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Nutritional Assesment of the Healthy and Unhealthy Watermelon Fruit in Uli, Anambra State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author ECF designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors OOJ and NNE managed the analyses of the study. Author EIS managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Fruits are excellent source of nutrition and should be consumed in moderation as part of a healthy diet. Just like vegetables, fruits are great source of vitamins, minerals, antioxidants, fiber and water. In the fruit group, several fruits are considered to be super foods. A study on the nutritional value of healthy and unhealthy watermelon fruit was carried out using standard laboratory procedures by using the method described by Association of Official Analytical Chemist. The proximate analysis of the healthy and unhealthy watermelon fruit studied showed that the highest carbohydrate (43.30±0.028), protein (8.82±0.025), crude fat (3.38±0.030) and crude fibre (30.25±0.28) contents were that of healthy watermelon fruit whereas the lowest [carbohydrate(30.58±0.028), protein (3.28±0.017), crude fat (1.36±0.028) and crude fibre (10.10±0.011)] were observed to be that of the unhealthy watermelon. However, in the case of the moisture content , the unhealthy watermelon fruit had the highest with 20.14±0.003 against the 9.89±0.028 of the healthy one. Analysis of the mineral

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content was found in the healthy and unhealthy watermelon fruit indicated high phosphorus (230±0.030) and potassium (122.4±0.028) content in the healthy fruit and the lowest (216±0.028 and 118±0.02 of P and K respectively) in the unhealthy one. The calcium content (146.5±0.001) of the unhealthy watermelon fruit on the contrary was the highest while that of the healthy one was the least with 120.0±0.003. Thus it can be concluded that nutrients found in the fruits are in variable concentrations. Therefore the consumption of healthy watermelon on daily basis is recommended for normal body function and healthy life.

Keywords: Watermelon; nutritional analysis; vitamins.

1. INTRODUCTION

Fruits are products of plant growth which are useful to man and animals. They are sweet, succulent or pulpy and edible source of nutrition [1] . They are great source of vitamins, minerals, antioxidants, fiber and water. Daily consumption of fruits is positively related to health benefits and reduced incidence of mortality by degenerative disorders, such as cancer and cardiovascular diseases [2]. Research has shown that fruits are a rich source of essential micronutrients such as vitamin C and folic acid and other bioactive compounds, including phenolic compounds [3,4]. These bioactives are "extra-nutritional" compounds commonly found in small amounts in plants and that have chemo-protective roles in human health, as demonstrated in epidemiological studies [5].

There are some basic characteristics of fruits that make them appealing to most people. They are great sources of dietary fiber and most fruits are low in calories and fat; good sources of healthy fats. They can also be used as combination of sugars: Fructose, glucose, and sucrose. Fructose is the principal sugar of many fruits and is considered to be the sweetest. Sucrose is the main sugar in several other fruits such as orange, melons and peaches [6]. Water makes up 80% to 95% of fruits. The water content in fruits keep their caloric content low and also provides fruit juice. Almost all fruits can be eaten raw juiced for a beverage, used in frozen desserts, preserved, or dried. Fresh whole fruits are considered to be the most nutrition [7].

Fruits storage is simply holding fruits until needed for further processing, marketing or consumption [8]. The expression connotes the expectation that goods would not just be kept, but in the most appropriate conditions for maximum retention of both quality and quantity. The term preservation cover an enormous field of widely different treatments carried out to render food safe, edible and palatable [9]. The freezing method of preservation causes some changes in the nutritional value of fruits but the loss is not significant. Nutrients are those substances in fruits which when eaten provide nourishment to the body [10]. The most sensitive nutrients to change in fruits are vitamins [11]. Other nutrients are much more stable and very little is lost in most processes. However, greater losses can occur due to improper storage of fruits under adverse environmental conditions [12].

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 [13]. The juice expressed from the pulp can be made into wine while the seeds are consumed as snacks in China and Isreal. The plant contains a significant amount of citrus line 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 [13].

