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Micronutrients and phytochemical properties of tigernut milk produced with blends of watermelon

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Abstract

The study's goal was to use watermelon juice blends to determine the phytochemical properties and micronutrients of tigernuts. The watermelon-containing juice samples could be combined with tigernut juice, which has a higher nutritious value. Juices from watermelon and tiger nuts were prepared independently and mixed in the following proportions: 50:50, 60:40, 70:30, 80:20, 90:10, and 100:0. The combined juices were separately pasteurized for 15 minutes at 72°C, cooled, labeled, and stored at 4°C before to being subjected to various analyses. The mixes contained far higher levels of vitamins, according to the vitamin composition results. The phytochemical results demonstrate that all blends are rich in phytochemicals, which are abundant in water melon, as the percentage of water melon in each mix rises.It is advised that additional research be done on the beverage's therapeutic qualities, antioxidant qualities, and storage stability in order to ascertain its shelf life.

Keywords: Tigernut milk, watermelon juice blends, micronutrients, phytochemicals

Introduction

Plant-based milks are being researched more and more due to consumer desire for sustainable, useful, and nutrient-dense alternatives to cow's milk (Oladunjoye and Idiat, 2025) [18]. Among these, tigernut milk—produced from Cyperus esculentus tubers—is highly prized for its nutritional profile and bioactive compounds. Vitamins and phytochemicals, including as lycopene and vitamin C, are abundant in watermelon (Citrullus lanatus) juice (Joseph and Adamu, 2025) [14]. Blending watermelon juice with tigernut milk can boost micronutrient richness and antioxidants while perhaps improving sensory quality. Tiger-nut milk, also known as "Kunun aya" in northern Nigeria, is a fermented, non-alcoholic beverage that is regularly consumed due to its nourishing and moisturizing properties (Okoh *et al*., 2025) [16].

Although it is consumed throughout the year, it is more commonly consumed during the dry season (Okoh *et al*., 2025) [16]. The tiger-nut is extensively cleansed to remove dirt in order to prepare it locally. The nuts are cleaned, soaked for four to eight hours, and then crushed into a mush with pineapple, date fruit, or coconut. For each kilogram of tiger nuts, three liters of cold water are added, and the mixture is then left to macerate. Before being made into milk, it needs to be soaked, ground, and filtered; variations in temperature and time have an impact on how well the nutrients are maintained (Oladunjoye and Idiat, 2025) [18]. Tigernut milk has significant levels of carbohydrates, moderate fat, and protein fractions.

The energy contribution is supported by the carbohydrate content, while the lipids—rich in monounsaturated fatty acids—add calories and functional value (Oladunjoye and Idiat, 2025) [18]. However, comprehensive fatty acid profiling is still a topic for future research. Tigernut contains phenolic compounds, flavonoids, saponins, and trace levels of sterols. They may be beneficial to health and promote antioxidant activity (Oluwakemi *et al*., 2021) [20]. Empirical studies show that adding watermelon juice to tigernut milk increases its vitamin C content, especially when the watermelon ratio is higher. Blends of 50:50 and more have higher vitamin levels than tigernut milk alone (Joseph & Adamu, 2025; Okoh *et al*., 2025) [14, 16]. According to Okoh *et al*. (2025) [16], certain cultures enjoy "tigernut milk" with various fruit flavors, while others prefer it without any added sugar.

Tiger-nut milk, sometimes referred to as "Kunun aya," should be consumed within two to twenty-four hours at 40 to 65 degrees Celsius due to its limited shelf life (Akoma *et al*., 2006) [2]. This beverage is quite affordable because the tiger nuts and other ingredients needed to prepare it are easily accessible and bought locally. The packing supplies are inexpensive and easily accessible. It has long been recognized that tiger nuts offer health benefits due to their high soluble glucose and oleic acid content, as well as their high calorie content (starch, lipids, sugar, and proteins).This nut produces up to 25.5% of high-quality oil and about 8% protein. According to Oladele and Aina (2007) [17], tiger nuts are also a great source of several beneficial elements, including calcium and iron, which are necessary for bodily growth and development.

They also include traces of copper, potassium, sodium, magnesium, zinc, phosphorus, and vitamins E and C, according to Oladele and Aina (2007) [17]. They are believed to help prevent heart attacks, thrombosis, and cancers, especially colon cancer (Bibek, 2001). They are believed to be beneficial for people with diabetes (if sugar-free) and those trying to reduce cholesterol or lose weight (Oladele and Aina, 2007) [17]. Tiger nuts are said to contain a high amount of dietary fiber, which may help prevent and treat a number of diseases, including heart disease, diabetes, obesity, colon cancer, and digestive problems. Its tubers are also utilized as an aphrodisiac, carminative, stimulant, and diuretic (Okoh *et al*., 2025) [16].

