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Original Research

Impact of Ethanolic Spice Extracts and Sodium Benzoate on the Physicochemical Properties and Health-Related Quality of Watermelon Juice

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ABSTRACT

Background: Watermelon juice is a refreshing drink to quench the extreme tropical heat thirst. Packed with simple carbs, antioxidants, vitamins, and minerals, it boosts immunity and aids in the body's recovery from dehydration. Moreover, it's a delicious and filling drink. A study was carried out to investigate the effects of ethanolic extracts on watermelon juices. **Methods:** Physicochemical changes such as total soluble solid, vitamin C, acidity, pH, non-enzymatic browning reaction, sensory evaluation, and total viable count were measured at 7-day intervals over 28 days. **Results:** The findings showed that clove and sodium benzoate had a greater effect on unpasteurized juice than black pepper and sodium benzoate on pasteurized juice. Clove and sodium benzoate outperformed the others in unpasteurized juice. For unpasteurized and pasteurized juice, black pepper and sodium benzoate showed greater results than others. Besides, sodium benzoate (3.10×10^2, 1.2×10^2, 0×10^2, and 1.0×10^2) and cinnamon (4.0×10^2, 2.2×10^2, 3.0×10^2 and 2.0×10^2) presented better antimicrobial activity than others for unpasteurized juice. Sodium benzoate (3.0×10^2, 1.10×10^2, 0×10^2, and 2.0×10^2) and black pepper (1.20×10^2, 2.1×10^2, 2.0×10^2, and 1.10×10^2) displayed better antimicrobial activity than others for pasteurized juice. For both unpasteurized and pasteurized juice, cinnamon and sodium benzoate were comparatively more popular than others. **Conclusions:** Based on the findings, these extracts could be employed as natural antimicrobial preservatives instead of artificial preservatives in watermelon juice to increase its shelf life.

Keywords: Ethanolic extract; natural preservatives; sodium benzoate; physicochemical changes; sensory evaluation; microbial analysis

1. INTRODUCTION

Watermelon (*Citrullus lanatus*) is an important summer cash crop that has great demand in the domestic market. It is a natural antioxidant source.[1] It is a unique fruit source of the carotenoid lycopene as well as a good source of phenolic antioxidants. Cucurbitacin E, a triterpene anti-inflammatory phytonutrient, and unusual amounts of the amino acid citrulline are present.[2] Watermelon is rich in the alpha-hydroxy acids citric acid and malic acid, which are natural exfoliants.[3]

The non-enzymatic browning reaction (NEB) affects organoleptic properties and is responsible for the most significant qualitative changes in food during storage, resulting in a decrease in shelf life.[4] Watermelon has a pH range of 5.18 to 5.60.[5] Preservatives are used to extend the shelf life of fruit juices, beer, wine, and water. Sodium benzoate causes skin and eye irritation, while sulfur dioxide has been linked to respiratory problems.[6] Spices are plant substances of indigenous or exotic origin, aromatic or with a strong flavor, used to enhance the flavor of foods.[7] Leaves (coriander, mint), flowers (clove), bulbs (garlic, onion), fruits (red chili, black pepper), stems (cinnamon), rhizomes (ginger, turmeric), and other plant parts are examples of spices.[8]

The main ingredient, eugenol,' is responsible for the sweet and pleasant aroma. The food and beverage industries frequently utilize sodium benzoate and sulfur dioxide due to their abilities as antioxidants and preservatives. Although it poses no danger to healthy individuals when taken at the recommended dosages, even at large dilutions, it can trigger asthma attacks in susceptible individuals who inhale or swallow it.[9] Clove oil contains 72–90% eugenol, which has antiseptic and anesthetic properties.[10] Other important constituents include essential oils such as acetyl eugenol, beta-caryophylline, and vanillin; crategolic acid; tannins, gallotannic acid, and methyl salicylate (painkiller); the flavonoids eugenin, kaempferol, rhamnetin, and eugenitin; and triterpenoids such as oleanolic acid and stigmasterol.[11]

Black pepper has a strong, penetrating aroma and a pungent, spicy flavor. The pungent and hot aroma of black pepper is largely due to the presence of monoterpenes such as sabinene, beta-pinene, limonene, terpinene, alpha-pinene, myrcene, delta-3-carene, and monoterpene derivatives.[12] It also contains 3% essential oil, with about 20% of that essential oil composed of volatile oils such as beta-caryophyllene, humulene, beta-bisabolone, and caryophyllene ketone.[13] Aside from these basic ingredients, black pepper contains approximately 8% to 14% moisture, 1.55% to 2.60% nitrogen, and 28% to 49% starch obtained through acid hydrolysis.[14] Cinnamon spice has a pungent taste and scent due to the chemical compounds cinnamic aldehyde and cinnamaldehyde. Cinnamon spice has anti-oxidant, anti-diabetic, anti-septic, local anesthetic, anti-inflammatory, rubefacient (warming and soothing), carminative, and anti-flatulent properties.[15]

The spice contains essential oils that are beneficial to health, such as eugenol, a phenylpropanol class of chemical compound that gives it a pleasant, sweet aromatic fragrance. Food preservation attempts to extend the shelf life of food by lowering the activity of bacteria that cause mold, rot, and yeast growth. These days, the focus is on contrasting different fruit juice preservatives and evaluating how well they preserve watermelon juice based on pH, total acidity, total soluble solids, vitamin C, and acidic contents. Furthermore, water melon is high in potassium and magnesium. Water melon has a diverse nutritional profile that includes carbohydrates, sugar, soluble and insoluble fiber, sodium, vitamins, minerals, fatty acids, amino acids, and so on. The outcomes demonstrate that the various preservatives employed are effective in maintaining the liquids' preservation. The study's goal was to find out how sodium benzoate and ethanolic spice extracts affected the physicochemical characteristics of watermelon juice.

