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EFFECTS OF PROCESSING METHODS (COOKING, FRYING AND ROASTING) ON THE NUTRITIONAL COMPOSITION OF WHITE YAM (*Dioscorea rotundata L*)

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ABSTRACT

One of the most significant food crops in West Africa is the yam (Dioscorea rotundata). For many people in tropical nations, it is a significant source of carbs and nutritious energy. Roots and tubers are rarely consumed uncooked, much like many other foods. The purpose of this study is to investigate how the nutritional makeup of white yams (Dioscorea rotundata) is affected by the processing techniques of cooking, frying, and roasting. After being peeled, cleaned, and diced, freshly collected Dioscorea rotundata tubers were processed domestically using a variety of methods, including boiling, frying, roasting, and roasting. Their vitamin, mineral, and proximate compositions were assessed. Roasted yams were shown to have the highest levels of ash and carbohydrates, while their other proximal properties were comparatively low. When compared to other processing methods, roasted yam had considerably higher mineral levels (p<0.05) in all mineral constituents, with the exception of salt. Compared to other processing processes, raw yam had a higher vitamin C concentration. In general, yams have nutritional content regardless of processing method, therefore they can be used for adult diets and for children's weaning or complementary feeding.

KEYWORDS

Nutritional Composition, Dioscorea rotundata L

I. INTRODUCTION

Yam is a member of the Dioscorea genus. It is an important staple food for an estimated 60 million people in the "Yam Zone" of West Africa, which stretches from Ivory Coast to Cameroon (Adepoju et al., 2010). More than half of the world's yams are produced in Nigeria alone. In addition to having a high starch content, yams also contain the enzyme alpha amylase, which, as the tuber ages in storage, turns starch into sugars (Adegunwa et al., 2011). Yams are frequently boiled, roasted, or fried and then eaten with sauces. Additionally, fresh yams can be peeled, boiled, and then pounded to create pounded yam, a sticky, elastic dough. Making roots, tubers, and their products more pleasant, digestible, and safe for human consumption is the main goal of these techniques. Additionally, processing prolongs the shelf life of roots and tubers, which are frequently quite perishable when fresh. Additionally, it offers a range of items that are easier to cook, prepare, and eat than the original new materials. According to Ferde et al. (2010), women are known to be highly involved in every step of the cultivation and processing of root crops. If efforts are made to identify and overcome the obstacles to its production, there are indications that yam has a strong chance of helping to close the anticipated food gap in Africa in the twenty-first century. Nonetheless, Nigeria is the world's largest producer, contributing 71% of global yam production, making West Africa the most significant yam-producing region in the world (BBC, 2010). Yam's relatively high moisture content and susceptibility to slow physiological deterioration after harvesting place it in the semi-perishable food class. Nonetheless, yams can be dried to create less perishable goods like yam flour (Inagbire and Hilda, 2011). Before yam tubers can be preserved, they must air dry in the sun. It is thought that the way these crops are processed may have an impact on their nutritional value.

Because it produces a large yield when there is rainfall, yams also play a significant role in Nigerians' nutrition and economics. Pharmaceutical substances including saponins and sapogenins, which are precursors of cortisone and steroidal hormones, are found in the majority of yam species. According to Ejimofor et al. (2023), yam plants belong to the order Dioscoreales, family Dioscoreaceae, and genus Dioscorea.

Dioscorea is the largest and most significant genus in the Dioscoreaceae family, which also includes several additional genera. Eleazu and Ironua (2013) reported eight yam species grown in Cameroon, while Away et al. (2017) recorded twelve cultivars and six common species grown in Jaimaca. There are many different cultivars of D. rotundata, which is consumed extensively in Nigeria. In one of its publication series, the Food Basket Foundation International (FBFI) listed the nutritional makeup of foods that are frequently consumed in Nigeria in their raw, processed, and prepared forms. It also included information on the energy and nutrient content of water yams (Dioscorea alata) (FBFI Publication Series, 1995). However, there was no information available on white yams, which are the most popular fruit in Nigeria. Relatively little is known about the nutritional makeup of the several prepared goods made from white yams, despite the fact that they are a staple diet in Nigeria.

