Studies on bio-chemical attributes of spiced beetroot Ready-to-Serve (RTS) beverage

Abstract

The study could be useful in determining how to use beetroot for juice production in order to reduce loss owing to underutilization, and the addition of spices can provide a distinct flavor while masking the earthy Odor of beetroot. The study was conducted at Post Harvest Laboratory, Department of Horticulture, School of Agriculture, ITM University, Gwalior. The experiment was laid in a Completely Randomized Design with fourteen treatment combinations and three replications in each treatment. The treatments consisted of several combinations of flavour with spices including various concentrations of Cumin, Cardamon, Cinnamon and Mint. Organoleptic attributes are the sensory parameters based on which, one can justify the taste, flavour and overall appearance of the product. From the conducted research trail, it has been observed that out of 11 treatments, T_0 (Beet root (20 ml) + Sugar (10 g) + Water (80 ml)), showed least results. In the aspects of taste T_0 ranked with the value of 5.67 followed by T_2 6.67 at 0^{th} day. In the aspect of taste, T_2 (Beet root (20 ml) + Sugar (10 g) + Water (80 ml) + Mint extract (10 ml)) ranked 8.67 in 0^{th} day, simultaneously after 2 days interval it has been observed that in taste categories, T_2 recorded 4.33. From the conducted experimental trail, it has been observed that at final day the TSS was recorded highest value with 11.78 ^{0}B in T_2 (Beet root (20 ml) + Sugar (10 g) + Water (80 ml) + Mint extract (10 ml)). From the conducted experiment it has been found that Vit-C was recorded highest in T_9 and T_{10}, with the value of 6.13 and 6.43 mg/100ml. it has been assumed that by the addition of spices like cumin and cinnamon the vit-C content of the RTS was increased, which was future countered by the fermentation process at 3^{rd} final day. The synergy between beetroot's betalains and mint's bioactive compounds could potentially amplify the overall health-promoting effects of the juice. Overall, mixing mint with Beetroot RTS juice results in a delightful, nutritious beverage that appeals to both the taste buds and the health-conscious consumer.

Keywords: Ready-to-serve (RTS); Beetroot (*Beta vulgaris* L.); TSS, Ascorbic acid,Nutrition; Health

1. Introduction

Beetroot (*Beta vulgaris* L.) includes a high concentration of biologically active chemicals such as betalains, carotenoids, phenols, B-vitamins (B1, B2, B3, B6, and B12), folate minerals, fibers, low-energy carbohydrates, and inorganic nitrate. All parts of this plant have medical properties, including anti-oxidant, anti-depressant, anti-microbial, anti-fungal, anti-inflammatory, diuretic, expectorant and carminative, hepatoprotective, and cardiovascular health protector (Kale *et al.,* 2018). Other stated benefits include suppression of lipid peroxidation and chemo preventive actions. (Wruss*et al.* (2015); Babarykin*et al.* 2019)

Beetroot's red hue is used to make jam, ketchup, sweets, sauce, desserts, juices, burgundy wine, and other products (Kumar and Kumar 2015). Beetroot was utilized to prepare and standardize beetroot-based goods such as halwa and lassi (Dwivedi *et al.* 2017). A slight increase in the regular consumption of antioxidant and polyphenol-rich beverages, such as beetroot juices mixed with other spices or sauces, could have a major favorable impact on public health. Blended ready-to-serve beverages allow the general population to drink beetroot juice with simplicity and convenience, potentially contributing to increased consumption of polyphenol-rich vegetables.

Cumin (*Cuminum cyminum*) seeds are utilized in culinary applications. It contains a lot of iron and can help you lose weight and lower cholesterol. It can also treat moderate digestive problems such as diarrhea, dyspepsia, gas, dyspeptic headaches, and bloating (Johri 2011). Mint (*Mentha arvensis*) can help with irritable bowel syndrome, stomach difficulties, indigestion, and respiratory illnesses. Its essential oils exhibit antifungal, antibiofilm, and cytotoxic properties (Stringaro*et al.*, 2018). Cardamom (*Amomum sublatum*roxb) is a medicinal plant from the Zingiberaceae family that grows as a perennial herb with subterranean rhizomes at elevations ranging from 765 to 1675 meters above sea level. The larger Nepalese cardamom, also known as huge cardamom (*Amomum sublutum*roxb.), is native to the eastern Himalaya.

Cinnamon has been shown to offer substantial health advantages, particularly as an anti-inflammatory, antitumor, anticancer, antidiabetic, and anti-hypertriglyceridemia agent, owing to its phytochemical contents, including phenolic and volatile chemicals. (Jeevanthi *et al.*, 2020).

The study could be useful in determining how to use beetroot for juice production in order to reduce loss owing to underutilization, and the addition of ginger can provide a distinct flavor while masking the earthy odor of beetroot. In today's world, people are becoming more concerned of nutrition and diet in all foods, so commercial production of this juice could result in a significant economic benefit to the nation. Beetroot and spices both contain significant levels of antioxidants and minerals, making them extremely nutritious. Despite its numerous health benefits, the majority of people are completely unaware of its relevance. Hence, this work might also provide enthusiastic market for beetroot which would also help the economy of people involved in its cultivation, production and marketing, ultimately uplifting their living standards.