Although, there are new cultivars that are seedless, but most naturally have seeds. The consumption of water melon in Nigeria has increased tremendously in recent years probably due to the increased awareness on the health benefits. Water melon is a potent source of a biological active compound known as caroteniods. Caroteniods such as β-carotene, -carotene and lycopene fight and neutralize freeα radicals in the body. Free radicals oxidize cholesterol in the body and make it to stick to the walls of the blood vessels that can lead to heart attack. Several studies have shown that high intake of these anti-oxidants (carotenoids) found in water melon fruits, tomatoes and other fruits reduce the risk of cancer and arthritis [14]. Apart from its low energy value, the fruits water melon is known for their high micronutrients

concentration such as vitamin K, ascorbic acid, riboflavin, iron and other minerals. Water melon seeds are high in proteins and fat and can find application as a protein source in various food formulations and preparations [15]. Water melon seeds are among the underutilized fruit by-products, though technologies exist for decorticating the seeds, only a small proportion of the seed is commercially processed while the remaining is discarded [16]. In Nigeria, the consumption of water melon is limited to the fresh fruits either as desert or as fruit salads with paw-paw, pineapple and other fruits while the seeds are often discarded. However, the seed is about 1 to 4% of the entire fruit while the pulp and the rind is 70 and 26%, respectively. Protein and fat together account for ¾ of the weight of the seeds and is grouped as oilseeds. It is used as a condiment, garnisher, thickener in soups, fat binder, flavourant, as snack in some parts of the world and its flour is added to wheat flour for production of bread in some countries [16]. Traditionally, the seeds are removed from the rind and then allowed to dry outside in the sun, once dried, the seeds are then milled into flour.

There is nutritional quantity of edible fruits in the developing countries like Nigeria [17]. Malnutrition results directly from inadequate dietary intake and infectious diseases caused by food insecurity at the household, village, community and national levels. Food insecurity is linked to dietary intake, nutritional status, and ultimately to physical health outcomes like child growth morbidity and mortality. In Nigeria, food insecurity is mainly caused by problems related to food production, harvesting, preservation, processing, distribution, preparation and use. The factors include poor storage facilities and poor transportation to move the fruits to the market before it spoils [18]. Other factors are refrigerated storage, drying equipment or poor drying season and traditional processing and marketing systems can be responsible for high losses of nutrient content [19]. The effect of food processing on nutrient content will depend on the sensitivity of the nutrient to the various conditions prevailing during the process, such as heat, oxygen, pH, temperature and light. The nutrient retention may vary with a combination of conditions, such as the characteristics of the food being processed and concentration of the nutrient in the food. During processing and storage of the fruits and vegetables, beta-carotene is degraded through oxidation reactions [20]. Storage of the fruits and vegetables under normal atmospheric conditions results in nutritive degradation, especially of beta-carotene. Considering the above facts, the present research has been undertaken to identifying the nutritional analysis, vitamins and mineral levels of both healthy and unhealthy watermelon.

2. MATERIALS AND METHODS

2.1 Preparation of Samples

The watermelon samples were taken into the laboratory, washed and sterilized with 70% alcohol and peeled before blending with an electric blender. Plant smoothy was used to carry out all the analyses required

2.2 Proximate Analysis

The proximate analysis was carried out mainly by using the method described by Association of Official Analytical Chemist (A.O.A.C) [21]. It involves the determination of crude protein, dry matter, ash, crude fiber, ether extract (fat), moisture content and carbohydrate content.

2.2.1 Crude protein analysis

The protein content of the samples was determined by the Kjeldahl method reported by James, [22]. The total nitrogen was determined and multiplied by the factor 6.25 to obtain the protein content. About 0.5g of the powdered sample was weighed into a kjeldahl digestion flask and a tablet of selenium catalyst was added to it. Also 10ml of concentrated H_2S0_4 was then added to the flask and digestion by heating under a fume cupboard until a clear solution was obtained in a separate flask. The acid and other reagent were digested but without sample to form the blank control.All the digests were carefully transferred to a 100ml volumetric flask and made-up with distilled water to a mark in the flask. A 100ml portion of each digest was mixed with equal volume of 45% NaOH solution in a Kjeldahl distilling unit. The mixture was distilled and the distillate collected into 10ml of 4% boric acid solution containing three drops of mixed indication (bromocresol green and methyl red). A total of 50ml distillate was obtained and titrated against 0.02m of H_2SO_4 solution. Titration was done from the initial green colour to a deep red end point.