II. MATERIALS AND METHODS

A. Materials

Weighing crucible, Soxhlet extractor, Beaker, Filter paper, Bucker funnel, Muffle furnace, Kjeldahlflusk, Muslin cloth

B. Reagent

Distilled water, N-hexane, Sulpuric Acid, Sodium hydroxide, Hydrochloric acid, Sodium hydroxide, H2SO4cristal

C. Method of collection of sample

White yam was bought at Eke Awka market in Anambra State Nigeria. They were taken to the laboratory. The identification was carried out by my supervisor.

D. Pre treatment

The white yam samples were separated into four parts. One part was boiled, 2nd part fried with oil, 3rd part roasted while the last part was used in raw form.

E. Proximate Analysis

The determination of the crude protein, moisture, ash and fat contents of the raw and smoked fish were carried out in triplicates in accordance with Association of Analytical Chemist AOAC (2015).

Determination of moisture content

This was done using the gravimetric method described by the AOAC (2015). A previously weighed moisture plate was filled with the sample's measured weight (5.0 g). The sample in the dish was chilled in a desiccator and weighed following three hours of oven drying at 105°C. When the weight stopped dropping (a constant weight was reached), it was returned to the oven to continue drying, cooling, and weighing every hour. The weight of moisture lost was expressed as a percentage of the sample's weight for analysis. The following expression supplied it:

$$\text{Moisture content (\%)} = \frac{M2 - M3}{M2 - M1} \times 100$$

Where:

M1 = Mass of empty moisture dish
M2 = Mass of empty dish + Sample before drying
M3 = Mass of dish + Sample dried to constant weight

Determination of crude protein

AOAC (2015) states that the Kjeldahl technique was applied in this case. One gramme of the substance was used to create a micro Kjeldahl flask. Ten grams of sodium sulphate (Na_2SO_4), one gram of cupric acid ($CuSO_4$), and twenty-five milliliters of sulfuric acid (H_2SO_4) were added to the micro Kjeldahl flask that held the sample. The flask was heated at a 60-degree inclination angle. An anti-bumping substance was employed to stop foaming. It was first heated gradually to 70 degrees Celsius, then steadily until the liquid lost its brown or black tinge and turned bluish green. 200 milliliters of distilled water and 60 milliliters of 40/50% NaOH were added to the flask to dilute its contents after it had cooled. The flask was connected to a distillation apparatus that had a head fitting and condenser. In a 250 mL conical flask with 4% boric acid, two drops of screened methyl red indicator were added. The combination was heated to 80 to 90 degrees Celsius until the contents of the conical flask reached 200 milliliters, which allowed the distillate (ammonia gas) to become trapped in the boric acid. A burette was filled with prepared 0.1N H_2SO_4, which was then titrated against the contents of the conical flask until a light pink color was obtained.

Calculation:
Final reading (cm3/ml) , Initial reading (cm3/ml), Volume of titrant (Tv)

$$\% \text{ Nitrogen} = \frac{(Tv \times 0.0014 \text{ g} \times 100)}{\text{Weight of the sample}}$$

% Protein = % Nitrogen × protein factor

Determination of total ash content

According to AOAC (2015), this was accomplished using the furnaces' incineration gravimetric method. A ceramic crucible that had been previously weighed was filled with precisely 10 g of the sample. For three hours, the sample was burned to ashes at 550°C in a muffle furnace. It was chilled in a desiccator and weighed once it was entirely ashed or gone grey. By calculating the difference, the weight of ash that was acquired was expressed as a percentage of the weight of the sample under analysis.

$$\text{Ash } (\%) = \frac{M2 - M1}{\text{Mass of sample}} \times 100$$

Where:
M1 = Mass (g) of empty crucible
M2 = Mass of crucible + Ash

Determination of crude fibre content

This was accomplished using the approach outlined by the AOAC (2015). A conical flask was filled with two grams of the defatted material. 200 mL of 1.25% or 0.127N H_2SO_4 was added to the conical flask, and it was boiled for 30 minutes at 80°C on a heating mantle. Using a muslin cloth, the solution was filtered while still hot, and the residue was then cleaned with boiling water. The residue was put into the conical flask and cooked for 30 minutes at 80 degrees Celsius using 200 milliliters of 1.25% OR 0.313M NaOH. Weighing and recording a filter paper (M1). After the mixture was filtered through the previously weighed filter paper, the paper and its residue were put in a petri dish and dried in an oven set to 80 degrees Celsius. It was weighed, documented, and allowed to cool in a desiccator after drying (M2). The paper with the residue was placed in a crucible (M4) that had already been cleaned, dried, cooled, and weighed. After being put in a muffle furnace, the crucible was left to burn at 600 degrees Celsius for five hours. It was then allowed to cool before being weighed as M5.