2. Materials and Methods

The study was conducted at Post Harvest Laboratory, Department of Horticulture, School of Agriculture, ITM University, Gwalior. The experiment was laid in a Completely Randomized Design with fourteen treatment combinations and three replications in each treatment. The treatments consisted of several combinations of flavour with spices including various concentrations of Cumin, Cardamon, Cinnamon and Mint.

2.1 Treatment Details

List 1. Treatment Details

Major Source Crop (RTS)	Beetroot (*Beta vulgaris* L.)
year	2023-24
Experimental Design	CRD (Completely randomized design)
No. of treatments	11
No. of replication	3
Date of conducted experiment	17-02-2024
List of Spices taken for RTS	Cardamom (*Elettaria cardamomum*) Cumin (*Cuminum cyminum*) Mint (*Mentha spp.)* Cinnamon (*Cinnamomum verum*)
Treatments	**Treatment Combination**
T_0	Beet root (20 ml) + Sugar (10 g) + Water (80 ml)
T_1	Beet root (20 ml) + Sugar (10 g) + Water (80 ml) + Mint extract (5 ml)
T_2	Beet root (20 ml) + Sugar (10 g) + Water (80 ml) + Mint extract (10 ml)
T_3	Beet root (20 ml) + Sugar (10 g) + Water (80 ml) + Cinnamon extract (2 ml)
T_4	Beet root (20 ml) + Sugar (10 g) + Water (80 ml) + Cinnamon extract (4 ml)
T_5	Beet root (20 ml) + Sugar (10 g) + Water (80 ml) + Cardamom extract (2 ml)
T_6	Beet root (20 ml) + Sugar (10 g) + Water (80 ml) + Cardamom extract (4 ml)
T_7	Beet root (20 ml) + Sugar (10 g) + Water (80 ml) + Cumin extract (1 ml)
T_8	Beet root (20 ml) + Sugar (10 g) + Water (80 ml) + Cumin extract (2 ml)
T_9	Beet root (20 ml) + Mint extract (5 ml) + Cardamom extract (2 ml) + Sugar (10 g) + Water (80 ml)
T_{10}	Beet root (20%) + Mint extract (5 ml) + Cinnamon extract (2 ml) + Sugar (10 g) + Water (80 ml)

2.2 Experimental Details

2.2 Analytical procedure

TSS, pH, acidity, reducing sugar, total sugar, and ash of the improved product were measured. The completed product was then stored at room temperature for 28 days, with analysis performed every 7 days to determine TSS, acidity, vitamin C, and browning index.

2.2.1 Sensory evaluation of formulated products

The sensory evaluation approach was used to select the best of 20 created RTS samples. Ranganna (1986) used a 9-point hedonic scale to evaluate sensory perception. The panelists were ITM University research students and teachers with previous experience (semi-trained) in sensory evaluation.

The sensory evaluation criteria were chosen to be appearance/color, smell/flavor, taste, mouth feel, and overall acceptability. Panellists were asked to rate the samples on a scale of 1 to 9, with 1 representing severely hated and 9 representing extremely liked samples. Sensory evaluation was carried out in an individual booth with enough lighting and no irritating odors. Each panellist was given coded samples with random numbers and an evaluation card.

2.3 Chemical Analysis

2.3.1 Titrable acidity

Titration was carried out by titrating 10 ml clear juice with standard N/10 NaOH and result was expressed as percentage citric acid.

$$\% \text{ Acidity} = \frac{\text{vol. of titrant X strength of NaOH X eqv. wt of citric acid}}{\text{wt of sample X1000}} \text{X } 100$$

2.3.2 Total soluble solid

Total soluble solid was determined with hand refractometer (0-30 ºBx) and values were expressed as degree brix according to Ranganna (1986).Total Soluble Solids (TSS) is an important quality parameter for Ready-to-Serve (RTS) beverages. It is typically measured using a refractometer, which gives a reading in degrees Brix, indicating the sugar content of the solution.

2.3.3 pH

pH was directly measured by using pH meter which was standardized by using buffer solution of pH 7 and 4 at the temperature required.

2.3.4 Reducing sugar

Reducing sugar and total sugar of RTS was determined by using Lane and Eynon as described in Ranganna (1986).

2.3.5 Vitamin C

Ascorbic acid was determined by 2-6-dichloro-indophenol titration method as given in Ranganna (1986).

Use the formula:

$$\text{Ascorbic Acid}(\text{mg}/100\text{ mL}) = \frac{V_{\text{sample}} \times C_{\text{std}} \times D \times 100}{V_{\text{std}} \times V_{\text{sample used}}}$$

where:

- V_{sample} is the volume of DCPIP used for the sample.
- C_{std} is the concentration of the standard ascorbic acid solution.
- D is the dilution factor, if any.
- V_{std} is the volume of DCPIP used for the standard.
- $V_{\text{sample used}}$ is the volume of the sample used for titration.

