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Proximate and Chemical Compositions of Watermelon (*Citrullus lanatus* (Thunb.) Matsum and Nakai cv Red and Cucumber (*Cucumis sativus* L. cv Pipino)

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Abstract

Citrullus lanatus and *Cucumis sativus* which are heavily consumed fruits in most households in Nigeria were analysed for their nutritional potential. The pulp and rind samples of the fruits were analysed for proximate, mineral compositions and vitamin C using standard methods of Association of Official Analytical Chemist (AOAC) and Atomic Absorption Spectrophotometer (ASS). The investigated pulp and rind contained highest amount of moisture (93.65 ± 0.03─96.79 ± 0.05%,) and followed in decreasing order of magnitude by carbohydrate (1.28 ± 0.06─4.23 ± 0.12%), protein (0.34 ± 0.01─0.86 ± 0.02%), fibre (0.23 ± 0.01─0.53 ± 0.02%) and ash (0.23 ± 0.01─0.38 ± 0.01%). Generally the fat content of the fruits was found to be low. In both fruits, protein and carbohydrate were found to be high in amount in the pulp when compared to the rind. Aside carbohydrate, all other proximate parameters were found in higher amount in *Cucumis sativus* when compared to *Citrullus lanatus*. The mineral analysis showed that the iron of these samples were relatively high with *Citrullus lanatus* pulp having the highest value of 0.242 ± 0.001 ppm compared with *Cucumis sativus* pulp 0.074 ± 0.001 ppm with the least value. Concentrations of magnesium, potassium, calcium and sodium were higher in *Citrullus lanatus* when compared to *Cucumis sativus.* The rind of both fruits contained higher amount of vitamin C (4.74 ± 0.07-5.32 ± 0.02 mg/100 g) when compared to the pulp (2.27 ± 0.03-2.81 ± 0.08 mg/100 g). The results showed that the pulp and rind of these fruits samples have adequate dietary nutrients that could be used to supplement diet of most Nigerians which are high in carbohydrates and deficient in nutrients.

Introduction

All life forms depend on plants either directly or indirectly for their survival and wellbeing. This is because plant and plant products provide man with basic necessity such as clothing, shelter and food (Alaekwe and Mojekwu, 2013). The significance of fresh fruits and vegetable in our daily cannot be overestimated (Pamplona-Roger, 2008). Ngoddy and Ihekoronye (1985), had found that fruits and vegetables offered the most rapid methods of providing adequate supplies of vitamins, minerals and fibre to people. They are also food sources with low energy density which are useful in weight management (Rolls *et al.,* 2004). Fruits contain high quantity of water, carbohydrates, vitamins A, B_1, B_2, C, D, E and minerals such as calcium, magnesium, zinc, iron, potassium and organic compounds which are required in small amounts, to make the body function properly (Okwu and Emelike, 2006; Onibon *et al.*, 2007; Dosumu *et al.*, 2009; Dimari and Hati, 2010). Consumption of fruits and vegetables at least 400 g daily as well as whole-grains, cereals and legume at least 30 g daily as been recommended by the world health organization and food and agriculture organization as the optimum diet for everyone (WHO/FAO, 2003).

Watermelon *(Citrullus lanatus)* is a pleasant-tasting fruit and one of the most economically important fruit in the Curcurbitaceae family. The fruit has both nutritional and medicinal values (Gwana *et al.*, 2014). The juice expressed from the pulp can be made into wine while the seeds are consumed as snacks in China and Isreal. In Nigeria, Sudan and Egypt, the pulp is cooked and seeds are eaten (Goda, 2007). The plant contains a significant amount of citrulline for improvement of erectile dysfunction. It possesses high level of antioxidant which decreases the risk of kidney stone and bone loss due to old age. It is a powerful diuretic diet with sufficient amino acid, beta-carotene which prevents ailment such as heart diseases. The lycopene content which gives the fruit its colour play a role in the protection of prostrate and oral cancer (Gwana *et al.,* 2014). Cucumber on the other hand is also an important vegetable and a member of Curcurbitaceae. Like other member of Curcurbitaceae, its fruit has high water content of about 95%. Its rind has high potassium and

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magnesium which help to relax nerves and muscle and keeps blood circulating smoothly (Muhammad *et al*., 2014).

The selection of watermelon and cucumber for this study is because the fruits are becoming increasingly important in many households in Nigeria as part of daily diets. This is traceable to the prevalent cases of diabetics and other related diseases that are caused by the consumption of carbohydrate food that form the major diets of people in Nigeria. This present study was therefore aimed at assessing the proximate, mineral and vitamin C content of both the pulp and the rind of *Citrullus lanatus* and *Cucumis sativus* which are abound in Nigeria with potential economic for use in food supplement.