Calculation:

$$\% \text{ Fibre} = \frac{M7 \times 100}{M}$$

M3 = M2 – M1
M6 = M5 – M4
M7 = M3 – M6
M = mass of sample

Determination of crude fat content

The Soxhlet extraction method, as outlined by AOAC (2015), was used to determine this. Five grams of the material were placed in a thimble after being wrapped in Whatman filter paper, a porous paper. The thimble was installed inside a weighted extraction flask that held 250 milliliters of petroleum ether after being placed in a Soxhlet reflux flask. A water condenser was attached to the reflux flask's top. In the reflux flask, the solvent (petroleum ether) was heated, boiled, evaporated, and condensed. Soon after, the solvent was poured over the sample in the thimble until the reflux flask was full and the oil extract was siphoned over to the boiling flask. Four hours were spent repeating this procedure before the defatted sample was taken out. The oil extract remained in the flask while the solvent recovered. To get rid of any remaining solvent, the flask containing the oil extract was dried in an oven set to 60°C for 30 minutes. After cooling in a desiccator, it was weighed. The difference was used to calculate the weight of the oil (fat) extract, which was then expressed as a percentage of the sample weight under analysis.

$$\text{Fat (\%)} = \frac{M2 - M1}{\text{Mass of sample}} \times 100$$

Where
M1 = Mass (g) of empty extraction flask
M2= Mass of flask + oil (fat) extract

Determination of carbohydrate content

The carbohydrate content was determined by difference. That was by deducting the mean values of other parameters that were determined from 100.

Calculation:
% Carbohydrate =100 - (% Mc + %Cp + % Fat + %Crude fibre + % Ash)
Mc =moisture content
Cp = crude protein
%fat= fat

F. Mineral Analysis

The mineral content of the crackers samples was determined using the standard methods described by the AOAC (2010).

Digestion of sample

Twenty (20) grams of the material will be heated to 550 °C for six hours in a porcelain crucible and ash. After that, the ash will be dissolved in two milliliters of pure HNO_3 and allowed to boil for one minute. After cooling, the liquid will be filtered through Whatman No. 42 filter paper into a 100 mL volumetric flask and adjusted with distilled water. After thoroughly mixing the solution, the minerals will be identified in the resulting ash solution.

Determination of calcium

The EDTA complex isometric titration was used to measure the test samples' calcium concentration. Panels of the masking agents, hydroxytannin, hydrochlorate, and potassium cyanide were placed to a conical flask containing twenty (20) milliliters of each extract. Twenty milliliters of ammonia buffer (pH 10.0) was then added. After adding a pinch of the indicator, ferrochrome black, the liquid was thoroughly agitated. Before taking a reading, it was titrated against a 0.02 N EDTA solution until a persistent blue color was seen. The following formula was used to determine the calcium contents.

Calcium (mg/100 g)$= \frac{(Tv\times 0.4008\times 1000)}{Vol.of\ sample\ used}$

Determination of Magnesium

Exactly 10ml of the sample filtrate will be pipetted into 250ml conical flask after which 25ml of ammonia buffer solution will be added into the conical flask and will be properly mixed. Then a pinch of Erichrome black T indicator will be added and titrated with 0.02N of EDTA until the colour of the solution changed from wine-red to blue colour.

Magnessium(mg/100g) **=** $\frac{(\text{Tv x 0.2432 x 1000})}{\text{Vol of sample used}}$

Determination of Iron

Five milliliters of the sample will be pipetted into a test tube, and then 1.5 milliliters of acetate buffer and 1 milliliter of 2.5% hydroquinol will be added. One milliliter of 0.1% pyridine will then be added, and everything will be thoroughly shaken to combine. Diluted water will be used to make up the volume of solution, and it will be well mixed. A spectrophotometer will be used to measure the absorbance at 530 nm after the color has had a maximum of 24 hours to develop.