The total nitrogen content was calculated asshown below;

$$\%\ N_2 = \left[\frac{100x}{W}\ \frac{N \times 14}{1000} \times \frac{VF}{VA}\right] T$$

Where:

W	=	Weight of sample analyzed
N	=	concentration of H_2SO_4 titrant
VF	=	Total volume of digest
VA	=	Volume of digest distilled
T	=	Titer Value-blank

2.2.2 Fat (ether extract) analysis

Fat content of the samples were determined by the continuous solvent extracting method using a soxhlet apparatus. The method was described by [23,22].

Five grammes of each sample were wrapped in a porous paper (Whatman number one filter paper). The wrapped samples were put in a soxhlet influx flask containing 200ml of petroleum ether. The upper end of the reflux flask was connected to a condenser. By heat the solvent in the flask through electro-thermals heater, it vaporizes and condensed into the reflux flask. Soon the wrapped samples was completely immersed in the solvent and remained in contact with it, the flask filed up and siphoned over, thus carrying oil extract from the sample down to the boiling flask.

This process was allowed on repeatedly for about 4 hours before the defatted sample was removed and reserved for crude fiber analysis. The solvent was recovered and the extracting flask with its oil content was dried in the oven at 60^0C for 3 minutes (This is to remove any residual solvent). After cooling in a desiccator, the flask was reweighed.

By difference, the weight of fat (oil) extract was determined and expressed as a percentage of sample weight. It was thereby calculated as.

$$\% \text{ fat (Ether extract)} = \frac{W_2-W_1}{\text{Weight of sample}} \times \frac{100}{1}$$

Where:

W_1	=	Weight of energy extraction flask
W_2	=	Weight of flask and oil extract

2.2.3 Crude Fibre Analysis

This was determined using the [22] method.

About 5g of each sample were defatted (during fat analysis). The defatted sample was boiled in 200ml of 1.25% H_2SO_4 solution under reflux for 30 minutes. After that, the samples were washed with several proportions of hot (boiling) water using a two-fold muslin cloth to trap the particle. The washed samples were carefully transferred quantitatively back to the flask and 20ml of 1.25% NaOH solution was added to it. Again the samples were boiled for 30minutes and washed as before with hot water. Then they were very carefully transferred to a weighed porcelain crucible and dried in the oven at 105^0C for 3 hours.

After cooling in a desiccator, they were reweighed (W_2) and then put in the muffle furnace and burn at 55^0C for 2hours, until they become ash. Again they were cooled in the desiccators and reweighed.

The crude fiber content was calculated mathematically as:

$$\% \text{ crude fiber} = \frac{W_2-W_3}{\text{Weight of sample}} \times \frac{100}{1}$$

Where:

W_2=Weight of crucible + sample after washing and drying in oven.

W_3=Weight of crucible + sample of ash.

2.2.4 Total Ash Content Analysis

This was done using the furnace incineration gravimetric method [21].

A measured weight 5g of each powdered samples was in the previous weighed into porcelain crucible. The sample in crucible was put the muffle furnace set at 550^0C and allowed to burn for 3 hours (until the sample becomes gray ash). The sample in crucible was very carefully removed from the furnace (taking care not to allow air blow away the ash) and cooled in a desiccator. It was reweighed by difference, the weight of ash was obtained and in percentage. It was calculated as shown below:

$$\frac{W_2-W_1}{\text{Weight of sample}} \times \frac{100}{1}$$

Where:

W_1 = Weight of crucible of Ash

`W_2 = Weight of crucible + sample after drying to constant weight

2.2.5 Moisture Content Analysis

The moisture contents of the samples were analyzed by the method described by [23,22]. A measured weight of each sample (5g) was weighted into a weighted moisture can. The can and its sample content were dried in the oven at

105^0C for 3 hours in the first instance. It was cooled in a desiccator and reweighed. The weight was recorded while the sample was returned to the oven for further drying. The drying, cooling and weighing continued repeatedly until a constant was obtained. By the difference, the weight of moisture lost was determined and expressed as a percentage. It was calculated as shown below:

$$\% \text{ moisture} \quad \frac{W_2-W_1}{W_3-W_1} x \frac{100}{1}$$

Where:
W_1 = Weight of empty moisture Can
W_2 = Weight of Can before drying
W_3 = Weight of Can + sample after drying to a constant weight.

2.2.6 Carbohydrate Determination

The carbohydrate content was calculated by arithmetic difference, as the Nitrogen Free Extractive (NFE), a method separately described by Pearson, 1976 and James, 1995. The NFE was calculated as:

% NFE = 100-% (A+ B+C+D+E)

Where:
A = Crude protein
B = fat (ether extract)
C = Crude fiber
D = Ash
F = Moisture

2.3 Mineral Content Determination

The mineral content of the test samples were determined by the dry ash extraction method. Here 2.0g of the samples were burnt to ashes in a furnace (as in ash determination) the resulting ash was dissolved in 100ml of dilute hydrochloric acid and then diluted to 100ml in a volumetric flask using distilled water. The digest obtained was used for the various analyses [24].

2.3.1 Determination of Phosphorus

Phosphorus in the samples was determined by using the vanado-mohybdate (yellow) spectrometry described by [22]. About 1ml extract from each sample was dispensed into a test tube, similarly the same volume of standard phosphorus solution as well as standard and blank respectively. The content of each tube was mixed with equal volume of the vanado-molybdate for 15 minutes at room temperature before their absorbance was taken in Jenway electronic spectrophotometer at wavelength of 420nm. Measurement was given with the blank at zero [24].

$$\text{Phosphorus} = \frac{100}{W} \times \frac{AU}{AS} \times C \times \frac{VF}{VA}$$

Where:
W = Weight of sample analyzed
AU = Absorbance of test sample
AS = Absorbance of standard solution
VF = Total volume of filtrate
VA = Volume of filtrate analyzed
C = Total volume of extract

2.3.2 Determination of Calcium and Magnesium

This method was described by [23]. Calcium and magnesium content of the test samples were determined by the versanale EDTA complexiometric titration. About 20ml of each extract was dispersed into a conical flask; pinches of the masking agent's hydroxyl tannin, hydrochlorate, potassium cyanide were added followed by 20ml of ammonia indicator solution pH 10.0. The pinch of the indicator-Erichrome black was added and the mixture was shaken very well, it was titrated against 0.02N of EDTA solution titration was from a mauve colour to a permanent blue coloration. A reagent blank consisting of 20ml distilled water was also treated as described above. The titration gave a reading for combined Ca and Mg complexes in samples. A separate titration was then conducted for calcium alone [24].

Titration for calcium alone was a repeat of the previous one with slight change 10% NaOH solution at pH 12.0 was used in place of the ammonia buffer while solchrome dark blue (calcon) was used as indicator in place of erichrome black [24].

Calcium and magnesium contents were calculated separately using the formula below.

$$\% \text{ calcium or magnesium} = \frac{100}{W} \times EW \times \frac{N}{100} \times \frac{VF}{VA}$$

Where:
W = Weight of sample analyzed
EW = Equivalent weight
VF = Total volume of extract
N = Normality of EDTA = 0.02n
VA =Volume of extract titrated
T = Titer value less bdlank.

2.3.3 Determination of potassium and sodium

Method of [21] was used. Potassium and sodium in the samples were determined by flame photometry. The instrument was set up according to the manufacturer's instruction. The equipment was turned on and allowed to stay for about 10minutes. The gas and air lets were opened as the start knob was turned on. The equipment being self igniting and the flame was adjusted to a non-luminous level (i.e. blue colour flame) [24].