Tiger nuts have reportedly been used to treat indigestion, flatulence, dysentery, and diarrhea. Additionally, it has been demonstrated that tigernut contains more essential amino acids than the 1985 FAO/WHO protein standard for fulfilling adult requirements (Belewu and Adedunmi, 2008) [8]. To compensate for its deficiency in these nutrients, tigernut milk could be fortified with premium sources of vitamins, minerals, and phytochemicals. Fruit juices have been used in several beverages to achieve this. According to the DPPH and FRAP tests, adding watermelon to blended drinks increases the concentration of carotenoid and phenolic content, which improves the antioxidant capacity (Joseph and Adamu, 2025; Okoh *et al*., 2025) [14, 16]. Tigernut contributes its own phenols and saponins to create a composite antioxidant profile.

Watermelon (Citrullus lanatus), a member of the Cucurbitaceae family, is grown in almost every warm area on the planet. It can be red, orange, or yellow, depending on how much lycopene and β-carotene are present. Watermelon was once believed to be a non-nutritious crop, but *in vitro* and *in vivo* research have demonstrated the fruit's health advantages, and several bioactive compounds have been discovered in recent years. Phenolics, which are mostly derivatives of hydroxycinnamic acid and a substantial amount of lycopene, give watermelon its characteristic red color and strong antioxidant qualities.

Using water melon to augment tigernuts helps reduce the enormous volume of water melon fruit that is wasted since many water melon and tigernuts decay during their prime growing season. A large amount of watermelon and tigernuts are thrown away due to improper processing and preservation. To reduce environmental pollution, these underutilized plant products must be transformed into high-value food items. The study's objective is to identify the micronutrients and phytochemical properties of tigernut milk prepared with watermelon mixes. This study involved the manufacturing and quality evaluation of tigernut milk boosted with watermelon juice. Adding watermelon juice to tigernut will improve the beverage's phytochemical and nutritional levels. Drinking the beverage will improve the customers' health. Farmers will profit more from these crops and waste from watermelon and tigernuts will be decreased by employing this product. For use in feeding programs, tigernuts are a great method to strengthen watermelon.

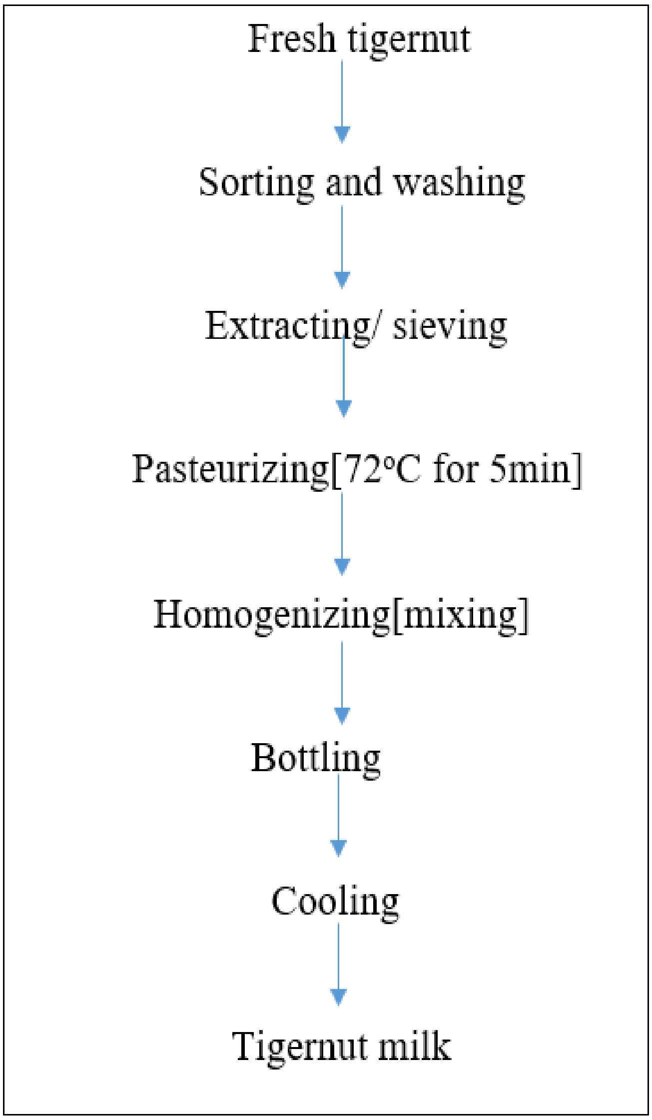
Material And Method

Material procurement

We bought water melon, ginger, cloves, sugar, and mature tiger nuts—the most common component of tiger nut milk—from Main Market Ozoro in Delta State, Nigeria. The watermelon and nuts were transported to the lab in a sterilized polythene bag for processing and analysis.