Concentration of sample **=** (Absorbance of sample / Absorbance of standard) × Concentration of standard

Iron(mg/100g) $=\frac{\text{Concentration (ppm) x Dilution factor x volume of extract used}}{\text{Wt.of Samplex100}}$

Determination of potassium

20 ml sample solution was put in a 100 ml volumetric flask. The solution was neutralized with ammonia and nitric acid solution (1:2). Twenty (20) ml of vanadate molybdate reagent was added and diluted to the mark and then allowed to stand for 10 min and absorbance was read at 470 nm n the ultra violet region and the mineral concentration in mg/100 g was calculated using the following equation:

Potassium (mg/100g)$= \frac{Concentration\ (ppm)\times Dilution\ factor}{Wt.of\ sample} \times 100$

G. Vitamin analysis

Determination of Vitamin A

The method outlined by the AOAC in 2015 was used to determine vitamin A. After mixing one gram of the sample with thirty milliliters of 100% ethanol and adding three milliliters of a 5% alcoholic KOH solution, the mixture was heated for thirty minutes at 70°C under reflux. 150 ml of diethyl ether was added to the mixture after it had been cleaned with 50 ml of water in a separating funnel. The extract was dissolved with 10 milliliters of isopropyl alcohol and dried in a water bath at a low temperature of 50 degrees Celsius. The absorbance was then measured. After dissolving precisely 1 milliliter of the standard vitamin A solution in 5–10 milliliters of diethyl ether and transferring it to a cuvette, the absorbance of the standard was measured. The wavelength used to take the readings was 460 nm.

Calculation**:**

$$\text{Vit. A (mg/100g)} = \frac{\text{Absorbance of sample (x)} \times \text{Concentration of sample (y)}}{\text{Absorbance of standard} \times \text{mass of test portion}}$$

Determination of Vitamin B_1

In a 250 ml flask, one gram of the sample was dissolved in 65 ml of 0.1N HCl. It was cooked to the 100 ml mark on a boiling water bath for 45–60 minutes while being shaken often to maintain a pH of roughly 4.5. After pipetting 10 milliliters of the extract into the flask, 5 milliliters of a 10% potassium ferricyanide solution were added, and the mixture was gently stirred for two to three minutes. After adding around 2 milliliters of concentrated H2SO4 to acidify the liquid, it was cooled under running water. A small amount of zinc sulphate crystals and five milliliters of a 10% potassium iodide solution were added. One percent starch was employed as an indicator. It was titrated until a bluish-green color was achieved against 0.5N sodium thiosulphate.

Calculation:

$$\text{Vit. } B_1 \text{ (mg/100g)} = \frac{\text{Titre value} \times \text{molarity of titrant} \times \text{volume made up} \times 100}{\text{Aliquot estimated} \times \text{mass of sample in milligram}}$$

Determination of Vitamin D

Vitamin D was determined by the method stated in AOAC (2015). Five grammes of the sample was mixed with 50ml of distilled water and allowed to shake in a rotary shaker for 3 hours. The whole solution was filtered and 2ml of the filtrate was collected into a test tube. 6.5ml of distilled water was added and 2ml of deniges reagent was added. Deniges reagent was prepared by mixing 1g of mercury II oxide and 10ml of sulphuric acid and made to the mark in 100ml volumetric flask using distilled water. The sample was read against the blank at 525nm.

Calculation:

$$\text{Vit. D (mg/100g)} = \frac{\text{Absorbance} \times \text{volume of extract} \times \text{dilution factor}}{1000 \times \text{mass of sample}}$$

Determination of Vitamin C (Ascorbic Acid)

AOAC 2015 provided a description of the procedure. After 10g of the sample was extracted for one hour using 50 mL of EDTA/TCA extracting solution, it was filtered through Whatman filter paper into a 50 mL volumetric flask and the extracting solution was added to make up the difference. A 250 mL conical flask was pipetted with 20 mL of the extract, followed by the addition of 50 mL of water and 10 mL of 10% KI. This was titrated to a dark end point using a 0.01 N $CuSO4$ solution, and the ascorbic acid content was computed as follows:

$$\text{Vitamin C mg/100} = \frac{20 \times (V1-V2) \times C}{\text{Weight of sample}}$$

