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Comparative Assessment of some Mineral, Amino Acid and Vitamin Compositions of Watermelon (*Citrullus lanatus*) Rind and Seed

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ABSTRACT

The mineral, amino acid and vitamin compositions of the rind and seed flours of Charleston gray variety of watermelon (*Citrullus lanatus*) were investigated, using standard methods. The mineral (mg/100 g) in the rind and seed, respectively viz: calcium (28±0.01, 54±0.02), phosphorous (129.7±0.01, 614.3±0.02), sodium (11.4±0.04, 87.0±0.06), potassium (21.7±0.00, 524.0±0.04), magnesium (30.4±0.01, 509.1±0.03), manganese (1.30±0.01, 6.40±0.04), iron (4.63±0.00, 7.08±0.01), copper (0.4±0.01, 0.7±0.00) and zinc (1.25±0.01, 10.13±0.02) was, aside that of copper (±0.3), significantly ($p<0.05$) higher in the seed. The value of the amino acids (g/100 g) in the seed sample viz: glutamate (11.43±0.01) followed by arginine (6.12±0.06), isoleucine (4.27±0.10), aspartate (2.81±0.01), glycine (2.47±0.03), leucine (2.09±0.01), valine (1.71±0.03), alanine (1.43±0.04), lysine (1.01±0.04), histidine (0.80±0.00), tryptophan (0.40±0.00) and cystine (0.39±0.02) was higher ($p<0.05$) than the corresponding value (0.00±0.00) in the rind sample. The vitamin composition in mg/100 g for the rind and seed, respectively for retinol (vitamin A) (50.15±1.41, 70.10±1.04), niacin (vitamin B_3) (0.04±0.1, 3.32±0.00), ascorbic acid (vitamin C) (7.23±0.02, 6.8±0.03), thiamine (vitamin B_1) (0.03±0.01, 0.20±0.00), riboflavin (vitamin B_2) (0.02±0.1, 0.15±0.04) and pyridoxine (vitamin B_6) (0.04±0.00, 0.09±0.01) was higher ($p<0.05$) in the seed flour for retinol and niacin. The preponderance of these nutrients in the, especially seed, samples, may be of nutritional and physiological importance warranting further studies to increase the dietary use of these food wastes and reduce the attendant burden in the environment.

Key words: Glutamate, isoleucine, zinc, retinol, nutraceuticals

INTRODUCTION

Watermelon (family Cucurbitaceae and species *Citrullus lanatus*) is a major fruit widely distributed in the tropics (Yamaguchi, 2006). The fruit pulp serves as a thirst-quencher owing to its high (92%) water content (Ensminger and Ensminger, 1986). It is an excellent source of minerals (Hall, 2004), vitamins C and A (Edwards *et al*., 2003). Pulps of various fruits, including watermelon (*Citrullus lanatus*) are consumed daily in Nigeria without, in most cases, consuming the rind/peel and seeds. This contributes to increasing solid food wastes with potential adverse environmental and public health implications.

Meaningful solid food waste related environmental and public health hazards management entails preventing (or at least minimizing) the accumulation of these solid food wastes. This could be achieved by efficient waste disposal and management or by increasing the dietary and industrial utilization of the wastes. In the latter option, studies on the properties of agricultural food wastes are required to provide scientific basis for their possible potential use, including in diets and drugs. For instance, the seeds and peels of grapes and pomegranates have rich natural antioxidant

(Jayaprakasha *et al*., 2001) that could reduce oxidative stress in animals. Studies on watermelon fruits were reported, but mainly on the juice/pulp (Johnson *et al*., 2012; Oseni and Okoye, 2013) and a little on the peel/rind for industrial application, nutrient value, antinutrient, antibacterial and antifungal properties (Fila *et al*., 2013; Gin *et al*., 2014; Egbuonu, 2015a, b, c). The food value and pharma-food potentials of a food source could be further assessed through the mineral, amino acid and vitamin compositions of the food source, warranting the present study of the rind and seed flours of Charleston gray variety of watermelon (*Citrullus lanatus* var. Charleston gray), a common variety of watermelon in Nigeria.

