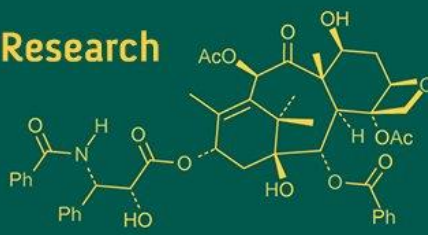
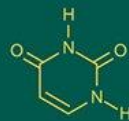
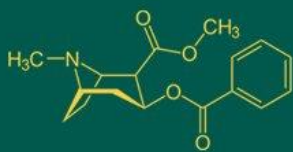


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Standardization and sensory evaluation of Watermelon (*Citrullus lanatus* L.) RTS blended with Mint (*Mentha piperita* L.) and Lime (*Citrus aurantiifolia* S.)

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Abstract

The study on “Standardization and Quality Evaluation of Watermelon (*Citrullus lanatus* L.) RTS Blended with Mint (*Mentha piperita* L.) and Lime (*Citrus aurantiifolia* S.)” was conducted during 2024-25 at the College of Horticulture and Research Station, Sankara-Patan, Durg (C.G.). Nine treatment combinations were evaluated under ambient storage conditions for 45 days in a CRD with three replications. Sensory attributes such as taste, colour, appearance, flavour and overall acceptability were assessed at 15-day intervals using a 9-point hedonic scale. All sensory scores decreased gradually during storage; however, significant differences among treatments were observed. Treatment T₄ (Watermelon 97% + Mint 2% + Lime 1%) recorded the highest mean scores for taste (7.10), colour (7.95), appearance (7.43), flavour (7.43) and overall acceptability (7.44) and retained superior quality throughout storage. T₅ and T₁ were the next best treatments, while T₉ showed the lowest scores. The results indicated that moderate blending of mint and lime improved the sensory quality and storage stability of watermelon RTS beverage.

Keywords: Watermelon, mint, lime, RTS beverage, sensory evaluation, storage stability

Introduction

Modern science increasingly prioritizes the development of health-optimized functional foods and beverages to satisfy rising health consciousness and rapidly changing urban dietary habits (Slavin and Lloyd, 2012; Santos *et al.*, 2020). Combining multiple plant matrices to build composite beverages has emerged as a key formulation strategy to maximize functional free and bound phenolics while balancing macro-nutrient profiles (Sayago-Ayerdi *et al.*, 2021). However, primary raw materials like fruits are highly perishable commodities vulnerable to severe post-harvest losses during handling and logistics, especially across developing regions (Kader, 2005). Converting seasonal agricultural surpluses into value-added, non-fermented Ready-To-Serve (RTS) beverages serves as a practical methodology to alleviate these physical losses, improve annual availability and correct undesirable raw juice defects such as astringency or flavor separation (Sharma *et al.*, 2022) [5, 14, 15, 16, 17].

Watermelon (*Citrullus lanatus* L.) is a widely cultivated, economically vital tropical fruit that contains 90-92% water, positioning it as an effective natural hydrator (Tarazona-Díaz *et al.*, 2013). The fruit serves as an abundant source of lycopene, vitamins, and L-citrulline, a key amino acid that supports vascular health and reduces post-exertion muscle soreness (Perkins-Veazie *et al.*, 2006; Burton-Freeman *et al.*, 2022). Despite its nutritional advantages, pure watermelon juice features a high water activity and a relatively neutral pH, rendering it highly susceptible to rapid microbial proliferation and immediate sensory deterioration during storage (Chaudhary and Mendiratta, 2019; Liu *et al.*, 2020) [1, 2, 8, 11, 19].

To counteract these stability limitations and elevate the consumer profile, blending the base juice with botanical extracts offers a viable solution (Sahu *et al.*, 2017) [13]. Mint (*Mentha piperita* L.) delivers characteristic aromatic qualities alongside menthol-driven antimicrobial and antioxidant defense mechanisms (McKay and Blumberg, 2006) [10]. Concurrently, incorporating lime (*Citrus aurantiifolia* S.) introduces vital ascorbic and citric acids that lower matrix pH, improve flavour dimensions, and enhance biochemical stability against

spoilage pathogens (Ghasemzadeh *et al.*, 2011; Loizzo *et al.*, 2012)^[4,9]. While separate baselines for fruit-herbal mixtures exist, extensive data regarding the exact standardization, physical adjustments of Total Soluble Solids (TSS) and long-term storage mechanics of an integrated watermelon-mint-lime RTS system remains scarce (Kumar *et al.*, 2021)^[6]. This study aims to standardize a precise watermelon-mint-lime RTS formulation, providing a scientifically validated method for commercial shelf-life extension and agricultural waste reduction.