Determination of vitamin E

Ten grams of the sample and ten milliliters of ethanoic sulfuric acid will be combined, and the mixture will be gently heated for five minutes. The ether extract will be moved to a desiccator, dried for half an hour, and then evaporated to dryness at room temperature after being placed in a separating funnel and treated with three 30 ml doses of diethyl ether and recovering ether layer each time. Ten milliliters of pure ethanol will be used to dissolve the dry extract. Separate tubes will be used to hold 1 milliliter of the dissolved extract and an equivalent volume of regular vitamin E. Five milliliters of absolute alcohol and one milliliter of strong nitric acid solution will be added continuously. The combination will then be let to stand for five minutes, and the absorbance will be measured in a spectrophotometer at 410 nm using a blank reagent at zero.

$$\text{Amount of Vitamin E (mg/100g)} = \frac{\text{Absorbance of sample x Concentration of standard}}{\text{Absorbance of standard}}$$

Determination of Vitamin B_2

Vitamin B_2 was determined by the method stated in AOAC (2015). Five grammes of the sample was mixed with 50ml of distilled water and allowed to shake in a rotary shaker for 3 hours. The whole solution was filtered and 2ml of the filtrate was collected into a test tube. 6.5ml of distilled water was added and 2ml of deniges reagent was added. Deniges reagent was prepared by mixing 1g of mercury II oxide and 10ml of sulphuric acid and made to the mark in 100ml volumetric flask using distilled water. The sample was read against the blank at 525nm.

Calculation:

$$\text{Vit. } B_2 \text{ (mg/100g)} = \frac{\text{Absorbance} \times \text{volume of extract} \times \text{dilution factor}}{1000 \times \text{mass of sample}}$$

E. Statistical Analysis

Fungal colony means and percentages were computed. When significant at the 5% level of probability, the data were subjected to Analysis of Variance (ANOVA), and the Duncan Multiple Range Test (DMRT) was employed to differentiate the treatment means.

III. RESULTS

Table 1: Proximate composition of raw, cooked, fried and roasted Yam

Proximate composition(%)	**Raw**	**Cooked**	**Fried**	**Roasted**
Moisture	51.00^{a}± 0.20	32.50 ^{b}± 0.20	7.20 ^{c}± 0.20	5.74^{d}± 0.20
Protein	3.01^{d}± 0.20	3.26 ^{c}± 0.20	3.70 ^{b}± 0.20	4.59^{a}± 0.20
Lipid	0.40^{c}± 0.20	0.80 ^{b}± 0.20	2.60 ^{a}± 0.20	0.66^{b}± 0.20
Fiber	6.00^{b}± 0.20	6.50 ^{a}± 0.20	6.25 ^{a}± 0.20	6.30^{a}± 0.20
Ash	2.66^{b}± 0.20	2.64b± 0.20	3.53^{a}± 0.20	3.70^{a}± 0.20
Carbohydrate	36.93^{d}± 0.20	53.66 ^{c}± 0.20	76.72^{b}± 0.20	79.01^{a}± 0.20

*Values are mean scores± Standard deviation of triplicate

*Data in the same column bearing different superscript differ significantly ($p < 0.05$)