1. **Sample Preparation**
   - Homogenize beetroot RTS beverage
   - Filter (if necessary)

2. **Standard Solutions Preparation**
   - Prepare 1 mg/mL standard ascorbic acid solution
   - Prepare 0.1% DCPIP solution
   - Prepare 3% metaphosphoric acid and 8% acetic acid solution

3. **Extraction of Ascorbic Acid**
   - Mix 10 mL beetroot RTS with 10 mL metaphosphoric acid-acetic acid solution
   - Filter the mixture to obtain a clear extract

4. **Titration of Sample**
   - Pipette 5 mL of filtered extract into a conical flask
   - Titrate with DCPIP until persistent pink color appears
   - Record volume of DCPIP used

5. **Standardization of DCPIP Solution**
   - Pipette 5 mL of standard ascorbic acid solution into a conical flask
   - Titrate with DCPIP until persistent pink color appears
   - Record volume of DCPIP used

6. **Calculation**

Chart-1Detailed Estimation of Vitamin C

2.3.6 Betalain

Light absorption measured at 538 nm and 476 nm was used to calculate the betanin and betaxanthin concentrations, respectively. In addition, the absorption at 600 nm was measured and used to correct for small amounts of impurities. The results were expressed as betacyanin (calculated in terms of betanin) and betaxanthin (calculated in terms of violaxanthin-I). The total Betalain concentration is expressed as the sum of the betacyanins and betaxanthins.

Calculation of Betanin Concentration

Step 1: Use the Beer-Lambert Law to calculate the betanin concentration in mol/L.

Step 2: Convert the concentration from mol/L to mg/L using the molar mass of betanin.

To estimate the betanin content in beetroot juice, you can use the Beer-Lambert Law, which relates the absorbance of light to the concentration of the absorbing substance (in this case, betanin). Here's the formula and explanation:

Formula

The Beer-Lambert Law equation is:

$$A=\epsilon \cdot c \cdot A$$

Where:

Ais the absorbance of the solution at a specific wavelength (538 nm for betanin).

ϵ is the molar absorptivity (extinction coefficient) of betanin at 538 nm, given in units of $L \cdot mol^{-1} \cdot cm^{-1}$.

- **c** is the concentration of betanin in the solution, expressed in mol/L.
- **l** is the path length of the cuvette that the sample is measured in, typically 1 cm.

Steps to Estimate Betanin Content

1. **Measure Absorbance**: Use a spectrophotometer to measure the absorbance (A) of the beetroot juice or its dilution at 538 nm. Ensure the spectrophotometer is calibrated with distilled water as the blank.
2. **Calculate Concentration (c)**:
    - Rearrange the Beer-Lambert Law equation to solve for

$$c = \frac{A}{\epsilon \cdot l}$$

3. **Convert Concentration to Desired Units**: Typically, you may need to convert the concentration from mol/L to mg/L (or other units) based on the application. This involves multiplying the concentration ccc by the molar mass of betanin (approximately 550.43 g/mol).

Constants:

- **Molar Absorptivity (ϵ)**: For betanin at 538 nm, the molar absorptivity is approximately 60,000 $L \cdot mol^{-1} \cdot cm^{-1}$.

2.4 Data analysis

Analysis of variance (ANOVA) was carried out for data from sensory evaluation. The data were analysed for one -way ANOVA, mean ANOVA (at 1% level of significance), CRD at 1% significance level were obtained to determine whether the sample were significantly different from each other and to determine which one is superior among them. The specimen evaluation card used for the sensory test appears in Appendix A. The mean was compared using CRD method. Standard deviation and means were also analysed from the same statistical tool.

3. Result and Discussion

3.1 Organoleptic Attributes

3.1.1 Taste

Organoleptic attributes are the sensory parameters based on which, one can justify the taste, flavour and overall appearance of the product. From the conducted research trail, it has been observed that out of 11 treatments, T_0 (Beet root (20 ml) + Sugar (10 g) + Water (80 ml)), showed least results. In the aspects of taste T_0 ranked with the value of 5.67 followed by T_2 6.67 at 0^{th} day. In the aspect of taste, T_2 (Beet root (20 ml) + Sugar (10 g) + Water (80 ml) + Mint extract (10 ml)) ranked 8.67 in 0^{th} day, simultaneously after 2 days interval it has been observed that in taste categories, T_2 recorded 4.33. T9 and T10 recorded 7.67 and 7.89 ranking in the category of taste. Ingham*et al*, (1995) reported that Beetroot has a strong, earthy taste that can be off-putting to some people. Mint leaves have a refreshing and cooling flavour that can help mask this earthiness, making the juice more palatable.Mint leaves contain aromatic oils, such as menthol, which release pleasant volatile compounds. These compounds can significantly improve the aroma of beetroot RTS juice, making it more attractive and enjoyable to consumers. Spices such as cloves, black pepper, and cumin can add bitterness or pungency to the juice. In high concentrations, these flavors can become unpleasant, reducing the overall sensory appeal (Shahidi, 2003).

3.1.2 Color and appearance

Color and appearance are also the major parameter under sensory evaluation. Under this category, T_3 (Beet root (20 ml) + Sugar (10 g) + Water (80 ml) + Cinnamon extract (2 ml)) and T_7 (Beet root (20 ml) + Sugar (10 g) + Water (80 ml) + Cumin extract (1 ml)) ranked best with value 8.00. At the same time T_0 (Beet root (20 ml) + Sugar (10 g) + Water (80 ml)), recorded with the minimum ranking of 5.33. T_9 (Beet root (20 ml) + Mint extract (5 ml) + Cardamom extract (2 ml) + Sugar (10 g) + Water (80 ml)) and T_{10} (Beet root (20%) + Mint extract (5 ml) + Cinnamon extract (2 ml) + Sugar (10 g) + Water (80 ml)) recorded 6.67 at 0^{th} day and similarly at 3^{rd} day 4.33 and 4.00 (Table 1.). Beetroot has a distinctive earthy and sweet flavor. Adding too many spices can overpower this primary flavor, leading to a loss of the characteristic taste of beetroot. At 3^{rd} day it has been observed that overall appearance showed reduction in the raking as per the taste. Mint leaves contain aromatic oils, such as menthol, which release pleasant volatile compounds. These compounds can significantly improve the aroma of beetroot RTS juice, making it more attractive and enjoyable to consumers (Eccles, 1994).

