



Influence of Geographical Location on Key Nutritional Properties of Watermelon (*Citrullus lanatus*) Pulp

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ABSTRACT: *Citrullus lanatus* (watermelon) which was only cultivated in Northern Nigeria in the past, is now cultivated in other parts of Nigeria. However, there is no data to show the nutritional quality of *C. lanatus* as it relates to the location of cultivation. Therefore, this study aimed to evaluate the nutritional properties of the pulp of *Citrullus lanatus* cultivated in four states, representing four geopolitical regions of Nigeria. *C. lanatus* samples were collected from the northeast, southwest, southeast and south-south geopolitical zones of Nigeria. They were thoroughly washed, then the pulp was separated, homogenized and freeze-dried. The amino acid profile, vitamins, proximate and mineral analyses of the freeze-dried samples were done by standard protocols. The amino acid profile results showed the presence of varied amino acids in the different zones, with the southwest giving the highest concentrations of the amino acids and the least concentration obtained from the south-south zone. The presence of vitamin C and A, and the minerals: Ca, Mg, K, Na, Fe, Pb, and Mn were detected in the pulp of *C. lanatus* at diverse concentrations in the various zones, with samples from the southwest zone also giving the highest composition of both vitamins and mineral contents. The proximate composition analysis results revealed a higher ($p < 0.05$) percentage of moisture, protein and fiber from the southwest sample when compared with other zones, and higher ($p < 0.05$) percentage composition of carbohydrate, ash and fat contents from the northeast samples relative to other zones. Thus, the nutritional value of the *C. lanatus* samples was in the order: Southwest > northeast > southeast > south-south. Conclusively, the results showed that the location of cultivation affects the nutritional value of *Citrullus lanatus* fruit.

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For survival and well-being, all living things rely on plants, either directly or indirectly. This is true because plants serve as the primary source of foods, medications, and other products that people utilize on a daily basis. They are important to all living things due to the nutrients found in their roots, stems, leaves, flowers, fruits, and seeds. Plants have been used as sources of remedies for the treatment of many diseases since ancient times. Despite the remarkable progress in synthetic organic medicinal products of the twentieth century, over 25% of prescribed medicines in industrialized countries are derived directly or indirectly from plants (Abdulazeez *et al.*, 2020). *Citrullus lanatus* (watermelon) is a harvested fruit that

grows as a creeping herb that belongs to the family of plants known as Cucurbitaceae. The "water" part of the name comes from the fact that the fruit yields roughly 90 percent water, and the "melon" part comes from the fact that the fruit is large, round, and sweet. *Citrullus lanatus*'s scientific name was derived from Latin and Greek roots. Citrullus is derived from the Greek word "citrus" which refers to the citrus fruit. The word lanatus comes from Latin and means "wooly" alluding to the plant's tiny hairs on the leaves and stems (Mustafa *et al.*, 2022). Watermelon fruit can be classified into three major parts which are the rind (peel), pulp and seeds respectively. Watermelon constitutes approximately 68 % flesh, the rind 30%

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and the seed 2% of the total fruit weight (Sadiq *et al.*, 2021). *C. lanatus* is known to be rich in nutrients because they contain many carbohydrates, fats, and proteins. It also include a variety of beneficial cations such as calcium, potassium, and magnesium, and phytochemicals such as flavonoids, polyphenols, saponins, and alkaloids. These by-products have antibacterial and antiviral properties, making them useful in preventing and treating various illnesses. In addition, isolated compounds from the fruits possess anti-hypertension, anti-diabetes, anti-cardiovascular diseases, and anticancer properties (Mustafa *et al.*, 2022; Okoro, 2020). *C. lanatus* is cultivated in sandy-loam soil which is rich in organic matter with a suitable drainage and pH range of 6.5 – 7.5. The seed develop better when the temperature is higher than 20°C. High humidity at the time of vegetative growth renders the crop at risk of diseases caused by fungal. Watermelon can be directly grown in the fields or grown as transplanted seeds in pots and then transferred to the field (Verma and Tomar, 2017).

Weather pattern and seasons differ from the northern part to the southern part of Nigeria. The composition of the soil has been said to affect plant's growth, as the location of the soil and climate around the location equally affect its composition. Thus, plants cultivated in different locations will have significant differences in both nutritional quality and yield, due to differences in soil composition and climate variations (Abbey *et al.*, 2017). Therefore the aim of this study is to evaluate the amino acid profile, vitamins, proximate and mineral contents of Watermelon (*Citrullus lanatus*) pulp as it relates to the location of cultivation.