Meanwhile, standard K and Na solutions were prepared separately and each was diluted to concentration and each was diluted to concentration of 2,4,6,8 and 10ppm respectively. When analyzing for specified element say K, the appropriate filter was selected and the instrument flushed with distilled water. The highest concentrated standard solutions were put in place and the reading adjusted to 100ml. Thereafter, starting with least concentration i. e. 2ppm, all the standard solutions were sucked into the instrument and caused to spray over the non-luminous flame. The readings were recorded and later plotted into a standard curve used to extrapolate the K level in the sample. After the standard, the sample digest were carefully siphoned in turns into the instrument, their readings recorded.

The samples were repeated with sodium (Na) standard and the place of the K filter. The concentration of the test mineral in the sample was calculated and obtained as follows:

$$\text{Mkmg/100g} = \frac{100}{W} \times \frac{VT}{1} \times \frac{N}{10^5} \times X \times D$$

Where:

W = Weight of sample used
Vt = Total extract volume since 1m was siphoned into the instrument.
X = Concentration from the graph
D = Dilution factor where applicable similarly.

For sodium concentration it was given:

$$\text{Kmg/100g} = \frac{100}{W} \times \frac{VT}{1} \times \frac{N}{10^5} \times D$$

2.4 Statistical Analysis

The data collected were subjected to analysis of Variance (ANOVA) using general linear model option SAS. Test of significance was determined by Duncan's multiple range test at 5% level of probability.

3. RESULTS

3.1 Proximate Analysis Result on Healthy and Unhealthy Watermelon Fruit

Results of the proximate analysis of the healthy and unhealthy watermelon fruit as shown in Table 1 indicated that the significantly highest carbohydrate (43.30±0.028), protein (8.82±0.025), crude fat (3.38±0.030) and crude fibre (30.25±0.028) contents were that of the healthy watermelon fruit whereas the lowest, carbohydrate (30.58±.0.024), protein (3.28±0.017), crude fat (1.36±0.028) and crude fibre (10.10±0.011) were observed in unhealthy one. However, the significantly highest moisture content (20.14±0.003) was observed in the unhealthy watermelon fruit and the lowest (9.89±0.028) in the healthy one.

3.2 Mineral Analysis Result on Healthy and Unhealthy Watermelon

Analysis of the mineral nutrients of both fruit showed that the healthy watermelon fruit significantly had the highest content of K (122.4±0.028), Na (152.0±0.025), P (230.6±0.030) and Mg (112.3±0.028) while the unhealthy one had the lowest. In terms of the Ca content however, the unhealthy watermelon fruit had the highest with 146.5±0.001 (Table 2).

Table 1. Proximate Analysis Result on Healthy and Unhealthy Watermelon Fruit

Treatment	Carbohydrate	Protein	Ether Extract	Crude Fiber	Moisture Content
Healthy watermelon	43.30±0.028	8.82±0.025	3.38±0.030	30.25±0.028	9.89±0.028
Unhealthy watermelon	30.58±0.024	3.28±0.017	1.36±0.028	10.10±0.011	20.14±0.003

Table 2. Mineral Analysis Result on Healthy and Unhealthy Watermelon

Treatment	Potassium	Sodium	Phosphorus	Magnesium	Calcium
Healthy watermelon	122.4±0.028	152.0±0.025	230.6±0.030	112.3±0.028	120.0±0.003
Unhealthy watermelon	118.9±0.023	126.7±0.029	216.4±0.028	80.6±0.018	146.5±0.001

4. DISCUSSION

The high moisture content of healthy watermelon was not a surprise. Fruits are known to contain higher moisture relative to different samples [25]. Location, maturity and seasonal variation affect moisture content of plants and their products [26]. The low moisture for fresh fruits might be attributed to unhealthiness and seasonality.

The carbohydrate level of the healthy fruit and unhealthy fruit indicates that the healthy fruits can act as deficient food supplement in providing carbohydrate than commonly consumed fruits.

