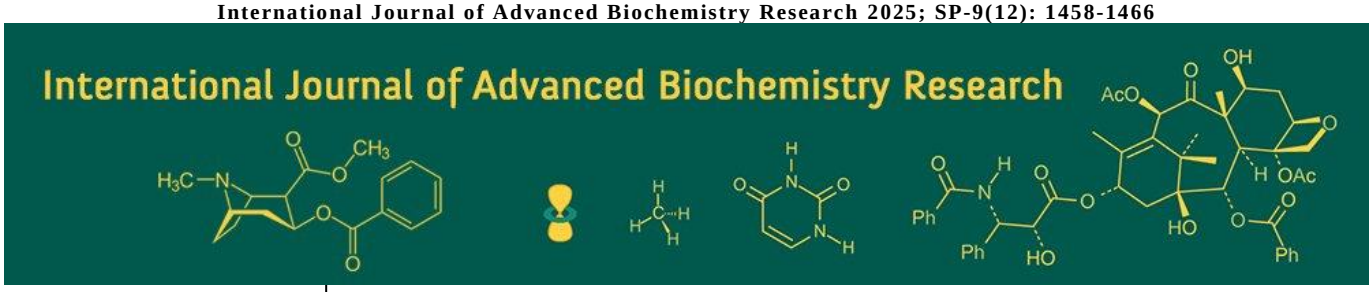

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To evaluate the physico-chemical characteristics of a blended beverage prepared of beetroot (*Beta vulgaris* L.) along with lime and mint

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Abstract
The present investigation entitled "Evaluation of physico-chemical characteristics of a blended beverage prepared from beetroot (*Beta vulgaris* L.) along with lime and mint" was carried out during 2024-25 at the Post-Harvest Management Laboratory, Department of Fruit Science, Pt. KLS College of Horticulture and Research Station, Rajnandgaon (Chhattisgarh). The study aimed to evaluate the physico-chemical quality of beetroot-based blended beverages during 90 days of storage at 15-day intervals under laboratory conditions. The experiment was conducted using a Completely Randomized Design with seven treatments and three replications. All treatments were standardized at 15 °Brix total soluble solids and 0.3 per cent acidity, while juice concentrations ranged from 20 to 80 per cent. Higher TSS and reducing sugars were observed in T5, maximum ascorbic acid in T6, and highest acidity, total sugars and pigment content in T7.

Keywords: Beetroot beverage, Physico-chemical properties, Lime

Introduction
Beetroot (*Beta vulgaris* L.) is a biennial root crop belonging to the family Chenopodiaceae, now classified under Amaranthaceae. It is grown globally for its enlarged, fleshy taproot, which is widely utilized for both culinary and medicinal purposes. Commonly referred to as beet, red beet, table beet, or garden beet, the crop is distinguished by its characteristic dark red to purplish coloration, distinctive earthy taste, and rich nutritional profile (Yadav *et al.*, 2015) [10]. In India, beetroot cultivation is predominantly concentrated in states such as Haryana, Uttar Pradesh, West Bengal, and Telangana, where suitable agro-climatic conditions favor its growth and productivity (Arulmani *et al.*, 2021).

Beyond its application as a natural colorant, beetroot juice has witnessed increasing global demand as a health-enhancing supplement, particularly within the fitness and sports nutrition industries. Owing to its low calorie content and high concentration of essential nutrients, beetroot serves as a promising raw material for the development of functional beverages and nutraceutical products.

Mint (*Mentha piperita*), belonging to the family Lamiaceae, is another important component recognized for its medicinal and therapeutic properties. It is a rich source of antioxidants and phytonutrients that aid digestive health. The presence of menthol stimulates digestive enzyme activity, while mint leaves exhibit notable antibacterial and anti-inflammatory effects (Kumar *et al.*, 2021) [4].

Lime (*Citrus aurantifolia*), a member of the Rutaceae family, is well known for its abundant vitamin C content and has traditionally been used in the prevention and treatment of scurvy. Its juice and essential oils offer benefits both internally and topically. Lime is rich in flavonoids that help rejuvenate the skin, protect against infections, reduce body odor, and promote overall skin health (Kumar *et al.*, 2021) [4].

Material and methods

Table 1: Experimental Details:

Name of Crop	Beetroot (Beta vulgaris L.)
Experimental Design	Completely Randomized Design (CRD)
Number of Treatments	07
Number of Replications	03 (5 Bottles in each replication)

Table 2: Treatment details

Notation	Treatment Details
T_1	Juice 20% (Beet root 10% +lime 5% + mint 5%),TSS 15 ^{0}Brix, acidity 0.3%
T_2	Juice 30% (Beet root 20% +lime 5% + mint 5%),TSS 15 ^{0}Brix,acidity 0.3%
T_3	Juice 40% (Beet root 30% +lime 5% + mint 5%),TSS 15 ^{0}Brix,acidity 0.3%
T_4	Juice 50% (Beet root 40% +lime 5% + mint 5%),TSS 15 ^{0}Brix,acidity 0.3%
T_5	Juice 60% (Beet root 50% +lime 5% + mint 5%),TSS 15 ^{0}Brix,acidity 0.3%
T_6	Juice 70% (Beet root 60% +lime 5% + mint 5%),TSS 15 ^{0}Brix,acidity 0.3%
T_7	Juice 80% (Beet root 70% +lime 5% + mint 5%),TSS 15 ^{0}Brix,acidity 0.3%

The present laboratory experiment was carried out during the year 2024-25 at Post Harvest Management laboratory in the Department of Fruit Science, Pt. KLS, College of Horticulture and Research Station, Rajnandgaon (C.G.)