MATERIALS AND METHODS

Collection and preparation of *Citrullus lanatus*: The samples (*Citrullus lanatus*) was collected from watermelon farms in Bali Local Government Area of Taraba State, Yewa North Local Government Area of Ogun State, Owerri West Local Government of Imo State and Ethiope East Local Government Area Delta State, Nigeria. The plant was authenticated by a taxonomist, Mr. M.E. Ozioma, at the Department of Botany, Faculty of Science, Delta State University, Abraka. The fruits were washed thoroughly, cut opened with a knife and the seeds were removed, then the pulp was separated from the rind. The pulp was homogenized using a blender and freeze dried. The freeze-dried sample was subsequently used for the amino acid profile, vitamins, proximate and mineral analyses.

Proximate Determination: The proximate composition assays for Moisture, protein, fats, and fibre contents were done as described earlier (AOAC 1990). The

carbohydrate content of the samples was estimated by difference (AOAC 1990):

$$\% \text{ Carbohydrate} = 100 - (\% \text{ Moisture} + \% \text{ Crude Fibre} + \% \text{ Crude Protein} + \% \text{ Ash}).$$

Mineral Analysis: The concentration of sodium and potassium was evaluated using a flame photometer, while the concentration of other minerals was evaluated using an atomic absorption spectrophotometer (AOAC, 1990).

Vitamin Analysis: Vitamin A was determined using the spectrophotometer method (Aremu and Nweze, 2017) while Vitamin C was estimated by the 2,4-dinitrophenol hydrazine method (AOAC, 1990).

Amino Acid Profile Analysis: Amino Acid Profile was carried out according to the method described by Tsugita and Scheffler (1982).

Statistical Analysis: Statistical analysis was done using SPSS-PC program package (Version 23.0). The data was analyzed by student T-test and One-way Analysis of Variance (ANOVA) and most of the results were expressed as Mean \pm (SD) Standard deviation for triplicate determinations. All results were considered significant at p-values of less than 0.05, that is, at 95% confidence level ($p < 0.05$).

RESULTS AND DISCUSSION

Presented in Table 1 are results of the proximate composition of *Citrullus lanatus* pulp cultivated in the four geopolitical zones of Nigeria. The results revealed that the carbohydrate content of *Citrullus lanatus* pulp cultivated in the Northeastern region was significantly higher when compared to the other regions. Carbohydrate has been found to act as a structural material (cellulose), a part of the energy-transporting molecule ATP, recognition sites on cell surfaces, and one of the three necessary components of DNA and RNA (Khowala, *et al.*, 2008). The ash content ranged from highest, being northeast (2.46%) to the lowest which is southwest (1.87%). This may be as a result of the low mineral content of southeastern states soil (Onweremadu *et al.*, 2007). The fibre content of the pulp of the different geopolitical region ranged from the highest southwest (2.27%) to the lowest northeast (0.38%). A wide variety of chemicals found in fiber have the potential to prevent certain cancers. Additionally, a number of fibers have shown (both *in vitro* and *in vivo*) that they have the ability to adsorb cancer-causing substances (Yangilar, 2013). The result of the crude fat of the different geopolitical region ranged from (0.55%) to (1.09%), with the Southwest having the lowest and Northeast having the highest.

Fats are known to have high energy content, which enables the largest potential energy storage in the least amount of food material, fats are important for people, animals, and plants. The protein content from the results ranged from 0.32% to 0.84%. *Citrullus lanatus* pulp cultivated in the Northeastern region had the least

protein content while that of the southwest region had the highest protein content. Proteins have been found to provide energy and play a significant part in the development and maintenance of the human body (Mæhre *et al.*, 2018; Moore, 2015).

Table 1: Proximate analysis of the *Citrullus lanatus* pulp cultivated in four geopolitical regions in Nigeria

Parameters (%)	South-South	Southwest	Southeast	Northeast
Moisture	23.10 ± 0.36 ^a	25.17 ± 0.35 ^b	22.44 ± 3.02 ^{ab}	17.67 ± 0.47 ^c
Crude Protein	0.50 ± 0.11 ^a	0.84 ± 0.05 ^b	0.52 ± 0.08 ^a	0.32 ± 0.02 ^a
Ash	2.17 ± 0.21 ^a	1.87 ± 0.01 ^a	2.17 ± 0.21 ^a	2.47 ± 0.57 ^a
Fat	0.57 ± 0.82 ^a	0.56 ± 0.01 ^a	0.56 ± 0.08 ^a	1.09 ± 0.05 ^b
Fibre	0.38 ± 0.02 ^a	2.27 ± 0.01 ^b	1.34 ± 0.24 ^a	0.38 ± 0.03 ^c
Carbohydrates	78.08 ± 0.58 ^a	69.89 ± 0.16 ^b	72.39 ± 0.93 ^a	78.08 ± 0.58 ^c

*Values are expressed as mean ± standard error of mean, **Values with different superscripts differ significantly (p<0.05) across rows

The result of the moisture content showed that the Southwestern region had the highest moisture content (25.17 ± 0.35%), while Northeastern region had the lowest moisture content (17.67 ± 0.47%). Free moisture is directly related to water activity; the higher the water activity, the more susceptible the food will be to interactions with microbes and its environment foods with a high moisture content frequently have a water activity of 0.99 or less, making them especially susceptible to microbial development (Syamaladevi *et al.*, 2016).

