



Development of a Nutritional Watermelon Rind Juice with Enhanced Antioxidant Properties

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Abstract

Watermelon skin, which is typically discarded as agricultural waste, contains essential minerals and bioactive chemicals that have the potential to improve health. This study investigates the development and evaluation of a functional beverage made from watermelon rind, which is blended with additional natural ingredients such as jaggery, mint, ginger and lemon. The juice was tested for nutritional value, antioxidant capacity and sensory qualities. The results revealed that the beverage is high in antioxidants, vital vitamins and minerals. It may also provide benefits such as better immunological response, digestive function and proper hydration. Consumers responded favorably to sensory evaluations. By utilizing watermelon peel, this study promotes a sustainable approach to food production, reducing waste and developing value-added products.

Keywords: Watermelon rind juice, Nutritional analysis, Antioxidant activity, Microbial safety, Functional beverage

1. Introduction

Watermelon (*Citrullus lanatus*) is typically eaten for its high-water content (about 91%), which provides hydration and a refreshing taste especially in hot weather. However the watermelon rind, that makes up an important portion of the fruit, is sometimes discarded as agricultural waste. Recent research demonstrates that watermelon rind includes significant nutrients such as carbohydrates proteins, vitamins, minerals and bioactive compounds like citrulline and lycopene (Kassim *et al.*, 2021) [8].

The present investigation plans to formulate a useful beverage by extracting juice from watermelon rinds. Jaggery, ginger, mint and lemon are used to improve the beverage's sensory characteristics as well as its antioxidant and nutritional benefits. The study focuses on assessing nutritional composition and Assessing the antioxidant activity, the microbial safety and shelf-life of the juice. This research also underscores the potential of watermelon rind juice as an innovative and sustainable product in the food and beverage industry.

2. Materials and Methods

2.1 Ingredient Purchase

Watermelons (*Citrullus lanatus*) were procured from a local market in Toopran, Medak district. Fresh, oval-shaped watermelons were selected for the study. Other ingredients, including jaggery powder, ginger, mint leaves, and lemon, were purchased from the local supermarket.

2.2 Preparation of Product

- 1. Watermelon Rind Extraction:** The rind was separated from the watermelon by removing the inner red flesh and outer green peel. The rind was then washed thoroughly.
- 2. Juice Preparation:** The watermelon rind was cut into small cubes and blended into a smooth puree. Jaggery powder (30g), ginger (15g), mint leaves (10g), and lemon juice (5ml) were added to the puree and blended again until smooth.
- 3. Chilling:** The prepared juice was refrigerated to chill before serving, ensuring a refreshing beverage.

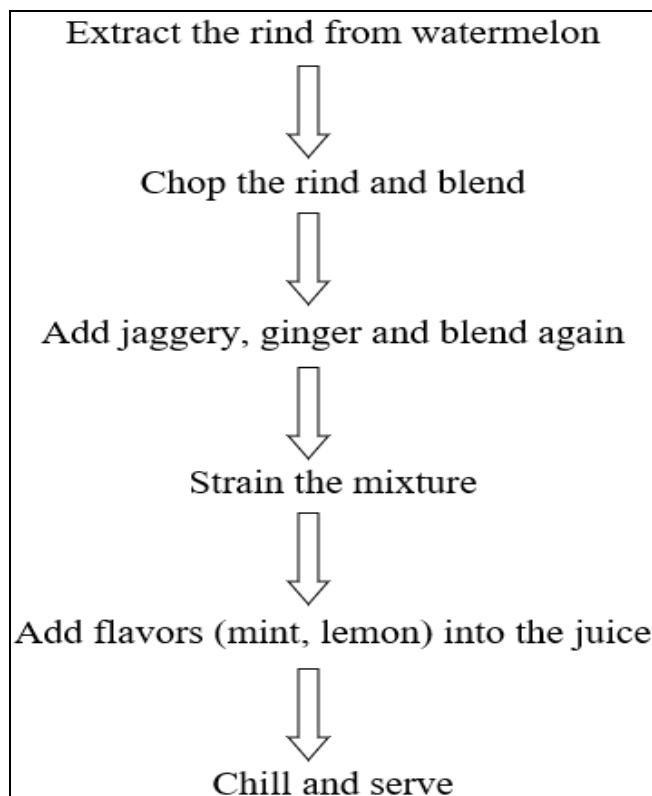


Fig 1: Method of Preparation of watermelon rind juice

Table 1: Composition of three variations T₁, T₂ and T₃ of watermelon rind juice

Ingredients	T ₁	T ₂	T ₂
Watermelon rind	60gm	80gm	100gm
Jaggery powder	30gm	30gm	30gm
Water	200ml	200ml	200ml
Ginger	15gm	15gm	15gm
Mint leaves	10gm	10gm	10gm
Lemon juice	5ml	5ml	5ml