Results

Physical character

Data revealed that the shape of fruits was globular and average weight of fruits was 130.83 g. The average length of fruit and diameter were recorded 6.2 and 5.1 cm, respectively. Weight of peels was 80.97 gm and pulp 658 gm. inedible index were 658.70, and edible index were 90.03, 7.26, 12.10 and 87.89 percent respectively.

Chemical composition

Data presented in Table 1 showed chemical composition of beetroot. The total soluble solid was 6.00 °Brix, acidity was 0.13 percent, Ascorbic acid was recorded 3.55 mg/100ml. The reducing sugar, total sugar and non- reducing sugar were recorded 4.50, 5.00 and 0.5 percent. The betacyanin and betaxanthin was 3.50 and 1.20 respectively.

Table 1: Physico-chemical composition of beetroot

Physical character

Shape of fruit	Globular
Weight of fruit	130.83
Length of fruit	6.2 cm
Diameter of fruit	5.2cm
Weight of peel	80.97gm
Weight of pulp	658.70 gm
Inedible index	641.56
Edible index	90.03

Chemical composition

TSS	6.00
Acidity	0.13
Ascorbic acid	3.55
Reducing sugar	4.50
Non reducing sugar	0.5
Total sugar	5.00
Betacyanin	3.50
Betaxanthin	1.20

Total soluble solids (TSS) °Brix

The data presented in Table 2 and Fig. 1 indicated that the Total Soluble Solids (TSS) of beetroot blended beverages with lime and mint increased gradually throughout the storage period from 0 to 90 days across all treatments. At the initial stage (0 day), TSS values varied among treatments, with the highest TSS consistently recorded in T_5 (juice 60%: beetroot 50% + lime 5% + mint 5%), while the lowest values were observed in T_2 (juice 30%). As storage progressed at 15-day intervals, a steady and significant rise in TSS was noted in all treatments, with T_5 maintaining the highest TSS throughout the entire storage period, followed by T_7 and T_6, which remained statistically at par with T_5 at several stages. By the end of 90 days of storage, TSS reached a maximum in T_5, whereas T_2 consistently recorded the minimum TSS. The gradual increase in TSS during storage may be attributed to the conversion of complex carbohydrates and polysaccharides into simpler soluble sugars under storage conditions. Similar trends have also been reported by Kumar (2021) in blended beverages prepared from bottle gourd with lime and mint.

Table 2: Effect on TSS (°Brix) of different recipe treatments of blended beetroot beverage during ambient storage condition

	Treatments	**0**	**15**	**30**	**45**	**60**	**75**	**90**
T_1	Juice 20% (Beet root 10% +lime 5% + mint 5%)	14.57	14.60	14.64	14.67	14.70	14.75	14.78
T_2	Juice 30% (Beet root 20% +lime 5% + mint 5%)	13.99	14.04	14.07	14.12	14.16	14.19	14.24
T_3	Juice 40% (Beet root 30% +lime 5% + mint 5%)	14.81	14.85	14.89	14.94	14.98	15.02	15.05
T_4	Juice 50% (Beet root 40% +lime 5% + mint 5%)	14.86	14.90	14.95	15.00	15.04	15.09	15.12
T_5	Juice 60% (Beet root 50% +lime 5% + mint 5%)	15.45	15.51	15.56	15.61	15.65	15.70	15.74
T_6	Juice 70% (Beet root 60% +lime 5% + mint 5%)	14.63	14.68	14.73	14.78	14.83	14.87	14.92
T_7	Juice 80% (Beet root 70% +lime 5% + mint 5%)	15.07	15.12	15.18	15.23	15.28	15.33	15.38
	CD at 5%	0.786	0.539	0.769	0.840	0.824	0.759	0.762
	SEm ±	0.259	0.178	0.253	0.277	0.272	0.250	0.251
	CV	3.038	2.079	2.953	3.217	3.147	2.892	2.895

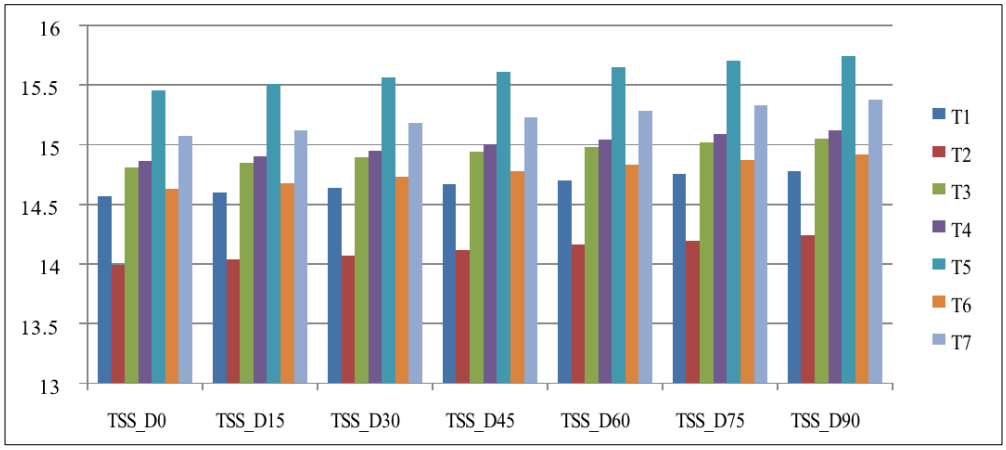

Fig 1: Effect on TSS (°Brix) of different recipe treatments of blended beetroot beverage during ambient storage condition