MATERIALS AND METHODS

Collection and preparation of samples: Watermelon fruits were bought from Onuimo market, Imo State, Nigeria. It was identified as Charleston gray variety in the Department of Plant Science and Biotechnology, Michael Okpara University of Agriculture, Umudike, Nigeria. The watermelon was thoroughly washed to remove sand particles after which it was sliced using a home choice European knife. The seeds were handpicked and washed off the pulp particles using clean water. The pulp was carefully scraped off to obtain the rind which was chopped into pieces with a chipping machine.

The rind chips and seeds were weighed. The rind (wet weight = 1900.7 g) and seed (wet weight = 1016.9 g) were spread separately on a foil and sundried to obtain the corresponding dry weight for the rind (82.6 g) and seed (468.5 g). The respective dry weight samples were milled into powder using Arthur Thomas Laboratory Mill, Crypto model, USA, covered separately in a labeled white nylon and kept in the desiccators prior to use.

Chemicals and reagents: All chemicals used, including those used in the preparation of reagents, were of analytical grade and products of reputable companies.

Determination of the vitamin, mineral and amino acid compositions: Vitamin A, B_1 (thiamine), B_2, B_3 (niacin) and B_6 were variously determined by the spectrophotometric methods reported by Onwuka (2005) whereas, vitamin C (ascorbic acid) was determined by the method described by Okwu and Josiah (2006).

Mineral content viz: phosphorous, iron, zinc, manganese, copper, potassium, sodium, calcium and magnesium were determined by the spectrophotometric method described by James (1995), using Jenway Digital Spectrophotometer, Model 6320D, manufactured by Jenway Equipment Company, France. Potassium and sodium were determined by the flame photometric method, using Jaway Digital Flame Photometer.

Amino acid content was determined based on the method described by Moore *et al*. (1958) using Technicon Sequential Multi-sample (TSM) Amino Acid Analyzer, Model GFL 1083 (Technicon Instruments Corporation), Germany and with norleucine as an internal standard. The hydrosylate was vacuum dried to remove buffer solution before loading into the TSM. Compressed nitrogen was passed into the TSM to serve as a segmented stream flow of the amino acid which helped the analyzer to detect any amino acid found without mixing up the amino acids. About 5-10 mL of the sample was dispensed into the analyzer cartridge. The TSM analyzer is designed in such a way as to separate and analyze free acid, neutral and basic amino acid of the hydrosylate. Diomax chromelon data analyzing system attached to the amino acid analyzer interpreted the data.

Data analysis: Data was analyzed for statistical significance by one-way analysis of variance, using the students 't' test for the comparison of means. Difference in the mean values (n = 2 obtained from duplicate test of each sample) at $p<0.05$ were regarded as significant. All data was expressed as Mean±SD (Standard Deviation).

RESULTS

As shown in Table 1, the mineral composition (mg/100 g) for the rind and seed, respectively viz: calcium (28±0.01, 54±0.02), phosphorous (129.7±0.01, 614.3±0.02), sodium (11.4±0.04, 87.0±0.06), potassium (21.7±0.00, 524.0±0.04), magnesium (30.4±0.01, 509.1±0.03), manganese (1.30±0.01, 6.40±0.04), iron (4.63±0.00, 7.08±0.01), copper (0.4±0.01, 0.7±0.00) and zinc (1.25±0.01, 10.13±0.02) was higher in the seed flour. The difference in value of the mineral compositions for the samples, except copper (±0.3), was significant ($p<0.05$).

The value of the amino acids (g/100 g) in the seed sample was significantly higher ($p<0.05$) than that (0.00 g/100 g) in the rind sample. As shown in Table 2, the highest composition of amino acids in the seed sample was glutamate (11.43±0.01) followed by arginine (6.12±0.06), isoleucine (4.27±0.10), aspartate (2.81±0.01), glycine (2.47±0.03), leucine (2.09±0.01), valine (1.71±0.03), alanine (1.43±0.04), lysine (1.01±0.04), histidine (0.80±0.00), tryptophan (0.40±0.00) and cystine (0.39±0.02).

