www.coast.oaustech.edu.ng
COAST
JOURNAL OF THE SCHOOL OF SCIENCE
Special Issue 1, September, 2025 ISSN: 2714-3716
Coast, J. Sch. Sci. 7 (2): 1507 - 1519

EVALUATION OF THE PHYSICOCHEMICAL PROPERTIES, MICROBIOLOGICAL QUALITY AND SENSORY EVALUATION OF WATERMELON JUICE BLENDED WITH GARLIC

***[1]Faturoti, A.O. and [2]Ajala, O.**

[1]Department of Food Science and Technology, Olusegun Agagu University of Science and Technology, Okitipupa, Ondo State, Nigeria.
[2] Department of Food Science and Technology, Federal University of Agriculture, Abeokuta.

*Corresponding Author's Email: ao.akintade@oaustech.edu.ng

https://dx.doi.org/10.4314/coast.v7i2.26s

Abstract

In response to the increasing global demand for beverages that are nutritious, health-promoting, and convenient, there has been a heightened interest in the development of innovative fruit-based juices. This study produced watermelon juice spiced with garlic juice at varying concentrations (0%, 10%, 20% and 30%). Watermelon fruits were washed, cut, seeds removed, the edible pink portion chopped, blended and the resulting pulp was filtered. Vary volumes of garlic juice were mixed with watermelon juice to produce different samples, which were packaged, pasteurized cooled and analyzed for physicochemical properties, microbiological quality, and sensory evaluation using analytical methods. The pH of the juices ranged from 5.80 to 6.90, total titratable acidity from 1.00 to 1.43 g/100%, total soluble solid from 5.00 - 7.00 °Brix, and total solids from 5.56 to 6.71%. Proximate composition showed that protein, ash, and carbohydrate contents increased with higher garlic juice inclusion. The juices were also found to be rich in essential minerals such as calcium, potassium, iron, and magnesium. Microbiological analysis confirmed that all juice samples were safe for consumption. Sensory evaluation revealed that the addition of 10% of garlic juice received the highest consumer acceptance due to its balanced favour. These findings suggested that incorporating garlic juice into watermelon juice can enhance its nutritional profile and produce a microbiologically safe, consumer - acceptable functional beverage.

Keywords: watermelon juice, garlic extract, functional beverage, physicochemical properties, sensory evaluation.

Introduction

Fruits are necessary foods due to their nutritional content and health benefits. They provide essential nutrients including vitamins, fatty acids, amino acids, minerals, phytonutrients, and dietary fibres (Slavin and Lloyd, 2012). Juice is the liquid naturally contained in fruit, prepared by mechanically squeezing or macerating fresh fruit without heat or solvent, and can be described as the extractable fluid content of cells or tissues (Mihalev *et al.*, 2018). Consuming fresh juices is increasing worldwide due to their freshness, vitamin

content, and ability to reduce risk of diseases like diabetes, heart diseases and cancer (Zhang *et al.*, 2023). The rising interest in functional foods has led to exploring unconventional ingredient combinations for nutritional and therapeutic benefits.

Watermelon (*Citrullus lanatus*), a vine-like plant from the Cucurbitaceae family, is renowned for yielding a juicy, nutrient-dense fruit enjoyed by humans (Nadeem *et al.,* 2022). It serves as an excellent source of vitamins A, B1, B6, and C, along with minerals such as potassium, calcium, iron, zinc, and magnesium—nutrients commonly found in fruits and vegetables (Fulgoni and Fulgoni, 2022). Rich in carotenoids, particularly lycopene, it also contains phytofluene, phytoene, beta-carotene, lutein, and neurosporene (Nadeem et al., 2022). Watermelon offers diverse applications; it can act as a natural alternative to energy drinks before exercise (Shanely *et al.,* 2016), be transformed into fermented wine (Ojo and Eniola, 2019), and serve as a functional food by mitigating cardiovascular risk factors, improving glycemic control, and alleviating vascular dysfunction in obese animals with type II diabetes (Wu *et al.*, 2007).

Garlic (*Allium sativum* L.) is renowned worldwide for its distinctive pungent flavor and is widely used as a seasoning. Beyond its culinary applications, garlic is also celebrated for its medicinal properties, serving as both a preventive and therapeutic plant (Ajami and Vazirijavid, 2019). It promotes respiratory and digestive health and has been historically used to treat conditions like leprosy and parasitic infections (Toledano-Medina *et al.*, 2016). Its therapeutic benefits are largely due to its antibacterial and antiseptic qualities. Additionally, garlic is rich in minerals such as phosphorus, zinc, potassium, and magnesium, along with vitamins like C, K, folate, niacin, and thiamine (Ankri and Mirelman, 1999).

Incorporating garlic into watermelon juice offers a novel approach to developing a functional beverage with improved shelf life, nutritional value, and health benefits. However, this blend may alter the juice's physicochemical properties, sensory attributes, and microbial profile. This study aims to determine the physicochemical characteristics, microbiological quality, and sensory acceptability of garlic-spiced watermelon juice to determine its feasibility and market potential.

Materials and Methods

Sourcing of Materials

Mature ripe watermelon fruits and garlic bulbs were gotten from Okitipupa market in Ondo State, Nigeria. All the reagents used were of analytical grade.