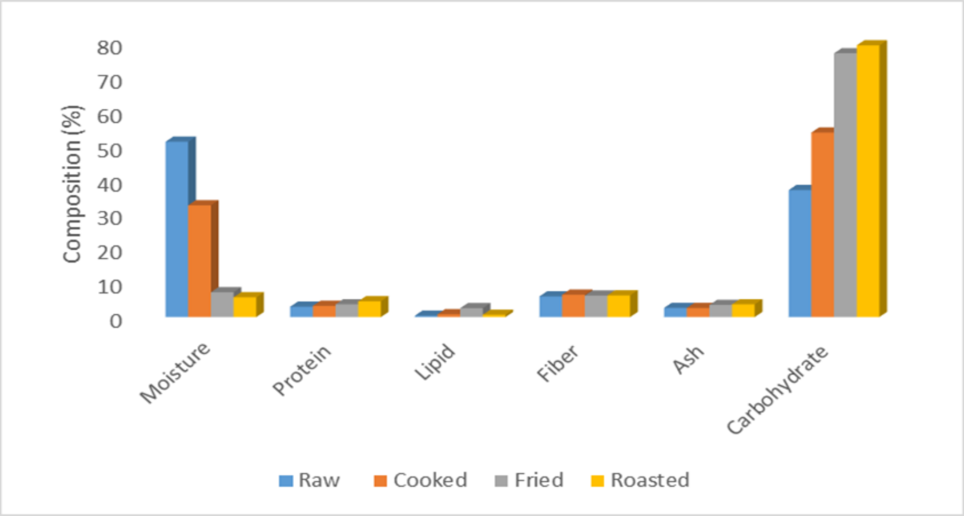

Fig 1: Proximate composition of raw, cooked, fried and roasted Yam

Table 2: Mineral composition of raw, cooked, fried and roasted Yam

Mineral composition (Mg/100g)	**Raw**	**Cooked**	**Fried**	**Roasted**
Calcium	$22.78^{b}\pm 0.20$	$18.76^{c}\pm 0.20$	$27.45^{a}\pm 0.20$	$28.44^{a}\pm 0.20$
Magnessium	$45.62^{c}\pm 0.20$	$37.65^{d}\pm 0.20$	$51.20^{b}\pm 0.20$	$57.33^{a}\pm 0.20$
Potassium	$264.60^{c}\pm 0.20$	$247.33^{d}\pm 0.20$	$281.40^{b}\pm 0.20$	$284.10^{a}\pm 0.20$
Iron	$11.40^{c}\pm 0.20$	$8.65^{d}\pm 0.20$	$13.76^{b}\pm 0.20$	$15.05^{a}\pm 0.20$
Phosphorus	$183.20^{b}\pm 0.20$	$180.33^{c}\pm 0.20$	$185.60^{b}\pm 0.20$	$187.33^{a}\pm 0.20$
Sodium	$2.38^{c}\pm 0.20$	$2.76^{a}\pm 0.20$	$2.55^{a}\pm 0.20$	$2.39^{b}\pm 0.20$

*Values are mean scores± Standard deviation of triplicate

*Data in the same column bearing different superscript differ significantly ($p < 0.05$)