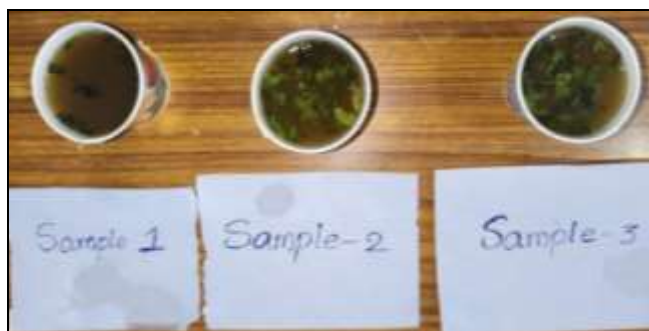


Fig 2: Sample T₁, Sample T₂ and sample T₃ of watermelon rind juice

2.3 Sensory Evaluation of watermelon rind juice

A sensory panel conducted a hedonic scale analysis to assess the color, texture, aroma, taste, and overall acceptability of the juice. A 9-point scale was used where 1 = "dislike extremely" and 9 = "like extremely."

2.4 Nutritional Analysis of watermelon rind juice

The nutritional composition of the juice was analyzed using standard methods. Parameters analyzed included energy (calories), protein, carbohydrates, fat, dietary fiber and sugar

content by AOAC method.

2.5 Vitamin and Mineral Analysis of watermelon rind juice

Vitamin C (AOAC 2015.06), vitamin E (AOAC 2017.16) were measured and Mineral content (calcium and iron) was determined after wet digestion of the sample using nitric, perchloric, and sulfuric acid (Sadiq *et al.*, 2021) [18].

2.6 Antioxidant Activity of watermelon rind juice

The antioxidant activity of the juice was assessed using three standard assays: DPPH (2,2-diphenyl-1-picrylhydrazyl), ABTS (2,2'-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid)), and FRAP (Ferric Reducing Ability of Plasma).

2.7 Microbial Analysis & Shelf-Life Studies of watermelon rind juice:

Microbial safety was evaluated by determining the aerobic plate count, yeast and molds, Enterobacteriaceae, and Staphylococcus aureus using standard microbiological techniques. The shelf life of the watermelon rind juice was evaluated over 10 days. Samples were stored at refrigeration temperatures and changes in quality (color, taste, texture) were monitored daily.

3. Results and Discussion

3.1 Sensory Evaluation of Watermelon Rind Juice

The sensory evaluation of three treated samples (T₁, T₂, and T₃) of watermelon rind juice revealed in Table 2. The Sample T₁, which showed a formulation with a balanced combination of ingredients, consistently received the highest ratings across all sensory attributes, with a mean score of 6.9 ± 0.3 for colour, 6.75 ± 0.433 for texture, 6.7 ± 0.45 for aroma and 6.5 ± 0.5 for taste. This suggests that the overall formulation of T₁ is likely due to the accurate ratio of watermelon rind, jaggery, ginger and mint. Which resulted in a more visually appealing, smoother, and aromatic juice that was most preferred by the panelists. For Sample T₂ and T₃ received lower mean scores in comparison, particularly in terms of aroma (T₂: 6.2 ± 0.67 , T₃: 6.45 ± 0.58) and taste (T₂: 6.25 ± 0.43 , T₃: 6.4 ± 0.66). These differences suggest that the proportion of ingredients and possibly the blending process influenced the sensory attributes, with the lack of a strong aromatic or flavor-enhancing ingredient in T₂ leading to a less favorable evaluation. The lower overall acceptability scores for Sample T₂ (6.35 ± 0.65) and Sample T₃ (6.3 ± 0.64) align with these observations. These results highlight the significance of ingredient selection and formulation optimization in achieving a high-quality, consumer-acceptable beverage. Similar findings have been observed in other studies on fruit-based beverages, where the balance of natural flavors and textures plays a crucial role in consumer preferences (Rico *et al.*, 2020) [15]. Furthermore, the positive sensory evaluation of T₁ underscores the potential for watermelon rind juice to be developed as a functional beverage that combines nutritional and sensory appeal, aligning with research indicating that natural ingredients such as ginger, mint and jaggery can enhance the overall sensory characteristics of fruit-based juices (Manay & Shadaksharaswamy, 2001) [11]. As per sensory score T₁ showed best sensory attributes and further analysis carried for T₁ sample.