The vitamin composition in mg/100 g (Table 3) for the rind and seed, respectively for retinol (vitamin A) (50.15±1.41, 70.10±1.04), niacin (vitamin B_3) (0.04±0.1, 3.32±0.00), ascorbic acid

Table 1: Some mineral composition of watermelon (*Citrullus lanatus*) rind and seed flours

Minerals	Rind	Seed	Difference
	(mg/100 g)		
Zinc	1.25±0.01	10.13±0.02	±8.88*
Copper	0.40±0.01	0.70±0.00	±0.3^{ns}
Iron	4.63±0.00	7.08±0.01	±2.45*
Manganese	1.30±0.01	6.40±0.04	±5.1*
Magnesium	30.40±0.00	509.10±0.03	±478.7*
Phosphorous	129.70±0.01	614.30±0.02	±484.6*
Calcium	28.00±0.01	54.00±0.02	±26.0*
Potassium	21.70±0.00	524.00±0.04	±592.3*
Sodium	11.40±0.04	87.00±0.06	±75.6*

Value±SD of duplicate determinations, ns: Difference is not significant ($p>0.05$), *: Difference is significant ($p<0.05$)

Table 2: Amino acid composition of watermelon (*Citrullus lanatus*) rind and seed flours

Amino acids	Rind	Seed	Difference
	(g/100 g)		
Essential amino acids			
Histidine	0.00±0.00	0.80±0.00	±0.80*
Isoleucine	0.00±0.00	4.27±0.10	±4.27*
Leucine	0.00±0.00	2.09±0.01	±2.09*
Lysine	0.00±0.00	1.01±0.04	±1.01*
Tryptophan	0.00±0.00	0.40±0.00	±0.40*
Valine	0.00±0.00	1.71±0.03	±1.71*
Semi-essential amino acids			
Arginine	0.00±0.00	6.12±0.06	±6.12*
Glycine	0.00±0.00	2.47±0.03	±2.47*
Cysteine	0.00±0.00	0.39±0.02	±0.39 *
Non-essential amino acids			
Aspartate	0.00±0.00	2.81±0.01	±2.81*
Alanine	0.00±0.00	1.43±0.04	±1.43*
Glutamate	0.00±0.00	11.43±0.01	±11.43*

Value±SD of duplicate determinations, *: Difference is significant ($p<0.05$)

Table 3: Vitamin composition of watermelon (*Citrullus lanatus*) rind and seed flours

Vitamins	Rind	Seed	Difference
	(mg/100 g)		
Retinol (vitamin A)	50.15±1.41	70.10±1.04	±19.95*
Thiamine (vitamin B_1)	0.03±0.01	0.02±0.00	$\pm0.01^{ns}$
Riboflavin (vitamin B_2)	0.02±0.1	0.15±0.04	$\pm0.13^{ns}$
Niacin (vitamin B_3)	0.04±0.1	3.32±0.00	±3.28*
Ascorbic acid (vitamin C)	7.23±0.02	6.81±0.03	$\pm0.42^{ns}$
Pyridoxine (vitamin B_6)	0.04±0.00	0.09±0.01	$\pm0.05^{ns}$

Value±SD of duplicate determinations, ns: Difference is not significant (p>0.05), *: Difference is significant (p<0.05)

(vitamin C) (7.23±0.02, 6.8±0.03), thiamine (vitamin B_1) (0.03±0.01, 0.20±0.00), riboflavin (vitamin B_2) (0.02±0.1, 0.15±0.04) and pyridoxine (vitamin B_6) (0.04±0.00, 0.09±0.01) was higher (p<0.05) in the seed flour for retinol and niacin.

DISCUSSION

The watermelon (*Citrullus lanatus*) rind and seeds are usually discarded as food wastes in Nigeria with attendant negative environmental and public health implications. The present study investigated the mineral, amino acid and vitamin compositions of the Charleston gray variety of the watermelon (*Citrullus lanatus*) rind and seed flours. The result could provide a scientific basis for their possible use in animal diets and thus reduce the accumulation of the wastes in and the attendant waste burden on, the environment.

