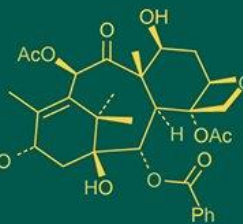
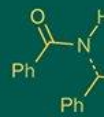


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Recipe standardization and quality evaluation of freshly prepared herbal nectar of Carambola (*Averrhoa carambola* L.)

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Abstract

The present study was conducted to standardize recipe of herbal nectar of carambola (*Averrhoa carambola* L.) blended with selected herbal juices. The experiment was carried out during 2025-26 at the Horticulture Processing Laboratory, Department of Fruit Science, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh. Nine treatment combinations were evaluated, comprising T₀: 100% carambola juice (control); T₁: carambola juice: ginger juice (95:5); T₂: carambola juice: ginger juice (90:10); T₃: carambola juice: lemongrass juice (95:5); T₄: carambola juice: lemongrass juice (90:10); T₅: carambola juice: basil juice (95:5); T₆: carambola juice: basil juice (90:10); T₇: carambola juice: mint juice (95:5) and T₈: carambola juice: mint juice (90:10). The experiment was conducted in a completely randomized design with three replications. The nectar was standardized to 17°Brix TSS and 0.30% acidity and evaluated for bio-chemical and sensory quality. Among the treatments, T₂ [carambola: ginger (90:10)] performed best, recording the highest ascorbic acid (24.27 mg/100 ml), total sugar (12.29%) and reducing sugar (11.04%). It also recorded the highest scores for colour and appearance (8.60), taste (8.90), flavour (8.50), aroma (8.80) and overall acceptability (8.70). Based on the overall biochemical and sensory evaluation, T₂ was identified as the most promising formulation for freshly prepared carambola herbal nectar.

Keywords: Carambola, ginger, lemongrass, basil, mint, herbal nectar, recipe standardization, quality evaluation

1. Introduction

Carambola (*Averrhoa carambola* L.), popularly known as star fruit, Kamrakh or Golden Star, is an attractive evergreen fruit species belonging to the family Oxalidaceae and possesses considerable potential for value addition. Native to Southeast Asia, it is cultivated in tropical and subtropical regions of the world (Tidbury, 1976) [13]. In India, carambola is considered a minor fruit crop and is mainly grown in Kerala, Karnataka, Tamil Nadu, Goa, Maharashtra, Andhra Pradesh, Odisha, West Bengal, Assam and Tripura, predominantly in home gardens and small orchards (Mitra, 2014) [7]. Although its commercial cultivation remains limited, a mature tree can produce 40-90 kg of fruit annually, with yields reaching 112-160 kg per tree under favourable conditions (Tripathi, 2021) [14].

The fruit is five-lobed and characteristically star-shaped in cross-section, with thin, waxy, golden-yellow skin and crisp, juicy, non-fibrous flesh (Chadha, 2001) [1]. It is a valuable source of potassium, copper, folate, vitamins A and C, iron and dietary fibre (Manda *et al.*, 2012; Kesavanath *et al.*, 2015) [6, 3]. However, carambola is highly perishable due to its high moisture content, which limits its storage, transportation and marketability (Shirsat and Thakur, 2014) [10]. Therefore, processing and value addition through products such as nectar, ready-to-serve (RTS) beverages, squash, jam, pickle, candy and dried products can provide an effective means of improving fruit utilization and reducing post-harvest losses.

Ginger (*Zingiber officinale* Rosc.) is an important spice and flavouring ingredient. Its characteristic pungency and flavour are mainly associated with gingerols and related compounds (Govindarajan, 1982) [2], making it suitable for fruit-based beverages.

Lemongrass (*Cymbopogon citratus* L.) is an aromatic herb valued for its characteristic citrus-like flavour and aroma and contains various phytochemicals, including flavonoids and terpenoid compounds (Kiani *et al.*, 2022) [4].

Mint (*Mentha arvensis* L.) is widely used as a flavouring herb in food and beverages. Menthol and menthone contribute to its characteristic cooling sensation and aroma (Thakur *et al.*, 2021; Tanvir *et al.*, 2021) ^[12, 11].