Table 2: Sensory evaluation of watermelon rind juice for three treated samples (T₁, T₂, T₃)

Sample	Colour	Texture	Aroma	Taste	Overall Acceptability
T ₁	6.9±0.3	6.75±0.433	6.7±0.45	6.5±0.5	6.55±0.49
T ₂	6.55±0.49	6.35±0.47	6.2±0.67	6.25±0.43	6.35±0.65
T ₃	6.5±0.5	6.25±0.53	6.45±0.58	6.4±0.66	6.3±0.64

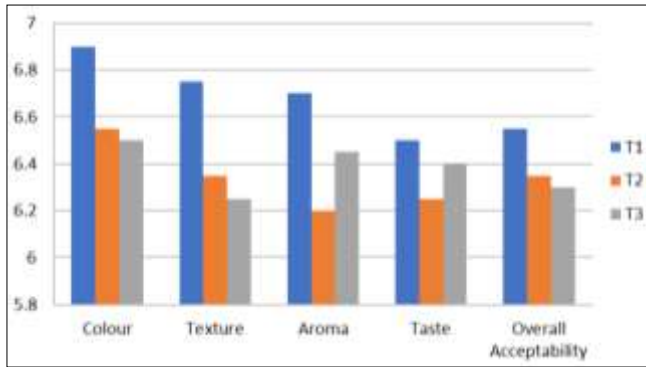


Fig 3: Sensory Parameters of T₁, T₂ and T₃ samples

3.2 Nutritional Analysis of Watermelon rind juice

The nutritional analysis of watermelon rind juice (T₁) reveals as a low-calorie and functional beverage. The juice contains a relatively low energy value of 17.2 K/cal per 100 mL, making it an excellent option for health-conscious individuals seeking a refreshing and low-calorie drink (Table 3). The protein content is minimal, at 0.1 g/100 mL, which is typical of fruit-based juices and not a significant source of protein. On the other hand, the carbohydrate content of 4.2 g/100 mL, which is primarily in the form of sugars (3.5 g/100 mL), provides a quick source of energy, though the total fat content is zero, indicating that the juice is virtually fat-free.

The dietary fiber content of 0.4 g/100 mL further highlights the potential of watermelon rind juice as a source of fiber, although the amount is relatively low compared to other high-fiber beverages (e.g., smoothies or whole fruit juices). This amount of fiber can still contribute to digestive health, though it is not substantial enough to be the primary source of fiber in a diet. The combination of these nutritional factors positions watermelon rind juice as a healthful, low-calorie alternative to traditional sugary beverages, which can contribute to the growing demand for functional drinks in the market (Mohan & Jayaprakasha, 2020) [12]. Additionally, this analysis underscores the importance of ingredient composition, as the inclusion of watermelon rind provides essential nutrients while maintaining a low calorie and fat profile, making it a suitable candidate for inclusion in weight management or health-conscious diets (Olsson *et al.*, 2020) [14].

Table 3: Nutritional analysis of watermelon rind juice (T₁)

Test Parameter	Unit	Results
Energy	K/cal	17.2
Protein	g/100ml	0.1
Carbohydrates	g/100ml	4.2
Total fat	g/100ml	0
Dietary Fiber	g/100ml	0.4
Total sugar	g/100ml	3.5

3.3 Vitamin and Mineral Content of Watermelon Rind Juice

The analysis of vitamin and mineral content in watermelon rind juice (Table 4) reveals the presence of several essential micronutrients. Vitamin E, with a content of 0.06 mg/100 ml, contributes to the juice's antioxidant properties, although the concentration is lower than in more concentrated sources such as nuts or seeds (Lee *et al.*, 2019) [9]. Similarly, Vitamin C, known for its role in immune function and collagen synthesis, is found at 0.2 mg/100 ml. While watermelon rind juice can provide some amount of this essential nutrient, it does not serve as a significant source compared to fruits such as citrus, which are more commonly recognized for high Vitamin C content.

In terms of minerals, watermelon rind juice contains 11 mg of calcium per 100 ml, which contributes to bone health and muscle function, but again, this amount is modest compared to dairy products or fortified beverages. The iron content is relatively low at 0.2 mg/100 ml, which may be of interest to those seeking alternative sources of this essential trace mineral, although the bioavailability of non-heme iron from plant sources like watermelon rind is generally lower than from animal sources (Zimmermann & Hurrell, 2007) [17]. Despite these relatively low concentrations of vitamins and minerals, the watermelon rind juice's value lies in its refreshing nature and its contribution to overall hydration and nutrition. These micronutrients, in combination with the juice's low-calorie and antioxidant-rich profile, support its potential as part of a balanced diet, though it should be complemented with other nutrient-dense foods to meet daily vitamin and mineral requirements (Dawson, 2016) [5].