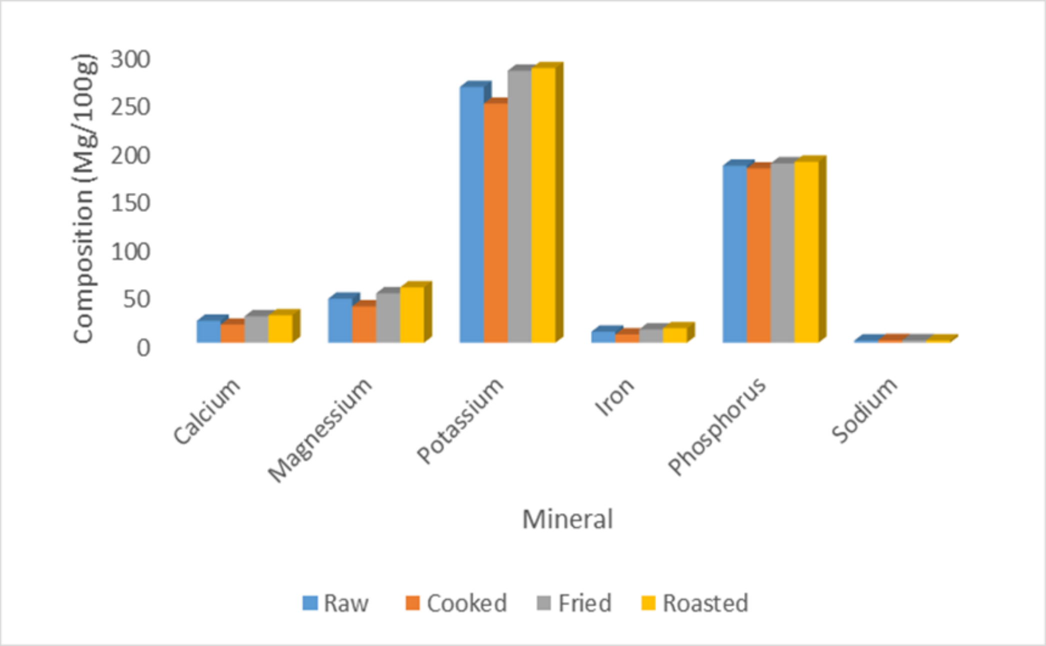

Fig 2: Mineral composition of raw, cooked, fried and roasted Yam

Table 3: Vitamin composition of raw, cooked, fried and roasted Yam

Vitamin composition (mg/100g)	**Raw**	**Cooked**	**Fried**	**Roasted**
Vitamin A	$0.07^{a}\pm 0.20$	$0.06^{a}\pm 0.20$	$0.04^{b}\pm 0.20$	$0.06^{a}\pm 0.20$
Vitamin B1	$1.23^{c}\pm 0.20$	$1.57^{b}\pm 0.20$	$1.75\ ^{a}\pm 0.20$	$1.84^{a}\pm 0.20$
Vitamin B2	$0.67^{c}\pm 0.20$	$1.04^{a}\pm 0.20$	$0.87^{b}\pm 0.20$	$0.53^{d}\pm 0.20$
Vitamin C	$12.25^{a}\pm 0.20$	$10.32^{b}\pm 0.20$	$12.10^{a}\pm 0.20$	$10.77^{b}\pm 0.20$
Vitamin D	$1.94^{a}\pm 0.20$	$1.65^{b}\pm 0.20$	$1.25^{d}\pm 0.20$	$1.39^{c}\pm 0.20$
Vitamin E	$3.12^{c}\pm 0.20$	$3.37^{a}\pm 0.20$	$3.48^{a}\pm 0.20$	$3.27^{b}\pm 0.20$

*Values are mean scores± Standard deviation of triplicate

*Data in the same column bearing different superscript differ significantly ($p < 0.05$)

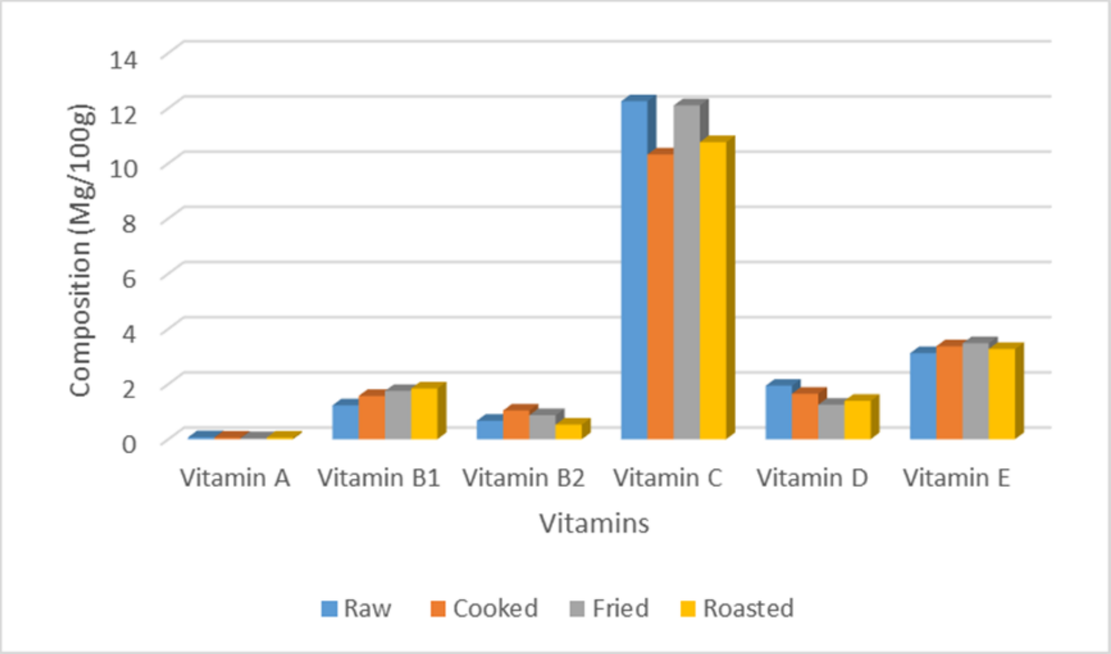

Fig 3: Vitamin composition of raw, cooked, fried and roasted Yam

IV. DISCUSSION

The outcome displays the minerals, vitamins, and proximate characteristics of different yam tuber processing techniques that were gathered from Nigerian marketplaces. The yam tuber typically has a high moisture content; our findings for raw yam were 51.00a+ 0.20, boiled yam was 32.50 b+ 0.20, fried yam was 7.20 c+ 0.20, and roasted yam was 5.74d+ 0.20. White yam tubers are renowned for their excellent nutritional value. This study's findings concur with those of Adepoju et al. (2010). The capacity of the various processing techniques to absorb water varied significantly ($P<0.05$). The value obtained is comparable to the D. rotundata value that was reported (Akissoe et al., 2010). It has been noted that carbs are often high, particularly in roasted yams, according to Akissoe et al. (2013). All of the carbs examined were moderately high, with the exception of roasted yam, which had 79.01a+ 0.20. The results are consistent with these observations.