Materials and Methods

Reagent used

All reagents used in this study were of analytical grades with high purity. They are obtained from Labtrade, Ilorin Kwara State.

Collection and preparation of plant materials

The fruits of *Citrullus lanatus* cv Red (Watermelon) and *Cucumis sativus* cv Pipino were collected from Oja Oba Market in Ilorin during the Month of April, 2015. The samples were brought to the Department of Plant Biology Herbarium Unit for authentication. The collected fruits were washed with 5% hypochloride solution and later rinsed several times with distilled water before subjecting them to analysis. Fresh samples of both fruits were sliced with cleaned knife to separate the rind (exocarp) from the pulp (mesocarp). The seeds were carefully removed from the pulp. The rind was chopped into tiny cubes while the pulp was shredded Each sample was transferred into a tray lined with foil, labeled appropriately and preserved in laboratory fridge at 4^{o}C before subjecting them to nutritional analysis.

Proximate composition

The fresh samples (rind and pulp) from each fruit were analysed for moisture, ash, fibre, protein, fat and carbohydrate by the methods of Association of Official Analytical Chemist (AOAC, 2005). Moisture was determined by oven drying methods. This was achieved by heating five grams (5.0 g) of well mixed ground sample in an oven (Gravity Convection Oven-DHG-9055A) at 103^{o}C for 5-7 hours until a constant weight was obtained. Ash content was determined by incinerating 5.0 g of well mixed ground sample in a muffle furnace (Yorco Sales PVT, LTD, New Delhi) at 600^{o}C for 3 hours until a light-grey ash was produced. The appearances of grey white ash indicate complete oxidation of all organic matter in the sample. Crude fibre was determined by extracting 5.0 g of the ground sample with hexane in a thimble for six hours to free the sample of fat. Thereafter, 200 ml of 1.25% sulphuric acid was added to three grams (3.0 g) of the free fat to remove the digestible nutrient in the fat. The resulting mixture was filtered in a Buchner funnel. The residue on the filter paper was placed in a muffle furnace at 600^{o}C for 30 minutes. Sample was cooled in a desiccator and weighed. Crude fat was determined by petroleum ether extract method using Soxhlet apparatus. Five grams of the ground sample were extracted with 150 ml petroleum ether as solvent in a Soxhlet extractor at a boiling point of 60-80^{o}C.The extraction was done for 6 hours with moderate boiling using Elecrothermal heater.

Crude protein in the sample was determined by Kjeldahl method. Approximately 1.0 g of the ground sample was taken in digestion flask. Ten milliliter (10) of concentrated sulphuric acid and 8 g of digestion mixture (K_2SO_4 $CuSO_4$ in the ratio of 8:1) was added. The flask was swirled to mix the contents thoroughly and placed on heater to start digestion till the mixture becomes clear. Complete digestion was achieved for 2 hours 30 minutes. The digest was cooled and transferred to 100 ml volumetric flask and volume was made up to mark by the addition of distilled water. 10 milliters of digest was introduced in the distillation tube and 10 ml of 0.5 N NaOH was gradually added. Distillation was continued for at least 10 min and NH3 produced was collected as NH_4OH in a conical flask containing 20 ml of 4% boric acid solution with few drops of methyl red indicator. The distillate was titrated with against standard 0.1 N HCl solution till the appearance of pink colour. A blank was also run through following the steps as explained above. Percent crude protein was calculated as %N × 6.25* (*Correction factor). Carbohydrate was determined by difference. This was achieved by subtracting the sum of moisture, ash, protein, crude fat and crude fibre percentage from hundred.

Energy calculation

The calorific value in each sample was calculated by multiplying the percentage protein and carbohydrate with 4 and percentage fat with 9.

Minerals quantification

The dried sample (0.5 g) was transferred into digestion glass tube. Ten milliliters (10 ml) of HNO_3 was added to the sample. The resulting mixture was kept overnight at room temperature. Thereafter, 4.0 ml perchloric acid ($HClO_3$) was added to the mixture and kept in fume cupboard. The temperature was increased gradually stating from 50°C and increasing up to 300°C in the digestion unit. The digestion was achieved in about 70-80 minutes as indicated by the appearance of the white fumes. The mixture was allowed to cooled and transferred into 100 ml volumetric flasks and the volume of the contents were made up to 100 ml with distilled water. The resulting solution was filtered. The filtrate was then used for the mineral determination. Nitrogen (N) was determined using micro Kjeldhal method. Calcium (Ca), iron (Fe) magnesium (Mg), and zinc (Zn) were determined with the use of Atomic Absorption Spectrophotometer (AAS) (Shimazzu, Japan AA-6200) Other mineral elements such as sodium (Na) potassium (K) were determined by Flame Photometer (Bibby Scientific Limited, UK: Model No PFP7) following the method of Allen (1989).