The relatively high protein content of the healthy watermelon 8.82±0.025 might be attributed to their low moisture content. It is known that the higher the moisture content of a given fruit the lower is the protein. [27] reported that moisture affects nutrient content of fruits. Generally, unhealthy fruits are low in protein, because they contain much more moisture and less protein.

The low fat content of the fruits studied in the present work is comparable to the observations of many researchers [28] who reported that fruits are not good sources of fat. This is in agreement with this research which showed that the fat content of healthy watermelon had 3.38±0.030 while unhealthy water melon had 1.36±0.028.

Fruits contain high fiber whether fresh or juicy. The differences in fiber content among the stored fruits might be associated with differences in moisture and varietal differences. The low fiber contentin unhealthy watermelon (10.10±0.011) is same for all the stored fruits which is in agreement with [25] who reported that storing of fruits for longer period is associated with the low fiber degradation in fruits, whereas freezing led to loss of fiber due to freeze cracking. The fiber content for the healthy watermelon was high (30.25±0.028).

Different fruits may accumulate different minerals, and the absorption ability varies in different biological species due to their diverse physiological character [29].
Calcuim (Ca) is an essential mineral that plays catalytic, structural and regulatory roles as an integral part of many enzymes in human body. It is essential for normal growth, strong bone, mental ability, immune system, reproduction and healthy function of the heart [30]. The concentration of Ca in the healthy watermelon fruit studied was below (120.0±0.003) the permissible level (1000 mg/kg) recommended by FAO/WHO (2001) in fruits. A low level of calcium may contribute to poor mineralization of bones, soft bones and in children, rickets and impaired growth [31].

Magnesium plays important role in the structure and the function of the human body. The adult human body contains about 25 grams of magnesium. Over 60% of all the magnesium in the body is found in the skeleton, about 27% is found in muscle, while 6 to 7% is found in other cells, and less than 1% is found outside of cells [32]. The healthy watermelon fruit was found to have high concentration of (112.3±0.028) than unhealthy one with (80.6±0.018).

The high potassium (K) content observed in this study is below the permissible level (400mg/kg) allowed in a fruit as recommended by FAO/WHO (2001). in fruits (400 mg/kg).

Because of the reciprocal effects of Mg and K authorities have argued that a diet high in potassium and low in Mg favours lower blood pressure. Increase in dietary potassium as the chloride salt has shown to decrease blood pressure in some hypertensive individuals [33].

It is also possible that a low Mg and high K diet would decrease the development of cardio vascular disease [31]. The Mg requirement from fruits source is not much important because of its availability as NaCl salt. Deficiency of calcium, potassium and magnesium leads to the classic bone symptoms associated with rickets, such as bowlegs, knock knees, curvature of the spine and pelvic and thoracic deformities [33].

5. CONCLUSION

The term fruits have different meaning. Botanically, a fruit is the ripened ovary together with seeds of a flowering plant. In many species, the fruit incorporates the ripened ovary and surrounding tissues. They are found to be rich in vitamins, especially vitamin C.Watermelon is packed with water and nutrients, contains very few calories and is exceptionally refreshing. The juicy water melon have several health benefits like lowering blood pressure, improved insulin sensitivity and reduced muscle soreness. The consumption of water melon in Nigeria has increased tremendously in recent years probably due to the increased awareness on the health benefits. Water melon is a potent source of a biological active compound known as caroteniods.The main sugar in fruits is glucose,

fructose and sucrose. Some fruits are low in carbohydrate and consequently low in calorie.Inthis present study, the fruits sample studied contained considerable nutritional value that may meet body needs. Additionally, there was no significant difference in minerals content of the fruits in all the sampled sites (locations) of the study. The study posits that the fruit species had the minerals within world health organization (WHO) permissible limit. Thus it can be concluded that nutrients found in the fruits are in variable concentrations. Therefore their consumption of healthy watermelon is recommended for normal body function and healthy life.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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