Titrable acidity (%)

The data presented in Table 3 and Fig. 2 revealed that the titratable acidity of beetroot blended beverage with lime and mint increased significantly with the advancement of storage period from 0 to 90 days under ambient conditions. At the initial stage of storage, acidity values varied among treatments, with the lowest acidity generally recorded in T_5 (juice 60%: beetroot 50% + lime 5% + mint 5%) and the highest in T_7 (juice 80%: beetroot 70% + lime 5% + mint 5%), which remained statistically at par with several other treatments. A gradual and consistent increase in acidity was observed at each storage interval (15, 30, 45, 60, 75 and 90 days) across all treatments, with T_7 maintaining the highest acidity throughout the storage period, while T_5 or T_2 recorded the lowest values at different stages. By the end of 90 days of storage, maximum acidity was observed in T_7, whereas minimum acidity was recorded in T_2. The progressive increase in acidity during storage may be attributed to the formation of organic acids and biochemical changes occurring in the beverage. Similar results were also reported by Kumar (2021) [4] in blended beverages prepared from bottle gourd with lime and mint.

Table 3 Effect on titrable acidity of different recipe treatments of blended beetroot beverage during ambient storage condition

	Treatments	0 days	15 days	30 days	45 days	60 days	75 days	90 days
T_1	Juice 20% (Beet root 10% +lime 5% + mint 5%)	0.32	0.33	0.34	0.35	0.36	0.37	0.37
T_2	Juice 30% (Beet root 20% +lime 5% + mint 5%)	0.30	0.31	0.32	0.33	0.34	0.34	0.36
T_3	Juice 40% (Beet root 30% +lime 5% + mint 5%)	0.32	0.33	0.34	0.35	0.36	0.37	0.38
T_4	Juice 50% (Beet root 40% +lime 5% + mint 5%)	0.30	0.31	0.32	0.33	0.34	0.35	0.36
T_5	Juice 60% (Beet root 50% +lime 5% + mint 5%)	0.28	0.29	0.30	0.31	0.32	0.33	0.34
T_6	Juice 70% (Beet root 60% +lime 5% + mint 5%)	0.32	0.33	0.34	0.35	0.36	0.37	0.37
T_7	Juice 80% (Beet root 70% +lime 5% + mint 5%)	0.33	0.34	0.35	0.36	0.37	0.38	0.39
	CD at 5%	0.015	0.013	0.019	0.015	0.015	0.019	0.021
	SEm ±	0.005	0.004	0.006	0.005	0.005	0.006	0.007
	CV	2.811	2.362	3.226	2.486	2.491	3.091	3.172

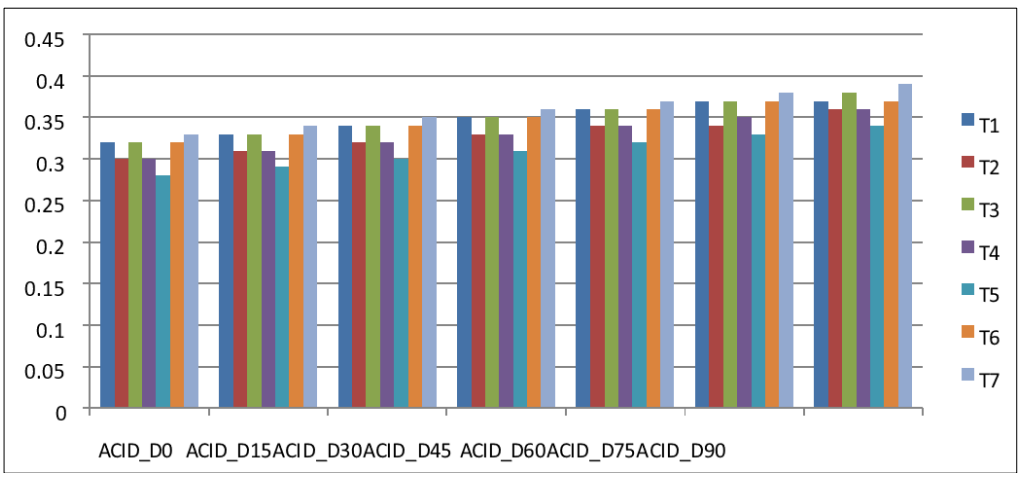

Fig 2: Effect on titrable acidity of different recipe treatments of blended beetroot beverage during ambient storage condition

Ascorbic acid (mg/100ml)

The data presented in Table.4 and Fig.3 revealed a significant and progressive decline in ascorbic acid content of beetroot blended beverages with lime and mint during ambient storage from 0 to 90 days. At the initial stage of storage, ascorbic acid content varied widely among treatments, with the lowest value recorded in T_1 (juice 20%) and the highest in T_7 (juice 80%), which remained statistically at par with T_6 and T_5. With advancement of storage at successive intervals of 15, 30, 45, 60, 75 and 90 days, a gradual decrease in ascorbic acid was observed in all treatments, though beverages with higher juice concentration (T_7, T_6 and T_5) consistently retained higher ascorbic acid levels compared to lower juice treatments. By the end of 90 days of storage, maximum ascorbic acid content was still observed in T_7, while the minimum was recorded in T_1. The continuous reduction in ascorbic acid during storage may be attributed to its high sensitivity to oxygen, light and heat, leading to oxidative degradation through enzymatic and non-enzymatic reactions. Similar findings have also been reported by Theba (2023) [9] in beetroot blended juice.