Basil (*Ocimum basilicum* L.) is an aromatic herb containing essential oils, flavonoids and phenolic compounds and is widely used as a culinary and flavouring ingredient (Yadav *et al.*, 2024) ^[15].

The incorporation of these herbs into carambola nectar may provide desirable flavour and sensory characteristics while creating a diversified value-added beverage. Recipe standardization is essential because the proportion of fruit and herbal juices directly affects the physicochemical properties, flavour, taste, aroma and overall acceptability of the beverage. An optimum blending ratio is therefore necessary to develop a consistent and acceptable product.

Therefore, the present study was undertaken to standardize recipe of herbal nectar of carambola by incorporating ginger, lemongrass, basil and mint juices at 5 and 10 percent levels and to identify the combination exhibiting superior bio-chemical and sensory parameters.

2. Materials and Methods

2.1 Materials required

Mature, firm carambola fruits and fresh ginger, lemongrass, basil and mint were procured from the local market. Non-perishable ingredients such as sugar and citric acid were also purchased from the local market. Clean, sterilized glass bottles (200 ml) were used for filling and storing the prepared herbal nectar.

2.2 Methods

Fresh carambola, ginger, lemongrass, basil and mint were used for the study. The fruits and herbs were sorted, washed thoroughly and processed separately to obtain their respective juices. Carambola juice was blended with herbal juices according to the treatment combinations of 95:5 and 90:10, while 100% carambola juice was maintained as the control. The required amount of water and sugar was added, and the nectar was adjusted to 17°Brix TSS and 0.30% acidity using sugar and citric acid, respectively. The prepared nectar was thoroughly mixed, filled into sterilized glass bottles, sealed and evaluated for bio-chemical and sensory parameters.

Table 1: Treatment details:

S. No.	Treatments	Notations used
01.	Carambola juice 100% (Control)	T ₀
02.	Carambola juice: Ginger juice (95:5)	T ₁
03.	Carambola juice: Ginger juice (90:10)	T ₂
04.	Carambola juice: Lemongrass juice (95:5)	T ₃
05.	Carambola juice: Lemongrass juice (90:10)	T ₄
06.	Carambola juice: Basil juice (95:5)	T ₅
07.	Carambola juice: Basil juice (90:10)	T ₆
08.	Carambola juice: Mint juice (95:5)	T ₇
09.	Carambola juice: Mint juice (90:10)	T ₈

3. Results and Discussion

3.1 Effect of different treatments on bio-chemical parameters of freshly prepared herbal nectar of carambola

The chemical parameters of herbal nectar of carambola were recorded for the following parameters *i.e.* total soluble solids (°Brix), titratable acidity (%), ascorbic acid (mg/100

g), total sugar (%), reducing sugar (%), non-reducing sugar (%), TSS: acid ratio, sugar: acid ratio which are presented in Table 2 to 3 and graphically shown in Fig. 1 to 2.

3.1.1 Total Soluble Solids (°Brix)

The TSS content at the time of preparation (0 day) was recorded as 17.00 °Brix in all treatments. No significant differences were observed among the treatments, indicating uniformity in the formulation and standardization of the nectar. Thus, the initial TSS level was maintained at 17.00 °Brix in freshly prepared nectar. The findings of the present investigation were in agreement with the observations reported by Kumar *et al.* (2025) ^[5] and Shinde *et al.* (2014) ^[9] in carambola nectar.

3.1.2 Titratable acidity (per cent)

The titratable acidity of freshly prepared herbal nectar of carambola was recorded as 0.30% in all treatments at the initial stage. No significant variation was observed among the treatments, indicating uniformity in the formulation and processing conditions of the nectar. Similar result was reported by Shinde *et al.* (2014) ^[9] in carambola nectar.