Production of Garlic Juice

Garlic juice was prepared with slight modification following the method outlined by (Cardinali *et al.*, 2024) as depicted in Figure1. The garlic bulbs were peeled, weighed, and washed. The cleaned garlic bulbs were then crushed using a sterile mortar and pestle, and the resulting mixture was filtered through a sterile muslin cloth to extract the garlic juice.

Production of Watermelon Juice

Watermelon juice was produced with modification as described by (Mandha *et al.*, 2021) as shown in Figure 1. Watermelon fruits were washed to remove soil, rewashed with saline (30%), and dried. The fruits were cut with a sterile knife and seeds removed. The pink portions were cut chopped, blended, then filtered using muslin cloth.

Formulation Ratio for the Production of Spiced Watermelon Juice

As outlined in Table 1, spiced watermelon juice was prepared using varying concentrations of garlic juice (0%, 10%, 20%,

30%) and watermelon juice (100%, 90%, 80%, 70%) to create different samples. These juice samples were then placed in sterilized plastic bottles, pasteurized in a water bath at 72^0 C for 15 mins and allowed to cool to 43^0 C for further analyses.

Table 1: Formulation Ratio (%) For the Production of Spiced Watermelon Juice

Sample s	Watermelon fruit juice	Garlic juice
WG1	100	0
WG2	90	10
WG3	80	20
WG4	70	30

Wg1 (control) = 100% watermelon juice: 0% garlic juice; WG2= 90% watermelon juice : 10% garlic juice; WG3= 80% watermelon juice: 20% garlic juice; WG4= 70% watermelon juice: 30% garlic juice.

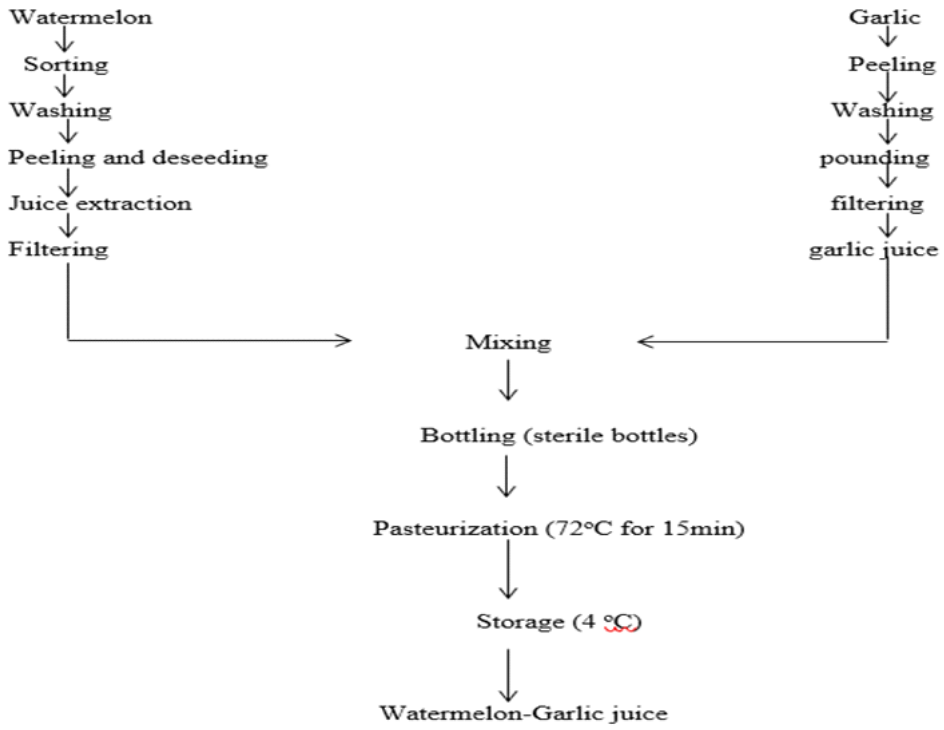

Figure 1: Flow chart for the production of spiced watermelon juice.
Sources: (Mandha *et al.*, 2021; Cardinali *et al.*, 2024)

Determination of Physicochemical Properties of Spiced Watermelon Juice

Prior to use, the pH meter was calibrated using buffer solutions with a pH of 7.0. The pH measurement was taken after the meter was placed in the sample and had stabilized, as described by Han *et al.* (2022). The determination of total soluble solids (TSS) followed the method outlined by AOAC (2005), while total titratable acidity (TTA) was

assessed according to the procedure by Sadler and Murphy (2010). Total solids were then calculated.

"Total Solids "("%")" = 100 - Moisture content"

Determination of Proximate Composition of Spiced Watermelon Juice

The samples were subjected to proximate analysis to assess their levels of moisture, protein, fat, fiber, and carbohydrates, adhering to the official procedures specified by the Association of Official Analytical Chemists (AOAC, 2005), with each analysis being performed three times.

Mineral Composition of Spiced Watermelon Juice

The procedure outlined by (Aransiola *et al.*, 2015) was employed for mineral analysis. Calcium, potassium, phosphorus, magnesium, iron, selenium, copper, and zinc were measured using an atomic absorption spectrophotometer (Buck scientific 210 VGP, Bulk Scientific Inc., 06855 USA).