2. METHODS

2.1 Study Design

It was an experimental study for the quantitative estimation of the physicochemical parameters of watermelon juice. The general laboratory of the department of Food Technology and Nutritional Science, Mawlana Bhashani Science and Technology University, Santosh, Tangail-1902, Bangladesh, is where we conducted our special research work. We purchased watermelon, black pepper, cinnamon, and cloves from Park Bazar in Tangail district, Bangladesh.

2.2 Ethanolic Extraction of Spices

First, all of the spices were dried in the cabinet dryer for 5-6 h at 45°C. The spices were then finely ground for better extraction. At room temperature, dried spices were extracted with 95% ethanol. Spice extracts were kept at 4°C for one day before being filtered through a 45 μm membrane filter. The solutions were then dried using a rotary vacuum evaporator. The crude extracts were kept at -20°C until they were used in the watermelon juice.[16]

2.3 Extraction of Juice

The watermelon was washed and the skin was peeled after it was purchased from the store. Under sanitary laboratory conditions, the watermelon was cut

to remove the juice using an electric juicer. To decrease the microbial load, the juicer was washed with distilled water and then swabbed in 70% ethanol. This extracted juice was then filtered through four layers of muslin fabric and transferred under aseptic circumstances into autoclaved glass bottles.

2.4 Pasteurization Technique

Pasteurized and non-pasteurized glass bottles holding juice and preservatives were divided into two groups. The juice was pasteurized at low temperature long time (LTLT,) 60°C for 30 m and cooled immediately.[17]

2.5 Sensory Evaluation

The sensory test was performed before starting the day count, taking into account the appearance, smell, consistency, and color of the pasteurized and non-pasteurized watermelon juice samples. The same process was repeated every 7 days for a total of 28 days of storage. For the overall acceptance of the juice, a nine-point structured hedonic scale test (9 = extremely like, 1 = extremely dislike) was used. The sensory evaluation was carried out by semi-trained panelists from the department of Food Technology and Nutritional Science at Mawlana Bhashani Science and Technology University in Santosh, Tangail-1902, Bangladesh. For sensory evaluation, informed consent was obtained from the panelists, and prior to starting the sensory-consumer research, we obtained an ethical approval letter from the departmental ethical review committee (ERC) with the approval number: #Approval No. 2023-02.[18]

2.6 Quantitative Estimation of Physicochemical Parameters

2.6.1 pH

The pH of watermelon juice samples was determined using a digital pH meter equipped with a standard glass electrode. After rinsing in distilled water, the glass electrode was dipped in juice and measurements were recorded according to the standard method.[19]

2.6.2 Total soluble solid (TSS)

The TSS content of the water was determined using a refractometer. A drop of watermelon juice was placed on the refractometer's prism, and the percent total soluble solid was determined by direct reading. The same process was repeated for all the samples.[20]

2.6.3 Vitamin C content

In a conical flask, 10 mL of standard vitamin C solution was titrated with the dye solution. In a test tube, 6 mL of watermelon juice was homogenized thoroughly with 3% metaphosphoric acid (approximately 20 mL). The solution was then centrifuged at 3000 rotation per minutes (rpm) for 10 m and the clear supernatant was titrated with 2, 6 dichlorophenol indophenols solution. The amount of vitamin C present in the extract was determined by comparing with the titration result of standard vitamin.[21]

2.6.4 Titratable acidity

By titrating against NaOH, the titratable acidity of juice samples was measured as a percentage of citric acid. 2g of juice was dissolved in boiled purified water and cooled to a volume of 100 mL with distilled water. The solution was filtered, and 25 mL of the filtrate was titrated against 0.1 N NaOH with phenolphthalein as a reagent to determine sample titratable acidity.[22]

2.6.5 Non-enzymatic browning reaction

At first 500 µL of watermelon juice sample was taken by micropipette and diluted with 5 mL of ethanol. Then the NEB of the solutions was measured by spectrophotometer. The reading was observed and recorded under spectrophotometer at 420 nm. The same process was repeated to measure the NEB of all other juice samples.[23]

2.7 Microbial Analysis

The nutrient agar medium was weighed 14 g and distilled water was measured 500 mL. The nutrient agar and distilled water were placed in conical flask and autoclaved at 121°C for 15 m. The juice was serially diluted, and 0.1 mL of the proper aliquot was added to the agar dish using sterilized pipette tips. For each therapy, a different sterile 1 mL pipette was used. The spread plate method was used, and the cultured plates were incubated for 24 h at 37°C. The number of colonies formed on the plates was then noted.[24]