Table 4 Effect on ascorbic acid (mg/100ml) of different recipe treatments of blended beetroot beverage during ambient storage condition

	Treatments	0 days	15 days	30 days	45 days	60 days	75 days	90 days
T_1	Juice 20% (Beet root 10% +lime 5% + mint 5%)	8.55	7.90	7.20	6.45	5.60	4.85	4.10
T_2	Juice 30% (Beet root 20% +lime 5% + mint 5%)	9.79	9.09	8.35	7.50	6.70	5.84	5.00
T_3	Juice 40% (Beet root 30% +lime 5% + mint 5%)	11.05	10.25	9.39	8.49	7.65	6.70	5.80
T_4	Juice 50% (Beet root 40% +lime 5% + mint 5%)	12.30	11.40	10.45	9.50	8.55	7.50	6.50
T_5	Juice 60% (Beet root 50% +lime 5% + mint 5%)	13.55	12.55	11.50	10.45	9.40	8.30	7.25
T_6	Juice 70% (Beet root 60% +lime 5% + mint 5%)	16.05	14.84	13.60	12.29	11.00	9.69	8.40
T_7	Juice 80% (Beet root 70% +lime 5% + mint 5%)	14.79	13.70	12.55	11.40	10.25	9.05	7.90
	CD at 5%	0.672	0.601	0.542	0.393	0.469	0.174	0.288
	SEm ±	0.222	0.198	0.179	0.129	0.155	0.057	0.095
	CV	3.120	3.011	2.964	2.376	3.172	1.336	2.562

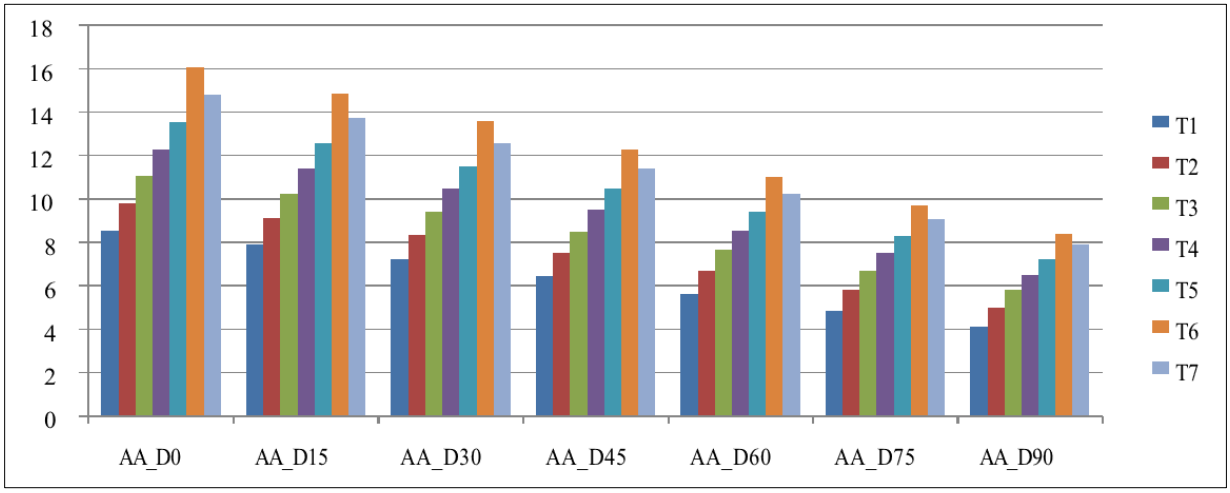

Fig 3: Effect on ascorbic acid (mg/100ml) of different recipe treatments of blended beetroot beverage during ambient storage condition

Reducing sugar (%)

The data presented in Table. 5 and Fig.4 indicated a significant and gradual increase in reducing sugar content of beetroot blended beverages with lime and mint during ambient storage from 0 to 90 days. At the initial stage of storage, reducing sugar content varied among treatments, with the lowest value recorded in T_1 (juice 20%) and the highest in higher juice concentration treatments, particularly T_8 (juice 90%), which remained statistically at par with T_6 and T_7. As storage progressed at successive intervals, a continuous increase in reducing sugars was observed in all treatments, with beverages containing higher proportions of beetroot juice consistently showing higher reducing sugar levels compared to lower juice treatments. By the end of 90 days of storage, maximum reducing sugar content was observed in T_6, followed by T_7 and T_8, while the minimum value remained in T_1. The gradual increase in reducing sugars during storage may be attributed to the inversion of non-reducing sugars into reducing sugars under the acidic conditions of the beverage. Similar results were reported by Mahnoori (2020) [6] in beetroot blended RTS beverage.