Preparation of Tigernut

Tiger nuts were sorted to remove any cracked, rotting, stones, pebbles, and other dirt particles before being rinsed in water to remove any soil that might have stuck. The other ingredients needed to make the milk—coconut, date, cinnamon, and ginger—were all prepared before being used. The coconut's shell was removed with a knife, and the water was discarded. The coconut flesh was removed in smaller pieces. The seeds of the date were removed and discarded. All of these ingredients were thoroughly cleaned with warm watermen's sugar. Explain which were cleaned. One kilogram (1 kg) of tiger nuts were soaked in three liters of boiling water at 60 degrees Celsius for six hours using a modified Okoh *et al*. (2025) [16] method. The flow diagram for making tigernut milk is shown in Figure 1.

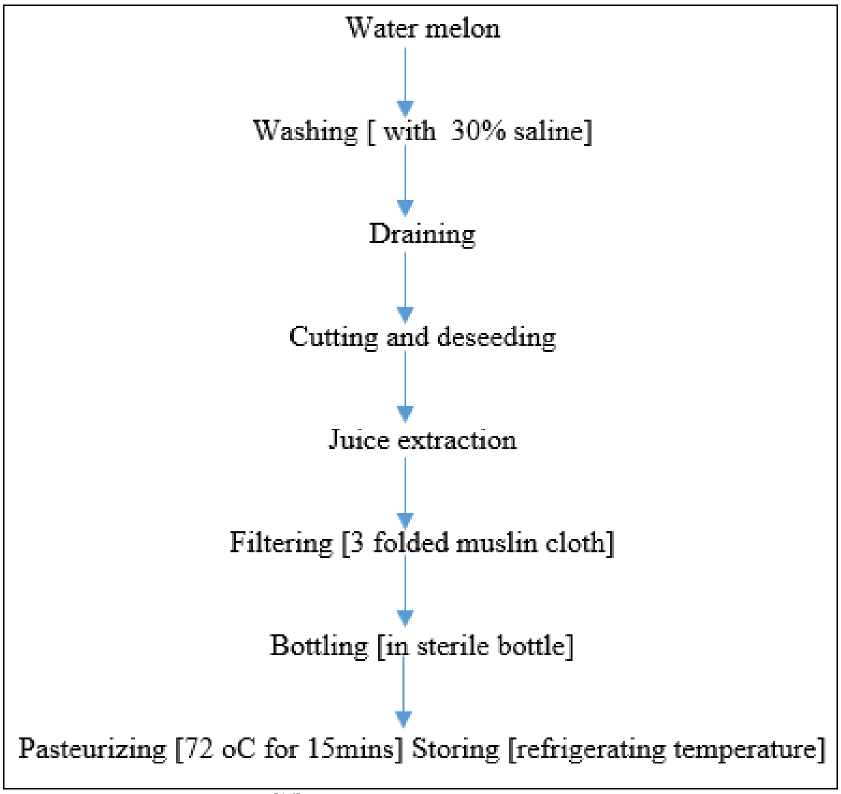


Source: Okoh *et al*. (2025) [16].

Fig 1: Flow chart for Tiger nut milk drink production

Preparation of water melon juice

The watermelon fruits were cleansed with 30% saline and then allowed to dry. A sharp, sterile kitchen knife was then used to remove the seeds from the fruits. The edible pink portion was cut into small pieces for extraction. The juice was extracted from the diced pieces using the Master Chef food processor, JBL, 2102. The extracted juice was then filtered through a three-fold cotton cloth. The production flow chart for watermelon juice is shown in Fig. 2.



Source: Okoh *et al.* (2025) [16].

Fig 2: Watermelon juice production

Blending of Tigernut, coconut and water melon juice

Ten, twenty, thirty, forty, and fifty percent of the tigernut were replaced with water melon juice in a food blender set to maximum speed for ten minutes. All of the control was made of tigernut. The samples were stored in plastic bottles at 10 ºC in a refrigerator before to use.

Analytical method

Analytical procedures of minerals and vitamins

The composition of vitamins B1, B2, B3, B5, B6, B9, B12, C, A, E, D, and K was ascertained using the AOAC (2023) [5] technique.