2.8 Statistical Analysis

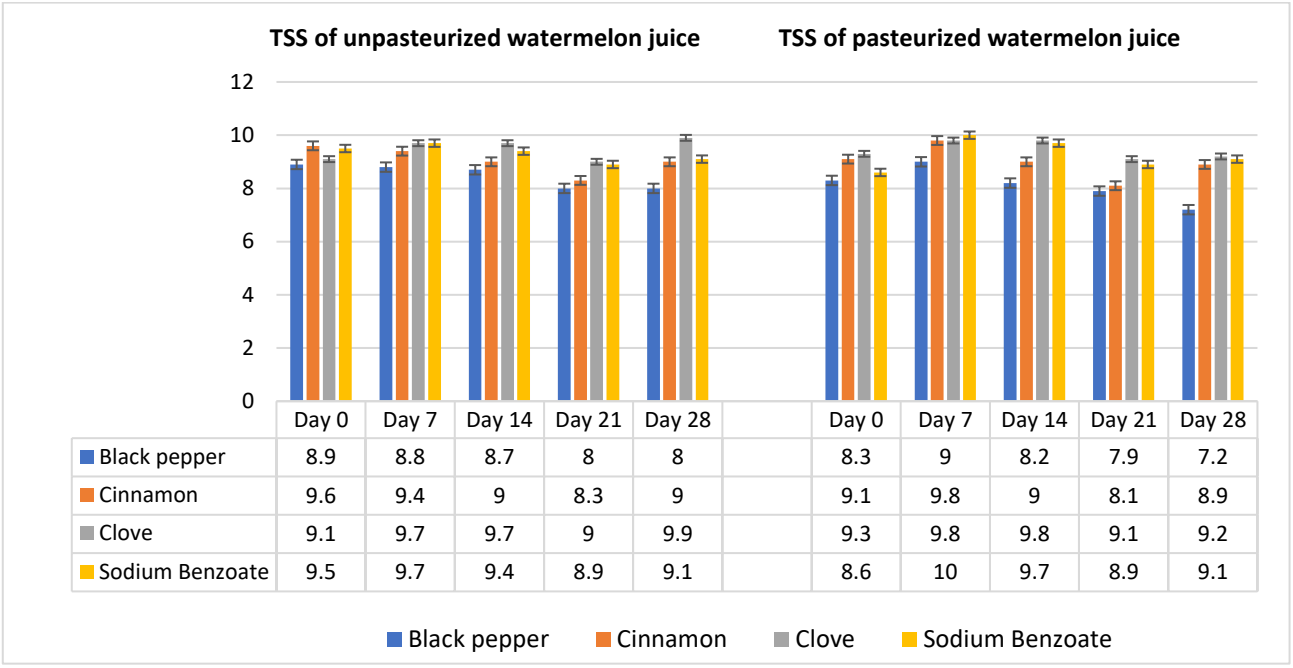
All sample analyses were done in triplicate and descriptive statistics were calculated using the SPSS software program version 20.0 (SPSS Inc., Chicago, IL, USA) for all variables. The significance of observed differences was tested at $P < 0.05$. All the experiments were done with replication and analyzed with mean and standard deviation through Microsoft Excel 2007

and significance was analyzed by one sample T-test and one-way ANOVA.

3. RESULTS

Watermelon was collected from Tangail region in Bangladesh and also was analyzed for physicochemical, microbiological and sensory properties.

Figure 1 represents the TSS of preserved unpasteurized watermelon juice in which black pepper, cinnamon, clove and sodium benzoate were mixed in fixed percentage observed from day 7 to day 28. Here found after 7 days TSS of black pepper, cinnamon, clove, sodium benzoate was 8.8, 9.4, 9.7 and 9.7, respectively. After 14 days TSS of black pepper, cinnamon, clove, sodium benzoate was 8.7, 9, 9.7 and 9.4, respectively. After 21 days later TSS of black pepper, cinnamon, clove, sodium benzoate was 8, 8.3, 9 and 8.9, respectively. After 28 days later TSS of black pepper, cinnamon, clove, sodium benzoate was 8.9, 9, 9.9 and 9.1, respectively. TSS of pasteurized watermelon juice from 7 days to 21 days. Here found after 7 days TSS of black pepper, cinnamon, clove, sodium benzoate was 9, 9.8, 9.8 and 10, respectively. After 14 days TSS of black pepper, cinnamon, clove, sodium benzoate was 8.2, 9, 9.8 and 9.7, respectively. After 21 days TSS of black pepper, cinnamon, clove, sodium benzoate was 7.9, 8.1, 9.1 and 8.9, respectively. After 28 days later TSS of black pepper, cinnamon, clove, sodium benzoate was 7.2, 8.9, 9.2 and 9.1, respectively.



	Day 0	Day 7	Day 14	Day 21	Day 28		Day 0	Day 7	Day 14	Day 21	Day 28
Black pepper	8.9	8.8	8.7	8	8		8.3	9	8.2	7.9	7.2
Cinnamon	9.6	9.4	9	8.3	9		9.1	9.8	9	8.1	8.9
Clove	9.1	9.7	9.7	9	9.9		9.3	9.8	9.8	9.1	9.2
Sodium Benzoate	9.5	9.7	9.4	8.9	9.1		8.6	10	9.7	8.9	9.1

Figure 1. TSS (%) of unpasteurized and pasteurized watermelon juice at room temperature

Figure 2 represents the pH value of unpasteurized and pasteurized watermelon juice. At the day of 7 pH value of black pepper, cinnamon, clove, sodium benzoate were 3.46, 4.17, 4.47 and 3.90. After 14 days later pH value of black pepper, cinnamon, clove, sodium benzoate were 3.10, 2.90, 4.08 and 3.53. 21 days later pH value of black pepper, cinnamon, clove, sodium benzoate were 2.77, 2.48, 3.44 and 3.14. After 28 days later pH value of black pepper, cinnamon, clove, sodium benzoate were 2.97, 2.60, 2.63 and 3.22. The pH value of pasteurized watermelon juice. At the day of 7 pH value of black pepper, cinnamon, clove, sodium benzoate were 4.46, 4.94, 4.61 and 4.41. After 14 days later pH value of black pepper, cinnamon, clove, sodium benzoate were 3.03, 3.09, 4.01 and 3.26. After 21 days later pH value of black pepper, cinnamon, clove, sodium benzoate were 2.81, 2.64, 3.73 and 3.02. After 28 days later pH value of black pepper, cinnamon, clove, sodium benzoate were 2.83, 2.57, 3.53 and 3.06.

