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Development and quality evaluation of partially lyophilized watermelon (*Mateera)* juice: Physicochemical and sensory characteristics

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Abstract
Watermelon (*Citrullus lanatus*) is a nutrient-rich fruit with high moisture content, making it highly susceptible to post-harvest deterioration and limiting its commercial utilization. The present study aimed to develop a functional beverage from indigenous *mateera* watermelon using partial lyophilization and to evaluate its physicochemical and sensory characteristics. Fresh watermelon juice was extracted, clarified, partially lyophilized, reconstituted and fortified with beetroot powder at different concentrations (0.0-2.5%) to optimize product quality. The physical characteristics of Mateera watermelon were assessed prior to processing to determine its suitability for juice production. Six formulations (T_1-T_6) were subjected to sensory evaluation using a nine-point hedonic scale, and the most acceptable formulation was selected for further quality evaluation. Among the treatments, T_2 (99.5% watermelon juice + 0.5% beetroot powder) recorded the highest overall acceptability and was identified as the optimized formulation. The optimized beverage exhibited desirable physicochemical characteristics, including pH (5.72), total soluble solids (14.00 °Brix), titratable acidity (0.64%), reducing sugars (4.42%), total sugars (4.17 g/100 g), ascorbic acid (5.55 mg/100 g) and lycopene (10.80 mg/kg). The findings demonstrate that partial lyophilization combined with natural beetroot fortification is an effective approach for developing a nutritionally desirable, visually appealing and highly acceptable functional beverage. The developed product offers considerable potential for value addition, reduction of post-harvest losses and commercial utilization of indigenous watermelon resources.

Keywords: *Mateera* (*Citrullus lanatus*), partial lyophilization, beetroot powder, functional beverage, physicochemical characteristics, sensory evaluation, value addition

1. Introduction

Watermelon (*Citrullus lanatus*), a member of the family *Cucurbitaceae*, is one of the most widely cultivated fruit crops owing to its high moisture content, refreshing taste and nutritional value. Originating from Southern Africa, it has been extensively domesticated and is now cultivated across tropical and subtropical regions worldwide (Collins *et al.,* 2007; Bang *et al.,* 2010) [7, 4]. According to FAOSTAT (2024) [9], global watermelon production reached approximately 104.9 million tonnes in 2023-2024, with India contributing nearly 3.6 million tonnes, emphasizing its economic importance and widespread cultivation.

Mateera, an indigenous watermelon ecotype traditionally grown in the arid regions of western Rajasthan, is well adapted to drought, high temperatures and limited water availability. These characteristics make it an important genetic resource for sustainable agriculture in arid and semi-arid regions (Mahla *et al.,* 2014; Masih *et al.,* 2021) [13, 15]. Besides its agronomic importance, *mateera* possesses desirable sensory characteristics and appreciable nutritional quality, making it a promising raw material for value-added processing.

Watermelon is composed of approximately 90-92 per cent moisture and contains natural sugars, vitamins, minerals and bioactive compounds, particularly lycopene and L-citrulline, which are associated with antioxidant activity and various health benefits (Tarazona-Díaz *et al.,* 2013) [25]. Consequently, watermelon has gained increasing attention as a suitable ingredient for the development of functional beverages. However, its high moisture content and delicate tissue structure make the fruit highly perishable, leading to rapid post-harvest deterioration and limiting its storage life and commercial utilization. Processing watermelon into juice provides an effective strategy for reducing post-harvest losses, although maintaining colour, flavour and nutritional quality during processing and storage remains a major challenge because of the susceptibility of bioactive compounds to oxidation and degradation (Marie-Michel *et al.,* 2020) [14].