Table 5: Effect on reducing sugar (%) of different recipe treatments of blended beetroot beverage during ambient storage condition

	Treatments	0 days	15 days	30 days	45 days	60 days	75 days	90 days
T_1	Juice 20% (Beet root 10% +lime 5% + mint 5%)	2.15	2.45	2.75	3.00	3.25	3.50	3.75
T_2	Juice 30% (Beet root 20% +lime 5% + mint 5%)	2.40	2.72	3.04	3.30	3.58	3.85	4.12
T_3	Juice 40% (Beet root 30% +lime 5% + mint 5%)	2.65	2.98	3.31	3.60	3.89	4.18	4.47
T_4	Juice 50% (Beet root 40% +lime 5% + mint 5%)	2.89	3.24	3.60	3.92	4.24	4.55	4.87
T_5	Juice 60% (Beet root 50% +lime 5% + mint 5%)	3.65	4.08	4.51	4.90	5.29	5.68	6.07
T_6	Juice 70% (Beet root 60% +lime 5% + mint 5%)	3.40	3.80	4.20	4.55	4.89	5.24	5.60
T_7	Juice 80% (Beet root 70% +lime 5% + mint 5%)	3.15	3.52	3.89	4.23	4.57	4.91	5.25
	CD at 5%	0.096	0.183	0.139	0.176	0.179	0.274	0.204
	SEm ±	0.032	0.060	0.046	0.058	0.059	0.090	0.067
	CV	1.884	3.216	2.195	2.564	2.401	3.430	2.386

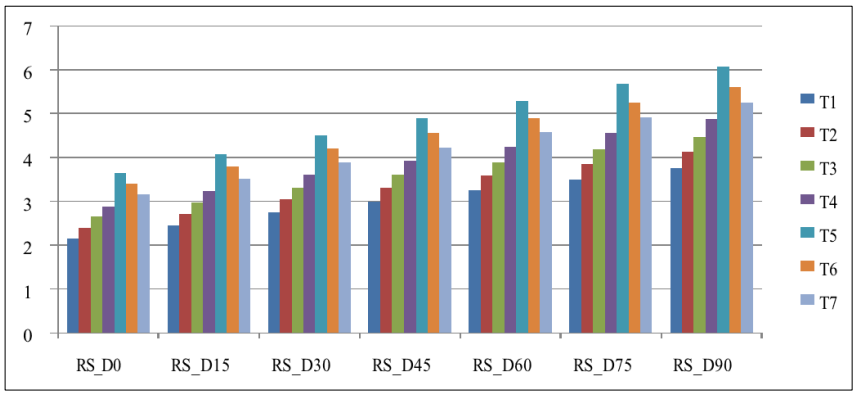

Fig 4: Effect on reducing sugar (%) of different recipe treatments of blended beetroot beverage during ambient storage condition

Non reducing sugar (%)

Sugar content of beetroot blended beverages with lime and mint during ambient storage from 0 to 90 days across all treatments. At the initial stage of storage, the highest non-reducing sugar content was recorded in T_1 (juice 20%), while the lowest value was observed in T_7 (juice 80%). With the advancement of storage at successive intervals (15, 30, 45, 60, 75 and 90 days), a gradual decrease in non-reducing sugars was noticed in all treatments, though beverages with lower juice concentration (T_1 and T_2) consistently retained higher non-reducing sugar levels compared to treatments with higher beetroot juice content. By the end of 90 days of storage, maximum non-reducing sugar content was still recorded in T_1, whereas the minimum value was observed in T_7. The decline in non-reducing sugars during storage may be attributed to the gradual inversion and hydrolysis of non-reducing sugars into reducing sugars under the acidic conditions of the beverage. Similar trends were also reported by Kumar (2021) [4] in blended beverages prepared from bottle gourd with lime and mint.

Table 6: Effect on non reducing sugar (%) of different recipe treatments of blended beetroot beverage during ambient storage condition

	Treatments	0 days	15 days	30 days	45 days	60 days	75 days	90 days
T_1	Juice 20% (Beet root 10% +lime 5% + mint 5%)	11.54	11.25	10.95	10.70	10.45	10.20	9.95
T_2	Juice 30% (Beet root 20% +lime 5% + mint 5%)	11.40	11.07	10.76	10.49	10.21	9.95	9.68
T_3	Juice 40% (Beet root 30% +lime 5% + mint 5%)	11.25	10.92	10.59	10.30	10.01	9.72	9.43
T_4	Juice 50% (Beet root 40% +lime 5% + mint 5%)	11.10	10.75	10.40	10.08	9.76	9.44	9.12
T_5	Juice 60% (Beet root 50% +lime 5% + mint 5%)	10.94	10.58	10.20	9.87	9.53	9.19	8.85
T_6	Juice 70% (Beet root 60% +lime 5% + mint 5%)	10.80	10.40	10.00	9.64	9.30	8.94	8.60
T_7	Juice 80% (Beet root 70% +lime 5% + mint 5%)	10.65	10.21	9.79	9.40	9.01	8.62	8.23
	CD at 5%	0.636	0.427	0.461	0.374	0.429	0.435	0.377
	SEm) ±	0.210	0.141	0.152	0.123	0.141	0.143	0.124
	CV	3.272	2.270	2.537	2.120	2.512	2.632	2.359