3.1.3 Flavour

In the category of flavour, it has been recorded that T_2 (Beet root (20 ml) + Sugar (10 g) + Water (80 ml) + Mint extract (10 ml)), has maximum ranking with 8.43 at 0^{th} day, but due to fermentation it has reduced to 3.33 at final day. T_9 (Beet root (20 ml) + Mint extract (5 ml) + Cardamom extract (2 ml) + Sugar (10 g) + Water (80 ml)) and T_{10} (Beet root (20%) + Mint extract (5 ml) + Cinnamon extract (2 ml) + Sugar (10 g) + Water (80 ml)), recorded the ranking with 7.33 and 7.00 at 0^{th} day, whereas 3.33 and 2.33 at final day. Excessive use of spices can lead to sensory overload, where the complexity and intensity of the flavors and aromas become overwhelming. This can cause sensory fatigue, making the juice less enjoyable over time (Lawless and Heymann, 2010)It has been noted that due to mixing of two major spices in beetroot RTS, masking the flavour of each other's and after 2 days interval due to fermentation the parameter showed reduction in the ranking. he combination of beetroot and mint creates a complex and layered flavor profile. The cool, refreshing flavor of mint complements the earthy and sweet flavors of beetroot, resulting in a more sophisticated and enjoyable drink (Spence, 2015).

3.1.4 Aroma

Aroma is the vital approach in any sensory parameters. It helps to increase the customer appeals towards the products. Beetroot RTS is having dusky flavour, after adding the species like mint, cinnamon, cumin and cardamom, helps to enhance the aroma of the RTS. As per the olfactory attributes shown the Table-1, it can be noticed that T_0(Beet root (20 ml) + Sugar (10 g) + Water (80 ml)), recorded least ranking in aroma with the value of 3.00 at 0^{th} day and 1.67 at 3^{rd} day. Mint is having strong flavour and aroma, as per the previous references, it can be noted that at 3^{rd} day T_2 (Beet root (20 ml) + Sugar (10 g) + Water (80 ml) + Mint extract (10 ml)) ranked 2.67, but in 0^{th} day highest value with 8.50. T_{10} (Beet root (20%) + Mint extract (5 ml) + Cinnamon extract (2 ml) + Sugar (10 g) + Water (80 ml)) recorded 1.67 in the category of aroma at 3^{rd} day. The aromatic oils in mint leaves, particularly menthol, provide a pleasant fragrance that enhances the sensory experience of the juice (Gholamipourfard*et al*, 2021).

3.1.5 Overall appearance

Comparing the overall appearance of the product RTS, it has been recorded that T_2 (Beet root (20 ml) + Sugar (10 g) + Water (80 ml) + Mint extract (10 ml)) ranked best with the value of 8.33 followed by T_4 and T_6. T_0(Beet root (20 ml) + Sugar (10 g) + Water (80 ml)), recorded least value at 0^{th} day with 5.00 and T_{10} recorded minimum value at 0^{th} day with 1.67Fig-1. The aroma of mint can enhance the overall sensory appeal of the juice. A pleasant aroma is a critical factor in the overall drinking experience, as it can influence taste perception and enjoyment. Mint leaves can help balance the natural sweetness of beetroot juice, making it more palatable without the need for added sugars. This balance can make the juice more appealing to a wider audience (McKay and Blumberg, 2006)