Non-thermal preservation technologies have emerged as promising alternatives to conventional thermal processing for maintaining the quality of fruit beverages. Lyophilization (freeze-drying) is recognized as one of the most effective dehydration techniques because water is removed through sublimation under reduced pressure, thereby minimizing thermal damage and preserving colour, flavour, nutrients and other bioactive constituents (Ratti, 2001) [21]. In addition, freeze-drying reduces water activity, thereby slowing undesirable chemical and microbial changes during storage (Ciurzyńska and Lenart, 2011) [6]. Nevertheless, the application of partial lyophilization for watermelon juice preservation has received limited scientific attention, particularly for indigenous cultivars such as *mateera.*

Consumer preference for clean-label foods has also increased the demand for natural alternatives to synthetic colourants. Beetroot (*Beta vulgaris*), a rich source of betalain pigments and natural antioxidants, has been widely recognized for enhancing colour stability and improving the functional value of fruit-based beverages (Kumar *et al.,* 2022) [11]. Incorporation of beetroot powder may therefore improve both the visual appeal and nutritional quality of watermelon juice while maintaining consumer acceptability.

Although several studies have investigated watermelon juice processing and preservation, limited information is available on the development of partially lyophilized functional beverages from indigenous *mateera* (watermelon) using natural beetroot fortification. Moreover, comprehensive studies evaluating the physicochemical and sensory characteristics of such products are scarce. Developing value-added beverages from drought-tolerant indigenous watermelon cultivars offers an opportunity to reduce post-harvest losses, enhance the utilization of underexploited fruit resources and promote sustainable food processing in arid and semi-arid regions. The application of partial lyophilization, combined with natural beetroot powder, may further improve product quality by preserving nutritional and sensory attributes while meeting the growing consumer demand for minimally processed and clean-label beverages.

Therefore, the present study was undertaken to develop a partially lyophilized functional beverage from *mateera* (*Citrullus lanatus*), optimize beetroot powder incorporation based on sensory acceptability and evaluate the physicochemical characteristics of the optimized formulation.

2. Materials and Methods

2.1 Procurement of Raw Material

Fresh mature fruits of *mateera* (*Citrullus lanatus*) were procured from local market of Bikaner, Rajasthan, India. Fruits were selected based on uniform maturity, size, colour firmness and absence of physical damage or microbial spoilage. The selected fruits were washed thoroughly with potable water to remove surface contaminants. The rind was removed manually and edible pulp was separated after removal of seeds. The prepared pulp was used for juice extraction and further processing.

Plate 1: Procured Fruits

2.2 Determination of Physical Characteristics of Mateera Watermelon

The physical characteristics of the procured Mateera watermelon fruits were determined prior to juice extraction to assess their suitability for beverage preparation. Fruit length, diameter and circumference were measured using a measuring tape, while fruit weight was recorded using a digital weighing balance. Juice recovery was determined by extracting juice from the edible pulp and expressing the yield as a percentage of the total fruit weight. All observations were recorded in triplicate and expressed as mean ± Standard deviation.

2.3 Extraction and Clarification of Watermelon Juice

Fresh watermelon pulp was homogenized using a laboratory mixer grinder to obtain juice. The extracted juice was filtered through a double-layered muslin cloth to remove coarse fibrous materials and suspended particles. The filtrate was allowed to stand undisturbed for approximately 2 h at refrigeration temperature to facilitate natural sedimentation of fine particles. The clarified supernatant was carefully decanted and used for subsequent partial lyophilization.

2.4 Partial Lyophilization of Watermelon Juice

Clarified watermelon juice was partially lyophilized using a laboratory-scale freeze dryer (Model INOFD-2005, India). The juice was transferred into stainless-steel trays and pre-frozen at −20 °C. Primary drying was performed at approximately −40 °C under reduced pressure to remove ice through sublimation, followed by secondary drying with gradual elevation of shelf temperature up to 40 °C to remove residual moisture. The total freeze-drying duration was approximately 14 h. The partially lyophilized juice was subsequently reconstituted prior to beverage formulation.

2.5 Development of Beetroot-Enriched Watermelon Juice

The reconstituted partially lyophilized watermelon (*mateera*) juice was incorporated with beetroot powder (*Beta vulgaris*) powder at six different concentrations (0.0, 0.5, 1.0, 1.5, 2.0 and 2.5%, w/v). The formulations were designated as T_1-T_6 (Table1 & Plate2). Sensory evaluation was conducted to identify the most acceptable formulation and the treatment receiving the highest overall acceptability score was selected for further physicochemical characterization.