Phytochemicl Analysis

Estimating Oxalate Composition

The acid digestion and potassium permanganate titrimetric method, as outlined by AOAC (2023) [5], was slightly modified to determine the oxalate level of the juice samples. To liberate soluble oxalates, 10 mL of the juice sample was combined with 75 mL of 3 M sulfuric acid and heated to 90 °C for 30 minutes. After filtering the mixture, the filtrate was heated and titrated against a standardized 0.05 M potassium permanganate ($KMnO_4$) solution until a consistent light pink color was achieved.The amount of $KMnO_4$ drank was used to compute the oxalate concentration, which was then expressed as mg oxalate per 100 mL of juice. Because of its precision and repeatability, this technique is frequently used to measure oxalate in plant-based foods and drinks (Abera, Yohannes, & Chandravanshi, 2023) [1].

Estimating Anthocyanin Concentration

According to Constantin and Istrati (2022) [9], the pH differential spectrophotometric method was used to calculate the total anthocyanin concentration. Potassium chloride buffer (pH 1.0) and sodium acetate buffer (pH 4.5) were used to dilute the juice extract independently. A UV-visible spectrophotometer was used to measure each solution's absorbance at 520 and 700 nm. The anthocyanin concentration, reported as mg cyanidin-3-glucoside equivalents (C3G)/100 mL of juice, was computed using the difference in absorbance between the two pH settings.

Estimating the Tannin Content

According to Abera *et al.* (2023) [1], the vanillin-HCl colorimetric method was used to evaluate the tannin level. One milliliter of the juice extract, five milliliters of vanillin reagent, and one milliliter of strong hydrochloric acid were combined. For twenty minutes, the mixture was incubated at room temperature. A UV-Vis spectrophotometer was used to detect absorbance at 500 nm. A standard tannic acid calibration curve was used to determine the tannin concentration, which was then represented as mg tannic acid equivalent (TAE)/100 mL of juice.

Estimating the Total Flavonoid Content

According to Nastasi (2025) [15], the aluminum chloride ($AlCl_3$) colorimetric method was used to determine the total flavonoid concentration. In short, 0.3 mL of a 5% sodium nitrite solution, 4 mL of purified water, and 1 mL of juice extract were combined. Five minutes later, 2 mL of 1 M sodium hydroxide and 0.3 mL of 10% aluminum chloride were added. A spectrophotometer was used to measure the absorbance of the resultant solution at 415 nm. A quercetin standard curve was used to determine the total flavonoid concentration, which was then reported as mg quercetin equivalent (QE)/100 mL of juice.

Estimating the Content of Epicatechin

High Performance Liquid Chromatography (HPLC) was used to measure the epicatechin content in accordance with the procedure outlined by Rasheed, Al-Phalahy, and Mohammed (2024) [23]. Before being injected into the HPLC system using a C18 reverse-phase column, juice samples were passed through a 0.45 µm membrane filter. Water acidified with formic acid and acetonitrile under gradient elution made up the mobile phase. At 280 nm, detection was done. By comparing retention periods and peak regions with those of standard epicatechin solutions, epicatechin was identified and quantified. The findings were reported as mg of epicatechin per 100 milliliters of juice.

Estimating the Phytate Content

The ferric chloride spectrophotometric method, as outlined by AOAC (2023) [5], was used to determine the phytate content. In short, 2.4% hydrochloric acid was used to extract 10 mL of the juice sample, which was then filtered. An iron-phytate compound was created by treating the filtrate with a ferric chloride solution. A UV-Vis spectrophotometer was used to detect the absorbance at 520 nm. A phytic acid standard curve was used to calculate the phytate concentration, which was then represented as mg phytic acid/100 mL of juice.

Statistical Analysis

A totally randomized design was used to conduct the experiment. Version 17 of the statistical package for social science (SPSS) program was used to analyze the data using one-way analysis of variance. The least significant difference (LSD) test was used to distinguish means that differed statistically. At $P<0.05$, significance was deemed to exist.

Results and Discussion

Vitamins Composition of Tigernut with Blends of Watermelon

Table 1: Vitamin composition of the Samples

SAMPLE	VIT_B1	VIT_B2	VIT_B3	VIT_B5	VIT_B6	VIT_B9
T	$0.47^{a}\pm0$	$0.11^{e}\pm0$	$1.74^{a}\pm0$	$1.82^{f}\pm0$	$0.56^{a}\pm0$	$1.66^{f}\pm0$
TW1	$0.46^{b}\pm0$	$0.11^{d}\pm0$	$1.74^{a}\pm0.01$	$1.85^{e}\pm0$	$0.54^{ab}\pm0$	$1.68^{e}\pm0$
TW2	$0.43^{c}\pm0$	$0.12^{cd}\pm0$	1.72a±0	$1.9^{d}\pm0$	$0.52^{bc}\pm0$	$1.7^{d}\pm0$
TW3	$0.4^{d}\pm0$	$0.12^{bc}\pm0$	$1.71^{b}\pm0$	$1.95^{c}\pm0$	$0.5^{cd}\pm0$	$1.72^{c}\pm0$
TW4	$0.38^{e}\pm0$	$0.13^{b}\pm0$	$1.67^{c}\pm0$	$2.21^{b}\pm0$	$0.49^{d}\pm0$	$1.9^{b}\pm0$
TW5	$0.38^{e}\pm0$	$0.13^{a}\pm0$	$1.62^{d}\pm0$	$2.42^{a}\pm0$	$0.46^{e}\pm0.03$	$1.94^{a}\pm0$