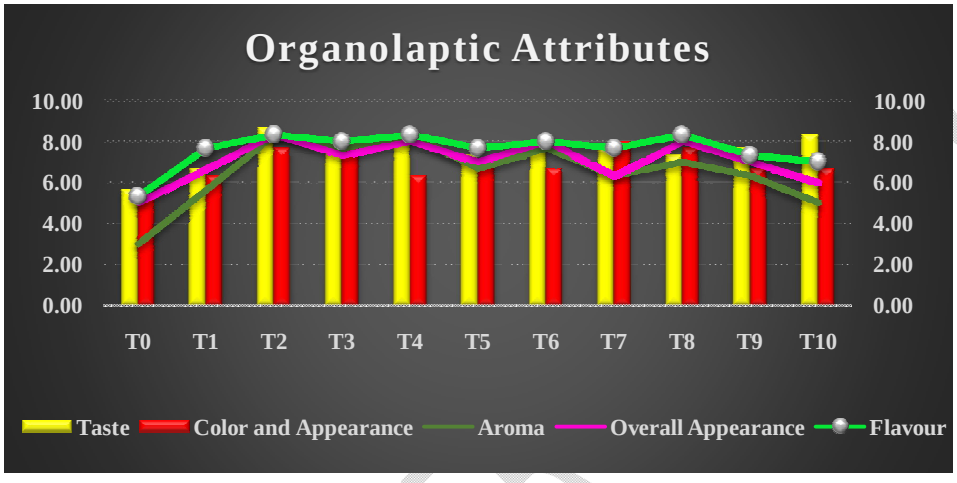

Fig-1 Graphical representation of Organoleptic attributes

3.2 Bio-chemical Attributes

3.2.1 TSS

Total Soluble Solids (TSS) refer to the combined content of all soluble substances in a liquid. In the context of RTS (Ready-to-Serve) juice, TSS primarily includes sugars, acids, vitamins, minerals, and other soluble compounds that contribute to the juice's flavor, sweetness, and nutritional value.From the conducted experimental trail, it has been observed that at final day the TSS was recorded highest value with 11.78 ^{0}B in T_2 (Beet root (20 ml) + Sugar (10 g) + Water (80 ml) + Mint extract (10 ml)). T_0 control (Beet root (20 ml) + Sugar (10 g) + Water (80 ml)), which is having normal juice of beetroot was recorded 10.08 ^{0}B (Table 2.). TSS gradually increasing from T_0 to T_2, after that it reduces till T_{10} with the value of 8.19 ^{0}B. T_1 and T_2 are at par with the value of 11.02 and 11.78 ^{0}B (Fig 2).Mint leaves contain some soluble compounds such as essential oils, flavonoids, and small amounts of sugars. These contribute to the TSS when added to the juice (Satpute*et al.* 2018).

3.2.2 Total Sugar

Research has been conducted on the Food tech lab, department of Horticulture, School of Agriculture. From the conducted experiment it has been observed that T_1Beet root (20 ml) + Sugar (10 g) + Water (80 ml) + Mint extract (5 ml), recorded good total sugar% as after T_0. Control recorded the higher sugar % as compared to the others treatments, this is due to no addition of spices, by the addition od spices the sugar level reduces as per the availability. T_2 (Beet root (20 ml) + Sugar (10 g) + Water (80 ml) + Mint extract (10 ml)), recorded total sugar% value 11.22. T_9Beet root (20 ml) + Mint extract (5 ml) + Cardamom extract (2 ml) +

Sugar (10 g) + Water (80 ml) and T_{10}Beet root (20%) + Mint extract (5 ml) + Cinnamon extract (2 ml) + Sugar (10 g) + Water (80 ml) recorded the minimum level of sugar at 3rd final day observation with the value 8.02 and 8.04. Additionally, the combination of spices and sugar can improve the antioxidant properties of beetroot juice, as evidenced by research indicating that sugar can stabilize the bioactive compounds in the presence of spices (González-Molina *et al.*, 2010). Thus, the total sugar percentage is crucial not only for flavor balance but also for enhancing the functional benefits of beetroot RTS juice when spices are added.

3.2.3 Reducing Sugar

Reducing sugars play a critical role in the quality and characteristics of beetroot Ready-to-Serve (RTS) juice. These sugars, such as glucose and fructose, are essential for balancing the flavor profile by enhancing the natural sweetness and masking any earthy or bitter notes inherent in beetroot. From the conducted experiment it can be recorded that T_2(Beet root (20 ml) + Sugar (10 g) + Water (80 ml) + Mint extract (10 ml)), recorded the maximum reducing sugar % as compared to the other treatments after T_0 (Beet root (20 ml) + Sugar (10 g) + Water (80 ml)), with the value of 5.41 and 5.81 respectively. By the addition of two or more spices the level of reducing sugar is decreasing as shown among the treatments(Fig 3).

3.2.4 Ascorbic Acid (mg/100ml)

Vitamin C plays a crucial role in Beetroot RTS (Ready-to-Serve) juice by not only enhancing its nutritional profile but also contributing to its shelf life and sensory qualities. Ascorbic acid (mg/100ml) was recorded in 3rd final day as a biochemical parameter and statistically analysed. From the conducted experiment it has been found that Vit-C was recorded highest in T_9Beet root (20 ml) + Mint extract (5 ml) + Cardamom extract (2 ml) + Sugar (10 g) + Water (80 ml) and T_{10}Beet root (20%) + Mint extract (5 ml) + Cinnamon extract (2 ml) + Sugar (10 g) + Water (80 ml), with the value of 6.13 and 6.43 mg/100ml (Fig 4). it has been assumed that by the addition of spices like cumin and cinnamon the vit-C content of the RTS was increased, which was future countered by the fermentation process at 3rd final day. T_0 Beet root (20 ml) + Sugar (10 g) + Water (80 ml), recorded the least Vit-C value with 3.65 followed by T_1 and T_2. Studies have indicated that spices can act synergistically with the ingredients in beetroot juice, potentially stabilizing Vitamin C and preventing its degradation during processing and storage (Siddiqui*et al.*, 2014)

3.2.5 pH

The pH level plays a crucial role in the quality and stability of Beetroot RTS (Ready-to-Serve) juice. Beetroot juice typically has a natural pH range of around 4.5 to 5.5. pH affects various aspects of the juice, including its taste, color, shelf-life, and nutritional content.From the conducted trail, it has been observed that T_0 (Beet root (20 ml) + Sugar (10 g) + Water (80 ml)), recorded highest pH with the value of 5.86, then decreases in T_1 (Beet root (20 ml) + Sugar (10 g) + Water (80 ml) + Mint extract (5 ml)) than again increases in T_2 (Beet root (20 ml) + Sugar (10 g) + Water (80 ml) + Mint extract (10 ml)). It has been observed from the data table, that pH was decreasing gradually within the treatment. T_9 Beet root (20 ml) + Mint extract (5 ml) + Cardamom extract (2 ml) + Sugar (10 g) + Water (80 ml) and T_{10} Beet root (20%) + Mint extract (5 ml) + Cinnamon extract (2 ml) + Sugar (10 g) + Water (80 ml), recorded acidic pH with the value of 3.60 and 3.61 respectively.