Fruit quality

Titratable acidity in the sample was determined by titrating 10 g of the sample mixed with 250 ml of distilled with 0.1 M NaOH using phenolphthalein as indicator. Vitamin C (Ascorbic acid) content was determined according to AOAC (2005) titrimetric method using 2,6 –Dichlorophenol indophenol (DCPIP). To achieve this, 5 g of each sample were weighed and macerated in 15 ml metaphosphoric glacial acetic acid mixture in a beaker containing 1.0 g activated charcoal. The resulting mixture was boiled for ten minutes and thereafter filters with Wattman No. 1 filter paper in a conical flask. For complete extraction of the vitamin C, 10 ml of metaphosphoric glacial acetic acid was added. Distilled water was added to each conical flask and made the volume to 100 ml. A blank solution was titrated with 2,6 –Dichlorophenol indophenol dye in a beaker until pink colour was obtained. The quantity of 2,6 –Dichlorophenol indophenol dye used to achieve the end point was recorded. The ascorbic acid was calculated as:

mg ascorbic acid/g sample = VxSxD.

Where V = Volume of dye used to titrate, S = Standardization value in mg ascorbic acid and D = dilution factor. It should be noted that each of the foregoing parameters was done in three replications.

Statistical analysis

The results were analyzed for statistical significance using paired sampled student "t' test $p \leq 0.05$). All data were expressed as means ± standard error of three replicates.

Results

Organic constituents

The results of the proximate analysis and energy content of freshly collected rind and pulp of *Citrullus lanatus* and *Cucumis sativus* are presented in Table 1. All the proximate parameters recorded from the rind and pulp of *Citrullus lanatus* differed significantly. The percentage moisture, fibre, ash and fat contents of the pulp were significantly higher compared to those of the rind (Table 1). Proximate compositions such as protein and carbohydrate were however higher in amount in the rind than those recorded from the pulp (Table 1). The calorific values of the rind and that of the pulp were statistically similar. Proximate composition and energy contents of both the rind and pulp of *Cucumis sativus* followed similar trend of results as recorded for *Citrullus lanatus*. Evaluation of the organic constituents of both fruit showed that *Cucumis sativus* recorded significantly higher proximate composition compared to *Citrullus lanatus* except for carbohydrate and energy values (Table 1). Generally both fruits showed the highest amount of moisture and lowest fat contents when compared to other proximate constituents (Table 1).

The mineral compositions recorded from the pulp and rind of samples fruits are shown in Table 2. All the mineral elements recorded from the rind and pulp of *Citrullus lanatus* showed statistical differences ($p < 0.05$) except sodium (Na). The pulp of *Cirtullus lanatus* had significantly higher Fe, Ca, Mg, Zn and K when compared to the rind (Table 2). Among all the mineral elements, and considering the parts investigated, iron (Fe) was the highest and followed in decreasing order of magnitude by those of Mg, K, Ca, Na and Zn (Table 2). The rind and the pulp of Cucumis sativus also differed significantly in their chemical compositions with respect to Ca, Fe, and Mg. Whereas, inorganic elements such as Zn, Na and K showed no statistical differences in both the rind and pulp of this fruit (Table 2). Mineral elements such as Ca, Fe, Na and Zn were respectively higher in the rind compared to those values recorded for the pulp. Conversely, Mg and K were higher in the pulp compared to those quantified for the rind (Table 2). Considering all the in organic constituents, *Cucumis sativus* pulp and rind contained highest amount of Fe and lowest amount of Zn (Table 2). The mean mineral differences between the two fruit showed that *Citrullus lanatus* had higher values of these elements than those of the *Cucumis sativus* with exception of Zn (Table 2).