Table 1 shows the acidity percentage of unpasteurized watermelon juice after mixing with sodium benzoate and ethanolic extraction of black pepper, cinnamon and clove. After 7 days later acidity percentage of mixed sodium benzoate and ethanolic extraction of black pepper, cinnamon and clove was 0.35, 0.64, 0.16 and 0.51. After 14 days later acidity percentage of mixed sodium benzoate and ethanolic extraction of black pepper, cinnamon and clove was

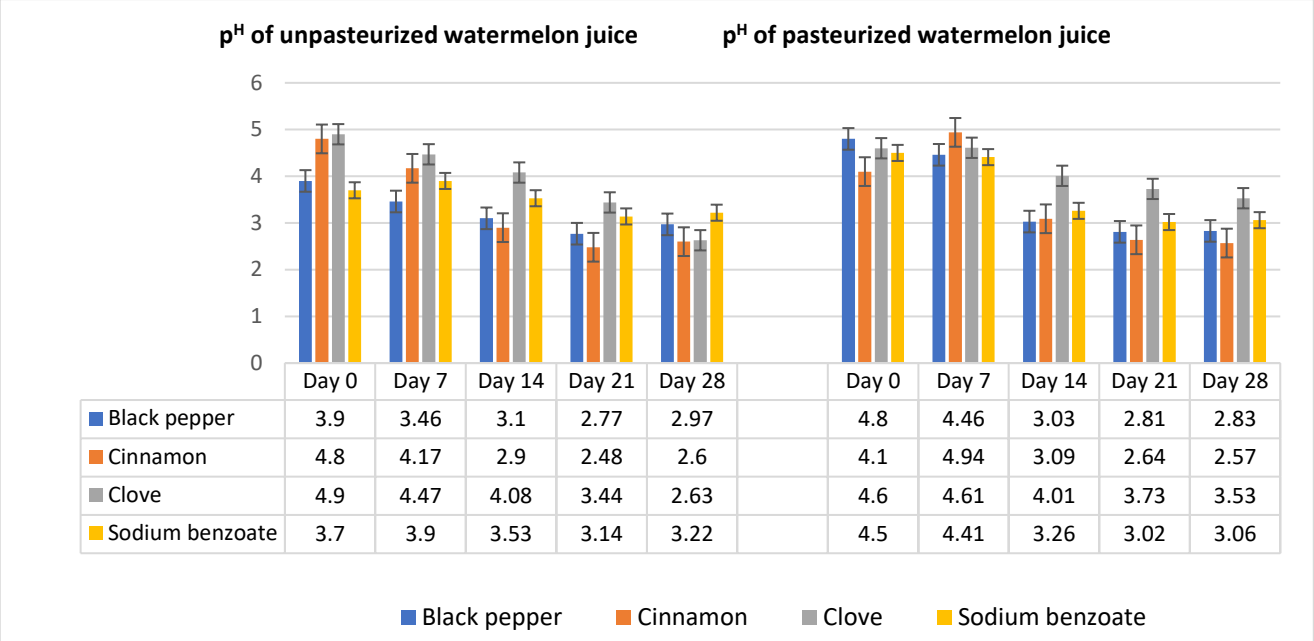


Figure 2. pH of unpasteurized and pasteurized watermelon juice at room temperature

0.60, 1.44, 1.12 and 0.16. After 21 days later acidity percentage of mixed sodium benzoate and ethanolic extraction of black pepper, cinnamon and clove was 0.96, 0.83, 1.41 and 0.26. After 28 days later acidity percentage of mixed sodium benzoate and ethanolic extraction of black pepper, cinnamon and clove was 0.80, 1.25, 1.15 and 0.38. Percentage of acidity pasteurized watermelon juice which were mixed with sodium benzoate and ethanolic extraction of black pepper, cinnamon and clove. After 7 days later acidity percentage of mixed sodium benzoate and ethanolic extraction of black pepper, cinnamon and clove was 0.10, 0.29, 0.16 and 0.10. After 14 days later acidity percentage of mixed sodium benzoate and ethanolic extraction of black pepper, cinnamon and clove was 0.48, 0.83, 1.22 and 032. After 21 days later acidity percentage of mixed sodium benzoate and ethanolic extraction of black pepper, cinnamon and clove was 0.61, 1.31, 1.02 and 0.70. After 28 days later acidity percentage of mixed sodium benzoate and ethanolic extraction of black pepper, cinnamon and clove was 0.83, 1.47, 1.18 and 0.45.

Table 2 reveals non-enzymatic browning reaction (NEB) of unpasteurized watermelon juices which were mixed with sodium benzoate and ethanolic extraction of black pepper, cinnamon and clove. After 7 days later NEB reading of mixed sodium benzoate and ethanolic extraction of black pepper, cinnamon and clove was

Table 1. Acidity (%) of unpasteurized and pasteurized watermelon juice

Day	Black pepper	Cinnamon	Clove	Sodium benzoate
Acidity (%) of unpasteurized watermelon juice				
Day 0	1.80±0.21	1.70±0.22	1.20±0.25	1.11±0.30
Day 7	0.64±0.20	0.16±0.12	0.51±0.50	0.35±0.12
Day 14	1.44±0.14	1.12±0.23	0.16±0.20	0.60±0.06
Day 21	0.83±0.23	1.41±0.20	0.26±0.11	0.96±0.08
Day 28	1.25±0.11	1.15±0.30	0.38±0.20	0.80±0.03
Acidity (%) of pasteurized watermelon juice				
Day 0	1.60±0.26	1.10±0.32	0.97±0.24	1.10±0.25
Day 7	0.29±0.10	0.16±0.20	0.10±0.11	0.10±0.11
Day 14	0.83±0.23	1.22±0.01	0.32±0.20	0.48±0.12
Day 21	1.31±0.22	1.02±0.10	0.70±0.12	0.61±0.25
Day 28	1.47±0.10	1.18±0.02	0.45±0.30	0.83±0.20