Determination of Microbiological Quality of Spiced Watermelon Juice

The microbiological quality of the spiced watermelon juice was analyzed following the method of (Ajala *et al.*, 2024) One gram of each sample was suspended into 9 ml of sterile normal saline, mixed and serial dilution was performed. One millilitre was taken from the last dilution, and dispensed into a sterile Petri dish while sterilized nutrient agar (NA) and potato dextrose agar (PDA) were added to determine bacterial and fungal count respectively. Nutrient agar plates were incubated using incubator at 37 °C for 24 h to check for bacteria and PDA plates were incubated at room temperature (28±2 °C) for 72 h to check for fungi

Sensory Evaluation of Spiced Watermelon Juice

Sensory evaluation was carried out on the produced watermelon-Garlic juice within 24 h of production by thirty (30) untrained sensory panelists. The judges scored the samples for taste, colour, texture, characteristics flavour and general acceptability using a 9-point hedonic scale ranging from 1 = dislike extremely and 9 = like extremely (Song, 2022)

Statistical analysis

All the experiment was conducted in triplicate in the average of three determinations. One-way Analysis of Variance (ANOVA) was performed and differences in new value was evaluated using Statistical Package for the Social Sciences (SPSS) version 25.0 software (SPSS Inc., Chicago, IL, 187 USA). P-value less than 0.05 will be considered statistically significant.

Results and Discussion

Physicochemical Properties of Spiced Watermelon Juice

The physicochemical characteristics of the spiced watermelon juice samples, as shown in Table 2, exhibit notable alterations due to the addition of garlic juice. The total solids (TS) content was significantly affected ($p \leq 0.05$) by different garlic concentrations. WG2, which included 10% garlic juice, had the highest TS at 8.01%, considerably surpassing the control (WG1) at 6.71%. This rise is likely due to the dry matter contribution from garlic. However, TS values decreased with further garlic additions, with WG3 (15%) and WG4 (30%) showing 5.96% and 5.56%, respectively. This inverse trend at higher concentrations aligns with the findings of Prisacaru *et al.* (2023), who observed that while moderate garlic inclusion boosts solids, excessive amounts may disrupt the matrix or cause phase separation, thus lowering the concentration of suspended solids. Similarly, titratable acidity (TTA) increased progressively from 1.00% in WG2 to 1.43% in WG4, indicating greater acidity with more garlic content. This pattern is consistent with Shang et al. (2019), who associated garlic's acidity with its sulfur-

containing organic acids. Although higher TTA can improve microbial safety and sensory sharpness, overly acidic drinks might cause gastrointestinal irritation in sensitive individuals, emphasizing the need for balanced formulation. The pH values, ranging from 6.90 in WG2 to 5.90 in WG4, showed a shift from near-neutral to mildly acidic conditions. A lower pH enhances microbial stability, reducing spoilage and pathogenic growth risks, which is a significant advantage for extending shelf life and ensuring food safety (Atasoy *et al.*, 2023). This effect is particularly beneficial for minimally processed beverages that may not be pasteurized. The pH reduction at higher garlic levels supports previous findings by Mohamad Salin *et al.* (2022) on garlic's organic acid interactions during juice blending. Regarding total soluble solids (TSS), garlic inclusion increased the °Brix values from 5.00 in WG1 to 7.00 in WG4, suggesting enhanced sweetness perception and improved energy density. This trend aligns with earlier research (Prisacaru *et al.,* 2023), which demonstrated that vegetable-based bioactive additives raise TSS through soluble phytochemicals and carbohydrates. TSS values in the current study are comparable to several commercial functional drinks, such as ginger and beetroot blends, which typically range between 6.5–9.0 °Brix (Kayın *et al.*, 2019). This highlights the potential for the developed beverage to compete favorably in the functional beverage market, especially with consumers seeking natural, plant-enriched options. From a public health standpoint, incorporating garlic, which is rich in allicin and antioxidant compounds, enhances the functional attributes of watermelon juice by potentially providing cardioprotective, antimicrobial, and anti-inflammatory effects (Ansary *et al.*, 2020). These characteristics make spiced watermelon juice a promising functional beverage for preventive health care. With the growing demand for clean-label products, using natural antimicrobial and antioxidant agents like garlic offers a safer alternative to synthetic preservatives, aligning with consumer preferences for minimally processed foods (Oliveira *et al.*, 2025). Furthermore, the improved TSS and acidity balance observed at moderate garlic concentrations (10–15%) indicates a flavor-stable and nutritionally enriched formulation that could be scaled for commercial production, provided sensory acceptability is optimized. This formulation meets key criteria for functional beverages, offering improved nutritional content, and potential therapeutic benefits.

Table 2: Physicochemical Properties of Spiced Watermelon Juice

Samples	TS	TTA
WG1	6.71 ± 0.72 ^{ab}	1.13± 0.60 ^{a}
WG2	8.01 ± 1.13 ^{a}	1.00± 0.60 ^{a}
WG3	5.96 ± 0.29 ^{b}	1.30± 0.60 ^{a}
WG4	5.56 ± 0.57 ^{b}	1.43± 0.60 ^{a}

Means in the same column with different superscripts are significantly different at p≤0.05
Wg1 (control) = 100% Watermelon juice: 0% garlic juice, WG2= 90% Watermelon juice: 10% garlic juice, WG3= 80% Watermelon juice: 20% garlic juice, WG4= 70% Watermelon juice: 30% garlic juice.