Table 1: Composition of beetroot-enriched watermelon juice formulations

Treatment	Watermelon Juice (%)	Beetroot Powder (%)
T_1	100	0.0
T_2	99.5	0.5
T_3	99.0	1.0
T_4	98.5	1.5
T_5	98.0	2.0
T_6	97.5	2.5

Plate 2: Treatment Combinations (T_1-T_6)

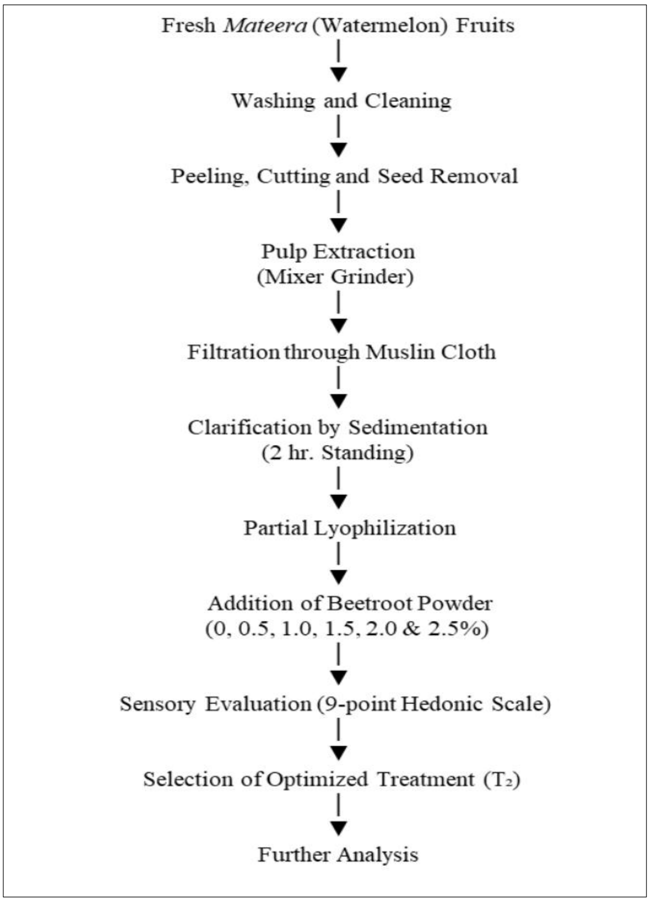

Fig 1: Experimental flow diagram for the development of partially lyophilized *mateera* watermelon juice

2.6 Sensory Evaluation

The developed formulations was evaluated using a nine-point hedonic scale (1 = dislike extremely and 9 = like extremely) as described by Srilakshmi (2018) [24]. A panel of ten semi-trained members from the Department of Food and Nutrition, College of Community Science, Swami Keshwanand Rajasthan Agricultural University, Bikaner, assessed the samples for colour, appearance, taste, flavour and overall acceptability. Samples were served in coded containers under identical conditions and potable water was provided for palate cleansing between successive samples (Potter, 1987) [18]. The formulation receiving the highest overall acceptability score was considered the optimized treatment and selected for further physicochemical evaluation.

2.7 Physicochemical Analysis

The optimized watermelon juice was analysed for physicochemical characteristics following standard analytical procedures (AOAC, 2012; Ranganna, 2017) [1, 20]. The pH was determined using a calibrated digital pH meter, while total soluble solids (TSS) were measured with a digital refractometer and expressed as °Brix. Titratable acidity was determined by titration with 0.1 N sodium hydroxide and expressed as percentage citric acid. Reducing sugars and total sugars were estimated by the Lane and Eynon method. Ascorbic acid content was determined by the 2,6-dichlorophenolindophenol titrimetric method following extraction with 3% metaphosphoric acid, whereas lycopene content was estimated spectrophotometrically after hexane extraction. All analyses were performed in triplicate and the results were expressed as mean ± Standard deviation.