The mineral composition (mg/100 g) for the rind and seeds, respectively was shown in Table 1. The watermelon rind and seed flours in this study were composed of the various minerals determined, concurring with that reported by Hafiza *et al.* (2002). However, the respective value of the minerals was higher in the seed, with the difference, except that for copper (±0.3), significant (p<0.05). Similar higher nutrient composition in the seed than in the rind was reported in a similar study (Egbuonu, 2015a). The zinc content in the seed (but not in the rind) was higher than the values reported for various plant species (Emmanuel *et al.*, 2011) and for *Aspilia africana* and *Bryophylum pinnatum* (Okwu and Josiah, 2006). The sodium content in the seed sample did compare with the values reported by Emmanuel *et al.* (2011) for *Vitex mombassae* (96.08±0.28) and *Maenua angolensis* (96.11±0.76). Manganese and magnesium contents value in some plant species reported by Emmanuel *et al.* (2011) compared with the value in the present samples. The composition of iron in the seed (but not in the rind) and that of sodium, potassium, calcium, magnesium and phosphorous (in the rind and seed) was higher when compared with the respective value for *Aspilia africana* and *Bryophylum pinnatum* (Okwu and Josiah, 2006). The zinc content reported for the rind and seed were lower than 44.3 mg/100 g reported by Siddeeg *et al.* (2014) but in *Cucumis melo* var. *tibish* seed flour. Minerals in adequate amount ensure the normal physiological functions, including iron utilization (Adeyeye, 2000); regulation of muscle contraction, protein and nucleic acids synthesis (Umeta *et al.*, 2005). Hence, the abundance of these minerals in the samples, especially in that of the seed, is nutritionally and physiologically noteworthy.

The value of the amino acids (g/100 g) in the seed sample (Table 2) was higher (p<0.05) than the corresponding value (0.00/100 g) in the rind sample. The seed, but not the rind, flour contains the determined essential, semi-essential and non-essential amino acids. This is a pointer that the watermelon seed flour could be a promising good source for these amino acids. The values obtained for isoleucine, arginine and glutamate in this study compare with even the values in the body wall and muscle band of freeze-dried *Parastichopus californicus* (Bechtel *et al.*, 2013). The amino acid composition (g/100 g) noted in the seed flour was highest for glutamate (11.43±0.01) followed by arginine (6.12±0.06) and isoleucine (4.27±0.10). These amino acids perform important functions in the synthesis of protein, nitric oxide (a vasodilator), key regulatory hormones and as a neurotransmitter (Collins *et al*., 2007; Ezeanyika and Egbuonu, 2011; Egbuonu, 2012; Egbuonu *et al.,* 2013; Egbuonu and Ezeanyika, 2013). Thus, the abundance of these amino acids in the seed flour may be of nutritional and physiological importance, warranting further studies.

Generally, vitamins are essential, but in small amounts, for the regulation of normal metabolism and as an antioxidant (Barminas *et al*., 1998). The vitamin compositions (mg/100 g) were shown in Table 3. The seed had higher ($p<0.05$) composition value for vitamins A (retinol) and B_3 (niacin) than the rind, but a non-significant ($p>0.05$) difference in the composition value for vitamins B_1, B_2 and B_6. These imply higher quantity of retinol and niacin in and possibly higher supply from, the seed sample. The vitamin C composition in the rind and in the seed compared with the value reported for *Sterculia africana* (Emmanuel *et al*., 2011), but lower than the values reported by Okwu and Josiah (2006) for *Aspilia africana* and *Bryophylum pinnatum* by Nangbes *et al*. (2014) for citrus lemon or in USDA (2011) for mango, pineapple, orange and even the watermelon pulp. The B vitamins (thiamine, riboflavin and niacin) compared fairly with the values reported for *Aspilia africana* and *Bryophylum pinnatum* (Okwu and Josiah, 2006).

CONCLUSION

The result shows that the seed is a better source for the minerals, amino acids, retinol (vitamin A) and niacin. The preponderance of these nutrients in the samples, especially in that of the seed, may be of nutritional and physiological importance. Further studies, aimed at exploiting the finding of this study to increase the dietary use of these hitherto food wastes thereby preventing possible solid waste related hazards to the environment, are warranted.

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