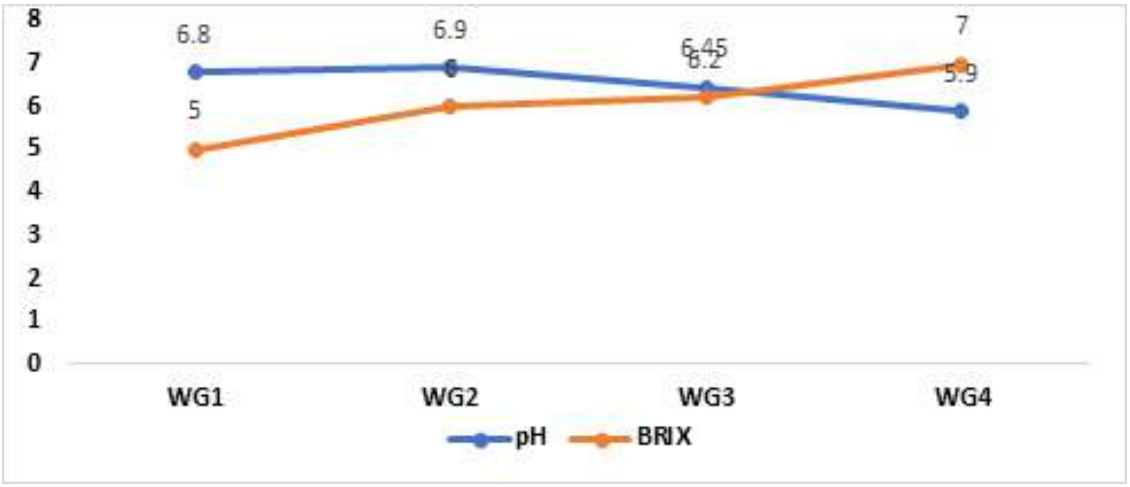

Figure 2: pH and Total Soluble Solid (°Brix) of Spiced Watermelon Juice

Wg1 (control) = 100% Watermelon juice: 0% garlic juice, WG2= 90% Watermelon juice: 10% garlic juice, W= 80% WG3 watermelon juice: 20% garlic juice, WG4= 70% Watermelon juice: 30% garlic juice.

Proximate Composition of Spiced Watermelon Juice

Table 3 illustrates the proximate composition of spiced watermelon juice samples, highlighting significant nutritional changes due to the addition of garlic juice. The moisture content varied from 91.99% to 94.43%, with WG4 having the highest percentage. This is indicative of the naturally high-water content in both watermelon and garlic juice, which enhances hydration potential. This finding aligns with Tiencheu *et al.* (2021), who noted that combining high-moisture ingredients in composite juices increases overall moisture levels, potentially aiding fluid intake, particularly in groups prone to dehydration like the elderly and children. The ash content, which reflects total mineral presence, rose with higher garlic juice concentration, peaking at 0.96% in WG4. WG2 and WG4 had significantly higher ash values than WG1 and WG3, suggesting improved mineral bioavailability. This trend is consistent with Prisacaru *et al.* (2023), who found that garlic-based juice blends have higher ash content due to garlic's inherent mineral richness. The mineral enrichment could enhance micronutrient intake, especially essential electrolytes like potassium, calcium, and magnesium. Conversely, fiber content gradually decreased with more garlic, from 0.47% in WG1 to 0.32% in WG4, possibly due to dilution or lower insoluble fiber from garlic juice compared to watermelon pulp. Reduced dietary fiber might lessen some digestive benefits associated with whole fruit consumption, which is a limitation to consider. Protein content showed a moderate increase in WG2 and WG4 (1.91% and 1.90%, respectively) compared to WG1 (1.74%), indicating that garlic juice might offer slight protein enrichment. Although modest, this could aid in developing plant-based functional beverages aimed at enhancing satiety and supporting muscle maintenance, particularly for vegetarians. Fat content was generally low across all formulations, aligning with consumer preferences for low-fat functional beverages. However, WG2 showed a slight increase (0.22%) compared to WG1 (0.14%) and WG3

(0.10%), possibly due to lipid-soluble organosulfur compounds naturally found in garlic, as suggested by Shang et al. (2019). These compounds are linked to cardioprotective effects, indicating potential added value beyond macronutrient contribution. Interestingly, carbohydrate content was highest in WG2 (4.54%) and lowest in WG4 (2.26%), likely due to varying natural sugar levels and dilution effects of garlic juice. While reducing carbohydrates may benefit those with glycemic concerns, it could also affect flavor and energy value, which must be balanced during product formulation. The observed nutritional changes underscore the potential of garlic-fortified watermelon juice as a functional beverage with added health benefits, such as mineral enrichment, moderate protein enhancement, and potential cardioprotective bioactives. Compared to existing commercial fruit juices or energy drinks, which often contain high sugar levels and artificial additives, this formulation offers a clean-label alternative that may appeal to health-conscious consumers. Additionally, the inclusion of garlic introduces bioactive phytochemicals like allicin, which provide antimicrobial and antioxidant properties, potentially supporting immune health (El-Saadony *et al.*, 2024).