2.8 Statistical Analysis

All experiments were conducted in triplicate, except sensory evaluation, which involved ten panellists. Data were expressed as mean ± Standard deviation. Statistical analysis was performed using one-way analysis of variance (ANOVA) following the procedure described by Gupta (2000) [10]. Differences among treatment means were considered statistically significant at $p \leq 0.05$.

3. Results and Discussion

3.1 Physical Characteristics of *Mateera* (Watermelon)

The physical characteristics of *mateera* (watermelon) were evaluated to determine its suitability as a raw material for juice production. The observed values are presented in Table 2.

Table 2: Physical characteristics of *Mateera*

Physical Parameter	Mean ± SD
Average Weight (kg)	3.44±0.75
Length (inch)	11.39±1.00
Diameter (inch)	10.28±0.46
Circumference (inch)	22.19±0.81
Juice recovery (%)	52.38±1.26

Values are mean ± SD of three replicates.

The average fruit weight was 3.44 kg, with a fruit length 11.56 inches, diameter 10.28 inches and circumference 22.19 inches. The juice recovery was 52.38 per cent. These results indicate good processing potential, as the moderate fruit size and high juice yield support efficient extraction and value-added utilization.

3.2 Optimization of Beetroot Powder Concentration through Sensory Evaluation

Sensory quality is one of the most important determinants of consumer acceptance and commercial success of fruit beverages. The incorporation of beetroot powder significantly influenced the organoleptic characteristics of the partially lyophilized Mateera watermelon juice. The sensory scores obtained for different formulations are presented in Table 3.

Table 3: Sensory evaluation of beetroot-enriched watermelon juice formulations

Treatment	Colour	Appearance	Taste	Flavour	Overall Acceptability
T_1	7.18±1.08	7.64±1.12	8.27±0.79	8.36±0.92	8.00±0.77
T_2	8.64±0.67	8.91±0.30	8.82±0.40	8.91±0.30	8.91±0.30
T_3	7.45±0.69	7.55±1.37	7.91±1.22	7.64±1.50	7.73±1.19
T_4	6.64±1.03	7.18±1.08	7.55±0.93	7.64±0.81	7.00±1.10
T_5	6.45±0.69	6.73±1.01	7.55±1.04	6.91±1.30	7.36±0.67
T_6	6.36±1.03	6.45±1.29	6.91±1.04	7.00±0.89	6.91±0.94
F value	9.72	11.85	8.42	10.26	12.14
SEM	0.18	0.19	0.19	0.20	0.18
CD (P≤0.05)	S	S	S	S	S

Values are mean ± SD of ten panelist. S= Significant, NS= Non-significant

- T_1 = 100% Watermelon Juice + 0.0% Beetroot Powder
- T_2 = 99.5% Watermelon Juice + 0.5% Beetroot Powder
- T_3 = 99.0% Watermelon Juice + 1.0% Beetroot Powder
- T_4 = 98.5% Watermelon Juice + 1.5% Beetroot Powder
- T_5 = 98.0% Watermelon Juice + 2.0% Beetroot Powder
- T_6 = 97.5% Watermelon Juice + 2.5% Beetroot Powder

The incorporation of beetroot powder exerted a highly significant ($p \leq 0.05$) influence on all sensory attributes evaluated, including colour, appearance, taste, flavour and overall acceptability. The findings indicate that beetroot powder concentration played a decisive role in determining consumer preference and overall product quality