The body needs micronutrients and macronutrients in tiny and large amounts, respectively, throughout life to coordinate a variety of physiological functions and sustain optimal health (Godswill *et al.*, 2020). When the mineral content of the pulp was compared across

the regions, Southwest recorded the highest concentration for calcium (0.16mg/kg) and magnesium (0.20mg/kg) while the region with the lowest concentration was seen in the Northeast region (calcium 0.12mg/kg and magnesium 0.15mg/kg). Thus, the concentration for potassium were in the order of Northeast>South-South=Southeast>Southwest, sodium: Northeast>Southwest=Southeast> South-South and iron: Northeast> Southwest> South-South=Southeast. Lead was only detected in the southwest region while no difference was observed in manganese (0.03mg/kg) across all the regions. The calcium content of the *Citrullus lanatus* pulp cultivated in the Southwest region agrees with that of Jatau *et al.* (2015) that recorded a calcium content of 0.16mg/kg.

Table 2: Mineral analysis of *Citrullus lanatus* pulp cultivated in four geopolitical regions in Nigeria

Mineral(mg/kg)	South-South	Southwest	Southeast	Northeast
Calcium	0.14 ± 0.02 ^a	0.16 ± 0.01 ^b	0.13 ± 0.01 ^a	0.12 ± 0.01 ^a
Magnesium	0.17 ± 0.00 ^a	0.20 ± 0.01 ^b	0.16 ± 0.00 ^a	0.15 ± 0.01 ^c
Potassium	0.14 ± 0.01 ^a	0.13 ± 0.01 ^a	0.14 ± 0.01 ^a	0.16 ± 0.02 ^a
Sodium	0.13 ± 0.01 ^a	0.14 ± 0.01 ^{ab}	0.14 ± 0.01 ^{ab}	0.15 ± 0.00 ^b
Iron	0.24 ± 0.02 ^a	0.27 ± 0.02 ^a	0.24 ± 0.02 ^a	0.32 ± 0.02 ^b
Lead	0.01 ± 0.01 ^a	0.01 ± 0.01 ^a	0.00 ± 0.01 ^a	0.00 ± 0.00 ^a
Manganese	0.03 ± 0.01 ^a	0.03 ± 0.01 ^a	0.03 ± 0.01 ^a	0.03 ± 0.01 ^a

*Values are expressed as mean ± standard error of mean, **Values with different superscripts differ significantly (p<0.05) across rows

Calcium is primarily associated with healthy bones and teeth, but it also plays a crucial role in blood clotting, assisting with muscle contraction, and regulating normal heartbeats and nerve functions (Chauhan, 2022). Magnesium controls the manufacture of DNA and RNA, cell development, and cell division, among other elements of cellular metabolism (Maradze *et al.*, 2018). The production, storage, and transport of ATP are controlled by potassium and calcium (Mathew and Panonnummal, 2021). In extracellular fluids, sodium is the main

cation. It controls plasma volume and acid-base equilibrium. Sodium is one of the electrolytes the body needs in relatively high level. Manganese (Mn) is a necessary nutrient. It serves as a cofactor for a number of enzymes such as arginase, glutamine synthetase (GS), pyruvate carboxylase, and Mn superoxide dismutase (Mn-SOD). It also plays vital function in the development, digestion, reproduction, and antioxidant processes through the mentioned metalloproteins (Asagba *et al.*, 2010). Iron is one of the most prevalent metals in the body, it is necessary for life. Iron

participates in the exchange of oxygen between blood and tissues, since it is a part of myoglobin and hemoglobin (Akram *et al.*, 2020). Table 2 shows the result for the vitamin composition of *Citrullus lanatus* pulp. Vitamin A was only detected in the *C. lanatus* cultivated in the southwest region. Vitamin A helps with night-time vision and safeguards the eyes from infections. Rhodopsin is created in the retinal rod cells when vitamin A and the protein opsin interact (Akram

et al., 2020). Vitamin C is a water-soluble vitamin which is also known as Ascorbic Acid and in addition to its role as an antioxidant, the water-soluble vitamin is crucial for numerous biological functions (Okoro *et al.*, 2015a). The result of the study revealed no significant difference in the Vitamin C content between the South- South, Southwest and Southeast regions, with the northeast having the least concentration.

