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

Ejimofor Chiamaka Frances[1], Nwakuche Adaugo Ozioma[2]

[1]Department Of Biological Sciences, Chukwuemeka Odumegwu Ojukwu University Uli, Anambra State.

[2]Department Of Botany, Nnamdi Azikiwe University Awka, Anambra State.

E-Mail: cf.anyaegbu@coou.edu.ng

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.

1. 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.

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2. MATERIALS AND METHODS

Materials

Weighing crucible

Soxhlet extractor

Beaker

Filter paper

Bucker funnel

Muffle furnace

Kjeldahlflusk

Muslin cloth

Reagent

Distilled water

N-hexane,

Sulpuric acid

Sodium hydroxide

Hydrochloric acid

Sodium hydroxide

H_2SO_4cristal

Method of collection of sample

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

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.

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:

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

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 (Na2SO4), one gram of cupric acid (CuSO4), and twenty-five milliliters of sulfuric acid (H2SO4) 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

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(ammonia gas) to become trapped in the boric acid. A burette was filled with prepared 0.1N H2SO4, 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)	-------

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

% Protein = % Nitrogen × protein factor

Determination of total ash content

AOAC (2015) states that the furnaces' incineration gravimetric method was used to accomplish this. The sample weighed precisely 10 g, which was then transferred into a porcelain crucible. In a muffle furnace set at 550°C for three hours, the sample was burned to ashes. It was cooled in a desiccator and weighed once it had turned entirely ashed or grey. Using the differential, the weight of ash that was acquired was computed as a percentage of the sample weight 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

The AOAC's (2015) approach was used to do this. A conical flask containing two grams of the defatted material was weighed. After adding 200 mL of 1.25% or 0.127N H2SO4 to the conical flask, it was heated to 80°C for 30 minutes on a heating mantle. A muslin cloth was used to filter the solution while it was still hot, and boiling water was used to further cleanse the residue. 200 milliliters of 1.25% OR 0.313M NaOH were used to transfer the residue into the conical flask, which was then heated for 30 minutes at 80 degrees Celsius. Weighing a filter paper and recording the results (M1). Filter paper that had been previously weighed was used to filter the mixture. The paper and residue were then put in a petri dish and dried in an oven set at 80 degrees Celsius. Following drying, it was weighed, recorded, and allowed to cool in a desiccator (M2). After the paper was cleaned, dried, cooled, and weighed, it was placed in a crucible (M4). The crucible was put in a muffle furnace and left to burn at 600 degrees Celsius for five hours. Following cooling, it was 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. Before the defatted sample was taken out, this procedure was permitted to continue repeatedly for four hours. Leaving the oil extract in the flask, the solvent recovered. For 30 minutes, the flask containing the oil extract was dried in an oven set at 60°C in order to eliminate

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any remaining solvent. It was weighed after cooling in a desiccator. By calculating the difference, the weight of the oil (fat) extract was computed as a percentage of the weight of the sample under analysis.

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

Where

M1 = Mass (g) of empty extraction flask

M2= Mass of flask + oil (fat) extract

Determination of carbohydrate content.

The difference was used to calculate the carbohydrate content. This was accomplished by subtracting from 100 the mean values of the other parameters that were established.

Calculation:

% Carbohydrate =100 - (% Mc + %Cp + % Fat + %Crude fibre + % Ash)

Mc =moisture content

Cp = crude protein

%fat= fat

Mineral Analysis

The mineral content of the samples were 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 HNO3 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

Using the EDTA complex isometric titration, the test samples' calcium concentration was ascertained. A conical flask was filled with twenty (20) milliliters of each extract, and panels of the masking agents—hydroxytannin, hydrochlorate, and potassium cyanide—were added. Twenty milliliters of ammonia buffer (pH 10.0) were then added. After that, a pinch of Ferrochrome black, the indicator, was added, and the mixture was thoroughly agitated. After titrating it against a 0.02 N EDTA solution until a persistent blue hue was seen, a reading was obtained. Using the following formula, the calcium contents were determined.

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

Determination of Magnesium

Twenty-five milliliters of ammonia buffer solution will be poured to a 250 milliliter conical flask and thoroughly mixed after precisely 10 milliliters of the sample filtrate have been pipetted into the flask. The solution will then be titrated with 0.02N of EDTA until its color shifts from wine-red to blue after a pinch of Erichrome Black T indicator has been added.

Magnessium (mg/100g) = (Tv x 0.2432 x 1000)

Vol of sample used

Determination of Iron

A test tube will be pipetted with precisely 5 ml of the sample, and then 1 ml of 2.5% hydroquinol and 1.5 ml of acetate buffer will be added. Additionally, 1 ml of 0.1% pyridine will be added, and the mixture will be thoroughly shaken. The volume of solution will be correctly blended and made up of diluted water. The color will be given no more than 24 hours to develop, and a spectrophotometer will be used to measure the absorbance at 530 nm.

