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Assessment of Vitamins, Minerals and Phytochemical Variability in Watermelon (*Citrullus lanatus*) Varieties from South-West Nigeria

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ABSTRACT

Background and Objective: Watermelon is a commonly consumed tropical fruit in developing countries including Nigeria. The pulp of the fruits is mainly consumed while the seeds and rinds are discarded, causing environmental pollution. This study investigated the nutritional composition of watermelon seeds and rinds for possible food or feed usage. **Materials and Methods:** Field experiments were conducted between August-November, 2016 in Ogbomoso to determine the variability of vitamins and minerals content among the pulp, seed and rind of four watermelon varieties (Sugar Baby, Kaolack, Grey Belle and Collos F1). At fruit maturity, six fruits per variety weighing 3 kg were randomly selected for vitamin (vitamin A, C and E) and mineral (calcium, magnesium, potassium, iron, zinc and copper) analyses. **Results:** The results of the experiment showed there are variations in the vitamins and mineral content of watermelon pulp, seed and rind. Kaolack pulp has the highest concentration of vitamin C (8.16 mg/100 g) while the seed and Collos F1 rind have the highest concentration of vitamin E (0.130 mg/100 g) and A (450.00 µg/100 g), respectively. Mineral content was higher in the seed and rind than in pulp. Collos F1 seed had the highest calcium content of 532.1 mg/100 g while Potassium content was found in larger quantities in Kaolack seed (1144.4 mg/100 g) while Kaolack rind had the highest Zinc (3.04 mg/100 g). **Conclusion:** The vitamins and minerals that are abundant in the rind and seed which are often discarded are good sources of vitamin and mineral elements that play various physiological functions in the human body. Also, the rind and seed can be used in animal feed.

KEYWORDS

Mineral content, rind, watermelon seed, varieties, vitamin content, *Citrallus lanatus*

INTRODUCTION

Watermelon (*Citrallus lanatus* (Thunb) Matsum. and Nakai) belong to the family Cucurbitacea, Genus: *Citrullus* and species: *Lanatus*[1]. It is an economically important fruit crop known for its sweet and juicy pulp[2]. Watermelons are consumed as deserts, fresh-cut fruit and processed into juice[3]. They are one of

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the major fruits grown in tropical regions of the world. The plant is a warm-season crop that requires long growing seasons and grows best on sandy loam soil that is rich in organic matter content. It can also grow on other soil types provided the soil is well drained[4].

Watermelon fruit has both nutritional and medicinal values[5]. It is a rich source of phytochemical compounds, which are beneficial for human health and well-being[6]. The liquid extracted from the pulp can be fermented into wine, while the seeds are enjoyed as snacks in China and Israel. In Sudan and Egypt, the pulp is typically cooked and the seeds are also consumed as food[7].

The watermelon rind, typically light green or white, harbors numerous nutrients that often go unnoticed. Despite its edibility, it's commonly shunned and thrown away due to its unattractive taste[7,8]. However, it's worth noting that both the rind and seeds are rich in carotenes (Alpha, Beta and Gamma), which the body can transform into essential vitamins.

Despite the presence of fruits and other vitamin A-rich sources, data from the World Health Organization[9] spanning from 1995 to 2005 revealed that roughly one-third of children under the age of five worldwide experience vitamin A deficiency. This deficiency is estimated to result in the deaths of 670,000 children under the age of five each year[10]. The highest prevalence is in developing countries of which Southeast Asia and Africa continents are not spared. The rind and seed also contain high potassium and magnesium which help to relax nerves and muscles and keep blood circulating smoothly[11]. The rind and seed are also used in preservatives, jellies and to make pickles[12]. Sometimes the rind is applied as feed to animals or as fertilizer materials for crops[13]. In Africa, watermelon seeds may be ground into a coarse flour and oil may be extracted from them[14,15].

