beverage enhanced flavour perception by adding complexity and brightness to the taste profile. Higher acidity levels helped extend the shelf life of the RTS beverage by acting as a natural preservative.

Effect of different treatments on Vitamin C of Starfruit RTS Beverage

Statistical analysis revealed that vitamin C content differed significantly across all treatments.The mean values of vitamin C content ranged from 21.34 to 24.76mg/100ml. The maximum vitamin C content 24.76mg/100ml was recorded in T_1(Starfruit Juice + Ginger Juice 2%), while the minimum vitamin C content 21.34mg/100ml was recorded in T_0 (Control).Similar results were reported by Behera*et al.* (2017) in Ready-to-Serve (RTS) beverage prepared from residual osmotic solution of starfruit; Goyal and Kumar (2017) in Ready-to-Serve (RTS) beverage prepared from apple, guava, carrot and banana; Das *et al.* (2021) in Ready-to-Serve (RTS) beverage prepared from kinnow and aonla. The presence of vitamin C in the RTS beverage offered added nutritional benefits, potentially appealing to health-conscious consumers.

Effect of different treatments on Reducing sugar of Starfruit RTS Beverage

Statistical analysis revealed that reducing sugarcontent differed significantly across all treatments.The mean values of reducing sugar content ranged from 6.90 to 7.31%. The maximum reducing sugar 7.31% was recorded in T_1(Starfruit Juice + Ginger Juice 2%), while the minimum reducing sugar 6.90% was recorded in T_0 (Control). Similar results were reported byMalav *et al.* (2014) in Ready-to-Serve (RTS) beverage prepared from orange; Hamid *et al.* (2017) in Ready-to-Serve (RTS) beverage prepared from mulberry; Bochare*et al.* (2020) in Ready-to-Serve (RTS) beverage prepared from kiwi incorporated with lemongrass; Das *et al.* (2021) in Ready-to-Serve (RTS) beverage prepared from kinnow and aonla. Reducing sugar content correlated positively with perceived sweetness of the beverage. Higher levels of reducing sugars contributed to a thicker consistency and smoother mouthfeel.

Effect of different treatments on Total sugar of Starfruit RTS Beverage

Statistical analysis revealed that total sugar content differed significantly across all treatments. The mean values of total sugar content ranged from 9.56 to 11.15%. The maximum total sugar 11.15 % was recorded in T_1(Starfruit Juice + Ginger Juice 2%), while the minimum total sugar 9.56 % was recorded in T_0 (Control). Similar results were reported byMalav *et*

al. (2014) in Ready-to-Serve (RTS) beverage prepared from orange; Hamid *et al.* (2017) in Ready-to-Serve (RTS) beverage prepared from mulberry; Kharsyntiew*et al.* (2019) in juice prepared from carambola; Shagiwal and Deen (2022) in Ready-to-Serve (RTS) beverage prepared from strawberry, ginger and aloe vera.The total sugar content played a key role in enhancing the flavour perception and overall sensory appeal of beverage. Total sugar content affected the texture and mouthfeel of the RTS beverage.

Organoleptic Properties of Starfruit RTS Beverage

The sensory acceptability of starfruit RTS beverage was evaluated by analyzing its organoleptic properties like colour, taste, flavour and overall acceptability. The data recorded on organoleptic properties of starfruit RTS beverage have been presented in Table 2.

Effect of different treatments on Colour of Starfruit RTS Beverage

Statistical analysis revealed that organoleptic scorefor colourdiffered significantly across all treatments.The mean organoleptic score for colour ranged from 6.0 to 8.3. The maximum organoleptic score for colour 8.3 was recorded in T_1 (Starfruit Juice + Ginger Juice 2%), while the minimum organoleptic score for colour 6.0 was recorded in T_0 (Control).

Effect of different treatments on Taste of Starfruit RTS Beverage

Statistical analysis revealed that organoleptic scorefor taste differed significantly across all treatments.The mean organoleptic score for taste ranged from 5.3 to 8.7. The maximum organoleptic score for taste 8.7 was recorded in T_1 (Starfruit Juice + Ginger Juice 2%), while the minimum organoleptic score for taste 5.3 was recorded in T_0 (Control).