3.1.3 Ascorbic acid (mg/100 ml)

At the time of preparation, the maximum ascorbic acid (24.27 mg/100 ml) were observed under the treatment T₂ [Carambola juice: Ginger juice (90:10)], which was statistically *at par* with T₁ (23.41 mg/100 ml). This was followed by T₄ (22.21 mg/100 ml), T₃ (21.48 mg/100 ml), T₆ (21.12 mg/100 ml), T₀ (20.48 mg/100 ml), T₅ (20.32 mg/100 ml), and T₈ (19.35 mg/100 ml). The minimum value of ascorbic acid was observed in T₇ (18.27 mg/100 ml). The findings of the present investigation were in agreement with the observations reported by Kumar *et al.* (2025) ^[5] in carambola nectar, Pillai *et al.* (2024) ^[8] in Ready-To-Serve (RTS) beverage of star fruit and Shinde *et al.* (2014) ^[9] in carambola nectar.

3.1.4 TSS: Acid ratio

At the initial stage of preparation, the TSS: acid ratio of the herbal nectar of carambola was 56.67 in all treatments, as the total soluble solids (17.00 °Brix) and titratable acidity (0.30%) were standardized during formulation. Consequently, no significant differences were observed among the treatments with respect to the TSS: acid ratio, indicating that the incorporation of different ratio of herbs with carambola juice did not affect the TSS: acid ratio. The findings of the present investigation are similar with the findings noted by Kumar *et al.* (2025) ^[5] in carambola nectar.

3.1.5 Total sugar (per cent)

The total sugar content varied significantly among the different treatments evaluated during the present investigation. The mean value ranged from 10.65 (T₀) to 12.29 (T₂). It was observed that the maximum mean value of total sugar (12.29%) was reported under the treatment T₂ [Carambola juice: Ginger juice (90:10)], which was statistically *at par* with T₁ (12.10%) and T₄ (12.02%). This was followed by T₃ (11.67%), T₆ (11.31%), T₈ (11.14%), T₅ (10.97%) and T₇ (10.83%), whereas the minimum total sugar was observed in the control treatment T₀ (10.65%). The increase in total sugar content in ginger and lemongrass blended nectar may be attributed to the contribution of

naturally occurring soluble sugars from the herbal juices and the hydrolysis of polysaccharides into simple sugars during processing. The higher sugar content also indicates better maturity and enhanced sweetness of the blended formulations. Similar findings were reported by Shinde *et al.* (2014)^[9] in carambola nectar, Pillai *et al.* (2024)^[8] in Ready-To-Serve (RTS) beverage of star fruit and Kumar *et al.* (2025)^[5] during the standardization of carambola nectar, where herbal blending improved the physicochemical quality of the beverage.

3.1.6 Reducing sugar (per cent)

The reducing sugar content varied significantly among the different treatments evaluated during the present investigation. The mean value ranged from 9.48 (T₀) to 11.04 (T₂). The maximum reducing sugar was recorded in T₂ (11.04%), which was *at par* with T₁ (10.89%). It was followed by T₄ (10.49%), T₃ (10.26%), T₆ (9.82%), T₈ (9.76%), T₅ (9.61%) and T₇ (9.54%), while the minimum value was observed in the control treatment T₀ (9.48%). The maximum reducing sugar content in the ginger-blended nectar may be attributed to the hydrolysis of sucrose into glucose and fructose during processing under acidic conditions. The natural reducing sugars present in the herbal extracts may also have contributed to the observed increase. Similar findings were reported by Shinde *et al.* (2014)^[9] in carambola nectar, Pillai *et al.* (2024)^[8] in Ready-To-Serve (RTS) beverage of star fruit and Kumar *et al.* (2025)^[5] during the standardization of carambola nectar, where herbal blending improved the physico-chemical quality of the beverage.