Among the six formulations, T_2 (99.5% watermelon juice + 0.5% beetroot powder) achieved the highest sensory scores for all evaluated parameters, recording 8.64 for colour, 8.91 for appearance, 8.82 for taste, 8.91 for flavour and 8.91 for overall acceptability. These results demonstrate that the incorporation of beetroot powder at 0.5% provided the optimum balance between improved visual appeal and retention of the characteristic flavour of watermelon juice. The enhanced colour score observed in T_2 may be attributed to the presence of betalain pigments naturally occurring in beetroot, which imparted an attractive bright red colour without adversely affecting the natural appearance of the beverage. In addition, the low concentration of beetroot powder enhanced colour intensity while avoiding excessive pigment accumulation that could negatively influence consumer perception. Taste and flavour scores also improved in T_2, suggesting that limited beetroot incorporation complemented the natural sweetness and refreshing flavour of watermelon rather than masking it. However, progressive increases in beetroot concentration beyond 0.5 per cent resulted in a gradual decline in sensory acceptability. Treatments T_3-T_6 exhibited significantly lower scores for all sensory attributes, with T_6 receiving the lowest overall acceptability (6.91). The reduction in sensory scores at higher beetroot concentrations may be attributed to the increasing dominance of the characteristic earthy flavour of beetroot, which can suppress the delicate flavour profile of watermelon. Furthermore, excessive beetroot powder may have altered beverage appearance and mouthfeel, thereby reducing panel preference. These observations indicate that although beetroot powder effectively enhances colour, excessive incorporation adversely affects overall sensory quality. The statistically significant differences observed among treatments further confirm that beetroot concentration was a critical factor influencing organoleptic acceptability. Based on the highest overall acceptability score and consistently superior performance across all evaluated sensory parameters, T_2 was selected as the optimized formulation for subsequent physicochemical evaluation.

The findings are consistent with those of Kumar *et al.* (2022) [11], who reported that beetroot incorporation improved the colour and consumer acceptability of watermelon-based beverages when used at appropriate concentrations. Similarly, Eke-Ejiofor *et al.* (2016) [8] observed that moderate supplementation with natural plant ingredients enhanced the sensory quality of watermelon beverages, whereas excessive addition resulted in reduced consumer acceptance due to flavour imbalance. The present results also agree with Chandra *et al.* (2017) [5], who emphasized that optimization of ingredient concentration is essential to achieve an acceptable balance between nutritional enhancement and desirable sensory quality.

Overall, the sensory evaluation clearly demonstrated that fortification of partially lyophilized Mateera watermelon juice with 0.5 per cent beetroot powder significantly improved product acceptability while preserving the characteristic sensory attributes of watermelon. Therefore, T_2 was identified as the optimum formulation and selected for detailed physicochemical characterization.

3.2 Physicochemical Characteristics of Optimized Watermelon Juice

The physicochemical properties of fruit beverages are important indicators that influence nutritional value, sensory acceptability and storage stability. These parameters provide valuable information regarding the effects of processing on the chemical composition and overall quality of the developed product. The optimized formulation (T_2), selected based on superior sensory acceptability, was analysed for major physicochemical attributes, and the results are presented in Table 4.

Table 4: Physicochemical characteristics of optimized watermelon juice

Parameters	Value
pH	5.72±0.03
Titratable Acidity -TTA (%)	0.64±0.02
Total Soluble Solids-TSS (°Brix)	14.00±0.05
Reducing Sugar (%)	4.42±0.04
Total Sugar (g)	4.17±0.05
Ascorbic Acid (mg)	5.55±0.06
Lycopene (mg)	10.80±0.12

Values are mean ± SD of three replicates

3.3.1 pH
The optimized beverage exhibited a pH of 5.72, indicating a mildly acidic nature that is characteristic of watermelon-based beverages. Maintenance of a slightly acidic pH is desirable because it contributes to flavour balance while also limiting the growth of spoilage microorganisms. The observed pH demonstrates that partial lyophilization did not adversely affect the natural acidity of the juice. The observed pH was comparable to values reported for watermelon-based beverages by Sodipo *et al.*, 2019 [23] (5.43) and Aderinola *et al.*, 2021 [2] (5.20), suggesting that partial lyophilization did not adversely alter the inherent acidity of the juice.

3.3.2 Titratable Acidity
Titratable acidity of the optimized beverage was 0.64 per cent, reflecting a desirable balance between sweetness and acidity. Organic acids are essential contributors to the characteristic flavour of fruit beverages and also influence microbial stability during storage. The acidity observed in the present investigation falls within the range reported by Arum and Ani, 2021 [3] (0.38-0.69%) for watermelon-based fruit beverages. The preservation of acidity suggests that the low-temperature nature of partial lyophilization effectively minimized degradation of naturally occurring organic acids during processing.