Key: values are mean±standard deviation from two determinations. Means in a column bearing similar superscripts are not significant ($p>0.05$). While means in the same column with different superscripts are significantly ($p<0.05$) different

The vitamin B1 content of the blended tigernut drinks with watermelon juice was lower than that of the 100% tigernut juice samples (Table 1). The amount of vitamin B1 in the beverage ranged from 0.38 to 0.47 IU. The values for composite flour prepared from African yam beans, pigeon peas, and black grams were somewhat less than 1.00 to 2.33 mg/100g, according to Anene *et al.* (2023) [3]. The watermelon-blended juice had a lower vitamin A concentration (0.34 to 0.47 IU) than the 100% tigernut juice (0.47). The results were slightly lower than the 5.570–7.795 mg/100g reported by Aniemena *et al.* (2024) [4] for cupcakes produced with garri composite flour.

Although this vitamin is relatively stable to heat (especially the heating needed during food preparation), the drop during blanching is likely due to heat destruction rather than leaching because it is not soluble in water. Compared to the watermelon juice samples including tigernuts, the 100% tigernut drink had a decreased riboflavin (vitamin B2) level (Table 1). The juice's vitamin B2 levels varied from 0.11 to 013 mg/100g, which was partly consistent with research by Emojorho *et al.* (2025) [11], who discovered that tortilla bread samples made from rice composite flour had vitamin B2 levels ranging from 0.03 to 0.14 mg/100g.

The tigernut juice with 50% watermelon had the highest value (0.13 mg/100g), while the tigernut juice with 100% watermelon had lower vitamin B2 levels (1.11 mg/100g–0.13 mg/100g) compared to the 100% tigernut juice (0.11 mg/100g–0.13 mg/100g). The vitamin B2 concentration increased along with the volume of watermelon juice. The juice samples' vitamin B2 levels differed significantly ($p<0.05$). Riboflavin is a yellow crystalline material that partially dissolves in water. Because it belongs to multiple enzyme systems, such as oxidases and dehydrogenases, it is engaged in energy metabolism. In addition to insufficient consumption, endocrine abnormalities (such thyroid hormone insufficiency) and specific diseases can cause riboflavin inadequacy (Emojorho *et al.*, 2023) [12].

Skin conditions, edema of the mouth and throat, hyperemia (excess blood), angular stomatitis (lesions at the corners of the mouth), cheilosis (swollen, cracked lips), hair loss, reproductive problems, sore throat, itchy and red eyes, and degeneration of the liver and nervous system are all signs of riboflavin deficiency, also known as ariboflavinosis (Mc Cormick, 2010). Some of these symptoms may be related to other vitamin deficiencies because riboflavin deficiency is often linked to other deficiencies. A riboflavin deficit causes glossitis, a condition in which the tongue and lips enlarge and the corners of the mouth get scaly (Onimawo and Akubor, 2011).

The niacin (vitamin B3) content of the tigernut drinks containing watermelon juice was lower than that of 100% tigernut juice. The amount of vitamin B3 in the juice ranged from 1.74 to 1.62 mg per 100 grams. The amounts of vitamin B3 in biscuits manufactured with composite flour were higher than the 0.23 to 0.36 mg/100g reported by Aphiar *et al.* (2024) [6]. 50% watermelon juice had the lowest vitamin B3 level (1.62 mg/100g), whereas 100% tigernut juice had a higher level (1.74 mg/100g–3.2 mg/100g) than tigernut juice combined with watermelon juice (1.62 mg/100g–1.74 mg/100g). Vitamin B3 levels decreased as watermelon juice content rose in the samples. "The vitamin B3 content of the juice varied significantly ($p<0.05$) between the samples."

White and crystalline, niacin dissolves in water. Coenzymes that contain niacin include nicotinamide adenine dinucleotide (NAD) and nicotinamide adenine dinucleotide phosphate (NADPH), as well as their reduced equivalents NADH and NADPH. It plays a part in $H+$ transport as well as energy release. The citric acid and glycolytic cycles, as well as protein metabolism, are supported by coenzymes. A niacin deficiency is the cause of pellagra, sometimes referred to as the "3-D disease" because of its main symptoms of delirium, dermatitis, and diarrhea (Emojorho *et al.* 2023) [12]. This water-soluble vitamin, which the body may also make from tryptophan, is necessary for human survival. Pellagra is caused by a dietary niacin deficit.