Materials and methods

The study was carried out in the Post-Harvest Laboratory, Department of Post Harvest management, College of Horticulture and Research station Durg (C.G), during the year 2024-25.

Raw materials

Fresh watermelon and lime fruits were procured from the local market of Durg, Chhattisgarh, while fresh mint leaves were collected from a kitchen garden at Amleshwar, Durg. Sugar, citric acid and sodium benzoate were used in beverage preparation, and sterilized glass bottles were used for packaging and storage.

Standardization of RTS

The various combinations of watermelon, mint and lime juice were used to determine the best combination for palatable RTS beverage through organolaptic evaluation

- T₀ Control Watermelon (100%)
- T₁ Watermelon (98%) + Mint (1%) + Lime (1%)
- T₂ Watermelon (97%) + Mint (1%) + Lime (2%)
- T₃ Watermelon (96%) + Mint (1%) + Lime (3%)
- T₄ Watermelon (97%) + Mint (2%) + Lime (1%)
- T₅ Watermelon (96%) + Mint (2%) + Lime (2%)
- T₆ Watermelon (95%) + Mint (2%) + Lime (3%)
- T₇ Watermelon (96%) + Mint (3%) + Lime (1%)
- T₈ Watermelon (95%) + Mint (3%) + Lime (2%)
- T₉ Watermelon (94%) + Mint (3%) + Lime (3%)

Preparation of RTS beverage

Fresh watermelon juice, mint extract and lime juice were prepared and blended with sugar syrup as per treatment combinations. The TSS and acidity were adjusted to RTS standards, sodium benzoate was added as a preservative, and the beverage was bottled in sterilized glass bottles and stored under ambient conditions for evaluation.

Storage studies

The prepared RTS beverages were stored at ambient temperature and analyzed at 0, 15, 30 and 45 days of storage for physicochemical and sensory parameters.

Sensory evaluation

The sensory acceptability of watermelon RTS blended with mint and lime was evaluated by a semi-trained panel of five judges from the College of Horticulture and Research Station, Sankra-Patan, Durg (C.G.). Evaluation was carried out using the 9-point hedonic scale described by Ranganna (1997)^[12]. The coded beverage samples were presented randomly and assessed for taste, colour, appearance, flavour and overall acceptability under uniform conditions. Drinking water was provided between samples to avoid carry-over effects. The sensory scores obtained were statistically analyzed to identify

significant differences among treatments and determine the most acceptable formulation.