24hoursfor it to develop and the absorbance will be read at 530nm using spectrophotometer.

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

Iron (mg/100g)=Concentration (ppm) x Dilution factor x volume of extract used

Wt.of Sample **x100**

Determination of potassium

In a 100 ml volumetric flask, 20 ml of the sample solution was added. A solution of ammonia and nitric acid (1:2) was used to neutralize the solution. After adding and diluting twenty (20) milliliters of vanadate molybdate reagent to the

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appropriate level, the mixture was let to stand for ten minutes. The absorbance was measured at 470 nm in the ultraviolet area, and the mineral concentration in milligrams per hundred grams was determined using the following formula:

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

Vitamin analysis

Determination of vitamin A

Vitamin A levels were measured using the AOAC 2015 technique. 30 milliliters of 100% ethanol were combined with one gram of the sample, and 3 milliliters of a 5% alcoholic KOH solution were added. The mixture was then heated for 30 minutes at 70 degrees Celsius under reflux. A separating funnel was filled with 150 ml of diethyl ether after the mixture had been cleaned with 50 ml of water. After the extract was dried in a water bath at a low temperature of 50°C, it was dissolved in 10 milliliters of isopropyl alcohol, and the absorbance was measured. Five to ten milliliters of diethyl ether were used to dissolve precisely one milliliter of the standard vitamin A solution, which was then transferred to a cuvette. The absorbance of the standard was then measured. A wavelength of 460 nm was used to take the readings.

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

A 250 ml flask containing 65 ml of 0.1N HCl was used to dissolve one gram of the material. It was brought up to the 100ml mark by heating it over a boiling water bath for 45–60 minutes while shaking frequently. The pH was approximately 4.5. Five millilitres of a 10% potassium ferricyanide solution were pipetted into the flask containing ten millilitres of the extract, and the mixture was gently stirred for two to three minutes. About 2 milliliters of concentrated H2SO4 were added to the mixture to acidify it, and it was then cooled under running water. It was mixed with 5 milliliters of a 10% potassium iodide solution and a few zinc sulfate crystals. As an indicator, 1 percent starch was utilized. A bluish-green color was achieved by titrating it against 0.5N sodium thiosulphate.

Ten milliliters of purified water, two milliliters of concentrated H2SO4, five milliliters of 10% potassium ferricyanide, five milliliters of 10% potassium iodide, and a few zinc and starch crystals were used as a blank.

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

The method described in AOAC (2015) was used to determine vitamin D. 50ml of distilled water was combined with five grams of the sample, and the mixture was shaken for three hours in a rotary shaker. Two milliliters of the filtrate were gathered into a test tube after the entire solution was filtered. Deniges reagent (2 ml) and 6.5 ml of distilled water were added. A 100 ml volumetric flask was filled with distilled water to make the Deniges reagent, which was created by combining 1 g of mercury II oxide with 10 ml of sulfuric acid. At 525 nm, the sample and blank were compared.

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)

The AOAC 2015 outlined the procedure. 50 mL of EDTA/TCA extracting solution was used to extract 10g of the sample for one hour. The sample was then filtered through Whatman filter paper into a 50 mL volumetric flask and the extracting solution was added to make up the difference. Ten milliliters of 10% KI and fifty milliliters of water were added to a 250 milliliter conical flask containing twenty milliliters of the extract. Ascorbic acid was computed as follows after this was titrated against a 0.01 N CuSO4 solution to a dark end point:

Vitamin C mg/100 = 20 x (V1-V2) x C

Weight of sample

Determination of vitamin E

After combining 10g of the sample with 10ml of ethanoic sulfuric acid, it will be gently heated for five minutes. Each time, it will be moved to a separating funnel and treated with three 30 ml treatments of diethyl ether and recovering

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ether layer. The ether extract will then be moved to a desiccator and dried for half an hour before being evaporated to dryness at room temperature. In ten milliliters of pure ethanol, the dried extract will dissolve. One milliliter of the dissolved extract and an equivalent amount of regular vitamin E will be moved into different tubes.

A spectrophotometer will be used to measure the absorbance at 410 nm using a blank reagent at zero after 5 ml of 100% alcohol and 1 ml of strong nitric acid solution have been continuously added. The combination will then be let to stand for five minutes.

Amount of Vitamin E (mg/100g) = Absorbance of sample x Concentration of standard

Absorbance of standard

Determination of Vitamin B_2

Vitamin B2 was measured using the AOAC (2015) technique. In a rotary shaker, five grams of the sample were combined with fifty milliliters of distilled water and shaken for three hours. After the entire solution was filtered, two milliliters of the filtrate were gathered and placed in a test tube. 2 ml of Denige's reagent and 6.5 ml of distilled water were added. Deniges reagent was created to the proper amount in a 100 ml volumetric flask using distilled water after 1 g of mercury II oxide and 10 ml of sulfuric acid were combined. At 525 nm, the sample and the blank were read.