Watermelon is rich in citrulline, which can aid in treating erectile dysfunction[16]. Additionally, its abundance of antioxidants combats harmful free radicals, safeguarding cells from damage. Its diuretic and cleansing attributes are advantageous for individuals with specific kidney and bladder conditions. Furthermore, it contains ample amino acids and beta-carotene, warding off ailments like heart disease[17]. Moreover, its lycopene content, responsible for its vibrant color, contributes to shielding against prostate and oral cancers[5]. The mineral contents are good for preventing conditions such as lowering high blood pressure and stroke and help to decrease the risk of kidney stone and bone loss due to old age[18]. Therefore, the main objective of this study is to analyzes four unique watermelon varieties. By comparing the nutrient content (vitamins, minerals and proteins) of pulp, seed and rind in each variety.

MATERIALS AND METHODS

Experimental site: A field experiment was conducted between March - June, 2018 at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Nigeria Oyo State, Nigeria. Ogbomoso lies on Latitude 18°10’N, Longitude 4°16'E and is located in the Guinea savanna zone of Southwest Nigeria. The temperature of the area ranges from 28-33°C with relative humidity of about 75% all year except in January when the dry wind blows from the north. Rainfall distribution is bimodal and extends for eight to nine months of the year. On the average, the total annual rainfall is about 128 mm.

Treatment: The treatments consisted of four varieties o f watermelon viz: Sugar Baby, Kaolack, Grey Belle and Collos F1 that were sourced from The Seed Project Co. Ltd., Khadejah Road, Kano, Nigeria. At fruit maturity, six fruits per variety weighing 3 kg were randomly selected to assess the nutritional contents. The selected fruits were cut vertically into two equal parts using a sharp kitchen knife and the pulp, seeds and rind were extracted separately to determine their vitamin A, C and E, mineral, proximate and phytochemicals contents. Data collected were subjected to analysis of variance according to Statistical Analysis System[19] and treatment means were compared using Duncan’s Multiple Range Test at 5% probability level.

Determination of vitamin content

Determination of vitamin A: Two grams of each sample were carefully weighed into a flat-bottomed reflux flask, followed by the addition of 10 mL of distilled water and thorough shaking to form a paste. Subsequently, 25 mL of alcoholic KOH solution was added and a reflux condenser was attached. The mixture was then heated in boiling water for one hour with frequent agitation. After heating, the mixture was rapidly cooled and 30 mL of water was added. The resulting hydrolysate was transferred into a separatory funnel and extracted three times with 250 mL portions of chloroform. To remove any residual water, 2 g of anhydrous Na_2SO_4 was added to the chloroform extract. The mixture was then filtered into a 100 mL volumetric flask and made up to the mark with chloroform.

For the preparation of standard solutions of beta-carotene vitamin A within the range of 0-50 µg/mL, 0.003 g of standard beta-carotene was dissolved in 100 mL of chloroform. The absorbance of various standard solutions was determined with reference to their gradients and an average gradient was calculated to determine the vitamin A content (beta-carotene in µg/100 g) of the samples using Eq. 1[20]. Absorbances of both the samples and standards were measured using a spectrophotometer (Metrohm Spectronic 21D Model) at a wavelength of 328 nm:

$$\text{Vitamin A } (\mu g/100\ g) = \frac{\text{Absorbances of sample} \times \text{Gradient factor} \times \text{Dillusion factor}}{\text{Weight of sample}} \quad (1)$$

Determination of vitamin C (ascorbic acid): Approximately 0.5 g of the sample was accurately weighed and macerated with 10 mL of 0.4% oxalic acid in a test tube for 10 min. Following this, the mixture was centrifuged for 5 min and the resulting solution was filtered. Then, 1 mL of the filtrate was carefully transferred into a dry test tube in duplicate. Subsequently, 9 mL of 2,6-dichlorophenol indophenol was added and absorbance readings were taken at 15 and 30 sec intervals at a wavelength of 520 nm.

Determination of vitamin E: One gram of the sample was precisely weighed and placed into a 250 mL conical flask, equipped with a reflux condenser. Subsequently, 10 mL of absolute alcohol and 20 mL of 1M alcoholic sulphuric acid were added to the flask. To ensure proper refluxing, the condenser and flask were wrapped with aluminum foil and heated for 45 min, followed by a cooling period of 15 min. After cooling, 50 mL of distilled water was added to the mixture, which was then subjected to extraction with 5 portions of 30 mL dimethyl ether. The combined extracts were thoroughly washed to remove any residual acid and then evaporated at a low temperature until dry. The resulting residues were promptly dissolved in 10 mL of absolute alcohol.