Table 3: Proximate Composition (%) of Spiced Watermelon Juice

Samples	Ash	Fibre	Protein	Fat	Carbohydrate	Moisture
WG1	0.71 ± 0.01 ^{b}	0.47 ± 0.01 ^{a}	1.74 ± 0.06 ^{b}	0.14 ± 0.01 ^{b}	3.63 ± 0.64 ^{ab}	93.28 ± 0.73 ^{ab}
WG2	0.85 ± 0.03 ^{a}	0.43 ± 0.07 ^{a}	1.91 ± 0.00 ^{a}	0.22± 0.02 ^{a}	4.54 ± 1.00a ^{a}	91.99 ± 1.13 ^{b}
WG3	0.62 ± 0.09 ^{b}	0.42 ± 0.40 ^{a}	1.60 ± 0.13 ^{b}	0.10 ± 0.01 ^{c}	3.44 ± 0.53 ^{ab}	94.03 ± 0.57 ^{a}
WG4	0.96 ± 0.06 ^{a}	0.32 ± 0.01 ^{a}	1.90 ± 0.01 ^{a}	0.11 ± 0.01 ^{c}	2.26 ± 0.50 ^{b}	94.43 ± 0.57 ^{a}

Means in the same column with different superscripts are significantly different at p≤0.05
Wg1 (control) = 100% Watermelon juice: 0% garlic juice, WG2= 90% Watermelon juice: 10% garlic juice, WG3= 80% Watermelon juice: 20% garlic juice, WG4= 70% Watermelon juice: 30% garlic juice.

Mineral composition of Spiced Watermelon Juice

Mineral composition of spiced watermelon juice (Table 4) showed significant enhancements with the addition of garlic juice, which could offer public health advantages, particularly in tackling micronutrient deficiencies. The calcium levels rose from 1.81% to 2.58% in the different formulations, playing a crucial role in bone mineralization and lowering the risk of osteoporosis and other degenerative bone conditions (Ciosek *et al.,* 2021). Likewise, potassium levels, which varied from 2.11% to 2.15%, contribute to cardiovascular health by aiding in blood pressure regulation and decreasing the likelihood of hypertension-related issues (Aburto *et al.*, 2013). The iron content was notably high, ranging from 13.52% to 19.02%, with the control sample (WG1) showing the greatest concentration. This is essential for addressing iron-deficiency anemia, especially in at-risk groups like pregnant women and young children (Abu-Ouf and Jan, 2015). The presence of phosphorus (3.14%–5.74%) and magnesium (1.43%–3.50%) further enhances the juice's value as a functional beverage,

supporting energy metabolism, cellular repair, and neuromuscular function (Kiani, 2022). Sodium levels, although low (1.09%–1.21%), fall within the recommended range for maintaining healthy fluid and electrolyte balance. In comparison to current commercial functional beverages, the spiced watermelon juice shows competitive mineral composition, particularly in iron and calcium. For instance, typical sports drinks and vitamin-enriched waters often lack significant amounts of iron or magnesium, limiting their effectiveness for individuals with specific nutritional requirements (Amawi et al., 2024). This indicates potential for commercialization, especially in the expanding market for natural, nutrient-rich, plant-based beverages.

Table 4: Mineral Composition of Spiced Watermelon Juice

Sample	Fe	P	Na	K	Ca	Mg
WG1	19.02 ± 0.80 ^{a}	5.100 ± 0.01 ^{b}	1.16 ± 0.75 ^{c}	2.13 ± 0.20 ^{c}	2.33 ± 0.70 ^{a}	3.50±0.14 ^{a}
WG2	13.52 ± 0.01 ^{c}	5.741 ± 0.27 ^{a}	1.09 ± 1.00 ^{d}	2.11 ^{d} ± 0.20 ^{d}	1.81± 0.15 ^{b}	1.58±1.00 ^{a}
WG3	15.72 ± 0.01 ^{b}	3.860 ± 0.01 ^{c}	1.21 ± 0.25 ^{a}	2.42 ^{a} ± 0.58 ^{a}	2.58 ± 0.10 ^{a}	1.91±0.25 ^{a}
WG4	18.85 ± 0.25 ^{a}	3.140 ± 0.16 ^{d}	1.17 ± 0.65 ^{b}	2.15 ^{b} ± 1.00 ^{b}	2.21± 0.15 ^{ab}	1.43±0.15 ^{a}

Means in the same column with different superscripts are significantly different at p≤0.05
Wg1 (control) = 100% Watermelon juice: 0% garlic juice, WG2= 90% Watermelon juice: 10% garlic juice, WG3= 80% Watermelon juice: 20% garlic juice, WG4= 70% Watermelon juice: 30% garlic juice.