If niacin is not consumed, it causes rashes, diarrhea, dementia, and eventually death. Niacin is a lipid-lowering vitamin that can be used to treat diabetes mellitus (Elam *et al*., 2000) [10].

The tigernut juice with watermelon juice sample had a higher level of vitamin B5 than the 100% tigernut juice sample. The amount of vitamin B5 in the juice ranged from 1.82 to 2.42 mg per 100 grams. The tigernut juice with watermelon juice had higher vitamin B5 concentrations (1.85 mg/100g–2.42 mg/100g) than the 100% tigernut juice (1.82 mg/100g). The amount of vitamin B5 increased with the amount of watermelon juice. The amount of vitamin B5 in each juice sample varied significantly (P < 0.05).

The amount of vitamin B6 in the juice ranged from 0.46 to 0.56 milligrams per 100 grams. The results were lower than the 2.30 to 6.11 mg/100g of vitamin B6 reported by Emojorho *et al*. (2023) [12] for biscuits produced with orange seed and wheat composite flour. 50% watermelon tigernut juice had the lowest amount of vitamin B6 (0.46 mg/100g), while 100% tigernut juice had greater levels (0.5.6 mg/100g) than watermelon juice (0.46 mg/100g–0.54 mg/100g). The juice samples' vitamin B6 concentration differed significantly (p<0.05). The amount of vitamin B6 in the juice was decreased by the watermelon. The amount of vitamin B6 in each juice sample varied significantly (P < 0.05). The crystalline material pyridoxine dissolves in water and alcohol.

It is necessary for the effective conversion of tryptophan to niacin and has a significant impact on the metabolism of proteins and amino acids. Numerous biochemical flaws are either directly or indirectly related to its lack. They appear in baby diets that are lacking in pyridoxine. Convulsions are one of the common symptoms of a deficiency that can be quickly resolved with prompt vitamin administration (Emojorho *et al*., 2023) [12]. "Malabsorption, severe diarrhea, congenital metabolic dysfunction, hyperthyroidism, renal and hepatic disease, congestive heart failure, addiction to alcohol, drug-induced conditions, and during pregnancy and lactation are among the conditions for which vitamin B6 is used for the prevention or treatment of vitamin B6 deficiency" (Emojorho *et al*., 2023) [12].

The amount of vitamin B9 in the juice ranged from 1.66 to 1.94 mg/100g. Emojorho *et al*. (2023) [12] reported that the vitamin B9 levels for biscuits manufactured with orange seed and wheat composite flour were somewhat less than 1.46 to 3.02 mg/100g. The juice including watermen juice had higher amounts of folate (vitamin B9) (1.68–1.94 mg/100g) than the 100% tigernut juice samples (1.66 mg/100g). The lowest value (1.66 mg/100g) was seen in the 100% tigernut milk sample. When watermelon juice was added, vitamin B9 levels increased. "The vitamin B9 contents of the juice varied significantly (p<0.05) between the samples." The vitamin B9 content of the juice rose in proportion to the amount of watermelon in it.

Folic acid is involved in the synthesis of DNA and the conversion of homocysteine to methionine. Folic acid participates in the interconversion of amino acids by absorbing a carbon atom. A folic acid deficiency is the cause of anemia. Folate is necessary for both protein metabolism and DNA and RNA synthesis.It is essential for the breakdown of homocysteine, an amino acid that, if consumed in excess, can be harmful to the body. "Healthy red blood cell production, which is particularly crucial during periods of rapid growth like pregnancy and fetal development, also requires folate" (Emojorho *et al*. 2023) [12]. Folate is essential for the synthesis and maintenance of healthy blood. By assisting vitamin B12 in the production of blood, it reduces anemia (Emojorho *et al*. 2023) [12].