3.2.6 Betalain mg/100ml

From the conducted trail it has been observed that Betalain was recorded highest in T_0 (Beet root (20 ml) + Sugar (10 g) + Water (80 ml)), as compared to the others treatments, with the value 64.14 mg/100ml. T_1 (Beet root (20 ml) + Sugar (10 g) + Water (80 ml) + Mint extract (5 ml)) and T_2 (Beet root (20 ml) + Sugar (10 g) + Water (80 ml) + Mint extract (10 ml)) are at par with the value of 61.79 and 61.48 mg/100ml. by the addition of the cardamon, Cumin and mint together in the last treatment the amount of Betalain reduced. T_9 Beet root (20 ml) + Mint extract (5 ml) + Cardamom extract (2 ml) + Sugar (10 g) + Water (80 ml) and T_{10} Beet root (20%) + Mint extract (5 ml) + Cinnamon extract (2 ml) + Sugar (10 g) + Water (80 ml), recorded the value 52.83 and 52.16 mg/100ml respectively (Fig 5).

3.2.7 Titratable acidity (%)

From the conducted trail it has been clearly observed that titratable acidity is increasing with the mixing of spices. T_0 (Beet root (20 ml) + Sugar (10 g) + Water (80 ml)) recorded 0.217 % of titratable acidity. As compared to the other attributes T2 recorded 0.277 % titratable acidity followed by T1 with the value of 0.250. It has been noticed from the data table that, T_9 Beet root (20 ml) + Mint extract (5 ml) + Cardamom extract (2 ml) + Sugar (10 g) + Water (80 ml) and T_{10} Beet root (20%) + Mint extract (5 ml) + Cinnamon extract (2 ml) + Sugar (10 g) + Water (80 ml), recorded the value 0.427 and 0.430% respectively(Fig 6).However, specific studies focusing on the direct impact of these spices on the titratable acidity of Beetroot RTS juice are limited. Understanding these interactions could provide insights into optimizing flavor profiles and enhancing the nutritional attributes of functional beverages (Lin *et al.,* 2010).

Conclusion

The incorporation of mint into Beetroot RTS (Ready-to-Serve) juice offers a refreshing twist to the beverage, enhancing both its flavor profile and potential health benefits. Mint, known for its aromatic and cooling properties, complements the earthy sweetness of beetroot, creating a more balanced and palatable drink. The addition of mint not only contributes to an invigorating taste but also brings additional nutritional benefits, including improved digestion, anti-inflammatory properties, and enhanced antioxidant capacity. In the aspect of taste, T_2 (Beet root (20 ml) + Sugar (10 g) + Water (80 ml) + Mint extract (10 ml)) ranked 8.67 in 0^{th} day, simultaneously after 2 days interval it has been observed that in taste categories, T_2 recorded 4.33. T9 and T10 recorded 7.67 and 7.89 ranking in the category of taste.The synergy between beetroot's betalains and mint's bioactive compounds could potentially amplify the overall health-promoting effects of the juice. Overall, mixing mint with Beetroot RTS juice results in a delightful, nutritious beverage that appeals to both the taste buds and the health-conscious consumer.

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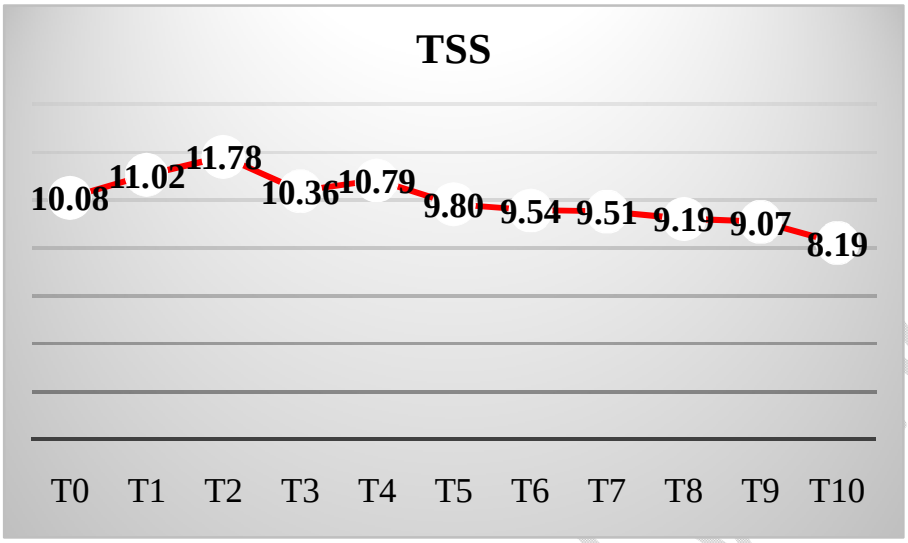