Table 3 shows the pH, titratable acidity, vitamin C contents of rind and pulp of *Citrullus lanatus* and

Table 1. Proximate composition of rinds and pulps of watermelon *(Citrullus lanatus)* and cucumber *(Cucumis sativus)*

Plant	Part	Moisture	Ash	Fibre	Protein	Fat	CHO	Energy
		%						(kcal)
Citrullus lanatus	Rind	93.65 ± 0.03^b	0.23 ± 0.01^b	0.23 ± 0.01^b	0.53 ± 0.02^a	0.13 ± 0.05^b	5.22 ± 0.06^a	24.17 ± 1.17^a
	Pulp	94.47 ± 0.04^a	0.31 ± 0.02^a	0.45 ± 0.03^a	0.34 ± 0.01^b	0.21 ± 0.01^a	4.23 ± 0.12^b	20.7 ± 0.61^b
Mean		94.06	0.27	0.34	0.44	0.11	4.73	22.17
t-test value		<0.001	0.01	0.02	0.001	0.01	0.02	0.16
Cucumis sativus	Rind	96.56 ± 0.03^b	0.33 ± 0.01^b	0.27±0.02b	0.86 ± 0.02^a	0.14 ± 0.01^b	1.85 ± 0.06^a	12.1 ± 0.49^a
	Pulp	96.79 ± 0.05^a	0.38 ± 0.01^a	0.53±0.02a	0.77 ± 0.02^a	0.23 ± 0.02^a	1.28 ± 0.06^b	10.27 ± 0.29^a
Mean		96.68	0.36	0.40	0.82	0.19	1.57	11.18
t-test value		0.03	0.01	<0.001	0.06	0.02	<0.001	0.15

Data were expressed as means ±SE of three replicates. Means within column followed by the same superscript are statistically the same at $p\leq0.05$

Table 2. Mineral composition of rind and pulp of watermelon *(Citrullus lanatus)* and cucumber *(Cucumis sativus)*

Plant	Part	Ca	Fe	Mg	Zn	Na	K
		ppm					
	Rind	0.095 ± 0.002^b	0.144 ± 0.001^b	0.107 ± 0.008^b	0.058 ± 0.009^b	0.085 ± 0.03^b	0.114 ± 0.006^b
Citrullus lanatus	Pulp	0.136 ± 0.004^a	0.242 ± 0.001^a	0.167 ± 0.006^a	0.086 ± 0.005^a	0.140 ± 0.006^b	0.158 ± 0.008^a
Mean		0.117	0.193	0.137	0.072	0.113	0.136
t-test value		<0.001	<0.001	<0.001	0.004	0.187	0.001
Cucumis Sativus	Rind	0.114 ± 0.004^a	0.131 ± 0.009^a	0.073 ± 0.0003^b	0.074 ± 0.0008^a	0.115 ± 0.0004^a	0.129 ± 0.0001^a
	Pulp	0.102 ± 0.005^b	0.074 ± 0.001^b	0.114 ± 0.0004^a	0.070 ± 0.0006^a	0.109 ± 0.0007^a	0.138 ± 0.0014^a
Mean		0.108	0.103	0.094	0.072	0.112	0.134
t-test value		<0.001	<0.001	<0.001	0.053	0.057	0.070

Data were expressed as means ±SE of three replicates. Means within column followed by the same superscript are statistically the same at $p\leq0.05$

Cucumis sativus. The pH of *citrullus lanatus* rind (5.18± 0.06) was slightly higher than that of the pulp (5.07±0.08). Whereas in *Cucumis sativus* higher pH value was recorded from the pulp (5.75 ±0.04) when compared to that of the rind (5.55±0.07). Titratable acidity in both fruits was generally low on account of their pH which was slightly acidic (Table 3). Significantly higher vitamin C content was recorded from the rind of both fruits as compared to their respective pulp. However, there is no significant difference between vitamin C content of *Citrullus lanatus* and *Cucumis sativus* (Table 3)

Discussion

The bulk of the fresh pulp and rind of *Citrullus lanatus* and *Cucumis sativus* contained high amount of moisture. However, the pulp of these fruits had higher moisture content compared to their rinds. The result was not misnomer since plants in the Curbitaceae family have been known to have high amount of water in their fruits. Therefore, consumption of these fruits by humans could serve as a better thirst quencher during hot weather conditions. Also, the high moisture content could account for rapid deterioration of these fruits if left unprocessed for long time (Ozioma *et al*., 2013). In this instance, *Cucumis sativus* fruit will be prone to faster deterioration given its higher moisture content as compared to *Citrullus lanatus*. Fibre and ash contents were respectively high in amount in the pulp than rind of both fruit samples. The pulp of both sample fruits could therefore serve as a better source roughages and minerals than the rind. Fruit difference indicated *Cucumis sativus* contained higher amount fibre and ash than *Citrullus lanatus.* Samples with high percentages of fibre and ash contents are expected to assist peristaltic movement as well as speed up metabolic processes necessary for improvement of growth and development (Bello *et*

Table 3. The pH, titritable acidity and Vitamin C of rinds and pulps of watermelon *(Citrullus lanatus)* and cucumber *(Cucumis sativus)*