3.3.3 Total Soluble Solids (TSS)
The optimized beverage recorded 14.00 °Brix, indicating a relatively high concentration of soluble solids. Total soluble solids largely represent soluble sugars and other dissolved constituents responsible for sweetness and body of fruit beverages. The observed TSS was considerably higher than values reported for fresh watermelon juice by Panwar, 2016 (7.2°Brix) and Aderinola *et al.,* 2021 [2] (8.0°Brix). The increase can primarily be attributed to the partial removal of moisture during lyophilization, which concentrated the naturally occurring soluble solids without subjecting the juice to high-temperature processing.

3.3.4 Reducing and Total Sugars
The optimized beverage contained 4.42 per cent reducing sugars and 4.17 g/100 g total sugars, demonstrating satisfactory retention of natural carbohydrates after processing. Sugars constitute the principal source of sweetness in watermelon juice and are highly influential in determining overall palatability. The values obtained in the present investigation were comparable with those reported by Qazi Tanveer Ul Haq *et al.,* 2022 [19] (5.40-5.55 per cent) for watermelon beverages. The effective preservation of sugars may be attributed to the low processing temperatures employed during lyophilization, which minimize thermal degradation, caramelization and Maillard reactions commonly associated with conventional heat processing. Consequently, the beverage retained its natural sweetness and characteristic flavour.

3.3.5 Ascorbic Acid and Lycopene
The ascorbic acid content (5.55 mg/100 g) and lycopene content (10.80 mg/kg) indicated effective retention of bioactive compounds during processing. Similar observations regarding preservation of heat-sensitive nutrients and pigments during freeze-drying have been reported by Ratti (2001) [21] and Ciurzyńska and Lenart (2011) [6].

Overall Discussion
The present study demonstrated the potential of developing a functional beverage from indigenous *mateera* (watermelon) through partial lyophilization and natural beetroot powder fortification. Sensory evaluation revealed that beetroot incorporation significantly influenced colour, appearance, taste, flavour and overall acceptability. Among the formulations, T_2 (99.5% watermelon juice + 0.5% beetroot powder) exhibited the highest acceptability due to improved colour appeal and balanced flavour characteristics. The optimized beverage showed desirable physicochemical properties, including suitable acidity, enhanced soluble solids, satisfactory sugar content and retention of bioactive compounds such as ascorbic acid and lycopene. The observed quality attributes indicate that partial lyophilization effectively concentrated the juice while minimizing deterioration of nutritional and sensory characteristics. The incorporation of beetroot powder further enhanced the functional value and visual appeal of the beverage through natural pigments and bioactive components. Thus, partial lyophilization combined with natural fortification represents a promising approach for value addition and sustainable utilization of *mateera* (watermelon).

4. Conclusion
The study successfully developed a partially lyophilized functional beverage from indigenous Mateera watermelon with improved sensory and physicochemical characteristics. The formulation containing 99.5 per cent watermelon juice and 0.5 per cent beetroot powder (T_2) was identified as the most acceptable treatment. Partial lyophilization effectively maintained desirable quality attributes while preserving important bioactive compounds. The developed beverage has potential for commercial value addition, reduction of post-harvest losses and utilization of indigenous watermelon resources as a clean-label functional product.

5. References

1. AOAC. Official methods of analysis. 19th ed. Rockville: Association of Official Analytical Chemists; 2012.
2. Aderinola TA, Adeniran AE. Effects of storage on physicochemical properties of orange-watermelon juice. Annals: Food Science and Technology. 2021;16(2).
3. Arum C, Ani JC. Production and quality evaluation of mixed juice blend from soursop (Annona muricata), mango (Mangifera indica) and watermelon (Citrullus lanatus). Asian Food Science Journal. 2021;19(4):25-41.