3.1.7 Non-reducing sugar (per cent)

The non-reducing sugar content varied significantly among the different treatments evaluated during the present investigation. Significant variation was observed in the non-reducing sugar content, which ranged from 1.17 to 1.53%. The maximum non-reducing sugar was recorded in T₄ (1.53%), which was *at par* with T₆ (1.49%), T₃ (1.41%), T₈ (1.38%) and T₅ (1.36%). This was followed by T₇ (1.29%), T₂ (1.25%) and T₁ (1.21%), whereas the minimum value was recorded in the control treatment T₀ (1.17%). The comparatively higher non-reducing sugar content observed in lemongrass and basil-blended nectar may be due to better retention of sucrose during processing. The variation among treatments could also be associated with differences in the biochemical composition of the herbal juices and their interaction with carambola juice. Similar findings were reported by Shinde *et al.* (2014)^[9] in carambola nectar, Pillai *et al.* (2024)^[8] in Ready-To-Serve (RTS) beverage of star fruit and Kumar *et al.* (2025)^[5] during the standardization of carambola nectar, where herbal blending improved the physicochemical quality of the beverage.

3.1.8 Sugar: acid ratio

The sugar: acid ratio varied significantly among the different treatments evaluated during the present investigation. The sugar: acid ratio differed significantly among the treatments and ranged from 35.63 to 40.96. The maximum sugar: acid ratio was recorded in T₂ (40.96), which was *at par* with T₁ (40.33) and T₄ (40.07). This was followed by T₃ (38.90), T₆ (37.70), T₈ (37.13), T₅ (36.57) and T₇ (36.10), whereas the minimum sugar: acid ratio was recorded in the control treatment T₀ (35.63). The maximum

sugar: acid ratio observed in T₂ indicates a better balance between sweetness and acidity, making the nectar more palatable and acceptable. Similar observations were reported by Shinde *et al.* (2014)^[9], who found that maintaining an optimum balance between sugars and acidity improved the quality and acceptability of carambola nectar.

3.2 Effect of different treatments on sensory parameters of freshly prepared herbal nectar of carambola

The organoleptic evaluation was carried out for all the sensory parameters, namely colour and appearance, taste, flavour, aroma and overall acceptability of freshly prepared herbal nectar of carambola. The results are presented in Table 4 and graphically illustrated in Fig.3.

3.2.1 Colour and appearance

The observed data revealed significant differences in the colour and appearance scores of carambola nectar among the treatments. The scores ranged from 6.10 to 8.60. The maximum score for colour and appearance was recorded in T₂ (8.60), which was significantly higher than those of all other treatments. This was followed by T₁ (8.10), T₈ (7.90), T₇ (7.70), T₄ (7.50), T₃ (7.20), T₆ (6.90) and T₅ (6.40), whereas the minimum score was observed in the control treatment T₀ (6.10).

The higher score recorded in T₂ may be attributed to the attractive colour imparted by the optimum level of ginger juice, which enhanced the visual appeal without masking the natural colour of carambola nectar. The lower score in the control may be due to the absence of herbal ingredients, resulting in comparatively less attractive appearance. Similar findings were reported by Shinde *et al.* (2014)^[9] in carambola nectar, Pillai *et al.* (2024)^[8] in Ready-To-Serve (RTS) beverage of star fruit and Kumar *et al.* (2025)^[5], who observed that incorporation of suitable herbal ingredients improved the appearance and consumer preference of carambola nectar.

3.2.2 Taste

The observed data indicated that taste was significantly influenced by the different treatments evaluated under the present investigation. The taste scores differed significantly among the treatments and ranged from 5.30 to 8.90. The maximum taste score was recorded in T₂ (8.90), which was *at par* with T₁ (8.60). This was followed by T₈ (8.30), T₇ (7.90), T₄ (7.40), T₃ (7.30), T₆ (6.70) and T₅ (6.60). The minimum taste score was recorded in the control treatment T₀ (5.30). The superior taste of T₂ may be attributed to the optimum blend of carambola and ginger juice, which provided a desirable balance between sweetness, acidity and pungency. Ginger at 10 percent imparted a pleasant spicy flavour that masked the excessive sourness of carambola, thereby improving palatability. Similar findings were reported by Shinde *et al.* (2014)^[9] in carambola nectar, Pillai *et al.* (2024)^[8] in Ready-To-Serve (RTS) beverage of star fruit and Kumar *et al.* (2025)^[5], who observed that incorporation of suitable herbal ingredients improved the appearance and consumer preference of carambola nectar.