Values are means ± standard deviation from triplicate determinations. Means within the same column are not significantly different at $p < 0.05$

0.62, 0.70, 1.38 and 1.03. After 14 days later NEB reading of mixed sodium benzoate and ethanolic extraction of black pepper, cinnamon and clove was 0.52, 0.77, 2.01 and 1.51. After 21 days later NEB reading of mixed sodium benzoate and ethanolic extraction of black pepper, cinnamon and clove was 0.31, 0.82, 1.70 and 0.74. After 28 days later NEB reading of mixed sodium benzoate and ethanolic extraction of black pepper, cinnamon and clove was 0.30, 0.84, 1.71 and 0.73. Non-enzymatic browning reaction (NEB) of pasteurized watermelon juices which were mixed with sodium benzoate and ethanolic extraction of black pepper, cinnamon and clove. After 7 days later NEB reading of mixed sodium benzoate and ethanolic extraction of black pepper, cinnamon and clove was 0.83, 1.05, 1.61 and 0.70. After 14 days later NEB reading of mixed sodium benzoate and ethanolic extraction of black pepper, cinnamon and clove was 0.79, 0.83, 1.56 and 1.37. After 21 days later NEB reading of mixed sodium benzoate and ethanolic extraction of black pepper, cinnamon and clove was 1.03, 1.19, 2.16 and 1.04. After 28 days later NEB reading of mixed sodium benzoate and ethanolic extraction of black pepper, cinnamon and clove was 1.05, 1.20, 2.19 and 1.08.

Table 2. Non-enzymatic browning reaction (NEB) of unpasteurized and pasteurized watermelon juice

Day	Black pepper	Cinnamon	Clove	Sodium benzoate
Non-enzymatic Browning Reaction (NEB) of unpasteurized watermelon juice				
Day 0	0.89±0.02	1.60±0.12	1.56±0.32	0.56±0.40
Day 7	0.70±0.02	1.38±0.10	1.03±0.20	0.62±0.22
Day 14	0.77±0.01	2.01±0.20	1.51±0.20	0.52±0.10
Day 21	0.82±0.03	1.70±0.30	0.74±0.11	0.31±0.23
Day 28	0.84±0.02	1.71±0.36	0.73±0.10	0.30±0.21
Non-enzymatic Browning Reaction (NEB) of pasteurized watermelon juice				
Day 0	1.31±0.33	1.61±0.22	1.11±0.31	0.98±0.34
Day 7	1.05±0.11	1.61±0.20	0.70±0.12	0.83±0.02
Day 14	0.83±0.37	1.56±0.11	1.37±0.22	0.79±0.23
Day 21	1.19±0.13	2.16±0.11	1.04±0.03	1.03±0.11
Day 28	1.20±0.10	2.19±0.15	1.08±0.06	1.05±0.10

Values are means ± standard deviation from triplicate determinations. Means within the same column are not significantly different at $p < 0.05$

Table 3 shows the amount of vitamin C present in unpasteurized watermelon juices which were mixed with sodium benzoate and ethanolic extraction of black pepper, cinnamon and clove. After 7 days later vitamin C content of mixed ethanolic extraction of black pepper, cinnamon, clove and sodium benzoate was 7.00, 5.00, 3.67 and 2.83. After 14 days later vitamin C content of mixed ethanolic extraction of black pepper, cinnamon, clove and sodium benzoate was 6.20, 6.33, 5.83 and 5.00. After 21 days later vitamin C content of mixed ethanolic extraction of black pepper, cinnamon, clove and sodium benzoate was 5.83, 8.50, 6.67 and 8.50. After 28 days later vitamin C content of mixed ethanolic extraction of black pepper, cinnamon, clove and sodium benzoate was 4.67, 5.00, 8.67 and 4.67. The amount of vitamin C present in pasteurized watermelon juices which were mixed with ethanolic extraction of black pepper, cinnamon, clove and sodium benzoate. After 7 days later vitamin C content of mixed ethanolic extraction of black pepper, cinnamon, clove and sodium benzoate was 1.84, 5.50, 3.83 and 2.84. After 14 days later vitamin C content of mixed ethanolic extraction of black pepper, cinnamon, clove and sodium benzoate was 5.33, 7.67, 6.20 and 4.50. After 21 days later vitamin C content of mixed ethanolic extraction of black pepper, cinnamon, clove and sodium benzoate was 7.00, 6.30, 8.50 and 6.30. After 28 days later vitamin C content of mixed ethanolic extraction of black pepper, cinnamon, clove and sodium benzoate was 6.20, 5.80, 7.20 and 7.00.