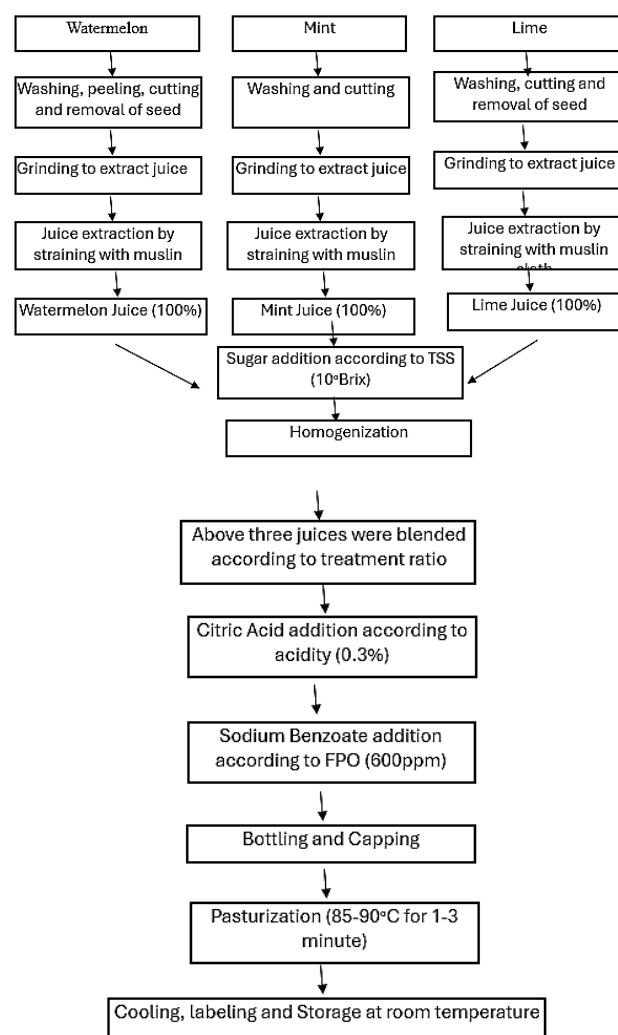


Fig 1: Flow chart for preparing watermelon, mint and lime blended RTS

Results and discussion

Taste

The taste scores of watermelon-mint-lime blended RTS beverages decreased gradually during the 45-day storage period in all treatments. Initial taste scores ranged from 6.50 to 7.40, with T₄ (Watermelon 97% + Mint 2% + Lime 1%) recording the highest score, followed by T₅ and T₁, while T₀ (Watermelon 100%) showed the lowest score. Despite the decline during storage, T₄ maintained the highest taste score (6.80) at 45 days and recorded the highest mean taste score (7.10), followed by T₅ (7.00) and T₁ (6.80). Lower scores were observed in T₀ and T₉. The reduction in taste may be due to biochemical and oxidative changes, degradation of sugars and organic acids, and loss of volatile flavour compounds. The results indicated that moderate incorporation of mint and lime improved flavour stability and taste acceptability during storage.

Colour

The colour scores of watermelon-mint-lime blended RTS beverages declined gradually during the 45-day storage period under ambient conditions. Initial colour scores ranged from 7.20 to 8.90, with T₄ (Watermelon 97% + Mint 2% + Lime 1%) recording the highest score, followed by T₅ and T₁,

while T₉ (Watermelon 94% + Mint 3% + Lime 3%) showed the lowest score. Although colour acceptability decreased in all treatments, T₄ maintained the highest score (7.00) at 45 days and recorded the highest mean colour score (7.95), followed by T₅ (7.50) and T₁ (7.33). The lowest mean scores (6.00) were observed in T₀ and T₉, with T₀ recording the lowest colour score (4.50) at the end of storage. The decline in colour may be due to oxidation of natural pigments, non-enzymatic browning, and degradation of colour compounds during storage. The results indicated that moderate incorporation of mint and lime improved colour stability and maintained the visual quality of the RTS beverage throughout storage.

Appearance

The appearance scores of watermelon-mint-lime blended RTS beverages showed a gradual decline during the 45-day storage period. Initial scores ranged from 7.09 to 7.53, with T₄ (Watermelon 97% + Mint 2% + Lime 1%) recording the highest score, followed by T₁ and T₅. At the end of storage, T₄ retained the highest appearance score (7.34), while T₉ (Watermelon 94% + Mint 3% + Lime 3%) recorded the lowest (6.61). The highest mean appearance score was observed in T₄ (7.43), followed by T₁ (7.35) and T₅ (7.31), whereas T₉ showed the lowest mean score (6.84). The decline in appearance was attributed to sedimentation, turbidity changes and pigment degradation. The results indicated that moderate levels of mint and lime improved appearance retention and visual stability during storage.

Flavour: The flavour scores of watermelon-mint-lime blended RTS beverages decreased gradually during the 45-day storage period. Initial scores ranged from 7.03 to 7.56, with T₄ (Watermelon 97% + Mint 2% + Lime 1%) recording the highest score, followed by T₅ and T₁, while T₉ (Watermelon 94% + Mint 3% + Lime 3%) showed the lowest score. Despite the decline during storage, T₄ maintained the highest flavour score (7.29) at 45 days and recorded the highest mean flavour score (7.43), followed by T₅ and T₁. Lower flavour stability was observed in T₈ and T₉. The reduction in flavour was attributed to oxidative and biochemical changes and the loss of volatile flavour compounds. The results indicated that moderate incorporation of mint and lime improved flavour retention and overall sensory quality during storage.