Table 1 displays the additional findings from the proximate analysis of the raw and processed yam samples. The raw yam sample's crude protein, crude lipid, crude ash, and crude fiber values were all significantly in line with those reported in the literature (Anyaegbu et al., 2019). Raw yam has a moderate amount of ash, a high amount of moisture, carbohydrates, and gross energy, and a very low amount of crude fat, crude fiber, and crude protein.

The reason yam is a main energy source in Nigeria is due to its high gross energy content. The yam's crude protein and fat value were significantly raised by roasting; however its moisture content was not significantly decreased ($p>0.05$). When compared to raw meals, processed foods have more nutrients available. In comparison to raw and roasted samples, frying considerably improved the crude protein and fat content of fried yams, while also increasing their moisture and ash content ($p<0.05$). The vegetable oil used for frying was directly responsible for the fried yam's observed rise in lipid content. Compared to proteins and carbs, fat and oil make up a larger portion of energy. When compared to roasted yam, fried yam had a lower crude protein level. This could indicate that the heat from frying has destroyed a peptide chain (Bonire et al., 2020).

Table 2 displays the mineral makeup of both raw and processed yams. Raw white yam had a moderate calcium content but a low sodium content. It was high in potassium and phosphorus. All mineral content was significantly reduced to varied degrees ($p<0.05$) when yam was processed into different products. When yams were roasted, their potassium, phosphorus, and iron contents significantly increased while their salt content somewhat increased. Additionally, the mineral content was significantly reduced as a result of frying. The mineral content of cooked yam samples was significantly reduced. According to Ejimofor et al. (2023), this was thought to be caused by the minerals leaching into the boiling water. Minerals are lost when food is soaked in water because they leach into the soaking water, according to Adepoju et al. (2010).

The most common and effective form of vitamin A is beta-carotene. Foods high in carotenoids have been shown to have angiogenic activity, which helps prevent the growth of new blood vessels that are frequently observed in cancer patients (Ejimofor et al., 2023). According to the study's findings, fried yams have the lowest vitamin A concentration (0.04b+0.20) while raw yams have the greatest (0.07a+0.20). The highest levels of vitamin C and D have been found in raw yams when compared to other processing processes. These have demonstrated efficacy in preventing gum disease. The vitamin E content of fried yams was 3.48a+ 0.20, while that of raw yams was the lowest at 3.12c+ 0.20. Vitamins B1 and B2 are essential for the conversion of carbohydrates into energy, the maintenance of a healthy neurological system, and their antioxidant properties, which are critical for the operation of the skin, eyes, and nerves, respectively (Julianti et al., 2017). Roasted yam showed a significant increase in vitamin B1 contents with 1.84a+ 0.20 while cooked yam has the highest value with 1.04a+ 0.20.

V. CONCLUSION

The nutritious composition of yam was significantly improved by processing it into several products. Cooking, frying, and roasting greatly increased the yam's macronutrient content. The findings of this study showed that the nutrient content, swelling power, and water binding capacity of yam tubers are significantly impacted by the methods used for processing (raw, boiling, roasting, and frying).

RECOMMENDATION

For both farmers and researchers, creating new sustainable yam planting systems is a major undertaking. Future studies on enhanced yam production systems are suggested to be extremely transdisciplinary and interdisciplinary, utilizing participatory technology development methodologies to collaboratively create new tactics with farmers. The reality of farmers in a given area, with all the different factors influencing farm yields, must be considered in case-specific investigations. In order to maintain soil fertility, further study is required, with a particular emphasis on the best organic resources. Finding safe, efficient, and environmentally friendly weed management techniques that are appropriate for yam production also requires careful study. In order to effectively address the challenges of sustainable yam production in the near future, further on-farm research is required. Additionally, farmers must be properly educated and trained in a variety of agronomic techniques, particularly in managing soil fertility. After that, farmers must be given incentives to invest in better soil fertility management techniques, such using compost, animal dung, and other organic fertilizers properly.

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