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"DEVELOPMENT OF RTS BY ADDING WATERMELON, BEETROOT AND GINGER"

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Abstract:

The present study was undertaken to develop a Ready-to-serve (RTS) functional beverage by blending watermelon (Citrullus lanatus), beetroot (Beta vulgaris), and ginger (*Zingiber officinale).*Physico chemical analysis of raw materials revealed that watermelon was rich in moisture, lycopene, and vitamins; beetroot provided carbohydrates, betalains, and essential minerals; while ginger contributed bioactive compounds such as gingerols with strong antioxidant potential. Based on these characteristics, six RTS formulations (T_0–T_5) were prepared in different combinations. Sensory evaluation carried out by a semi-trained panel indicated that the blend containing 60% watermelon, 20% beetroot, and 20% ginger (T_4) was most preferred in terms of flavor, color, mouthfeel, and overall acceptability.

Shelf life studies demonstrated that the developed beverage maintained acceptable pH, acidity, total soluble solids, and microbial quality for up to 28 days under refrigerated storage. The study concludes that RTS prepared from watermelon, beetroot, and ginger can serve as a nutritious, palatable, and shelf-stable functional beverage with great potential for commercialization.

Keywords: Beetroot (Beta vulgaris), Watermelon (Citrullus lanatus), Ginger (Zingiber officinale), RTS.

1. Introduction:

In recent years, Ready-to-Serve (RTS) beverages have emerged as one of the fastest-growing segments of the food and beverage industry. Their popularity is largely due to convenience, refreshing taste, and the ability to deliver nutrition in an easily consumable form. Unlike conventional drinks, functional RTS beverages are formulated to provide not only hydration but also added health benefits, as they are enriched with vitamins, minerals, and bioactive compounds (Sharma et al., 2021). Growing consumer awareness of diet-related health issues and interest in natural foods has further driven demand for functional beverages (Clifford et al., 2021). Among fruits, watermelon (Citrullus lanatus) is especially valued for its high water content (approximately 92%), natural sweetness, and abundance of nutrients. It contains lycopene, vitamin C, β-carotene, potassium, and magnesium, all of which contribute to antioxidant defense and cardiovascular support (Yimer et al., 2020; Rico et al., 2021). Beetroot (Beta vulgaris L.) is recognized as a rich source of dietary nitrates, betalains, phenolic compounds, and essential minerals. These constituents have been shown to lower blood pressure, enhance blood circulation, improve stamina, and reduce oxidative stress (Clifford et al., 2021; Georgiev et al., 2020). Ginger (Zingiber officinale), on the other hand, has long been used as both a spice and a medicinal root. Its major bioactive molecules, including gingerols and shogaols, exhibit strong antioxidant, anti-inflammatory, antimicrobial, and digestive

properties (Shagol et al., 2021; Semwal et al., 2020). The blending of fruits and medicinal plants in RTS formulations represents a promising strategy for creating beverages with balanced sensory appeal, nutritional value, and functional properties (Bhardwaj et al., 2022). Developing an RTS beverage using watermelon, beetroot, and ginger can therefore result in a product that is not only palatable and refreshing but also nutritionally enhanced and beneficial to health.

2. Material and Method

2.1 Raw Material: Freshly harvested watermelon (Citrullus lanatus), red beetroot (Beta vulgaris L.), and ginger (Zingiber officinale) were collected from the local fruit and vegetable market in Thane, Maharashtra. Only healthy and uniform raw materials were selected, while overripe, diseased, and damaged samples were discarded. The selected produce was washed thoroughly under running potable water to remove soil, dust, and surface impurities.

Food-grade ingredients, namely granulated sugar (10%), citric acid (0.3%), common salt (2%), and sodium benzoate (0.07%), were incorporated in all formulations. The preservative concentration was maintained within FSSAI permissible limits (<120 ppm) Distilled water was used wherever required.

2.2 Formulation of RTS juice

RTS juice was prepared by blending three ingredients—watermelon, beetroot, and ginger—in varying proportions to evaluate their combined effect on nutritional, sensory, and microbial characteristics. Six different formulations were developed and coded as T_0 to T_5. T_0 (Control): 100% watermelon juice without the addition of beetroot or ginger. This served as the baseline for comparison.

T_1 to T_5: In each subsequent treatment, watermelon juice was reduced by 10%, while beetroot and ginger were added in equal proportions (5% each).