3.2.3 Flavour

The flavour scores varied significantly from 6.30 to 8.50. The maximum flavour score was obtained in T₂ (8.50), which was significantly superior to all other treatments. This was followed by T₁ (8.10), T₈ (7.80), T₇ (7.60), T₄ (7.30), T₃

(7.20) and T₆ (6.70). The minimum flavour score was recorded in T₀ (6.30), which was *at par* with T₅ (6.30). The improved flavour of the ginger-blended nectar may be due to the characteristic volatile compounds present in ginger, which complemented the natural flavour of carambola and enhanced the overall sensory quality. In contrast, the control treatment lacked the additional flavour contributed by herbal ingredients. Similar findings were reported by Shinde *et al.* (2014) [9], Pillai *et al.* (2024) [8] and Kumar *et al.* (2025) [5].

3.2.4 Aroma

The aroma scores showed significant variation among the treatments and ranged from 6.20 to 8.80. The maximum aroma score was recorded in T₂ (8.80), which was significantly higher than those of all other treatments. This was followed by T₁ (8.30), T₈ (7.80), T₇ (7.60), T₄ (7.40), T₃ (7.10), T₅ (6.70) and T₆ (6.50), whereas the minimum aroma score was recorded in T₀ (6.20). The higher aroma score in T₂ may be attributed to the presence of aromatic essential oils such as gingerols and shogaols, which imparted a pleasant aroma and enhanced the overall sensory perception of the nectar. The lower aroma score in the control treatment may be due to the absence of these aromatic compounds. Similar results have been reported by Pillai *et al.* (2024) [8]

in Ready-To-Serve (RTS) beverage of star fruit containing herbal ingredients.

3.2.5 Overall acceptability

Overall acceptability is considered the most important sensory parameter as it reflects the combined effect of colour, taste, flavour and aroma. Significant differences were observed among the treatments, with scores ranging from 5.90 to 8.70. The maximum overall acceptability was recorded in T₂ (8.70), which was significantly superior to all other treatments. This was followed by T₁ (8.40), T₈ (7.90), T₇ (7.70), T₄ (7.40), T₃ (7.20), T₆ (6.70) and T₅ (6.50), whereas the minimum overall acceptability was observed in the control treatment T₀ (5.90). The higher overall acceptability of T₂ may be attributed to its desirable balance of sweetness and acidity, attractive colour, pleasant ginger flavour and aroma, all of which contributed to greater consumer preference. The incorporation of 10% ginger juice effectively improved the organoleptic quality of carambola nectar compared to the other herbal blends and the control. Similar observations were reported by Pillai *et al.* (2024) [8], who found that blending Ready-To-Serve (RTS) beverage of star fruit with suitable ingredients significantly improved its sensory quality.

Table 2: Effect of different treatments on bio-chemical parameters of freshly prepared herbal nectar of carambola

Notations	Treatments	TSS (°Brix)	Titratable acidity (%)	Ascorbic acid (mg/100 ml)	TSS: acid ratio
T ₀	Carambola juice 100% (Control)	17.00	0.30	20.48	56.67
T ₁	Carambola juice: Ginger juice (95:5)	17.00	0.30	23.41	56.67
T ₂	Carambola juice: Ginger juice (90:10)	17.00	0.30	24.27	56.67
T ₃	Carambola juice: Lemongrass juice (95:5)	17.00	0.30	21.48	56.67
T ₄	Carambola juice: Lemongrass juice (90:10)	17.00	0.30	22.21	56.67
T ₅	Carambola juice: Basil juice (95:5)	17.00	0.30	20.32	56.67
T ₆	Carambola juice: Basil juice (90:10)	17.00	0.30	21.12	56.67
T ₇	Carambola juice: Mint juice (95:5)	17.00	0.30	18.27	56.67
T ₈	Carambola juice: Mint juice (90:10)	17.00	0.30	19.35	56.67
	SE (m) +	NS	NS	0.30	NS
	C.D. at 5%	NS	NS	0.91	NS