Microbiological Quality of Spiced Watermelon Juice

Table 5 delineates the microbiological quality of spiced watermelon juice. The total fungal count (TFC) varied from 0.2 × 10^4 to 0.3 × 10^4 cfu/ml, with the control sample (WG1) exhibiting the highest TFC. Conversely, samples incorporating garlic juice (WG2–WG4) consistently demonstrated a TFC of 0.2 × 10^4 cfu/ml, which means that garlic may possess antifungal properties. Garlic is renowned for its broad-spectrum antimicrobial effects, attributed to bioactive compounds such as allicin, diallyl sulfides, and ajoene (Bhatwalkar *et al.*, 2021). These compounds disrupt microbial membranes and inhibit enzymes, thereby constraining microbial growth. However, the total bacterial count (TBC) remained constant across all samples at 0.2 × 10 cfu/ml, indicating that the garlic concentrations employed (up to 30%) might not have been adequate to influence bacterial populations or that the bacteria present were resistant under the study conditions. This observation is consistent with findings by Trivedi et al. (2015), who reported greater reductions in fungal growth compared to bacterial counts when assessing garlic's antimicrobial activity in fruit juice blends. The findings of this study indicate that the decrease in TFC observed in samples treated with garlic implies that garlic improve the microbial safety of fruit juice products, especially by reducing fungal spoilage.

Table 5: Microbiological Quality of Spiced Watermelon Juice

Parameter	WG1	WG2	WG3	WG4
Total fungi count (sfu/ml)	0.3×10^{4}	$0.2\ x10^{4}$	$0.2\ x10^{4}$	$0.2\ x10^{4}$
Total bacterial count (cfu/ml)	$0.2x10^{5}$	$0.2\ x10^{5}$	$0.2x10^{5}$	$0.2x10^{5}$

Wg1 (control) = 100% Watermelon juice: 0% garlic juice, WG2= 90% Watermelon juice: 10% garlic juice, WG3= 80% Watermelon juice: 20% garlic juice, WG4= 70% Watermelon juice: 30% garlic juice, TFC: Total fungal count, TBC: Total bacterial count

Sensory Evaluation of Spiced Watermelon Juice

The sensory evaluation (Table 6) reveals the subtle effects of adding garlic juice to spiced watermelon juice on its organoleptic characteristics. Although the color scores (6.00–8.00) remained largely unaffected ($p \leq 0.05$), indicating good visual appeal even with 30% garlic addition, the more volatile sensory aspects taste, mouthfeel, and flavor were significantly impacted. The control sample (WG1) consistently scored higher across all sensory categories, especially in taste (6.40) and overall acceptability (6.20), indicating a consumer preference for unaltered watermelon juice. The decline in taste scores with increased garlic concentration, with WG4 scoring the lowest (2.80), can be attributed to the presence of allicin and other sulfur compounds in garlic, which are known for their pungent, spicy, and sometimes bitter taste (Shang *et al.,* 2019). These compounds can overshadow or diminish the natural sweetness and fruity flavor of watermelon, resulting in decreased palatability. Similarly, the reduction in mouthfeel, from 5.60 in WG1 to 2.80 in WG4, suggests that high garlic levels may introduce astringency or alter the juice's viscosity and smoothness, as previously noted in garlic-enhanced food matrices (Ansary *et al.*, 2020). Interestingly, flavor ratings peaked in WG2 (5.60), slightly surpassing the control (5.40), possibly due to a balanced interaction between the sweet watermelon base and the mild pungency of garlic, which might enhance the perception of complexity or functional benefit. This aligns with previous findings that moderate levels of garlic or spice can enhance flavor perception without overwhelming the base food (Shang *et al.,* 2019). However, at higher concentrations (WG3 and WG4), the emergence of off-flavors likely contributed to lower scores, consistent with the sensory suppression threshold of pungent additives in beverages (Chen *et al.,* 2022). Garlic is well-known for its antimicrobial, antioxidant, and cardioprotective properties (Amagase, 2006), and its inclusion in beverages offers potential as a functional drink with added health benefits. Therefore, a product like WG2 which balances acceptable sensory qualities with functional enhancement could attract health-conscious consumers, especially given the global demand for natural functional beverages (Udomwong *et al.*, 2023). The moderately garlic-fortified juice (WG2) presents a viable product for the functional beverage market. The flavor enhancement and maintained consumer acceptability suggest its suitability for niche markets targeting immune-boosting or detox beverages. However, to improve marketability, product reformulation strategies such as flavor masking, microencapsulation of garlic extract be necessary to reduce pungency while preserving health. When compared quantitatively, the overall acceptability of

WG2 (5.20) falls within the range of other experimental functional beverages fortified with herbal extracts or spices, where consumer scores typically range from 4.5 to 6.5 on 9-point hedonic scales (Skąpska *et al.,* 2020). This underscores the potential of garlic-fortified watermelon juice as a competitive entrant in the functional drink sector, albeit with targeted sensory optimization.

Table 6: Sensory Evaluation of Spiced Watermelon Juice

Samples	Color	Taste	Mouth feel	Flavour	Overall acceptability
WG1	8.00 ± 0.70 ^{a}	6.40 ± 1.14 ^{a}	5.60 ± 1.81 ^{a}	5.40 ± 1.67 ^{a}	6.20 ± 0.83 ^{a}
WG2	7.00 ± 1.58 ^{a}	5.20 ± 0.83 ^{ab}	5.20 ±1.64 ^{a}	5.60 ± 1.14 ^{a}	5.20 ± 1.09 ^{a}
WG3	6.80 ± 1.48 ^{a}	4.20 ± 1.30 ^{bc}	3.60 ± 1.14 ^{ab}	4.40 ± 1.14 ^{ab}	4.60±0.89 ^{ab}
WG4	6.00 ± 2.00 ^{a}	2.80 ± 1.78 ^{c}	2.80 ± 1.78 ^{b}	3.40 ± 1.51 ^{b}	3.40 ±1.94 ^{b}

Means in the same column with different superscripts are significantly different at p≤0.05
Wg1 (control) = 100% Watermelon juice: 0% garlic juice, WG2= 90% Watermelon juice: 10% garlic juice, WG3= 80% Watermelon juice: 20% garlic juice, WG4= 70% Watermelon juice: 30% garlic juice.