Table 4: Vitamin and Mineral of watermelon rind juice

Test Parameter	Unit	Results
Vitamin E	mg/100ml	0.06
Vitamin C	mg/100ml	0.2
Calcium	mg/100ml	11
Iron	mg/100ml	0.2

3.4 Antioxidant Activity of Watermelon Rind Juice

The antioxidant activity of watermelon rind juice was evaluated using three different assays: DPPH (2,2-diphenyl-1-picrylhydrazyl), ABTS (2,2'-azinobis (3-ethylbenzothiazoline-6-sulfonic acid)), and FRAP (Ferric Reducing Antioxidant Power) (Table 5). The results indicate significant antioxidant potential, with the highest activity observed in the ABTS assay (300 mg/100 ml), followed by the FRAP assay (225 mg/100 ml) and the DPPH assay (110 mg/100 ml). These values suggest that watermelon rind juice possesses strong free radical scavenging properties, which could potentially contribute to the prevention of oxidative stress-related diseases. The ABTS assay, which measures both water-soluble and lipid-soluble antioxidants, shows the juice's ability to neutralize a wide range of free radicals. The FRAP assay further supports these findings by highlighting the juice's capacity to reduce ferric ions, a marker of its reductive antioxidant potential (Basu *et al.*, 2016; Halliwell & Gutteridge, 2015) [3, 6]. The observed antioxidant activity is consistent with other studies that have demonstrated the potential of watermelon rind as a source of bioactive compounds with antioxidant properties (Liu *et al.*,

2018) [10]. These results underscore the health-promoting potential of watermelon rind juice, suggesting its application as a functional beverage for enhancing oxidative health.

Table 5: Antioxidant activity of watermelon rind juice

Test Parameter	Units	Results
DPPH	mg/100ml	110
ABTS	mg/100ml	300
FRAP	mg/100ml	225

3.5 Microbial Activity of Watermelon Rind Juice

The microbial analysis of watermelon rind juice demonstrates that the juice meets acceptable safety standards, with no detectable presence of harmful microorganisms. The Aerobic Plate Count and Yeast and Moulds values were both found to be below the detection limit of 10 CFU/ml, which is well below the acceptable threshold of 1×10^6 CFU/ml (Karakaya & El, 2020) [7]. Additionally, no growth of Enterobacteriaceae or *Staphylococcus aureus* was detected, confirming the absence of these potentially pathogenic bacteria in the juice, both of which are considered critical indicators for food safety. These results are significant, as the absence of these microorganisms suggests that watermelon rind juice can be considered microbiologically safe for consumption, in line with regulatory standards for juice products (Codex Alimentarius Commission, 2018) [4]. The low microbial load and the absence of common foodborne pathogens further highlight the potential of watermelon rind juice as a safe and health-promoting beverage, with minimal risk of contamination.

Table 6: Microbial Activity of watermelon rind juice

Test Parameter	Unit	Results	Limits
Aerobic Plate Count	CFU/ml	<10	1×10^6
Yeast and moulds	CFU/ml	<10	1×10^6
Enterobacteriaceae	CFU/ml	Absent	Absent/25ml
<i>S. aureus</i>	CFU/25ml	Absent	Absent/25ml

4. Conclusion

Watermelon rind juice exhibits promising nutritional, antioxidant, and microbiological properties that support its potential as a functional and health-promoting beverage. The sensory evaluation revealed that the juice samples were generally well-accepted, with sample T₁ demonstrating the highest overall acceptability. Nutritional analysis indicated that the juice is low in calories and fats, while providing modest amounts of carbohydrates, dietary fiber, and essential micronutrients such as vitamin C, vitamin E, calcium, and iron. Furthermore, its high antioxidant activity, as evidenced by DPPH, ABTS, and FRAP assays, highlights the juice's potential for combating oxidative stress. Microbial analysis confirmed the safety of the juice, with no detectable pathogenic microorganisms and microbial counts well within acceptable limits. These findings suggest that watermelon rind juice not only offers a sustainable way to utilize watermelon by-products but also has the potential to be developed into a nutritious, antioxidant-rich, and safe functional beverage for health-conscious consumers.

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