Fig 2 Graphical representation of TSS

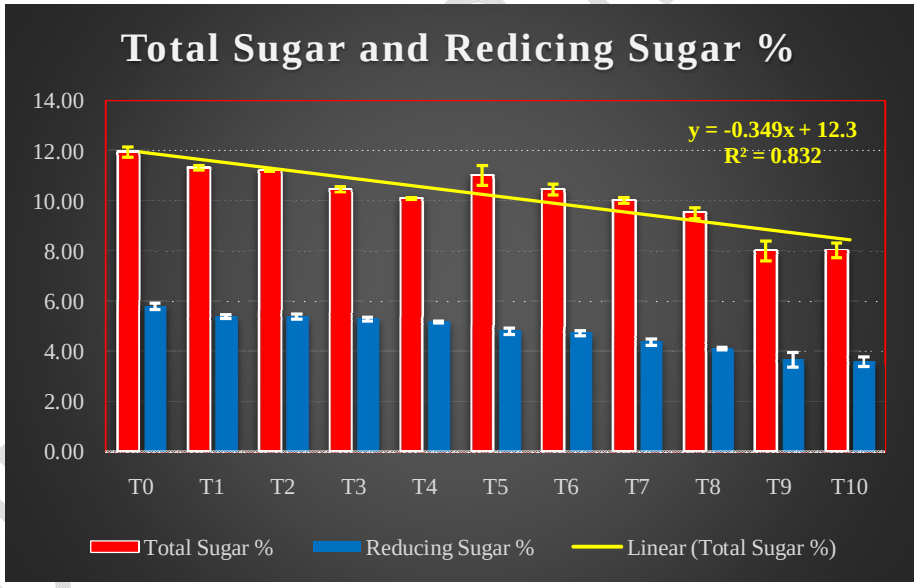

Fig 3. Graphical representation of Total Sugar and Reducing Sugar %

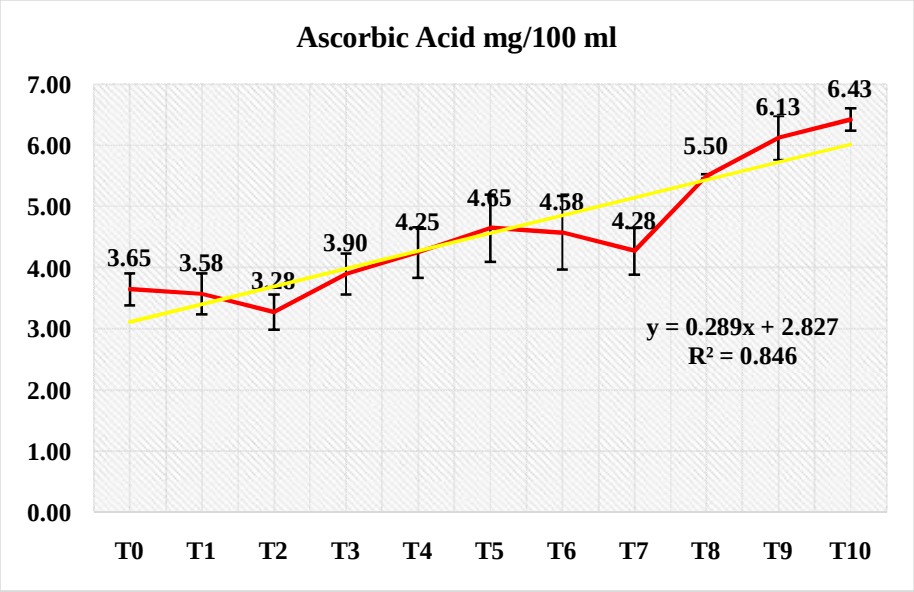

Fig 4. Graphical representation of Ascorbic Acid mg/100ml

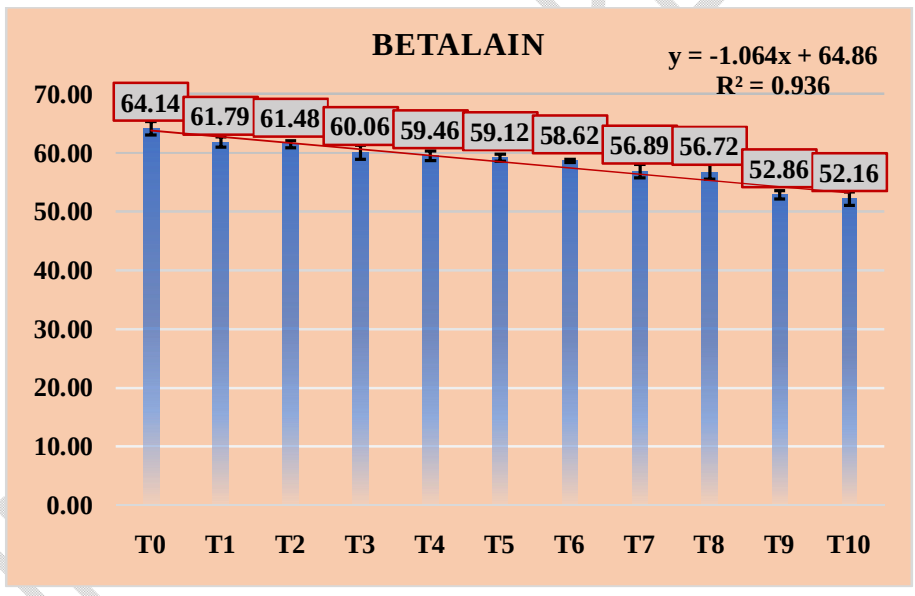

Fig 5. Graphical representation of Betalain mg/100ml

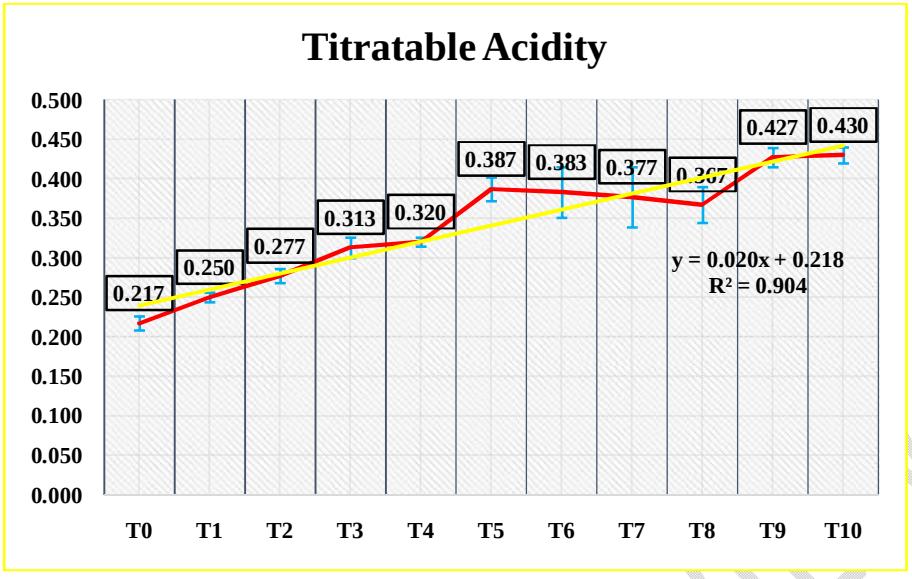

Fig 6. Graphical representation of Titratable acidity %

Table 1. Organoleptic attributes of Spiced Beetroot RTS

	Taste		Color and Appearance		Flavour		Aroma		Overall Appearance	
	0 day	3rd Day	0 day	3rd Day	0 day	3rd Day	0 day	3rd Day	0 day	3rd Day
T_0	5.67	2.67	5.33	3.67	5.33	2.67	3.00	1.67	5.00	2.33
T_1	6.67	3.67	6.33	3.67	7.67	3.33	5.67	2.67	6.67	3.67
T_2	8.67	4.33	7.67	4.33	8.43	3.33	8.50	2.67	8.33	3.33
T_3	7.67	5.33	8.00	4.67	8.00	3.67	7.67	2.33	7.33	3.33
T_4	8.33	6.33	6.33	5.33	8.33	5.33	8.33	3.67	8.00	5.33
T_5	7.33	5.67	7.00	3.33	7.67	4.00	6.67	3.00	7.00	3.67
T_6	7.67	5.33	6.67	3.67	8.00	2.67	7.67	3.00	8.00	3.33
T_7	7.67	5.33	8.00	4.33	7.67	4.00	6.33	2.67	6.33	2.33
T_8	7.33	5.67	7.67	3.67	8.33	3.67	7.00	2.33	8.00	3.00