Table 4 reveals the amount of total viable count (TVC) (cfu/mL) in unpasteurized watermelon juices which were mixed with ethanolic extraction of black pepper, cinnamon, clove and sodium benzoate. After 7 days later TVC of mixed ethanolic extraction of black pepper, cinnamon, clove and sodium benzoate was 6.0×10^2, 4.0×10^2, 6.0×10^2 and 3.0×10^2. After 14 days later TVC of mixed ethanolic extraction of black pepper, cinnamon, clove and sodium benzoate was 3.0×10^2, 2.20×10^2, 3.0×10^2 and 1.20×10^2. After 21 days later TVC of mixed ethanolic extraction of black pepper,

Table 3. Vitamin C content (mg) in unpasteurized and pasteurized watermelon juice

Day	Black pepper	Cinnamon	Clove	Sodium benzoate
Vitamin C content (mg) in unpasteurized watermelon juice				
Day 0	7.51±0.01	6.80±0.21	6.30±0.32	6.40±0.41
Day 7	7.00±0.01	5.00±0.12	3.67±0.02	2.83±0.03
Day 14	6.20±0.02	6.33±0.34	5.83±0.31	5.00±0.04
Day 21	5.83±0.30	8.50±0.02	6.67±0.34	8.50±0.35
Day 28	4.67±0.33	5.00±0.13	8.67±0.32	4.67±0.28
Vitamin C content (mg) in pasteurized watermelon juice				
Day 0	4.20±0.10	5.03±0.11	6.10±0.33	4.90±0.21
Day 7	1.84±0.31	5.50±0.01	3.83±0.23	2.84±0.12
Day 14	5.33±0.23	7.67±0.21	6.20±0.41	4.50±0.11
Day 21	7.00±0.21	6.30±0.23	8.50±0.26	6.30±0.12
Day 28	6.20±0.23	5.80±0.32	7.20±0.12	7.00±0.03

Values are means ± standard deviation from triplicate determinations. Means within the same column are not significantly different at $p < 0.05$

cinnamon, clove and sodium benzoate was 3.10×10^2, 3.0×10^2, 4.0×10^2 and 0. After 28 days later TVC of mixed ethanolic extraction of black pepper, cinnamon, clove and sodium benzoate was 1.20×10^2, 2.0×10^2, 3.0×10^2 and 1.0×10^2. The amount of total viable count (TVC) (cfu/mL) in pasteurized watermelon juices which were mixed with ethanolic extraction of black pepper, cinnamon, clove and sodium benzoate. After 7 days later TVC of mixed ethanolic extraction of black pepper, cinnamon, clove and sodium benzoate was 4.0×10^2, 4.0×10^2, 5.0×10^2 and 3.0×10^2. After 14 days later TVC of mixed ethanolic extraction of black pepper, cinnamon, clove and sodium benzoate was 2.0×10^2, 2.0×10^2, 1.0×10^2 and 1.10×10^2. After 21 days later TVC of mixed ethanolic extraction of black pepper, cinnamon, clove and sodium benzoate was 2.0×10^2, 1.0×10^2, 2.0×10^2 and 0. After 28 days later TVC of mixed ethanolic extraction of black pepper, cinnamon, clove and sodium benzoate was 1.0×10^2, 3.0×10^2, 3.0×10^2 and 2.0×10^2.

Table 4. TVC (cfu/mL) in unpasteurized and pasteurized watermelon juice

Day	Black pepper	Cinnamon	Clove	Sodium benzoate
Total Viable Count (cfu/mL) in unpasteurized watermelon juice				
Day 0	6.50×10^2	5.90×10^2	6.40×10^2	4.20×10^2
Day 7	6.00×10^2	4.00×10^2	6.00×10^2	3.00×10^2
Day 14	3.00×10^2	2.20×10^2	3.00×10^2	1.20×10^2
Day 21	3.10×10^2	3.00×10^2	4.00×10^2	0
Day 28	1.20×10^2	2.00×10^2	3.00×10^2	1.00×10^2
Total Viable Count (cfu/mL) in pasteurized watermelon juice				
Day 0	4.90×10^2	5.00×10^2	5.80×10^2	5.20×10^2
Day 7	4.00×10^2	4.00×10^2	5.00×10^2	3.00×10^2
Day 14	2.00×10^2	2.00×10^2	1.00×10^2	1.10×10^2
Day 21	2.00×10^2	1.00×10^2	2.00×10^2	0
Day 28	1.00×10^2	3.00×10^2	3.00×10^2	2.00×10^2

Table 5 shows the sensory evaluation of preserved unpasteurized watermelon juice (in room temperature) based on Hedonic Scale. In the table mentioned color, odor, consistency, appearance of watermelon juice mixing with black pepper, cinnamon, clove, sodium benzoate. Juices which were mixed with black pepper extraction liked moderately, which were mixed with cinnamon also liked moderately. Juices which were mixed clove doesn't like by the panelist. Juices which were mixed with sodium benzoate liked very much to the panelist. Sensory evaluation of preserved unpasteurized watermelon juice (in room temperature) after one month based on Hedonic Scale. In the table mentioned color, odor, consistency,

appearance of watermelon juice mixing with black pepper, cinnamon, clove, sodium benzoate extraction. Juices which were mixed with black pepper extraction dislike slightly, which were mixed with cinnamon neither like nor dislike. Juices which were mixed clove also neither like or dislike by the panelist. Juices which were mixed with sodium benzoate liked very much to the panelist. Sensory evaluation of preserved pasteurized watermelon juice (in room temperature) based on Hedonic Scale. In the table mentioned color, odor, consistency, appearance of watermelon juice mixing with black pepper, cinnamon, clove, sodium benzoate extraction. Juices which were mixed with black pepper extraction liked very much, which were mixed with cinnamon likes by them. Juices which were mixed clove also likes by the panelist. Juices which were mixed with sodium benzoate liked very much to the panelist. Sensory evaluation of preserved pasteurized watermelon juice (in room temperature) after based on Hedonic Scale. In the table mentioned color, odor, consistency, appearance of watermelon juice mixing with black pepper, cinnamon, clove, sodium benzoate. Juices which were mixed with black pepper extraction neither like or dislike, which were mixed with cinnamon also liked slightly. Juices which were mixed clove dislike moderately by the panelist. Juices which were mixed with sodium benzoate liked to the panelist.