Aliquots of both the sample solution and standard solutions (ranging from 0.3 to 3.0 mg vitamin E) were transferred to 20 mL volumetric flasks. To each flask, 5 mL of absolute alcohol was added, followed by the careful addition of 1 mL of concentrated HNO_3. These flasks were then placed in a water bath at 90°C for precisely 3 min from the moment the alcohol began to boil. Following this, the flasks were rapidly cooled under running water and adjusted to volume with absolute alcohol. Absorbance measurements were conducted at 470 nm against a blank containing 5 mL of absolute alcohol and 1 mL of concentrated HNO_3, treated similarly. The vitamin E was obtained using the Eq. 2[20]:

$$\text{Vitamin E } (\mu g/100\ g) = \frac{\text{Absorbances of sample} \times \text{Gradient factor} \times \text{Dillusion factor}}{\text{Weight of sample}} \quad (2)$$

Determination of mineral content: The mineral content, including calcium, magnesium, potassium, iron, zinc and copper, in the pulp, seed and rind of watermelon fruit was analyzed. This analysis involved digesting 5 g of the samples with 10 mL of 5 N concentrated hydrochloric acid. The resulting mixtures were then evaporated almost to dryness in a water bath. Once cooled, the solutions were filtered into 100 mL standard flasks and diluted to volume with distilled water. The mineral analysis was carried out separately for each element using an Atomic Absorption Spectrophotometer (specifically, the Milton Ray Spectronic 21D UV-visible spectrophotometer). This analysis method follows the protocol outlined in the official method of the Association of Official Analytical Chemists[21] for acid digestion of the sample.

Determination of proximate content: The watermelon pulp, seeds and rind underwent proximate content analysis using the methods outlined by the Association of Official Analytical Chemists[21]. The proximate contents analyzed included crude protein, crude fiber, crude fat and carbohydrate content according to AOAC[22] and ash content[21] procedures.

Determination of phytochemicals content

Lycopene: Lycopene extraction was conducted utilizing organic solvents, namely hexane, acetone and petroleum ether, in a ratio of 2:1:1, respectively. To achieve optimal recovery, a 0.05% concentration of Butylated Hydroxytoluene (BHT) was employed as the extracting medium, following the method described by Perkins-Veazie and Collins[23].

Carotene: The pulp, seed and rind extracts were analyzed for antioxidant activity using a spectrophotometer at a wavelength of 470 nm. This assay is based on the coupled oxidation of beta-carotene and linoleic acid, following the procedure outlined by Singleton *et al.*[24].

Total phenols content: The total phenolic contents (TPC) of the watermelon pulp, seeds and rind were determined using the Folin-Ciocalteu method, following the procedure outlined by Singleton *et al.*[24].

RESULTS

The results of vitamin contents of the pulp, seed and rind of fresh watermelon varieties are presented in (Table 1). Statistical assessment shows that vitamin A was generally higher in the rind than in the pulp and seed (Table 1). Vitamin A content of Collos F1 rind was the highest (450 µg/100 g) while the lowest of 80 µg/100 g was obtained from Grey Belle pulp. Vitamin C content was the highest in pulp than the seed and rind (Table 1). The highest vitamin C content of 8.16 mg/100 g was obtained from Kaolack pulp while the least of 1.14 mg/100 g was obtained from Collos F1 seed. Vitamin E content was significantly($p>0.05$) higher in the seed than in the pulp and rind. Kaolack seed had a vitamin E content of 0.120 mg/100 g which was significantly ($p>0.05$) higher than 0.034 mg/100 g of Collos F1 pulp.

The results of mineral compositions are presented in Table 2. Significant highest calcium content was obtained from the seeds and rinds followed by pulps for all the varieties. The Collos F1 seed had the highest seed calcium (532.1 mg/100 g) followed by Kaolack seed (529.6 mg/100 g) while the least was from the pulps of all the varieties. The seed and rind of watermelon fruits were considered excellent natural sources of calcium.