Overall acceptability: The overall acceptability of watermelon-mint-lime blended RTS beverages decreased gradually during the 45-day storage period. Initial scores ranged from 7.12 to 7.55, with T₄ (Watermelon 97% + Mint 2% + Lime 1%) recording the highest score, followed by T₁ and T₅, while T₉ (Watermelon 94% + Mint 3% + Lime 3%) showed the lowest score. Despite the decline during storage, T₄ maintained the highest overall acceptability score (7.32) at 45 days and recorded the highest mean score (7.44), followed by T₅ and T₁. Lower acceptability was observed in T₉, indicating reduced sensory stability. The decline in acceptability was attributed to flavour loss, colour deterioration and physicochemical changes during storage. The results showed that moderate incorporation of mint and lime improved sensory quality, consumer acceptability and storage stability of the RTS beverage.

Table 1: Effect of different recipes on taste of watermelon, mint and lime blended RTS during storage period.

Treatments	Taste				
	Storage Period (in days)				
	0	15	30	45	Mean
T ₀ Control Watermelon (100%)	6.5	6.3	6.1	6	6.22
T ₁ Watermelon (98%) + Mint (1%) + Lime (1%)	7.1	6.9	6.7	6.5	6.8
T ₂ Watermelon (97%) + Mint (1%) + Lime (2%)	7	6.8	6.6	6.4	6.7
T ₃ Watermelon (96%) + Mint (1%) + Lime (3%)	6.85	6.65	6.45	6.25	6.55
T ₄ Watermelon (97%) + Mint (2%) + Lime (1%)	7.4	7.2	7	6.8	7.1
T ₅ Watermelon (96%) + Mint (2%) + Lime (2%)	7.3	7.1	6.9	6.7	7
T ₆ Watermelon (95%) + Mint (2%) + Lime (3%)	6.75	6.55	6.35	6.15	6.45
T ₇ Watermelon (96%) + Mint (3%) + Lime (1%)	6.9	6.7	6.5	6.3	6.6
T ₈ Watermelon (95%) + Mint (3%) + Lime (2%)	6.8	6.6	6.4	6.2	6.5
T ₉ Watermelon (94%) + Mint (3%) + Lime (3%)	6.3	6.2	6.1	6	6.15
SE(m)±	0.046	0.122	0.012	0.065	
CV (%)	1.16	3.15	0.31	3.85	
CD at 5%	0.14	0.36	0.03	0.19	

Table 2: Effect of different recipes on colour of watermelon, mint and lime blended RTS during storage period.

Treatments	Colour				
	Storage Period (in days)				
	0	15	30	45	Mean
T ₀ Control Watermelon (100%)	7.5	6.5	5.5	4.5	6
T ₁ Watermelon (98%) + Mint (1%) + Lime (1%)	8.4	7.7	7	6.2	7.32
T ₂ Watermelon (97%) + Mint (1%) + Lime (2%)	8.2	7.5	6.8	6	7.12
T ₃ Watermelon (96%) + Mint (1%) + Lime (3%)	7.9	7.1	6.4	5.7	6.77
T ₄ Watermelon (97%) + Mint (2%) + Lime (1%)	8.9	8.3	7.6	7	7.95
T ₅ Watermelon (96%) + Mint (2%) + Lime (2%)	8.5	7.8	7.2	6.5	7.5
T ₆ Watermelon (95%) + Mint (2%) + Lime (3%)	7.7	6.9	6.1	5.4	6.52
T ₇ Watermelon (96%) + Mint (3%) + Lime (1%)	8	7.2	6.5	5.8	6.87
T ₈ Watermelon (95%) + Mint (3%) + Lime (2%)	7.8	7	6.2	5.5	6.62
T ₉ Watermelon (94%) + Mint (3%) + Lime (3%)	7.2	6.4	5.6	4.8	6
SE(m)±	0.46	0.156	0.183	0.18	
CV (%)	1	3.73	4.87	5.43	
CD at 5%	0.14	0.46	0.54	0.53	

Table 3: Effect of different recipes on appearance of watermelon, mint and lime blended RTS during storage period.