Table 5. Sensory evaluation of unpasteurized and pasteurized watermelon juice at room temperature

Parameters	Black pepper	Cinnamon	Clove	Sodium benzoate
Unpasteurized (First day)				
Color	7.51±0.01	6.80±0.21	6.30±0.32	6.40±0.41
Odor	7.00±0.01	5.00±0.12	3.67±0.02	2.83±0.03
Consistency	6.20±0.02	6.33±0.34	5.83±0.31	5.00±0.04
Appearance	5.83±0.30	8.50±0.02	6.67±0.34	8.50±0.35
Unpasteurized (After one month)				
Color	4.20±0.10	5.03±0.11	6.10±0.33	4.90±0.21
Odor	1.84±0.31	5.50±0.01	3.83±0.23	2.84±0.12
Consistency	5.33±0.23	7.67±0.21	6.20±0.41	4.50±0.11
Appearance	7.00±0.21	6.30±0.23	8.50±0.26	6.30±0.12

Values are means ± standard deviation from triplicate determinations. Means within the same column are not significantly different at $p < 0.05$

Table 6 represents the organoleptic changes of pasteurized and unpasteurized juice containing ethanolic extract of black pepper in which day 0 to day 14 color was red, consistency was smooth, appearance was clear, and odor was favorable. But in day 21 odor has been changed to unfavorable. Day 28 color and odor has been changed others parameter remain unchanged. The organoleptic changes of pasteurized and unpasteurized juice containing ethanolic extract of clove in which day 0 to day 14 color was red, consistency was smooth, appearance was clear, odor was favorable. But in day 21 color has been changed red to light brown odor has been changed to unfavorable. Day 28 color changed to dark brown and others parameter remain unchanged. The organoleptic changes of pasteurized and unpasteurized juice containing ethanolic extract of cinnamon in which day 0 to day 21 color was red, consistency was smooth, appearance was clear, odor was favorable. But in day 28 color changed red to light brown and others parameter remain unchanged. The changes of pasteurized and unpasteurized juice containing ethanolic extract of sodium benzoate in which day 0 to day 28 color was red, consistency was smooth, appearance was clear, odor was favorable.

4. DISCUSSION

Watermelon is a natural antioxidant source, high in carotenoid lycopene, phenolic antioxidants, cucurbitacin E, citrulline, vitamin C, vitamin A, potassium, magnesium, and a diverse nutritional profile. Watermelon juice compositional analysis was performed after processing. The results indicate that watermelon contains pH 5.58, TSS 9.4 acidity 10 and vitamin C 8 mg. According to a research by Jafari et al. (2017),[25] TSS and vitamin C were 7.9 mg and 8.5–9.1 mg, respectively.

Figure 1 shows that the TSS of watermelon juice flavored with cinnamon, clove, black pepper, and

Table 6. Organoleptic characteristics of pasteurized and non-pasteurized juice containing ethanolic extract of black pepper, clove, cinnamon and sodium benzoate

Days	Color	Consistency	Appearance	Odor	Color	Consistency	Appearance	Odor
	Pasteurized black pepper extract				**Non pasteurized black pepper extract**			
Day 0	Red	Smooth	Clear	Favorable	Red	Smooth	Clear	Favorable
Day 7	Red	Smooth	Clear	Favorable	Red	Smooth	Clear	Favorable
Day 14	Red	Smooth	Clear	Favorable	Red	Smooth	Clear	Favorable
Day 21	Red	Smooth	Clear	Unfavorable	Red	Smooth	Clear	Unfavorable
Day 28	Light brown	Smooth	Clear	Unfavorable	Light brown	Smooth	Clear	Unfavorable
	Pasteurized clove extract				**Non pasteurized clove extract**			
Day 0	Red	Smooth	Clear	Favorable	Red	Smooth	Clear	Favorable
Day 7	Red	Smooth	Clear	Favorable	Red	Smooth	Clear	Favorable
Day 14	Red	Smooth	Clear	Favorable	Red	Smooth	Clear	Favorable
Day 21	Light brown	Smooth	Clear	Unfavorable	Light brown	Smooth	Clear	Unfavorable
Day 28	Dark brown	Smooth	Clear	Unfavorable	Dark brown	Smooth	Cleat	Unfavorable
	Pasteurized cinnamon extract				**Non pasteurized cinnamon extract**			
Day 0	Red	Smooth	Clear	Favorable	Red	Smooth	Clear	Favorable
Day 7	Red	Smooth	Clear	Favorable	Red	Smooth	Clear	Favorable
Day 14	Red	Smooth	Clear	Favorable	Red	Smooth	Clear	Favorable
Day 21	Red	Smooth	Clear	Favorable	Red	Smooth	Clear	Favorable
Day 28	Light Brown	Smooth	Clear	Favorable	Light Brown	Smooth	Clear	Favorable
	Pasteurized juice containing sodium benzoate				**Non pasteurized juice containing sodium benzoate**			
Day 0	Red	Smooth	Clear	Favorable	Red	Smooth	Clear	Favorable
Day 7	Red	Smooth	Clear	Favorable	Red	Smooth	Clear	Favorable
Day 14	Red	Smooth	Clear	Favorable	Red	Smooth	Clear	Favorable
Day 21	Red	Smooth	Clear	Favorable	Red	Smooth	Clear	Favorable
Day 28	Red	Smooth	Clear	Favorable	Red	Smooth	Clear	Favorable

sodium benzoate dramatically dropped between 7 and 21 days before increasing after 28 days, which is nearly identical to the findings of De Souza et al. (2016).[26] The TSS of watermelon juice with black pepper decreased significantly from 7 to 28 days which is almost similar to the result of Mala et al. (2021).[27]

Figure 2 indicates after adding sodium benzoate, cinnamon, and black pepper to watermelon juice, the pH of the liquid dropped for seven to twenty-one days before rising for the remaining 28 days. When watermelon juice was combined with black pepper and sodium benzoate, its pH dropped from 7 to 21 days before increasing after 28 days; however, when cinnamon and clove were added, the pH of the juice dramatically declined from 7 to 28 days.