Magnesium concentration was significantly ($p>0.05$) higher in the rind followed by seed while the pulp shows the least magnesium content for the varieties. These concentrations vary from Sugar Baby (33.50-54.0 g/100 g), Kaolack (38.7-64.8 mg/100 g), Grey Belle (33.5-56.4 mg/100 g) and Collos F1 (31.8-67.8 mg/100 g). Potassium is the highest concentration (664.2-1144.5 mg/100 g) of mineral in all the four varieties of watermelon. Potassium content was highest in the seed and rind than the pulp, with Kaolack seed containing the highest concentration (1144.5 mg/100 g) of potassium while Sugar Baby pulp had the least (664.2 mg/100 g) value. In terms of micro-minerals, the rind of all four varieties had the highest iron, zinc and copper contents. The highest iron content was obtained from Kaolack rind (11.3 mg/100 g) while the least of 1.4 mg/100 g was obtained from Sugar Baby seed. Highest zinc of 3.04 mg/100 g was obtained from Kaolack rind while the least of 0.09 mg/100 g was obtained from sugar

Table 1: Vitamin content of pulp, seed and rind of four varieties of watermelon

Treatment	Sugar Baby	Kaolack	Grey Belle	Collos F1
Vitamin A (µg/100 g)				
Pulp	110.00^{b}	130.00^{a}	80.00^{d}	100.00^{c}
Seed	230.00^{d}	290.00^{b}	280.00^{c}	350.00^{a}
Rind	310.00^{c}	430.00^{b}	310.00^{c}	450.00^{a}
Vitamin C (mg/100 g)				
Pulp	6.45^{d}	8.16^{a}	6.72^{b}	6.51^{c}
Seed	1.51^{b}	1.65^{a}	1.45^{c}	1.41^{c}
Rind	4.26^{d}	4.88^{a}	4.43^{c}	4.78^{b}
Vitamin E (mg/100 g)				
Pulp	0.038^{b}	0.043^{a}	0.038^{b}	0.034^{c}
Seed	0.100^{c}	0.130^{a}	0.100^{c}	0.120^{b}
Rind	0.040^{b}	0.040^{b}	0.040^{a}	0.060^{a}
Potassium				
Pulp	664.2^{d}	666.5^{c}	686.9^{b}	689.3^{a}
Seed	1082.5^{c}	1144.5	1126.3^{b}	1044.4^{d}
Rind	977.2^{c}	972.1^{d}	993.4^{b}	1022.2^{a}

Means along the row with the same letter(s) are not significantly different from each other using Duncan's Multiple Range Test at 5% probability level

Table 2: Mineral content of pulp, seed and rind of four varieties of watermelon

Treatment	Sugar Baby	Kaolack	Grey Belle	Collos F1
Calcium				
Pulp	157.2^{a}	159.5^{a}	143.7^{c}	129.4^{d}
Seed	407.3^{d}	529.6^{a}	440.1^{c}	532.1^{a}
Rind	328.1^{c}	333.5^{a}	330.2^{a}	330.1^{a}
Magnesium				
Pulp	51.0^{a}	59.1^{a}	46.2^{d}	49.5^{c}
Seed	54.0^{d}	64.8^{a}	56.4^{c}	67.8^{a}
Rind	33.5^{c}	38.7^{a}	33.5^{a}	31.8^{d}
Potassium				
Pulp	664.2^{d}	666.5^{c}	686.9^{a}	689.3^{a}
Seed	1082.5^{c}	1144.5	1126.3^{a}	1044.4^{d}
Rind	977.2^{c}	972.1^{d}	993.4^{a}	1022.2^{a}
Iron				
Pulp	0.61^{a}	0.62^{a}	0.55^{d}	0.58^{c}
Seed	0.14^{d}	0.19^{a}	0.17^{c}	0.25^{a}
Rind	1.44^{a}	1.53^{a}	1.35^{d}	1.46^{c}
Zinc				
Pulp	0.09^{d}	0.13^{a}	0.11^{c}	0.18^{a}
Seed	0.84^{a}	0.83^{a}	0.72^{d}	0.73^{c}
Rind	2.87^{d}	3.04^{a}	2.90^{c}	3.01^{a}
Copper				
Pulp	0.63^{a}	0.61^{c}	0.58^{d}	0.65^{a}
Seed	0.04^{d}	0.07^{a}	0.05^{c}	0.09^{a}
Rind	1.49^{c}	1.58^{a}	1.47^{d}	1.58^{a}

Means along the row with the same letter(s) are not significantly different from each other using Duncan's Multiple Range Test at 5% probability level

baby pulp. Both Kaolack and Collos F1 rind shows the highest copper of 1.58 mg/100 g while the least of 0.04 mg/100 g was obtained from Sugar Baby seed. These minerals are important for health status and these results showed that watermelon seeds and rinds have highest contents of mineral elements than pulps.