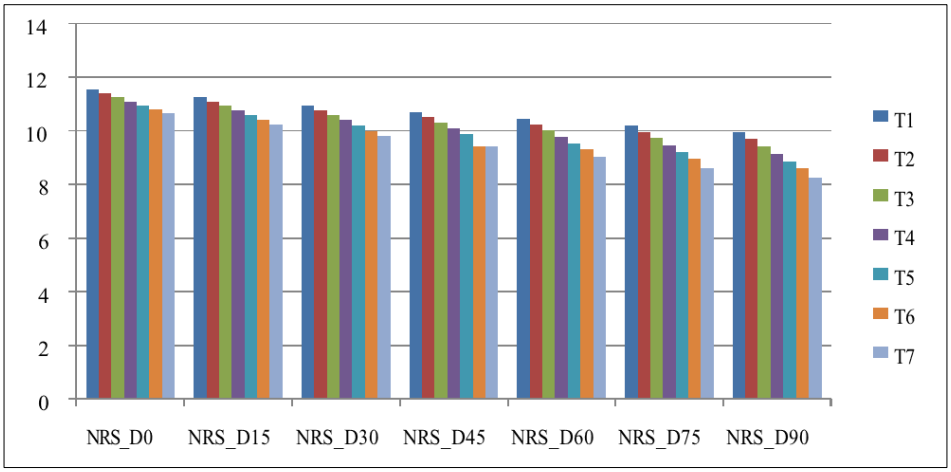

Fig 5: Effect on non reducing sugar (%) of different recipe treatments of blended beetroot beverage during ambient storage condition

Total sugar (%)

The total sugar content of beetroot blended beverages showed a gradual increase during ambient storage from 0 to 90 days across all treatments. At the beginning of storage, total sugar ranged from 13.70% in T_1 juice (Beetroot 10% + lime 5% + mint 5%) to 14.30% in T_7 juice (Beetroot 70% + lime 5% + mint 5%), with intermediate treatments showing incremental increases corresponding to higher beetroot content. This trend persisted throughout the storage period, with T_7 consistently recording the highest values and T_1 the lowest, while other treatments remained statistically comparable to each other. By 90 days, total sugar content stabilized, ranging from 13.69% in T_1 to 14.30% in T_7. The observed increase in sugar during storage is likely due to the hydrolysis of polysaccharides, such as starch and pectin, into simpler sugars, a pattern consistent with findings in beetroot blended RTS beverages reported by Mahnoori (2020) [6].

Table 7: Effect on total sugar (%) of different recipe treatments of blended beetroot beverage during ambient storage condition

	Treatments	0 days	15 days	30 days	45 days	60 days	75 days	90 days
T_1	Juice 20% (Beet root 10% +lime 5% + mint 5%)	13.70	13.70	13.70	13.70	13.70	13.69	13.69
T_2	Juice 30% (Beet root 20% +lime 5% + mint 5%)	13.80	13.80	13.80	13.80	13.80	13.80	13.80
T_3	Juice 40% (Beet root 30% +lime 5% + mint 5%)	13.90	13.90	13.90	13.90	13.90	13.90	13.90
T_4	Juice 50% (Beet root 40% +lime 5% + mint 5%)	14.00	13.99	14.00	14.00	14.00	14.00	14.00
T_5	Juice 60% (Beet root 50% +lime 5% + mint 5%)	14.09	14.10	14.10	14.10	14.09	14.10	14.10
T_6	Juice 70% (Beet root 60% +lime 5% + mint 5%)	14.20	14.19	14.20	14.20	14.20	14.20	14.20
T_7	Juice 80% (Beet root 70% +lime 5% + mint 5%)	14.30	14.30	14.30	14.29	14.30	14.30	14.30
	CD at 5%	0.678	0.752	0.633	0.477	0.606	0.827	0.625
	SEm) ±	0.224	0.248	0.209	0.157	0.200	0.273	0.206
	CV	2.766	3.065	2.580	1.947	2.473	3.373	2.551

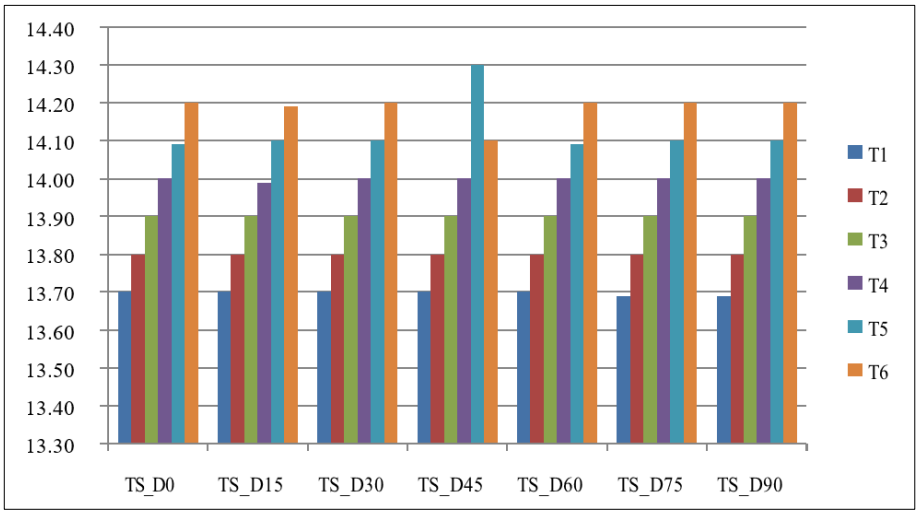

Fig 6: Effect on total sugar (%) of different recipe treatments of blended beetroot beverage during ambient storage condition

Betacyanin

The betacyanin content of beetroot blended beverages with lime and mint showed a gradual decline during ambient storage from 0 to 90 days. At the beginning of storage, betacyanin ranged from 1.45% in T_1 juice (Beetroot 10% + Lime 5% + Mint 5%) to 8.47% in T_7 juice (Beetroot 70% + Lime 5% + Mint 5%), with intermediate treatments exhibiting values proportional to their beetroot content. This decreasing trend persisted throughout storage, with T_7 consistently maintaining the highest betacyanin levels and T_1 the lowest, while other treatments remained statistically comparable. By 90 days, betacyanin content had declined to 0.87% in T_1 and 5.42% in T_7. The reduction in betacyanin over time is attributed to pigment degradation during storage, a pattern consistent with findings in blended beverages of bottle gourd, beetroot, and aloe vera reported by Jalchhatri (2024) [2].