Treatments	Appearance				
	Storage Period (in days)				
	0	15	30	45	Mean
T ₀ Control Watermelon (100%)	7.21	6.99	6.89	6.85	6.98
T ₁ Watermelon (98%) + Mint (1%) + Lime (1%)	7.5	7.44	7.32	7.14	7.35
T ₂ Watermelon (97%) + Mint (1%) + Lime (2%)	7.33	7.29	7.12	7.11	7.21
T ₃ Watermelon (96%) + Mint (1%) + Lime (3%)	7.23	7.18	7.08	6.98	7.11
T ₄ Watermelon (97%) + Mint (2%) + Lime (1%)	7.53	7.5	7.36	7.34	7.43
T ₅ Watermelon (96%) + Mint (2%) + Lime (2%)	7.45	7.41	7.19	7.17	7.30
T ₆ Watermelon (95%) + Mint (2%) + Lime (3%)	7.28	7.1	7.01	6.88	7.06
T ₇ Watermelon (96%) + Mint (3%) + Lime (1%)	7.4	7.26	7.25	7.03	7.23
T ₈ Watermelon (95%) + Mint (3%) + Lime (2%)	7.25	7.21	7.19	6.94	7.14
T ₉ Watermelon (94%) + Mint (3%) + Lime (3%)	7.09	6.95	6.71	6.61	6.84
SE(m)±	0.018	0.02	0.022	0.024	
CV (%)	0.35	0.39	0.42	0.46	
CD at 5%	0.052	0.058	0.063	0.069	

Table 4: Effect of different recipes on flavour of watermelon, mint and lime blended RTS during storage period.

Treatments	Flavour				
	Storage Period (in days)				
	0	15	30	45	Mean
T ₀ Control Watermelon (100%)	7.14	7	6.9	6.79	6.95
T ₁ Watermelon (98%) + Mint (1%) + Lime (1%)	7.46	7.23	7.2	7.13	7.25
T ₂ Watermelon (97%) + Mint (1%) + Lime (2%)	7.37	7.19	7.11	7.1	7.19
T ₃ Watermelon (96%) + Mint (1%) + Lime (3%)	7.22	7.14	7.05	6.91	7.08
T ₄ Watermelon (97%) + Mint (2%) + Lime (1%)	7.56	7.48	7.41	7.29	7.43
T ₅ Watermelon (96%) + Mint (2%) + Lime (2%)	7.46	7.32	7.26	7.26	7.32
T ₆ Watermelon (95%) + Mint (2%) + Lime (3%)	7.17	7.03	6.93	6.87	7
T ₇ Watermelon (96%) + Mint (3%) + Lime (1%)	7.29	7.16	7.07	6.96	7.12
T ₈ Watermelon (95%) + Mint (3%) + Lime (2%)	7.19	7.03	7	6.89	7.02
T ₉ Watermelon (94%) + Mint (3%) + Lime (3%)	7.03	6.98	6.82	6.76	6.89
SE(m)±	0.022	0.025	0.028	0.031	
CV (%)	0.42	0.48	0.53	0.58	
CD at 5%	0.064	0.071	0.08	0.089	

Table 5: Effect of different recipes on overall acceptability of watermelon, mint and lime blended RTS during storage period.

Treatments	Overall acceptability				
	Storage Period (in days)				
	0	15	30	45	Mean
T ₀ Control Watermelon (100%)	7.16	6.99	6.87	6.79	6.95
T ₁ Watermelon (98%) + Mint (1%) + Lime (1%)	7.48	7.33	7.24	7.14	7.3
T ₂ Watermelon (97%) + Mint (1%) + Lime (2%)	7.36	7.26	7.15	7.11	7.22
T ₃ Watermelon (96%) + Mint (1%) + Lime (3%)	7.26	7.17	7.08	6.99	7.13
T ₄ Watermelon (97%) + Mint (2%) + Lime (1%)	7.55	7.49	7.39	7.32	7.44
T ₅ Watermelon (96%) + Mint (2%) + Lime (2%)	7.46	7.37	7.25	7.2	7.32
T ₆ Watermelon (95%) + Mint (2%) + Lime (3%)	7.22	7.06	6.97	6.88	7.03
T ₇ Watermelon (96%) + Mint (3%) + Lime (1%)	7.35	7.21	7.16	7.03	7.19
T ₈ Watermelon (95%) + Mint (3%) + Lime (2%)	7.24	7.18	7.14	6.96	7.13
T ₉ Watermelon (94%) + Mint (3%) + Lime (3%)	7.12	6.98	6.78	6.66	6.89
SE(m)±	0.03	0.04	0.05	0.06	
CV (%)	0.48	0.55	0.61	0.67	
CD at 5%	0.09	0.12	0.15	0.18	

Table 6: Organolaptic quality of RTS prepared from blended juices of watermelon, mint and lime.