The proximate composition of pulp, seed and rind of four watermelon varieties are presented in Table 3. Statistical analysis showed that watermelon seeds contain the highest crude protein, crude fiber, total soluble solid and fat content than rind and pulp, while ash content was found higher in the rind than in

Table 3: Proximate composition of pulp, seed and rind of four varieties of watermelon

Treatment	Sugar Baby	Kaolack	Grey Belle	Collos F1
Crude protein				
Pulp	0.12^{d}	0.19^{b}	0.18^{c}	0.22^{a}
Seed	0.51^{d}	055^{c}	0.57^{b}	0.60^{a}
Rind	0.27^{c}	0.36^{a}	0.27^{c}	0.30^{b}
Crude fibre				
Pulp	0.10^{c}	0.11^{b}	0.11^{b}	0.12^{a}
Seed	0.23^{d}	0.34^{b}	0.25^{c}	0.37^{a}
Rind	0.19^{b}	0.21^{a}	0.15^{d}	0.16^{c}
Carbohydrate				
Pulp	14.3^{d}	15.0^{c}	17.4^{a}	15.4^{b}
Seed	21.26^{c}	24.00^{b}	27.65^{a}	27.32^{a}
Rind	34.57^{d}	35.69^{c}	37.39^{b}	39.29^{a}
Total soluble solid (TSS)				
Pulp	1.45^{a}	1.40^{b}	1.35^{c}	1.35^{c}
Seed	1.77^{d}	1.84^{b}	1.81^{c}	2.00^{a}
Rind	2.16^{a}	1.58^{b}	1.56^{b}	1.50^{b}
Fat				
Pulp	0.12^{b}	0.14^{a}	0.11^{c}	0.07^{d}
Seed	0.21^{c}	0.23^{a}	0.20^{d}	0.22^{b}
Rind	0.05^{d}	0.06^{c}	0.06^{b}	0.07^{a}
Ash				
Pulp	0.04^{c}	0.05^{b}	0.04^{d}	0.06^{a}
Seed	0.16^{a}	0.15^{b}	0.12^{d}	0.13^{c}
Rind	1.11^{d}	1.23^{c}	1.29^{b}	1.36^{a}

Means along the row with the same letter(s) are not significantly different from each other using Duncan's Multiple Range Test at 5% probability level

Table 4: Phytochemicals content of pulp, seed and rind of four varieties of watermelon

Treatment	Sugar Baby	Kaolack	Grey Belle	Collos F1
Lycopene (mg/100 g)				
Pulp	11.03^{c}	11.25^{a}	11.21^{b}	11.28^{a}
Seed	6.69^{c}	6.98^{a}	6.65^{d}	6.96^{b}
Rind	3.05^{a}	3.02^{b}	2.49^{d}	2.78^{c}
Carotene C (mg/100 g)				
Pulp	8.20^{c}	8.69^{a}	8.08^{d}	8.27^{b}
Seed	0.15^{d}	0.18^{b}	0.16^{c}	0.28^{a}
Rind	9.43^{d}	9.86^{a}	9.84^{b}	9.81^{c}
Phenol (mg/100 g)				
Pulp	0.118^{b}	0.119^{a}	0.114^{d}	0.116^{c}
Seed	0.115^{c}	0.121^{a}	0.118^{b}	0.124^{d}
Rind	0.133^{c}	0.144^{a}	0.130^{d}	0.141^{b}