Conclusion

This study demonstrates that garlic juice significantly influences physicochemical properties, such as pH, total solids, acidity, moisture, and mineral composition. The sample containing 10% garlic juice (WG2) achieved an optimal balance, maintaining acceptable quality while enhancing nutritional value. Spiced watermelon juice samples were microbiologically safe, due to garlic preservative effect. The inclusion notably increased minerals, particularly calcium, magnesium, and iron. In conclusion, blending watermelon juice with 10% garlic results in a functional, nutrient-rich beverage that satisfies health-conscious consumers and contributes to the functional foods market. Future studies should explore **long-term storage effects, consumer perception,** and **clinical validation of health benefits** to further establish its utility.

References

Abu-Ouf, N., and Jan, M. (2015). The impact of maternal iron deficiency and iron deficiency anemia on child's health. *Saudi Med. J.*, 36(2): 146–149. https://doi.org/10.15537/smj.2015.2.10289

Aburto, N. J., Hanson, S., Gutierrez, H., Hooper, L., Elliott, P., and Cappuccio, F. P. (2013). Effect of increased potassium intake on cardiovascular risk factors and disease: systematic review and meta-analyses. *BMJ*, 346: f1378. https://doi.org/10.1136/bmj.f1378

Ajala, O., Adelusi, O. A., Kajihausa, O. E., Onabanjo, O. O., Oyewole, O. B., and Obadina, A. O. (2024). Effect of storage temperature and time on microbial quality and sensory properties of extrudates from pearl millet (*Pennisetum glaucum*) and Bambara groundnut (*Vigna subterranea*) flour blends. *J. Stored Prod. Res.*, 109: 102442.

https://doi.org/10.1016/j.jspr.2024.102442

Ajami, M., and Vazirijavid, R. (2019). Garlic (*Allium sativum* L.). In: *Nonvitamin and Nonmineral Nutritional Supplements*, pp. 227–234. https://doi.org/10.1016/b978-0-12-812491-8.00033-3

Amawi, A. T., Al-Kasasbeh, W. J., Jaradat, M., et al. (2024). Athletes' nutritional demands: a narrative review. *Front. Nutr.*, 10: 1331854. https://doi.org/10.3389/fnut.2023.1331854

Ankri, S., and Mirelman, D. (1999). Antimicrobial properties of allicin from garlic. *Microbes Infect.*, 1(2): 125–129. https://doi.org/10.1016/s1286-4579(99)80003-3

Ansary, J., Forbes-Hernández, T. Y., Gil, E., et al. (2020). Potential health benefit of garlic based on human intervention studies: a brief overview. *Antioxidants*, 9(7): 619. https://doi.org/10.3390/antiox9070619

AOAC. (2005). *Official Methods of Analysis*, 15th ed., Vol. 2. Washington D.C., USA: Oxford University Press, pp. 910–928.

Aransiola, S. A., Ijah, U. J. J., and Ayodele, H. S. (2015). Microbiological and sensory attributes of watermelon juice and watermelon-orange mix. *J. Food Resour. Sci.*, 4(3): 49–61. https://doi.org/10.3923/jfrs.2015.49.61

Atasoy, M., Álvarez Ordóñez, A., Cenian, A., et al. (2023). Exploitation of microbial activities at low pH to enhance planetary health. *FEMS Microbiol. Rev.*, 48(1). https://doi.org/10.1093/femsre/fuad062

Bhatwalkar, S. B., Mondal, R., Krishna, S. B. N., et al. (2021). Antibacterial properties of organosulfur compounds of garlic. *Front. Microbiol.*, 12: 613077. https://doi.org/10.3389/fmicb.2021.613077

Cardinali, F., Botta, C., Harasym, J., et al. (2024). Lacto-fermented garlic from Lower Silesia: microbial diversity and volatile compounds. *Food Res. Int.*, 188: 114484. https://doi.org/10.1016/j.foodres.2024.114484

Ciosek, Ż., Kot, K., Kosik-Bogacka, D., et al. (2021). Effects of calcium, magnesium, phosphorus, fluoride, and lead on bone tissue. *Biomolecules*, 11(4): 506. https://doi.org/10.3390/biom11040506

Dai, R., and Lim, L. T. (2013). Release of allyl isothiocyanate from mustard seed meal powder. *J. Food Sci.*, 79(1): 47–53. https://doi.org/10.1111/1750-3841.12322

El-Saadony, M. T., Saad, A. M., Korma, S. A., et al. (2024). Garlic bioactives and their therapeutic applications. *Front. Immunol.*, 15: 1277074. https://doi.org/10.3389/fimmu.2024.1277074

Fulgoni, K., and Fulgoni, V. L. (2022). Watermelon intake and nutrient quality: NHANES 2003–2018. *Nutrients*, 14(22): 4883. https://doi.org/10.3390/nu14224883

Han, H., Wang, H., Gao, G., et al. (2022). pH effect on micro-nano particles in black tea infusion. *Food Control*, 133: 108643.