Treat ments	Treatment combinations			Organolaptic score					
	Watermelon (%)	Mint (%)	Lime (%)	Taste	Colour	Appearance	Flavour	Overall acceptability	Rating
T ₀	100	0	0	6.9	6	6.99	6.96	6.71	Like slightly
T ₁	98	1	1	7.32	7.32	7.35	7.26	7.31	Like moderately
T ₂	97	1	2	7.21	7.13	7.21	7.19	7.18	Like moderately
T ₃	96	1	3	7.05	6.78	7.12	7.08	7.01	Like moderately
T ₄	97	2	1	7.48	7.95	7.43	7.44	7.57	Like very much
T ₅	96	2	2	7.39	7.5	7.31	7.33	7.38	Like moderately
T ₆	95	2	3	7.05	6.53	7.07	7	6.91	Like moderately
T ₇	96	3	1	7.18	6.88	7.24	7.12	7.11	Like moderately
T ₈	95	3	2	7.09	6.63	7.15	7.03	6.98	Like moderately
T ₉	94	3	3	6.92	6	6.84	6.9	6.66	Like slightly

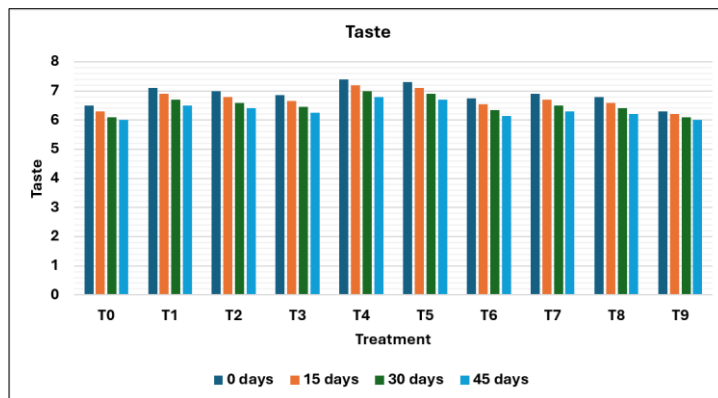


Fig 1: Effect of different recipes on taste of watermelon, mint and lime blended RTS during storage period.

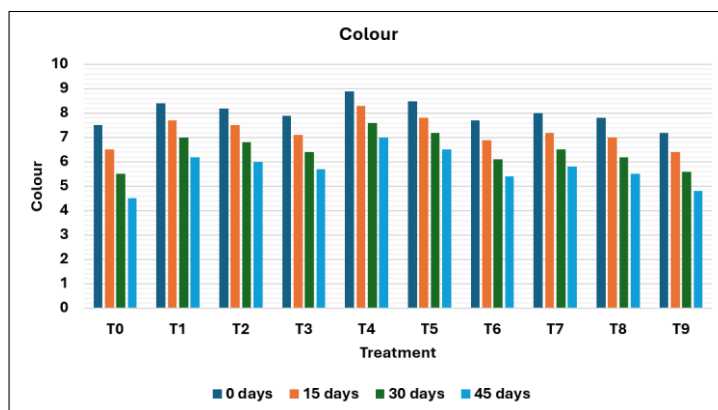


Fig 2: Effect of different recipes on colour of of watermelon, mint and lime blended RTS during storage period.

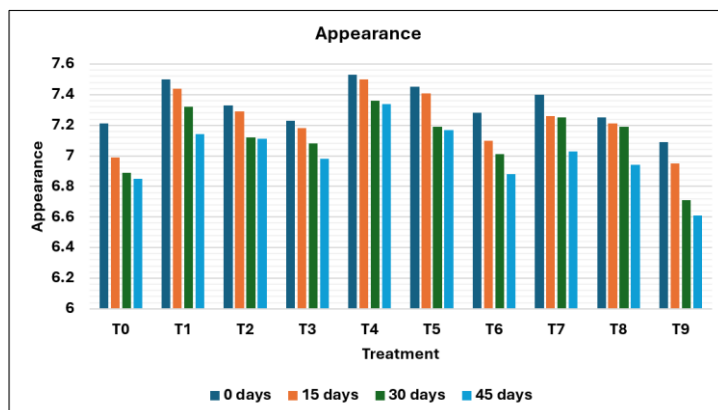


Fig 3: Effect of different recipes on appearance of of watermelon, mint and lime blended RTS during storage period.