Calculation:

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

Statistical Analysis

The means and percentages of fungal colonies were calculated. The data underwent Analysis of Variance (ANOVA) when significant at the 5% level of probability, and the Duncan Multiple Range Test (DMRT) was used to distinguish between treatment means.

3. 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 ($p < 0.05$)

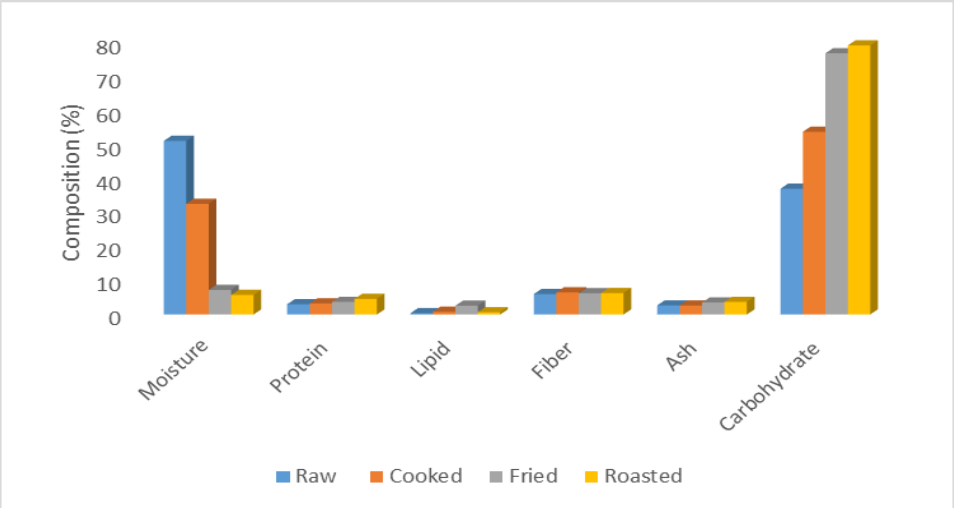

Fig 1: Proximate composition of raw, cooked, fried and roasted Yam

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

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

*Values are mean scores± Standard deviation of triplicate

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

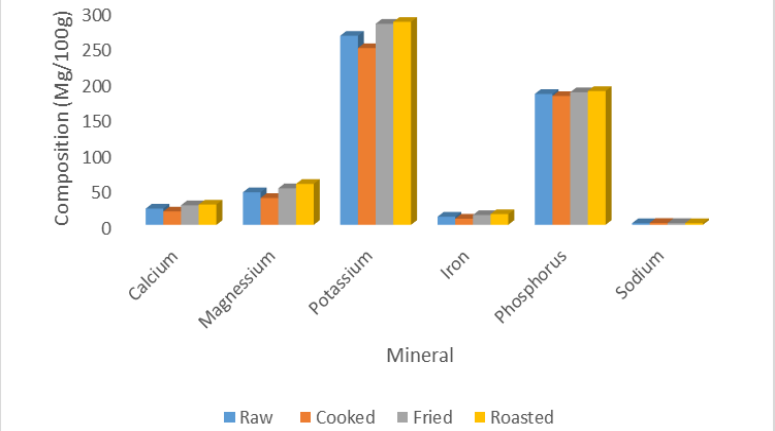

Fig 2: Mineral composition of raw, cooked, fried and roasted Yam

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

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

*Values are mean scores± Standard deviation of triplicate

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

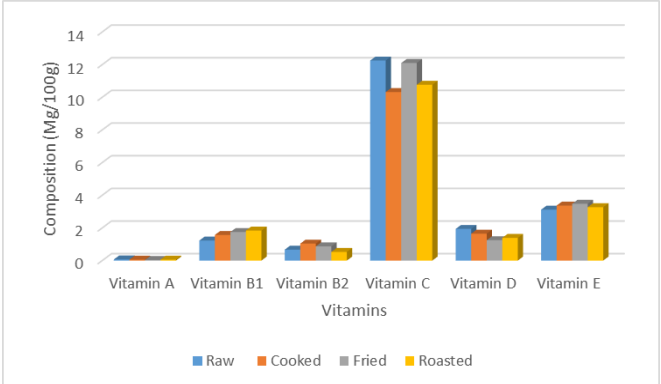

Fig 3: Vitamin composition of raw, cooked, fried and roasted Yam

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4. 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 1.84^{a}+ 0.20 while cooked yam has the highest value with 1.04^{a}+ 0.20.

5. 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).

6. RECOMMENDATIONS

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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