Kiani, A. K. (2022). Main nutritional deficiencies. *J. Prev. Med. Hyg.*, 63(3):

9 3 – 1 0 1 . https://doi.org/10.15167/2421-4248/jpmh2022.63.2S3.2752

Lietzow, J. (2021). Biologically active compounds in mustard seeds: a toxicological perspective. *Foods*, 1 0 (9) : 2 0 8 9 . https://doi.org/10.3390/foods10092089

Nadeem, M., Navida, M., Ameer, K., et al. (2022). Review on watermelon phytochemicals and bioactivities. *Korean J. Food Preserv.*, 29(4): 5 4 6 – 5 7 6 . https://doi.org/10.11002/kjfp.2022.29.4.546

Mandha, J., Shumoy, H., Devaere, J., et al. (2021). Fermentation of watermelon juice: sensory and volatile analysis. *Food Chem.*, 358: 129809. https://doi.org/10.1016/j.foodchem.2021.129809

Mihalev, K., Dinkova, R., Shikov, V., and Mollov, P. (2018). Classification of fruit juices. In: *Fruit Juices*, pp. 3 3 – 4 4 . https://doi.org/10.1016/b978-0-12-802230-6.00003-5

Mohamad Salin, N. S., Md Saad, W. M., Abdul Razak, H. R., and Salim, F. (2022). Effects of storage on watermelon juice properties. *Metabolites*, 12(1): 75. https://doi.org/10.3390/metabo12010075

Ojo, R., and Eniola, E. (2019). Production of fermented wine using watermelon. *Int. J. Adv. Chem. Res.*, 1(2): 37–41. https://doi.org/10.33545/26646781.2019.v1.i2a.55

Piyachat, U., Vassilis, K., Tanachai, P., et al. (2023). Nutritional value and properties of garlic during processing. *Front. Nutr.*, 10: 1 1 4 2 7 8 4 . https://doi.org/10.3389/fnut.2023.1142784

Prisacaru, A. E., Ghinea, C., Albu, E., and Ursachi, F. (2023). Effects of ginger and garlic powders on fruit juices. *Foods*, 12(6): 1311. https://doi.org/10.3390/foods12061311

Sadler, G. D., and Murphy, P. A. (2010). pH and titratable acidity. In: *Food Science Texts Series*, pp. 219–238. https://doi.org/10.1007/978-1-4419-1478-1_13

Setiyoningrum, F., Priadi, G., Afiati, F., et al. (2021). Spontaneous black garlic fermentation. *Food Sci. Technol.* https://doi.org/10.1590/fst.28720

Shang, A., Cao, S., Xu, X., et al. (2019). Bioactive compounds and functions of garlic. *Foods*, 8(7): 246. https://doi.org/10.3390/foods8070246

Shanely, R., Nieman, D., Perkins-Veazie, P., et al. (2016). Watermelon vs. carb beverage in exercise recovery. *Nutrients*, 8(8): 518. https://doi.org/10.3390/nu8080518

Skąpska, S., Marszałek, K., Woźniak, Ł., et al. (2020). Development and acceptance of fruit-herbal beverages. *Foods*, 9 (1 2) : 1 8 1 9 . https://doi.org/10.3390/foods9121819

Slavin, J. L., and Lloyd, B. (2012). Health benefits of fruits and vegetables. *Adv. Nutr.*, 3(4): 5 0 6 – 5 1 6 . https://doi.org/10.3945/an.112.002154

Song, Q., Li, R., Song, X., et al. (2022). High-pressure processing effect on fruit juice quality. *Food Res. Int.*, 157: 1 1 1 2 5 0 . https://doi.org/10.1016/j.foodres.2022.111250

Tesfaye, A. (2021). Therapeutic uses of garlic and drug potential. *Sci. World J.*, 2021: 1–7. https://doi.org/10.1155/2021/8817288

Tiencheu, B., Nji, D. N., Achidi, A. U., et al. (2021). Natural fruit juice formulation: nutritional and shelf-life study. *Heliyon*, 7(6): e07177. https://doi.org/10.1016/j.heliyon.2021.e07177

Toledano-Medina, M. A., Pérez-Aparicio, J., Moreno-Rojas, R., and Merinas-Amo, T. (2016). Evolution of antioxidant properties in black garlic. *Food Chem.*, 199: 135–139. https://doi.org/10.1016/j.foodchem.2015.11.128

Trivedi, N., Yadav, S., and Bhatt, J. (2015). Antimicrobial activity of fresh garlic juice. *AYU*, 36(2): 203. https://doi.org/10.4103/0974-8520.175548

Wu, G., Collins, J. K., Perkins-Veazie, P., et al. (2007). Watermelon pomace juice and metabolic syndrome in rats. *J. Nutr.*, 137(12): 2680–2685. https://doi.org/10.1093/jn/137.12.2680

Zhang, X., Liao, X., Wang, Y., et al. (2023). Health effects of fruit juices with varying processing levels. *Food Sci. Hum. Wellness*, in press. https://doi.org/10.26599/fshw.2022.9250202x