Plant	Part	pH	Titratable acidity	Vitamin C (mg/100 g)
	Rind	5.18 ± 0.06[a]	0.084 ± 0.003[a]	5.32 ± 0.02[a]
Citrullus latatus	Pulp	5.07 ± 0.08[b]	0.096±0.006[a]	2.27 ± 0.03[b]
Mean		5.13	0.09	3.79
t-test value		0.007	0.06	0.008
Cucumis sativus	Rind	5.55 ± 0.07[a]	0.098 ± 0.0001[a]	4.74 ± 0.07[a]
	Pulp	5.74±0.04[b]	0.094 ± 0.0005[a]	2.81 ± 0.08[b]
Mean		5.65	0.096	3.78
t-test value		0.008	0.187	0.007

Data were expressed as means ±SE of three replicate. Means within column followed by the same superscript are statistically the same at p≤0.05

al., 2008; Atasie *et al.*, 2009).

The fat content though high in the pulp is generally low in both fruits as compared to all other proximate composition. The results agreed with the observation made by Ngoddy and Ihekoronye (1985) and the resent findings of Fila *et al.* (2013) that fruits contain high percentage of water averaging 85% but have not been a very good source of fat and thus recommended as part of weight reducing diets. The carbohydrate and protein were higher in the rind compared to the pulp. These suggest that the rind of *Citrullus lanatus* that is often discarded could be used to provide energy and feed supplement for rearing of livestocks (Ngoddy and Ihekoronye, 1985; Olayinka and Etejere, 2013). Both the rind and the pulp had calorific values that compared well with that of cooked pumpkin pulp having calorific value of 20.93 k/cals but lower than those of African star apple (162.58±3.49 k/cal), mango (63 k/cal), orange (49 k/cal) pineapple (65 k/cal) fruit per 100 g of edible portion (Ngoddy and ihekoronye, 1985; Fila e*t al.*, 2013). The carbohydrate values and protein values of the samples fruits were respectively lower and higher than reported for *Musa domestica, Psidium guajava* and *Carica papaya* (Ozioma *et al.*, 2013). In this study, *cucumis sativus* fruit contained low carbohydrate and fat and energy values as compared to *Citrullus lanatus*. Fruits with low carbohydrate and fat have been reported to be ideal for diabetic and hypertensive patients requiring low sugar fat diets (Ekpete *et al.*, 2013).

As it has been said, iron has the highest concentration and the zinc the lowest in both the pulp and rind of the two fruits under investigation. Iron is said to be important element in the diet of pregnant women, nursing mother and infant to prevent anaemia (Oluyemi *et al.*, 2006). The presence of zinc, though very low implies that it might play a major role in normal body development since zinc is essential element in protein and nucleic acid synthesis (Abitogun *et al.*, 2010). It should be emphasized here that with the exception of Na, *Citrullus lanatus* pulp showed appreciable higher amount of all the minerals assessed when compared to the rind. This implies that the pulp of *Citrullus lanatus* could be a good source of these elements. Various physiological functions had been ascribed to these elements. For instance, Ca helps to regulate muscle contraction, transmit nerve impulse and bone formation (Okwu and Emenike, 2006). Magnesium has been established to be required by many enzymes, particularly the sugar and protein kinase families that catalyze ATP-dependant phosphoylation reaction (Rahul and Parimelazhagan, 2012). Na/K ratio in the body is of great concern for prevention of high blood pressure. Na/K ratio less than on is recommended (Daffodil *et al.*, 2016). This implies that consumption of these fruits would probably reduce high blood pressure because they had Na/K ratio that was less than one (FNB, 2005; Daffodil *et al.*, 2016). In alongside with this, sodium and potassium are important intracellular and extracellular cations respectively, which are involved in the regulation of plasma volume, acid-base balance, nerve and muscle contraction (Akpanyung, 2005). Generally, all the mineral investigated were higher in amount in *Citrullus lanatus* than *Cucumis sativus* with the exception of Zn.

The slightly acidic pH and low titratable acidity values showed clear indications that the fruits used for the study were matured. The presence of vitamin C (ascorbic acid) which was significantly higher in the rind of both sample fruits when compared to the pulp showed that the fruits had scavenger capability (antioxidant properties) most importantly the rind of watermelon that are often discarded. Vitamin C is an important water-soluble vitamin that had being implicated in many life processes apart from its antioxidant property (Abitogun *et al.,* 2010).

Conclusion

The observation made in this study had shown that rind and pulp of *Citrullus lanatus* and *Cucumis sativus* are good sources of vital nutrients that could supplementing the diets of Nigerians that are high carbohydrates and deficient in nutrients.

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