Table 1 Formulation of RTS Beverage

Test	Watermelon	Beetroot	Ginger
T_0	100%	-	-
T_1	90%	5%	5%
T_2	80%	10%	10%
T_3	70%	15%	15%
T_4	60%	20%	20%
T_5	50%	25%	25%

2.3. Physicochemical Properties of RTS Formulations

The physicochemical properties of the prepared RTS beverages were analyzed following standard analytical protocols. The pH of each formulation was measured using a calibrated digital pH meter to determine the acidity and overall stability of the beverage (AOAC, 2019). The total soluble solids (TSS) were recorded with a handheld digital refractometer and expressed in °Brix, representing the concentration of soluble sugars and solids (Ranganna, 2017). Titratable acidity was determined by titration using standardized 0.1 N NaOH with phenolphthalein as an indicator, and results were expressed as citric acid percentage (AOAC,

2019). Protein content was estimated using the Lowry method, which measures color intensity formed by the reaction between protein and Folin–Ciocalteu reagent (Lowry et al., 1951). Carbohydrate content was analyzed by the phenol–sulphuric acid method, based on the development of a colored complex measured spectrophotometrically (Dubois et al., 1956). Ash content was determined by incinerating a known quantity of sample in a muffle furnace at 550°C until a constant weight was achieved, representing the mineral residue of the beverage (Ranganna, 2017). These physicochemical evaluations provided essential information on the nutritional quality, composition, and storage stability of the developed RTS formulations.

2.4. Sensory analysis

Sensory evaluation is a critical aspect in assessing the consumer acceptability and organoleptic quality of fruit and vegetable-based beverages. In this study, a composite RTS (Ready-to-Serve) beverage formulated using beetroot, watermelon, and ginger juice was subjected to systematic sensory analysis. The evaluation was performed by a Jalaram health care staff, friends and unknown consumers. The objective of the sensory evaluation was to determine the overall acceptability, as well as individual sensory attributes such as appearance, color, aroma, taste, mouth feel, and aftertaste, to support formulation optimization and market readiness.

2.5 FLOW CHART:

Procurement & Sorting

⇩

Washing

⇩

Peeling & Cutting

⇩

Juice Extraction

⇩

Sugar Syrup Preparation

⇩

Blending & Addition of Preservative

⇩

Pasteurizaion

⇩

Bottling & Sealing

⇩

Labelling & Coding

⇩

Packaging

⇩

Cold Storage

3. Result and Discussion

3.1. Physicochemical Properties of RTS

The physicochemical characteristics of the six RTS formulations (T_0–T_5) are presented in Table. The incorporation of beetroot and ginger significantly improved the nutritional and functional profile of the beverage. The Total Soluble Solids (TSS) increased from 8.50 °Brix (T_0) to 10.77 °Brix (T_4), attributed to the natural sugars and solids present in the added ingredients. Carbohydrate content increased from 8.50 g/100 ml (T_0) to 11.01 g/100 ml (T_4), while protein content rose from 0.02 g/100 ml (T_0) to 0.09 g/100 ml (T_4), indicating an overall enhancement in nutritional composition.
The pH decreased gradually from 4.25 (T_0) to 3.80 (T_4), while titratable acidity increased from 0.10% to 0.25%, indicating better product stability during storage. Similarly, ash content increased from 0.15% (T_0) to 0.28% (T_4), reflecting a higher mineral content as the proportion of beetroot and ginger increased.

Table 2 Physico-chemical properties of RTS

Treatment	TSS	pH	Titratable acidity
T_0	8.50	4.25	0.10
T_1	9.02	4.10	0.13
T_2	9.65	3.95	0.17
T_3	10.10	3.85	0.21
T_4	10.77	3.80	0.25
T_5	10.25	3.90	0.23

Treatment	Protein	Carbohydrates	Ash content
T_0	0.02	8.50	0.15
T_1	0.04	9.00	0.18
T_2	0.06	9.60	0.21
T_3	0.08	10.30	0.24
T_4	0.09	11.01	0.28
T_5	0.07	10.50	0.26