Means along the row with the same letter(s) are not significantly different from each other using Duncan's Multiple Range Test at 5% probability level

the seed and pulp (Table 3). Of all the four varieties, the crude protein content of Collos F1 seed (0.60 %) was significantly ($p>0.05$) higher when compared with the least of 0.12 % that was obtained from Sugar Baby pulp (Table 3). Crude fiber content was obtained from the seed of Collos F1 (0.37 %) while the least of 0.10% was obtained from the pulp of Sugar Baby (Table 3). The Collos F1 rind had a carbohydrate content of 39.29 % which was significantly higher than the Sugar Baby pulp of 14.30 % (Table 3). The highest total soluble solid content was obtained from Sugar Baby rind (2.16%) while the least of 1.35% was obtained from Grey Belle and Collos F1 pulp (Table 3). Fat content was significantly ($p>0.05$) higher (0.23 %) in Kaolack seed when compared with Koalack pulp (0.14 %) and Grey Belle rind (0.07 %) which were thehighest fat content for pulp and rind part (Table 3). Ash content was significantly higher in the rind than in the pulp and seed. Grey Belle rind had an Ash content of 1.36% which was significantly ($p>0.05$) higher than 0.04% obtained from both Sugar Baby and Grey Belle pulp which was the least value obtained (Table 3).

The results of phytochemical content of pulp, seed and rind of four watermelon varieties are presented in Table 4. The result showed that the highest lycopene content of 11.28 mg/100 g was obtained from Kaolack pulp but significantly ($p>0.05$) different from what was obtained from Collos F1 pulp (11.25 mg/100) while the least of 2.49 mg/100 g was obtained from Grey Belle rind (Table 4). The highest Carotene content of 9.86 mg/100 g was obtained from Kaolack rind and significantly ($p>0.05$) similar to 9.84 mg/100g obtained from Grey Belle rind while the least of 0.15 mg/100 was obtained from the Sugar Baby seed (Table 4). Generally, phenol content was significantly($p>0.05$) higher in the rind than in the pulp and seed of all four watermelon varieties (Table 4). A phenol content of 0.114 mg/100 g was obtained from Kaolack seed which was significantly ($p>0.05$) higher than 0.114 m/100 g obtained from Grey Belle seed that was the least phenol content but significantly ($p>0.05$) similar to 0.115 mg/100 g obtained from Sugar Baby seed (Table 4).

DISCUSSION

The pulp, seed and rind of four varieties of watermelon fruits were analyzed for vitamins, minerals, proximate and phytochemicals. The value obtained for vitamin A content of Collos F1 watermelon rind (450 µg/100 g) was higher than that of the findings of Johnson *et al.*[7] for watermelon (15.73 µg/100 g). The present result was also higher than the finding of Rimando and Perkins-Veazie[25] on watermelon (350.12 µg/100 g). From the result, it was observed that all the watermelon fruit varieties studied are good sources of vitamin A. In general, this study showed that vitamin A content is higher in the watermelon rind than in the pulp and seed. This observation was in agreement with the findings of Setiawan *et al.*[26], who reported that watermelon rind is an important source of vitamin A. Vitamin C was higher in the pulp than in the seed and rind. A similar result was reported by Johnson *et al.*[7] on watermelon. The highest vitamin C values obtained for pulp (8.16 mg/100 g) in this study are closer to the vitamin C content of watermelon (9.39 mg/100) reported by Johnson *et al.*[7].

Calcium present in the diet plays a crucial role in regulating muscle contractions, transmitting nerve impulses and promoting bone formation within the body[27]. Magnesium is known to be essential for numerous enzymes, particularly those belonging to the sugar and protein kinase families, which catalyze ATP-dependent phosphorylation reactions[28]. The presence of potassium helps to regulate high blood pressure[29]. Iron constitutes a vital element in the diets of infants, pregnant women and nursing mothers, serving to prevent anemia[30]. Calcium, magnesium and potassium content were highest in the seed than in the rind and pulp while iron, zinc and copper were highest in the rind followed by pulp and seed. Olayinka and Etejere[31] reported the highest Ca, Mg and K (9770.9, 195.6 and 3734.2 mg/100 g) from the rind of watermelon which was similar to the result obtained. These values were higher than the highest values recorded in this study (532.1, 67.8 and 1144.5 mg/100 g). This implies that watermelon seed and rind are good sources of minerals and elements that play various physiological functions in the body.