Table 8: Effect on betacyanin of different recipe treatments of blended beetroot beverage during ambient storage condition

Treatment	Recipe composition	Day 0	Day 15	Day 30	Day 45	Day 60	Day 75	Day 90
T1	Juice 20% (Beetroot 10% + Lime 5% + Mint 5%)	1.45	1.38	1.29	1.18	1.08	0.97	0.87
T2	Juice 30% (Beetroot 20% + Lime 5% + Mint 5%)	2.90	2.76	2.58	2.40	2.19	1.98	1.77
T3	Juice 40% (Beetroot 30% + Lime 5% + Mint 5%)	4.35	4.14	3.90	3.63	3.33	3.00	2.70
T4	Juice 50% (Beetroot 40% + Lime 5% + Mint 5%)	5.80	5.52	5.19	4.83	4.44	4.02	3.60
T5	Juice 60% (Beetroot 50% + Lime 5% + Mint 5%)	6.05	5.75	5.40	5.00	4.57	4.15	3.75
T6	Juice 70% (Beetroot 60% + Lime 5% + Mint 5%)	7.26	6.90	6.47	6.00	5.50	4.97	4.45
T7	Juice 80% (Beetroot 70% + Lime 5% + Mint 5%)	8.47	8.05	7.55	7.00	6.42	5.80	5.20
CD at 5%	—	0.202	0.322	0.259	0.364	0.207	0.222	0.175
SEm ±	—	0.066	0.106	0.085	0.120	0.068	0.073	0.056
CV (%)	—	2.219	3.736	3.197	2.592	3.003	3.564	3.044

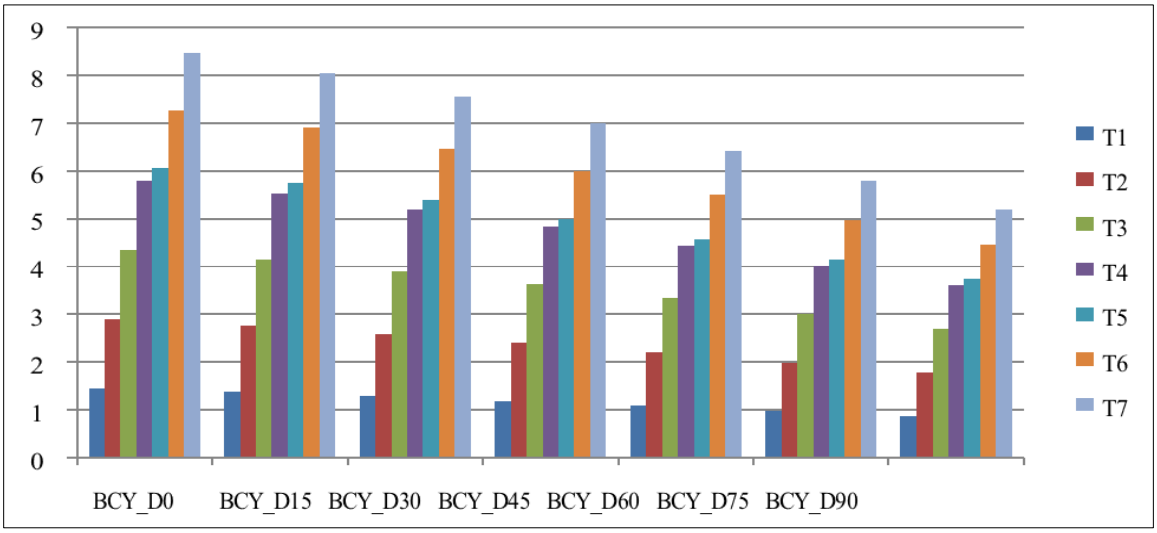

Fig 7: Effect on betacyanin of different recipe treatments of blended beetroot beverage during ambient storage condition

Betaxanthin

The Betaxanthin content of beetroot blended beverages with lime and mint showed a steady decline during storage from 0 to 90 days across all treatments. Initially, Betaxanthin ranged from 0.98% in T_1 juice (Beetroot 10% + Lime 5% + Mint 5%) to 6.86% in T_7 juice (Beetroot 70% + Lime 5% + Mint 5%), with intermediate treatments reflecting proportional beetroot content. This decreasing trend continued over the storage period, with T_7 consistently maintaining the highest levels and T_1 the lowest, while other treatments were statistically comparable. By 90 days, Betaxanthin content had reduced to 0.54% in T_1 and 4.17% in T_7. The observed decline in Betaxanthin during storage is attributed to pigment degradation, a trend consistent with findings in blended beverages of bottle gourd, beetroot, and aloe vera reported by Jalchhatri (2024) [2].