4. Bang H, Davis AR, Kim S, Leskovar DI, King SR. Flesh color inheritance and gene interactions among canary yellow, pale yellow, and red watermelon. Journal of the American Society for Horticultural Science. 2010;135(4):362-368.
5. Chandra D, Bharti MK, Yadav A. Development and quality analysis of watermelon juice blends with bitter gourd-ginger juice during storage. International Journal of Current Microbiology and Applied Sciences. 2017;5(5):1420-1424.
6. Ciurzyńska A, Lenart A. Freeze-drying: Application in food processing and biotechnology—A review. Polish Journal of Food and Nutrition Sciences. 2011;61(3):165-171.
7. Collins JK, Wu G, Perkins-Veazie P, Spears K, Claypool PL, Baker RA, *et al*. Watermelon consumption increases plasma arginine concentrations in adults. Nutrition. 2007;23(3):261-266.
8. Eke-Ejiofor J, Banigo EB, Victor-Uku E. Product development, sensory and chemical composition of spiced watermelon juice. International Journal of Biotechnology and Food Science. 2016;4(2):15-21.
9. FAOSTAT. FAOSTAT statistical database. Food and Agriculture Organization of the United Nations; 2024. Available from: https://www.fao.org/faostat
10. Gupta PS. Statistical methods. Rev. ed. New Delhi: Sultan Chand and Sons; 2000.
11. Kumar V, Jain SK, Amitabh A, Chavan SM. Effect of ohmic heating on physicochemical, bioactive compounds, and shelf life of watermelon flesh-rind drinks. Journal of Food Process Engineering. 2022;45(7):e13818.
12. Lane JH, Eynon L. Determination of sugars by Fehling's solution with methylene blue as indicator. Journal of Scientific Chemistry. 1923;42:32-34.
13. Mahla HR, Singh JP, Roy MM. Seed purpose watermelon in arid zone. Jodhpur: Central Arid Zone Research Institute, Indian Council of Agricultural Research; 2014.
14. Marie-Michel CA, Valery NKP, Christine EA, Salomée KGA, Maxwell BGA. Physicochemical, microbiological and sensory characterization of juice produced from watermelon (Citrullus lanatus) consumed in Côte d'Ivoire. Saudi Journal of Biomedical Research. 2020;5(11):335-342.
15. Masih A, Kaur M, Singh B. Watermelon (Citrullus lanatus): A comprehensive review. International Journal of All Research Education and Scientific Methods. 2021;9(5):3628-3645.
16. NHB. Indian horticulture database. Ministry of Agriculture and Farmers Welfare, Government of India; 2024. Available from: https://www.nhb.gov.in/
17. Pawar AD. Studies on preparation and storage of ready-to-serve beverage from watermelon juice [doctoral dissertation]. Rahuri: Mahatma Phule Krishi Vidyapeeth; 2016.
18. Potter NN. Food science. 3rd ed. New Delhi: CBS Publishers and Distributors; 1987.
19. Qazi Tanveer ul Haq, Akbar K, Ul Haq N, Taran SNU, Sarwar J, Ihsan A, *et al*. Effect of sodium benzoate and refrigeration storage on the overall quality of pasteurized tomato and watermelon blends. Journal of Xi'an Shiyou University (Natural Science Edition). 2022;18(8):257-279.
20. Ranganna S. Manual of analysis of fruits and vegetable products. New Delhi: Tata McGraw-Hill Publishing Company Pvt. Ltd.; 2017.
21. Ratti C. Hot air and freeze-drying of high-value foods: A review. Journal of Food Engineering. 2001;49(4):311-319.
22. Reetu V, Tomar M. Watermelon: A valuable horticultural crop with nutritional benefits. Popular Kheti. 2017;5(2):5-9.
23. Sodipo MA, Owolabi AT, Oluwajuyitan TD. Physico-chemical, antioxidant properties and sensory attributes of golden melon (Cucumis melo L.)-watermelon (Citrullus lanatus) juice blends. Archives of Current Research International. 2019;18(3):1-11.
24. Srilakshmi B. Food Science. 7th ed. New Delhi: New Age International Publishers; 2018. p. 309-337.
25. Tarazona-Díaz MP, Alacid F, Carrasco M, Martínez I, Aguayo E. Watermelon juice: Potential functional drink for sore muscle relief in athletes. Journal of Agricultural and Food Chemistry. 2013;61(31):7522-7528.