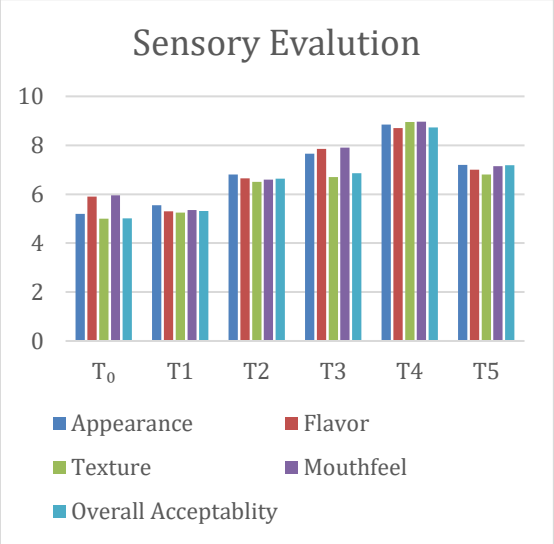
3.2. Sensory Evaluation

The sensory evaluation results Table indicated a notable improvement in consumer acceptance with increasing beetroot and ginger content. Formulation T_4 (60% watermelon, 20% beetroot, and 20% ginger) received the highest overall scores for appearance (8.85), flavor (8.70), texture (8.95), mouthfeel (8.97), and overall acceptability (8.73) on a 9-point hedonic scale. Panelists particularly appreciated the deep red color imparted by beetroot, the refreshing

sweetness from watermelon, and the mild spiciness from ginger. The control sample (T_0) received the lowest scores due to its lack of flavor complexity and dull appearance.

Treatment	Appearance	Flavor	Texture
T_0	5.20	5.90	5.00
T_1	5.55	5.30	5.25
T_2	6.80	6.65	6.50
T_3	7.65	7.85	6.70
T_4	8.85	8.70	8.95
T_5	7.20	7.00	6.80

Treatment	Mouthfeel	Overall Acceptablity
T_0	5.95	5.01
T_1	5.35	5.31
T_2	6.60	6.64
T_3	7.90	6.86
T_4	8.97	8.73
T_5	7.15	7.18



3.3. Shelf Life Study

Shelf life evaluation was conducted over 28 days under refrigerated conditions (4 ± 2°C) to determine product stability and safety. The Total Plate Count (TPC) showed a gradual increase over time, ranging from 2.10×10^4 cfu/ml (day 0) to 4.10×10^4 cfu/ml (day 28) in formulation T_4.

Despite this increase, microbial counts remained within the permissible limits ($\leq 10^5$ cfu/ml) as per FSSAI standards. Yeast and mould counts, as well as E. coli, were absent throughout the 28-day period, indicating effective pasteurization and hygienic handling during production. No visible signs of separation, gas formation, or discoloration were observed during storage,

confirming that the beverage remained stable and safe for consumption for up to 28 days under refrigeration.

Treatment	0 Day	14 Day	28 Day
T_0	1.12×10^4	1.58×10^4	2.67×10^4
T_1	1.30×10^4	1.82×10^4	2.99×10^4
T_2	1.65×10^4	2.25×10^4	3.42×10^4
T_3	1.85×10^4	2.60×10^4	3.85×10^4
T_4	2.10×10^4	2.80×10^4	4.10×10^4
T_5	2.35×10^4	3.10×10^4	4.50×10^4

4. Conclusion

The present study successfully developed and evaluated a functional Ready-to-Serve (RTS) beverage using watermelon, beetroot, and ginger in varying proportions. The combination of these three ingredients provided a balanced profile of hydration, nutrition, and functional health benefits. The physicochemical analysis revealed that increasing beetroot and ginger content significantly enhanced total soluble solids, carbohydrate, protein, and ash levels while slightly lowering pH, thereby improving product stability.

Sensory evaluation demonstrated that the T_4 formulation (60% watermelon, 20% beetroot, and 20% ginger) achieved the highest scores for appearance, flavor, texture, mouthfeel, and overall acceptability, indicating its superior consumer appeal. The bright red color, refreshing sweetness, and mild spiciness contributed to its preference.

Shelf life assessment showed that the beverage remained microbiologically safe and stable for up to 28 days under refrigerated conditions, with total plate counts within permissible FSSAI limits and absence of yeast, mould, and E. coli.

Overall, the developed RTS beverage proved to be a nutritionally enriched, sensorially acceptable, and microbiologically safe product with good market potential. The incorporation of watermelon, beetroot, and ginger in optimal proportions offers a natural, refreshing, and health-promoting functional drink suitable for commercial production.

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