Table 9: Effect on betaxanthin of different recipe treatments of blended beetroot beverage during ambient storage condition

	Treatments	0 days	15 days	30 days	45 days	60 days	75 days	90 days
T_1	Juice 20% (Beet root 10% +lime 5% + mint 5%)	0.98	0.92	0.85	0.77	0.69	0.61	0.54
T_2	Juice 30% (Beet root 20% +lime 5% + mint 5%)	1.96	1.85	1.72	1.57	1.43	1.28	1.14
T_3	Juice 40% (Beet root 30% +lime 5% + mint 5%)	2.94	2.78	2.59	2.40	2.20	1.97	1.78
T_4	Juice 50% (Beet root 40% +lime 5% + mint 5%)	3.92	3.7	3.48	3.22	2.95	2.68	2.4
T_5	Juice 60% (Beet root 50% +lime 5% + mint 5%)	4.90	4.65	4.35	4.05	3.7	3.35	3
T_6	Juice 70% (Beet root 60% +lime 5% + mint 5%)	5.88	5.55	5.2	4.80	4.40	3.95	3.54
T_7	Juice 80% (Beet root 70% +lime 5% + mint 5%)	6.86	6.5	6.1	5.65	5.15	4.65	4.17
	CD at 5%	0.183	0.202	0.158	0.199	0.143	0.063	0.046
	SEm) ±	0.06	0.067	0.052	0.066	0.047	0.021	0.015
	CV	2.669	3.11	2.607	3.536	2.793	1.362	1.117

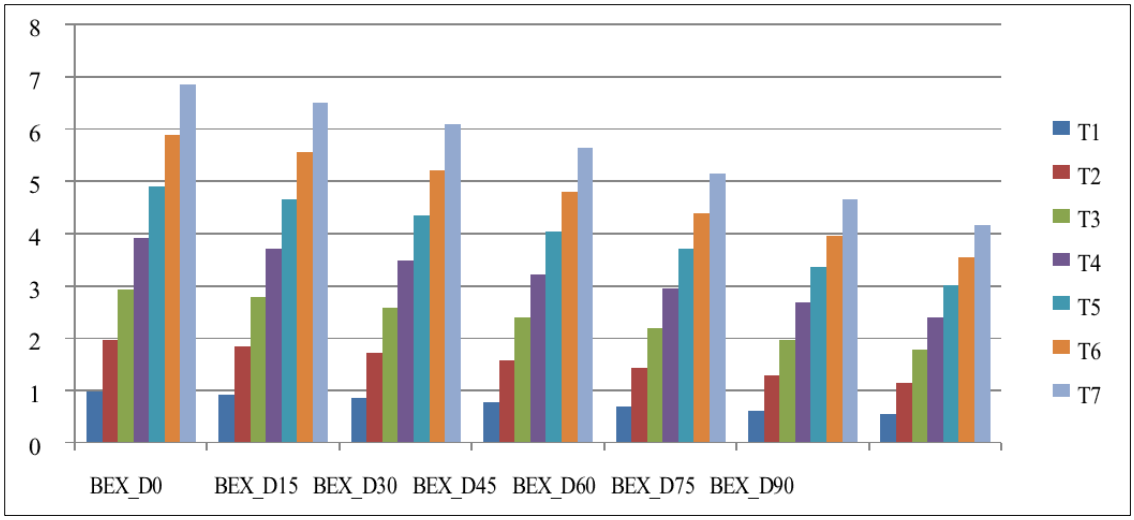

Fig 8: Effect on betaxanthin of different recipe treatments of blended beetroot beverage during ambient storage condition

Conclusion

The present investigation on the physico-chemical evaluation of a blended beverage prepared from beetroot (*Beta vulgaris* L.) along with lime and mint clearly demonstrated that formulation and storage period significantly influenced the quality attributes of the beverage. Among the seven treatments evaluated, while total soluble solids, acidity, and reducing sugars showed an increasing trend. This indicates normal biochemical changes occurring during storage. Treatments with higher juice concentrations exhibited increased nutritional parameters such as total sugars, acidity, and pigments, but excessively high beetroot content negatively affected sensory acceptability.

Overall, the study concludes that a balanced proportion of beetroot, lime, and mint not only enhances sensory appeal but also ensures better physico-chemical stability during storage, making T4 the most suitable, economical, and consumer-preferred formulation for the development of a functional blended beverage.

Importance of this research

This research holds significant importance from nutritional, technological, and commercial perspectives. Beetroot is a rich source of natural pigments, antioxidants, and bioactive compounds, while lime and mint contribute vitamin C, digestive benefits, and refreshing flavor. The successful development of a stable and acceptable beetroot-based blended beverage promotes the utilization of nutrient-dense vegetables in value-added forms, reducing post-harvest losses. The findings provide scientific guidance for standardizing beverage formulations with optimal juice concentration, sweetness, and acidity, which can be adopted by small-scale entrepreneurs, food processing industries, and start-ups focusing on functional and health beverages. Additionally, the study supports the growing consumer demand for natural, non-carbonated, and plant-based functional drinks. From an academic and research standpoint, this work contributes valuable data on physico-chemical changes during storage, which can serve as a reference for future studies on blended beverages, nutraceutical drinks, and post-harvest value addition. Overall, the research promotes sustainable food processing, enhances nutritional security, and opens avenues for commercialization of beetroot-based functional beverages.

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