T_9	7.67	4.67	6.67	4.33	7.33	3.33	6.33	2.67	7.00	2.33
T_{10}	7.89	4.67	6.67	4.00	7.00	2.33	5.00	1.67	6.00	1.67
C.D. (p= 0.01)	**0.98**	**1.10**	**1.42**	**1.64**	**1.68**	**1.69**	**1.51**	**1.35**	**1.81**	**1.64**
SE(m)	**0.33**	**0.04**	**0.48**	**0.55**	**0.57**	**0.57**	**0.51**	**0.46**	**0.61**	**0.55**

Table 2. Biochemical Attributes of Spiced Beetroot RTS

Treatment	Total Sugar %	Reducing Sugar %	Ascorbic Acid mg/100 ml	pH	Betalin mg/100ml	TSS	Titratable Acidity
T_0	11.96	5.81	3.65	5.86	64.14	10.08	0.217
T_1	11.34	5.39	3.58	5.02	61.79	11.02	0.250
T_2	11.22	5.41	3.28	5.12	61.48	11.78	0.277
T_3	10.47	5.30	3.90	4.83	60.06	10.36	0.313
T_4	10.11	5.18	4.25	4.85	59.46	10.79	0.320
T_5	11.03	4.81	4.65	4.52	59.12	9.80	0.387
T_6	10.46	4.74	4.58	4.20	58.62	9.54	0.383
T_7	10.04	4.37	4.28	4.05	56.89	9.51	0.377
T_8	9.52	4.12	5.50	3.80	56.72	9.19	0.367
T_9	8.02	3.67	6.13	3.60	52.86	9.07	0.427
T_{10}	8.04	3.60	6.43	3.61	52.16	8.19	0.430
C.D.(p= 0.01)	**0.68**	**0.41**	**0.33**	**1.10**	**2.75**	**0.19**	**0.056**
SE(m)	**0.23**	**0.14**	**0.08**	**0.37**	**0.93**	**0.06**	**0.019**