Vitamins composition of Juice Samples

Table 2: Vitamins composition of Juice Samples

Sample	VIT_B12	VIT_C	VIT_A(IU)	VIT_E	VIT_D	VIT_K
T	0.88^{d}±0	161.27^{f}±0	1.83^{f}±0	21.57^{f}±0	1.97^{f}±0	1.34^{b}±0
TW1	0.9^{c}±0	203.28^{e}±0	1.98^{e}±0	21.83^{e}±0	2^{e}±0	1.39^{a}±0
TW2	0.^{9c}±0	287.51^{d}±0	2.12^{d}±0	21.95^{d}±0	2.02^{d}±0	1.44^{a}±0.06
TW3	0.91^{b}±0	300.37^{c}±0.04	2.72^{c}±0	22.25^{c}±0	2.03^{c}±0	1.42^{a}±0
TW4	0.91a^{b}±0	322.07^{b}±0	3.18^{b}±0	22.83^{b}±0	2.08^{b}±0	1.43^{a}±0
TW5	0.91^{a}±0	345.82^{a}±0	3.99^{a}±0	23.02^{a}±0	2.14^{a}±0	1.44^{a}±0

Key: values are mean±standard deviation from two determinations. Means in a column bearing similar superscripts are not significant (p>0.05). While means in the same column with different superscripts are significantly (p<0.05) different

The tigernut juice combined with watermelon had higher vitamin B12 concentrations (0.9–0.91) than 100% tigernut juice (0.88 mg/100g). "The juice samples' vitamin B12 levels varied considerably (p<0.05)." The 100% tigernut juice contained less cyanocebalamine, or vitamin B12, than the juice combined with watermelon samples. The vitamin B12 content of the juice ranged from 0.88 to 0.91 mg/100g. The tigernut juice combined with watermelon had higher vitamin B12 concentrations (0.9–0.91) than 100% tigernut juice (0.88 mg/100g). "The juice samples' vitamin B12 levels varied considerably (p<0.05).A part of the coenzymes B12 enzyme system, cyanocobalamine replaces the cyanide in the basic structure with 5-deoxyadenine nucleosides.

Methylation of homocysteine, which produces the essential amino acid methionine, is the main function of the coenzymes. In terms of nutrition, they also aid in the body's conversion of methylmalonyl CoA to succinyl CoA during the metabolism of fat. Without vitamin B12, erythrocytes do not develop. Physical weakness, fatigue, sore and cracked lips, and glossitis, or smooth tongue, are symptoms of pernicious anemia (Onimawo and Akubor, 2011). The 100% tigernut juice contains less vitamin C (161.27 mg/100g) than the juice combined with watermelon samples. The amount of vitamin C in the juice ranged from 203.28 to 345.82 mg/100g. Compared to the 1.63 to 4.67 mg/100g of tigernut juice with watermelon mixes published by Okoh *et al*. (2025) [16], the results were much greater.As the amount of watermelon juice in the samples grew, so did the vitamin C concentration.

The drink's pro-vitamin A levels varied significantly (p<0.05), which ranged from 1.83 to 3.99 IU. Heat, light, and air cause vitamin A to become unstable, although it remains stable in neutral and alkaline solutions. The aldehyde form of vitamin A, or retina, is responsible for vision. Night blindness is treated with both retinal and retinol. Vitamin A's biological role in low-light vision is

well understood. On the other hand, vitamin A seems to support the development of long bones during growing. Vitamin A deficiency causes dermatitis-like symptoms and dry skin. Pro-vitamin A is necessary for eyesight, growth regulation, and the preservation of moist surface tissues.A lack of it causes night blindness, delayed growth, or impaired vision in low light (Emojorho *et al*., 2023) [12].
The 100% tigernut juice contained less vitamin E (21.57 mg/100g) than the juice combined with watermelon samples. The vitamin E content of the juice ranged from 21.83 to 23.02 mg/100g. The results were higher than the 4.56 to 11.70 mg/100g for orange seed composite four biscuits reported by Emojorho *et al*. (2023) [12]. The concentration of vitamin E increased along with the amount of watermelon juice in the samples.
The 100% tigernut juice contained less vitamin K (1.34 mg/100g) than the juice combined with watermelon samples. The vitamin K content of the juice ranged from 1.39 to 1.44 mg/100g. The results were higher than the 0.23 to 0.72 mg/100g of tigernut juice with watermelon mixtures that Emojorho *et al*. (2023) [12] reported. The concentration of vitamin K increased along with the amount of watermelon juice in the samples. The vitamin D content of the juice ranged from 1.97 to 2.14 mg/100g, as shown in Table 2. The combination of watermelon and tigernut juice contained less vitamin D. The vitamin D concentration dropped by nearly two times when defatted samples were compared to undefatted samples. The lower values for the defatted samples can be explained by vitamin D being lost with oil during the defatting process because it is an oil-soluble vitamin. Ergocalciferol (D2) and cholecalciferol (D3) are the two forms of vitamin D, sometimes known as sunshine vitamin. Sterols, the building blocks of vitamins, are converted into vitamins by vitamin D2 and UV radiation D3. Vitamin D is necessary for healthy calcification of teeth and bones. Osteomalacia, or weakening of the bones, and rickets are nutritional disorders associated with vitamin D deficiency (Onimawo and Akubor, 2011).