Table 3: Effect of different treatments on bio-chemical parameters of freshly prepared herbal nectar of carambola

Notations	Treatments	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)	Sugar:acid ratio
T ₀	Carambola juice 100% (Control)	10.65	9.48	1.17	35.63
T ₁	Carambola juice: Ginger juice (95:5)	12.10	10.89	1.21	40.33
T ₂	Carambola juice: Ginger juice (90:10)	12.29	11.04	1.25	40.96
T ₃	Carambola juice: Lemongrass juice (95:5)	11.67	10.26	1.41	38.90
T ₄	Carambola juice: Lemongrass juice (90:10)	12.02	10.49	1.53	40.07
T ₅	Carambola juice: Basil juice (95:5)	10.97	9.61	1.36	36.57
T ₆	Carambola juice: Basil juice (90:10)	11.31	9.82	1.49	37.70
T ₇	Carambola juice: Mint juice (95:5)	10.83	9.54	1.29	36.10
T ₈	Carambola juice: Mint juice (90:10)	11.14	9.76	1.38	37.13
	SE (m)±	0.13	0.08	0.07	0.41
	C.D. at 5%	0.38	0.24	0.21	1.23

Table 4: Effect of different treatments on sensory parameters of freshly prepared herbal nectar of carambola

Notations	Treatments	Colour and appearance	Taste	Flavor	Aroma	Overall acceptability
T ₀	Carambola juice 100% (Control)	6.10	5.30	6.30	6.20	5.90
T ₁	Carambola juice : Ginger juice (95:5)	8.10	8.60	8.10	8.30	8.40
T ₂	Carambola juice : Ginger juice (90:10)	8.60	8.90	8.50	8.80	8.70
T ₃	Carambola juice : Lemongrass juice (95:5)	7.20	7.30	7.20	7.10	7.20
T ₄	Carambola juice : Lemongrass juice (90:10)	7.50	7.40	7.30	7.40	7.40
T ₅	Carambola juice : Basil juice (95:5)	6.40	6.60	6.30	6.70	6.50
T ₆	Carambola juice : Basil juice (90:10)	6.90	6.70	6.70	6.50	6.70
T ₇	Carambola juice : Mint juice (95:5)	7.70	7.90	7.60	7.60	7.70
T ₈	Carambola juice : Mint juice (90:10)	7.90	8.30	7.80	7.80	7.90
	SE (m)±	0.12	0.11	0.09	0.10	0.08
	C.D. at 5%	0.35	0.34	0.28	0.31	0.25

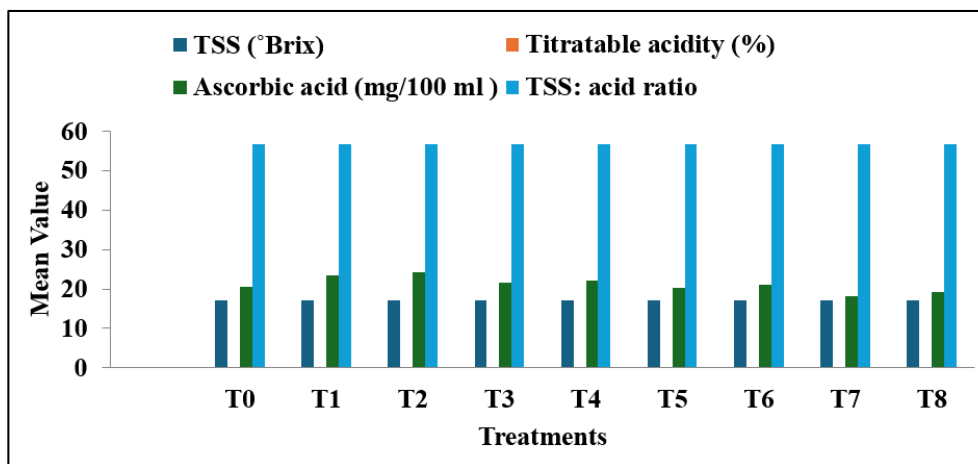


Fig 1: Effect of different treatments on bio-chemical parameters of freshly prepared herbal nectar of carambola