Table 3. Vitamin content of *Citrullus lanatus* pulp cultivated in four geopolitical regions in Nigeria

Vitamin mg/kg	South-South	Southeast	Southwest	Northeast
Vitamin A	0	1620	0	0
Vitamin C	3.00	3.00	3.00	1.00

From the results presented in Table 4, eleven (11) amino acids were detected, out of which two (2) were non-essential (alanine and aspartic acid), three (3) were conditionally essential (The body produces amino acids that are conditionally necessary. But occasionally, as in times of stress or disease, the body doesn't create enough) which includes; arginine, cysteine and proline and six (6) were essential (cannot be synthesized by the body and so must be gotten from diets) which includes histidine, leucine, methionine, tryptophan, threonine and valine. The results revealed higher concentrations of most of the amino acids in the southwest region followed by the northeastern regions. Highest concentration of aspartic acid (40.86pmol/ul), leucine(63.83 pmol/ul), cysteine(94.39 pmol/ul) and valine(5.99pmol/ul) were found in the southwest region and the lowest concentration were recorded in the northeast region but aspartic acid was not detected

in the Northeastern region. South-south and southwest gave the highest concentration of arginine (7.32 pmol/ul and 7.37 pmol/ul) and the lowest was seen in southeast (6.07 pmol/ul) and northeast (6.05 pmol/ul). Tryptophan had higher concentration in the Northeastern(68.08pmol/ul) region and the lowest was recorded in the south- south region (52.26pmol/ul), methione and proline was higher in the Northeastern region(1285.12pmol/ul and 14.52pmol/ul respectively) and lowest concentrations were found in the Southwestern region(309.55pmol/ul and 10.54pmol/ul). South-South had the highest threonine concentration (16.35pmol/ul), but threonine was not detected in the southeast and northeastern regions, while South-South and Southeast had the highest concentration in histidine and alanine and the region with the lowest concentration for histidine was the Southwest region.

Table 4 Amino acid profile of *Citrullus lanatus* pulp cultivated in four geopolitical regions in Nigeria

Amino Acids (Pmol/Ul)	South-South	South-West	South-East	North-East
Aspartic Acid	25.08	40.86	30.95	-----
Tryptophan	52.26	56.78	52.27	68.08
Leucine	58.64	63.83	56.71	46.52
Histidine	17.25	9.69	17.27	11.21
Threonine	16.35	11.06	*****	****
Alanine	11.58	6.55	11.36	3.07
Arginine	7.32	7.37	6.07	6.05
Cysteine	83.46	94.39	84.06	67.21
Valine	4.15	5.99	4.27	3.81

Methionine controls the innate immune system, digestive function, and metabolic functions in mammals, and also helps to combat oxidative stress and affects lipid metabolism (Martínez, *et al.*, 2017). Threonine plays a significant role as an essential component of mucin in intestinal health and is involved in a crucial metabolic process like the generation of uric acid (Alagawany *et al.*, 2021). Cysteine is utilized as an antidote in the pharmaceutical industry, where it is most well-known for its capacity to mitigate acetaminophen toxicity. It has been used successfully to treat metabolic abnormalities, genetic flaws, and infections like HIV

and chronic obstructive pulmonary disease that result in GSH shortage. Valine is an important amino acid that has uses in nutrition, cosmetics, and pharmaceuticals (Herring *et al.*, 2021). Tryptophan is required for the *in vivo* production of proteins. Following intake, it undergoes metabolic conversion to beneficial metabolites such as kynurenine, melatonin, serotonin, and the vitamin niacin (Friedman, 2018; Okoro *et al.*, 2015b). Leucine is crucial for cell signaling, promotes protein synthesis, and controls catabolism, primarily in skeletal muscle (Pedroso *et al.*, 2015). Aspartic acid is used in the synthesis of proteins and the regulation of several

hormones (Ullah *et al.*, 2016). The Krebs Cycle can be replenished by breaking down arginine into chemical intermediates, which is one among the many biological processes for which it is used (Albaugh *et al.*, 2017). Prolin helps to reduce oxidative stress. Histidine performs particularly significant functions in the catalytic triad of enzymes like serine proteases like trypsin (Brosnan and Brosnan, 2020). The variation in nutrients concentrations of *Citrullus lanatus* pulp cultivated in four geopolitical regions in Nigeria maybe attributed to the fact that optimum soil for growing watermelons is non-saline sandy loam. Light-textured fields are preferred for early output since they warm up more quickly in the spring. Sandy and loamy soil are good for growing watermelons (Ibrahim *et al.*, 2021), while Aizebeokhai *et al* (2018) reported that sandy and loamy soils are the predominant soil types in the Southwestern regions of Nigeria.

Conclusion: The study showed that *Citrullus lanatus* cultivated in the four geopolitical zones had significant differences. The highest value for moisture, protein, and fibre were obtained from the southwest, while samples from the northeast gave the highest carbohydrate, ash and fat values. For most of the parameters examined, southwest region samples gave the highest values. The results indicate that the nutritional quality of *Citrullus lanatus* have a relationship with the location of cultivation.

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