Phytochemical Composition of Tigernutmilk with blends of Watermelon

Table 3: Phytochemical Composition of Tigernutmilk with blends of Watermelon (mg/100g)

Sample	Oxalate	Anthocyanin	Tannin	Flavon	Epihehd	Phytate
T	1.99^{e}±0	1.93^{e}±0	6.74^{e}±0	3.86^{a}±0	1.96^{a}±0	3.77^{e}±0
TW1	2.01^{d}±0	2.16^{d}±0	7.72^{d}±0	3.71^{b}±0	1.82^{b}±0	3.79^{d}±0.01
TW2	2.51^{c}±0	3.01^{c}±0	8.02^{e}±0	$3.^{7c}$±0	1.74^{c}±0	3.81^{c}±0
TW3	2.63^{b}±0	4.42^{b}±0	8.96^{b}±0	3.69^{d}±0	1.74^{c}±0.01	3.86^{b}±0
TW4	2.73^{a}±0	5.82^{a}±0	9.45^{e}±0	3.52^{e}±0	1.63^{d}±0	3.93^{a}±0

Key: values are mean±standard deviation from two determinations. Means in a column bearing similar superscripts are not significant (p>0.05). While means in the same column with different superscripts are significantly (p<0.05) different

The oxalate concentration ranged from 1.99 to 2.73 mg/100g. The findings for composite flour biscuits were lower than the range of 20.06 to 77.21 mg/100g reported by Emojorho *et al*. (2024) [13]. The oxalate increased along with the amount of watermelon juice. This is probably the outcome of the additive effect because watermelon has a high oxalate concentration. The levels of oxalate in the juice samples varied significantly (p<0.05).
The anthocyanin content of the beverage ranged from 1.93 to 5.82 milligrams per 100 grams. The antocyanin rose along with the amount of watermelon juice. This is probably the outcome of the additive effect because watermelon has a high anthocyanin concentration. The juice samples' anthocyanin levels varied significantly (p<0.05).
The tannin concentration ranged from 6.74 mg/100g to 9.45 mg/100g. The readings for biscuits manufactured with orange seed composite flours were lower than the range of 20.06 to 77.21 mg/100g reported by Emojorho *et al*. (2024) [13]. The tannin rose along with the amount of watermelon juice. This is probably the result of the additive effect because watermelon has a high tannin content. The juice samples' tannin concentrations varied significantly (p<0.05).
The concentration of flavonoids ranged from 3.52 to 3.86 mg/100g. There was less flavor the more watermelon juice there was. This is probably due to the dilution effect because watermelon has fewer flavonoids. The juice samples' flavone concentrations varied considerably (p<0.05). The epihehd content ranged from 1.63 to 1.96 mg/100g. The epiheld decreased as the quantity of watermelon juice rose. This is probably due to the diluting effect because watermelon has a low epihehd concentration. The juice samples' epihehd contents differed considerably (p<0.05).
The phytate content of the juice ranged from 3.77 to 3.93 milligrams per 100 grams. The phytate increased along with the amount of watermelon juice. This is probably the outcome of the additive effect because watermelon has a high phytate level. The juice samples' phytate level varied significantly (p<0.05). As the quantity of watermelon increased, oxalate, anthocyanin, tannin, and phytate all climbed but epihehd and flavon decreased. Tigernut contains phenolic compounds, flavonoids, saponins, and trace levels of sterols. They may be beneficial to health and promote antioxidant activity (Oluwakemi *et al*., 2021) [20].

Conclusion

The current study has shown that a safe, ready-to-serve beverage with high levels of vitamins and phytochemicals may be produced by adding up to 50% tiger nut juice to a watermelon juice blend. The tigenut juice combined with watermelon contains more vitamins and phytochemicals than the 100% tiger nut blend control. The products contain a substantial quantity of vitamins and phytochemicals that, when ingested, will enhance the customers' nutrition and overall health. If tiger nut juice is effectively added to watermelon juice, the use of tiger nuts—which are now underutilized in Nigeria—will rise. The results of the study suggest that tigernut production and consumption in combination with up to 50% water melon juice should be encouraged.
Small businesses are being developed to enhance the production of tiger nut milk and water melon juice from tiger nut and water melon fruits in order to boost economic development and reduce unemployment in society. Blending watermelon juice with tigernut milk improves the micronutrient content and phytochemical profiles more than using either ingredient alone. These beverages may be beneficial, high-nutrient alternatives to plant-based diets. Comprehensive characterization—including the effects of

enhanced processing and long-term stability—remains crucial for food science and industrial adoption.

Disclaimer (Artificial intelligence)

The authors hereby declare that this paper was written and edited without the aid of any generative AI technologies or text-to-image generators.

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