The crude protein, crude fiber and total soluble solid and fat content of seed and rind were significantly higher than pulp. A similar result was reported by Morais *et al.*[32] on watermelon. The highest concentration of crude protein in watermelon seeds underscores their significance as a valuable protein source, akin to cotton, groundnut, soybean and rape seeds[33] and are naturally complete with essential amino acids[34]. Proteins derived from cucurbit seeds have been documented to possess pharmacological properties, such as anti-diabetic, anti-fungal, antibacterial, anti-inflammatory and antioxidant activities. However, the relatively low crude protein content in the fruit suggests that watermelon and fruits in general may not be significant sources of protein[35].

Crude fiber content was found higher in the seeds while the pulp and peel showed low concentrations. A similar finding was reported by Morais *et al.*[32]. The elevated crude fiber content found in watermelon seeds suggests that they are a rich source of dietary fiber. Fruits with high fiber and ash content have been noted to support peristaltic movement and accelerate metabolic processes essential for enhancing growth and development[36,37].

Fat content was found in higher concentration in the seed and lower in the pulp and rind. This finding agreed with the report of Morais *et al.*[32] and Jarret *et al.*[38] on watermelon. The result of this finding does not agree with the findings of Olayinka and atejere[31]. They reported higher fat content from the pulp of watermelon. The minimal fat content observed in watermelon pulp highlights its efficacy as an excellent dietary option for weight reduction. Kirkpatrick *et al.*[39] reported that fruits containing high water percentages are not very good sources of fat and thus are recommended as part of a weight-reducing diet. Campbell *et al.*[40] reported that fruit with low-fat content is good for diabetic and hypertension patients. Studies have indicated that fruit pulp and peel typically contain low levels of fat, whereas seeds tend to harbor higher concentrations. The elevated fat content in seeds suggests their potential for oil extraction, which could serve as a source of edible oils for human consumption. These oils could serve as viable substitutes for highly unsaturated oils[41]. The potential of the seed oil of various cucurbits for making soap has been reported by Baboli and Kordl[41].

Carbohydrate and ash content were found to be higher in the rind than in the seed and pulp for all the varieties tested. The rind shows the highest ash content of 1.36%. A similar result was reported by Guimarães *et al.*[42] who evaluated watermelon ash content of 12.7% from the peel of watermelon and El-Adawy and Taha[34] reported similar results on watermelon. The present result agreed with the findings of Olayinka and Etejere *et al.*[31] on watermelon. Carbohydrate and ash content of 39.29 and 1.36% were higher than that of EL-Adawy and Taha[34] (5.22 and 0.23%), respectively. This indicates that the watermelon rind, typically discarded, holds potential as a valuable feed supplement for livestock. Campbell[40] reported that fruits with low carbohydrate content are good for diabetic and hypertension patients.

CONCLUSION

The results of this study showed that watermelon fruits are good sources of vitamins, minerals and proximate and phytochemicals that are abundant in the rind and seed which are often discarded are good sources of vitamins and minerals elements that play various physiological functions in the human body. Vitamin A can help combat vitamin A deficiency which has been a major public health problem in many developing countries including Nigeria. Also, the presence of potassium is abundant which is one of the important minerals in the body which helps to regulate fluid balance, muscle contractions, reduced blood pressure and osteoporosis. Also, the rind and seed can be used in animal feed.

SIGNIFICANCE STATEMENET

Watermelon, often relegated to a simple summer treat, holds hidden potential. While its juicy flesh is enjoyed fresh or as juice, the discarded rinds and seeds boast nutritional value. These parts, rich in protein and minerals, are frequently overlooked alongside similar discards from other fruits. A recent trend towards maximizing resources focuses on utilizing byproducts and underused crops. In Nigeria, where information on the full potential of watermelon is lacking. Therefore, this study analyzes four unique watermelon varieties. By comparing the nutrient content (vitamins, minerals, proteins) of pulp, seed and rind in each variety, the research aims to uncover their health benefit while promoting value addition. Exploring how nutrient profiles differ across watermelon parts can reveal hidden health benefits from consuming the entire fruit which can encourage innovative food industry uses, reducing waste and creating new products.

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