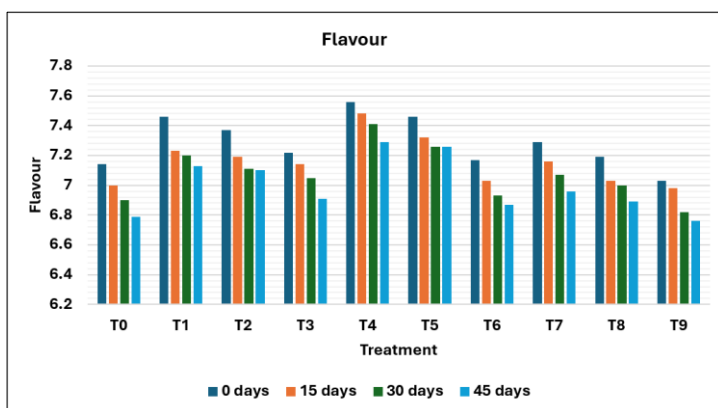


Fig 4: Effect of different recipes on flavour of of watermelon, mint and lime blended RTS during storage period.

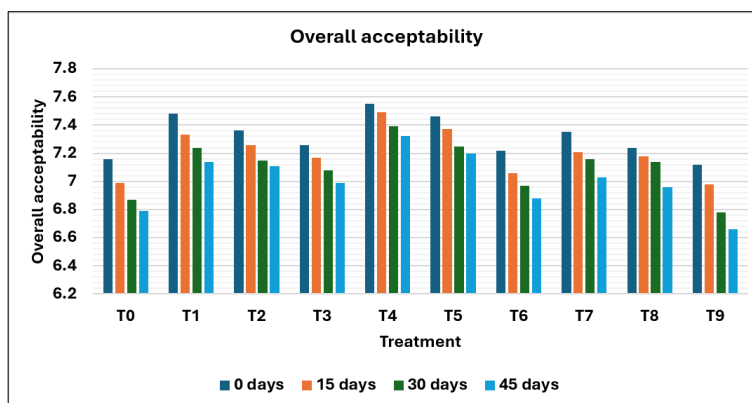


Fig 5: Effect of different recipes on overall acceptability of watermelon, mint and lime blended RTS during storage period.

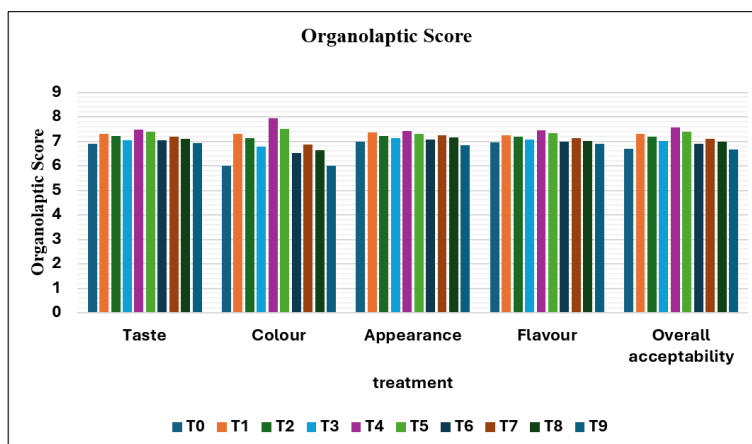


Fig 6: Organolaptic quality of RTS prepared from blended juices watermelon, mint and lime.

Conclusion

The study demonstrates that blending watermelon juice with moderate levels of mint and lime improves the sensory stability of ready-to-serve (RTS) beverages over 45 days of ambient storage. While natural biochemical degradation caused a gradual decline in all treatments, T₄ (Watermelon 97% + Mint 2% + Lime 1%) consistently emerged as the superior formulation. It retained the highest final and mean scores across all parameters: taste (initial 7.40, final 6.80), colour (initial 8.90, final 7.00), appearance (initial 7.53, final 7.34), flavour (initial 7.56, final 7.29) and overall acceptability (initial 7.55, final 7.32). Conversely, the control (T₀) suffered severe color degradation (final 4.50) and high-adjunct T₉ (Watermelon 94% + Mint 3% + Lime 3%) recorded the lowest overall scores (final appearance 6.61). Ultimately, optimizing the beverage with 2% mint and 1% lime (T₄) provides a synergistic balance that retards sensory deterioration and maximizes shelf-life.

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