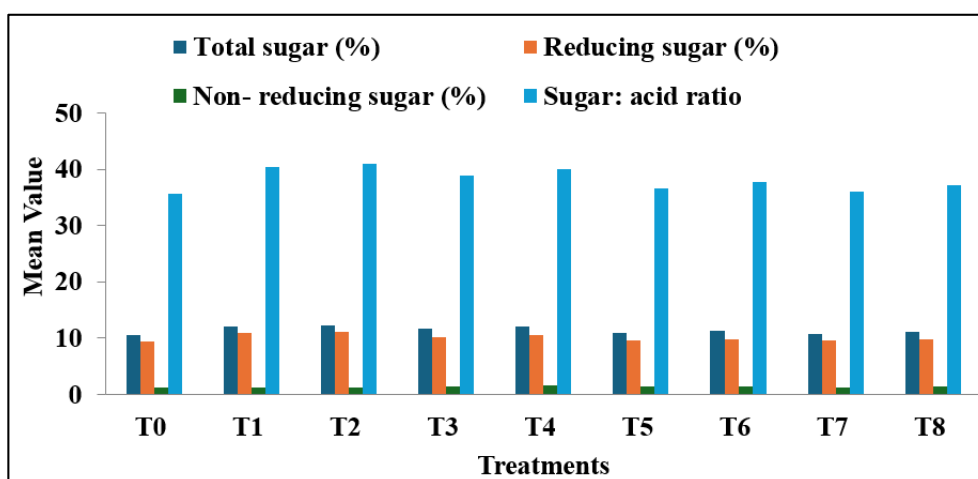


Fig 2: Effect of different treatments on bio-chemical parameters of freshly prepared herbal nectar of carambola

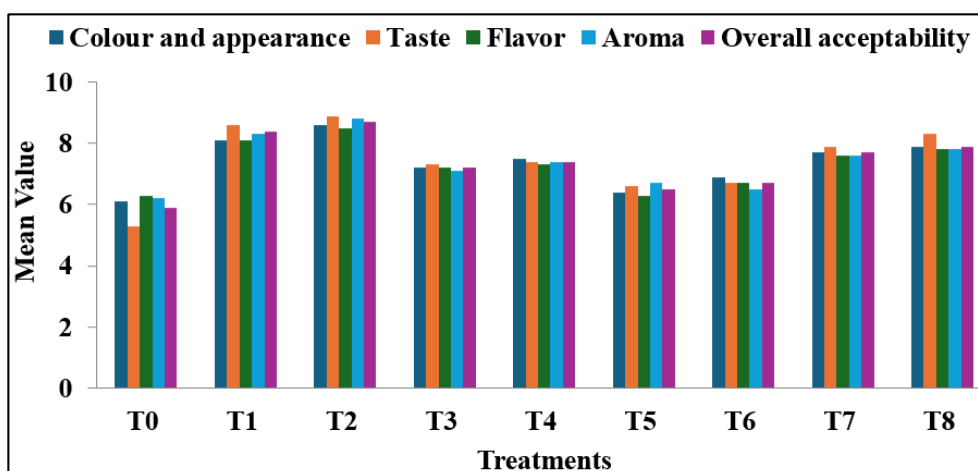


Fig 3: Effect of different treatments on bio-chemical parameters of freshly prepared herbal nectar of carambola

4. Conclusions

The present study demonstrated the potential of carambola for development of a value-added herbal nectar. Among the nine formulations, T₂ [carambola juice: ginger juice (90:10)] showed the most favourable overall performance in terms of bio-chemical and sensory parameters. It recorded the maximum ascorbic acid (24.27 mg/100 ml), total sugar (12.29%) and reducing sugar (11.04%), along with superior sensory scores for colour and appearance, taste, flavour, aroma and overall acceptability. Thus, carambola: ginger (90:10) was identified as the most suitable recipe for

preparation of herbal nectar and may be considered a promising formulation for further processing and commercial utilization.

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6. Competing interests

The authors have no conflicts of interest to declare regarding this manuscript.

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