Table 1 shows the acidity of black pepper extract mixed watermelon juice first increased then decreased and again increased, cinnamon extract and sodium benzoate first increased and then decreased, clove extract first decreased and then increased. According to Bor et al. (2016),[28] there was a rise, a drop, and a subsequent increase in the acidity of black pepper extract mixed with watermelon juice, cinnamon extract and sodium benzoate, clove extract, and both. The acidity of black pepper extract and sodium benzoate mixed watermelon juice increased gradually, cinnamon first increased then decreased and again increased, clove first increased then decreased. According to Ogwaro et al. (2022),[29] the acidity of watermelon juice mixed with black pepper extract and sodium benzoate grew steadily, while cloves initially increased and then dropped and cinnamon first increased and then declined.

Table 2 depicts the percentage of NEB of unpasteurized watermelon juice which were mixed with sodium benzoate and ethanolic extraction of black pepper, cinnamon, and clove. NEB of watermelon juice mixed with black pepper increased, cinnamon and clove first increased then decreased, sodium benzoate decreased significantly from 7 to 21 days. Del Olmo et al. (2017)[30] demonstrated that NEB of watermelon juice combined with black pepper rose, sodium benzoate dramatically dropped from 14 to 21 days, and NEB of cinnamon and clove juice first increased and subsequently declined. NEB of pasteurized watermelon juice which were mixed with sodium benzoate and ethanolic extraction of black pepper, cinnamon, and clove. NEB of watermelon juice mixed with black pepper, cinnamon and sodium benzoate first decreased then increased cinnamon, clove first increased then decreased from 7 to 21 days.

Table 3 shows vitamin C of watermelon juice with black pepper decreased, cinnamon and sodium benzoate first increased then decreased, clove increased gradually from 7 to 28 days. The vitamin C of watermelon juice with black pepper, cinnamon and clove first increased from 7 to 21 days then decreased after 28 days but sodium benzoate increased significantly from 7 to 28 days.

Table 4 denotes TVC in watermelon juice with black pepper decreased significantly, cinnamon and clove first decreased then increased and again decreased and sodium benzoate first decreased from 7 to 21 days and then increased after 28 days which is almost similar to the result of Bor et al. (2016).[28] The TVC of pasteurized watermelon juice with black pepper decreased gradually, cinnamon and sodium benzoate first decreased from 7 to 21 days then increased after 28 days, clove first decreased from 7 to 14 days then increased from 21 to 28 days. According to Bor et al. (2016),[28] the TVC of pasteurized watermelon juice with black pepper gradually dropped, whereas cloves first declined from 7 to 21 days and then increased from 21 to 35 days, and cinnamon and sodium benzoate first decreased from 7 to 21 days and then increased after 35 days.

Table 5 illustrates the sensory evaluation based on Hedonic Scale of preserved unpasteurized watermelon juice (at room temperature) at first day. Juices which were mixed with black pepper and cinnamon extract were liked moderately, clove not liked, sodium benzoate liked very much by the panelist. Naina et al. (2012) provides an example of the sensory assessment of preserved, unpasteurized watermelon juice on the first day using the Hedonic Scale.[31] The panelists provided informed consent for the sensory evaluation, and we received ethical approval from the departmental ethics review committee (ERC) with approval number: #Approval No. 2023-02 before beginning the sensory-consumer research. The panelists liked the juices that had cinnamon extract and black pepper somewhat, disliked the juices that contained clove, and loved the juices that contained sodium benzoate.

Table 6 represents the sensory evaluation of preserved unpasteurized watermelon juice at room temperature after one month. Juices which were mixed with black pepper extract disliked slightly, cinnamon and clove neither liked or disliked, sodium benzoate liked very much by the panelist. The sensory assessment of preserved, unpasteurized watermelon juice at room temperature after a month is presented by Kashyap et al. (2016).[32] Mixed juices with black pepper extract were slightly despised, while clove and cinnamon juices were neither liked nor disliked. Sodium benzoate, on the other hand, was highly loved. Juices mixed with black pepper and sodium benzoate extract were liked very much, cinnamon and clove were liked by the panelists. The panelists had mixed feelings about juices containing black pepper extract; they liked cinnamon marginally, disliked cloves somewhat, and had no preference for sodium benzoate. Nevertheless, at the end of the investigation, we can state that cinnamon and sodium benzoate showed more antibacterial action than the others for unpasteurized juice. Sodium benzoate and black pepper exhibited the strongest antibacterial efficacy for pasteurized juice. As a result, cloves and sodium benzoate outperformed cinnamon and black pepper in the end. Clove can be utilized as an efficient natural preservative because sodium benzoate has harmful effects on the body.

5. CONCLUSION

In conclusion, cinnamon and sodium benzoate were preferred over others in both unpasteurized and pasteurized watermelon juice. In case of pH and acidity, clove and sodium benzoate outperformed others in both unpasteurized and pasteurized juices. Black pepper and sodium benzoate worked better in both unpasteurized and pasteurized juice. For unpasteurized juice, sodium

benzoate and cinnamon demonstrated greater antimicrobial activity than others. For pasteurized juice, sodium benzoate and black pepper had higher antimicrobial activity than others. The final result shows that clove and sodium benzoate performed greater than cinnamon and black pepper. As sodium benzoate has negative health effects, clove can be used as effective natural preservative.

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Conflict of Interest

The authors declare no conflict of interest.

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