Effect of different treatments on Flavour of Starfruit RTS Beverage

Statistical analysis revealed that organoleptic scorefor flavourdiffered significantly across all treatments. The mean organoleptic score for flavour ranged from 6.0 to 8.3. The maximum organoleptic score for flavour 8.3 was recorded in T_1 (Starfruit Juice + Ginger Juice 2%), while the minimum organoleptic score for flavour 6.0 was recorded in T_0 (Control).

Effect of different treatments on Overall acceptability of Starfruit RTS Beverage

Statistical analysis revealed that organoleptic scorefor overall acceptabilitydiffered significantly across all treatments. The mean organoleptic score for overall acceptability ranged from 5.7 to 8.7. The maximum organoleptic score for overall acceptability 8.7 was recorded in T1 (Starfruit Juice + Ginger Juice 2%), while the minimum organoleptic score for overall acceptability 5.7 was recorded in T0 (Control).

Table 1: Effect of different treatments on Physico-chemical properties of Starfruit RTS Beverage

Treatment	pH	TSS (^{o}Brix)	Acidity (%)	Vitamin C (mg/100ml)	Reducing Sugar (%)	Total Sugar (%)
T0 (Control)	4.53	9.70	0.11	21.34	6.90	9.56
T1 (Ginger)	5.14	10.12	0.21	24.76	7.31	11.15
T2 (Mint)	4.62	9.88	0.17	21.20	7.16	10.68
T3 (Aloe vera)	4.45	10.09	0.29	22.01	7.06	10.04
T4 (Lemon grass)	4.97	9.78	0.34	23.83	6.86	10.16
T5 (Basil)	4.71	9.42	0.30	22.57	7.04	10.42
T6 (Rosemary)	4.23	9.59	0.38	23.37	6.73	10.03
F-test	S	S	S	S	S	S
S.Ed (+/-)	0.236	0.194	0.062	0.872	0.139	0.341
CV	6.199	2.420	29.598	4.698	2.434	4.060
CD at 5%	0.514	0.422	0.134	1.899	0.304	0.743

Table 2: Effect of different treatments on Organoleptic properties of Starfruit RTS Beverage

Treatment	Colour	Taste	Flavour	Overall acceptability
T0 (Control)	6.0	5.3	6.0	5.7
T1 (Ginger)	8.3	8.7	8.3	8.7

T2 (Mint)	7.7	7.7	8.0	7.7
T3 (Aloe vera)	6.3	6.3	6.3	6.7
T4 (Lemon grass)	7.3	7.3	7.3	7.3
T5 (Basil)	7.0	6.7	6.7	7.0
T6 (Rosemary)	6.7	7.7	7.3	7.7
F-test	S	S	S	S
S.Ed (+/-)	0.509	0.642	0.613	0.675
CV	8.849	11.089	10.509	11.414
CD at 5%	1.109	1.400	1.336	1.470

CONCLUSION

Based on the results of assessment, it has been concluded that T_1 (Starfruit Juice + Ginger Juice 2%) performed best in terms of physico-chemical properties *viz* pH (5.14), acidity (0.21%), TSS (10.12^{o}Brix), vitamin C (24.76mg/100ml), reducing Sugar (7.31%) and total Sugar (11.15%). On the basis of sensory evaluation, T_1 (Starfruit Juice + Ginger Juice 2%) was found most acceptable with regard to organoleptic properties *viz* colour (8.3), taste (8.7), flavour (8.3) and overall acceptability (8.7).

The development of starfruit RTS beverages enriched with a variety of herbs presents a promising avenue for value added beverage production. By blending starfruit with extracts of medicinal herbs, these beverages not only offer enhanced palatability but also provide significant health benefits to consumers. Furthermore, this approach facilitates the efficient utilization of perishable raw materials, thereby reducing post-harvest losses.

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