**Advanced Food Science, Technology, and Nutrition Journal**
**ISSN 3065-0968**
Volume 13 Issue 3
July-September 2025
Impact Factor: 7.88
Enquiry: contact@continentalpub.online
Published by Continental Publication | https://cspjournals.org/index.php/Science-Technology-Nutrition

# IMPACT OF COOKED AFRICAN WALNUT FLOUR ON THE NUTRITIONAL QUALITY OF WHEAT-BASED MUFFINS

***Amadi Chidinma Grace***
Department of Food Science and Technology, Rivers State University, Nkpolu-Oroworukwo, Port Harcourt, Rivers State, Nigeria

***Abstract:***
*The influence of cooked African walnut flour substitution levels in the proportion of 100:0, 95:5, 90:10, 85:15,80:20 on nutrient composition of muffin was investigated. The composite flour was produced and then analyzed for proximate properties. Muffin was produced from the composite flours and analysed for nutrient composition. All data generated in the study were analyzed statistically. Results of the composite flour showed that moisture content, ash and fat varied between 9.68 and 15.20%, 1.30 and 3.52%, 1.82 and 45.34%, respectively, for wheat flour and cooked African walnut samples; likewise, crude fiber, protein and carbohydrate were 1.00 and 1.14%, 10.34 and 24.13, 74.09 and 15.38% correspondingly. Muffin sample indicated increasing level of moisture, protein, fat and crude fibre while there was decrease in carbohydrate as the proportion of cooked African walnut flour increases. Values obtained showed that moisture content increased from 9.68-24.17% with the highest and lowest moisture content observed in sample T0 and T4. Ash, fat, crude fibre and protein content also increased from 1.30-1.88%, 1.82-19.54%, 1.00-1.68% and 10.34-22.44% respectively, for muffin produced from 100% wheat flour and muffin from different blends of wheat- cooked African walnut flour. However, carbohydrate content decreased from 74.11-54.66-% respectively, for muffin from 100% wheat flour and muffin made using different blends of wheat- cooked African walnut flour. The study showed muffin produced using T4(80:20 wheat- cooked African walnut flour) was better in terms of nutrient composition and can be recommended for commercial production of muffin.*

***Keywords:*** *Muffin, wheat flour, cooked African walnut flour, nutrient composition*

## Introduction

In Nigeria especially in Rivers State. Muffin is a cereal based product and low in protein. Normally, bakery products like muffin do not contain high protein, incorporation of ingredients with high nutritional value can enrich the product. Enriching muffin by protein fortification using cooked walnut can be a way of improving the nutritional health of the people and can be used to reduce protein malnutrition in developing countries according to Marchetti, Califano & Andrés, (2018).

African walnuts (*Tetracarpidium conophorum*) is a member of the Euphorbiaceae family. It is a climber usually found in some states of south-west and south-south geopolitical regions of Nigeria. Conophor plants are cultivated principally for the nuts which has been identified to possess both nutritional and health benefits are usually cooked and consumed as snacks (Enujiugha and Ayodele, 2003). The nut is rich in protein and fat and it is a good source of both macro and micro minerals. It is

Advanced Food Science, Technology, and Nutrition Journal
Vol. 13 No. 3 | Imp. Factor: 7.88
DOI:https://doi.org/10.5281/zenodo.15855360

also a rich source of bioactive phytochemicals that can exert some health benefits. Health and nutritional assets have become crucial in new product development due to increasing consumer awareness who desire to remain healthy and fit. African walnut find use in a wide range of food applications (cookies and bread) due to their nutritional and functional properties (Almoraie, 2019). In this background, the aim of the study was to substantiate the nutrient composition of muffin produced by partial substitution of wheat flour in muffin formulation with cooked African walnut flour to improve the nutritional value.

## 2. Materials and Methods

### 2.1. Materials

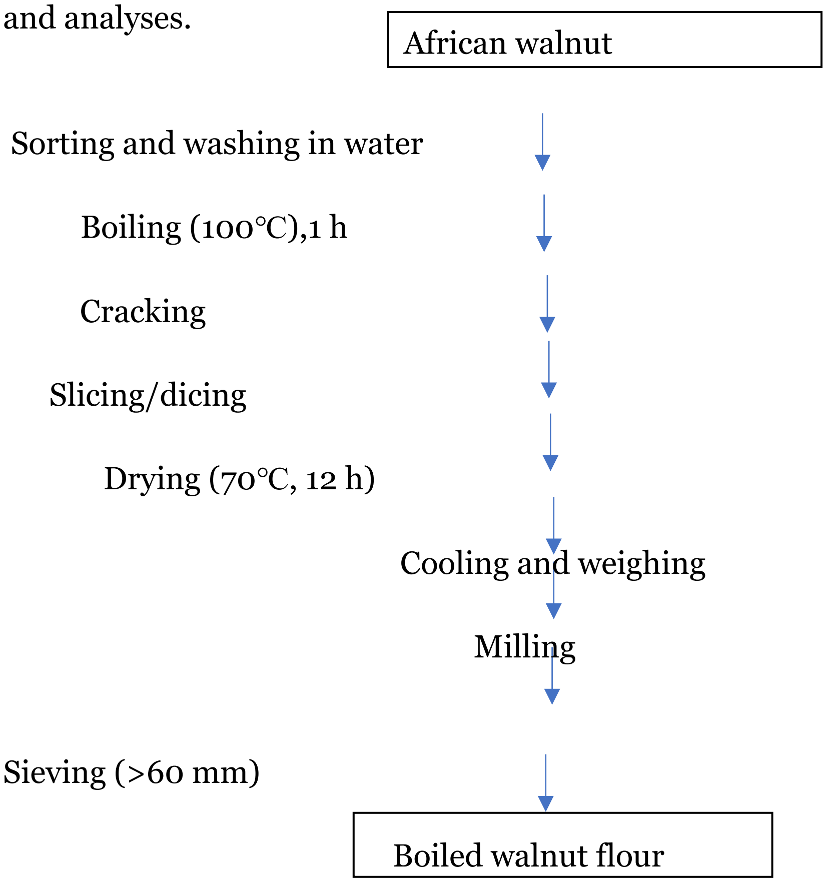
#### 2.1.1 Plant Materials

Wheat flour and raw African walnut were purchased from Mile 1 Market, Diobu, Port Harcourt, Rivers State. Egg, sugar, vegetable oil, baking powder and whole milk were purchased from De-giant bakers, 304 Ikwerre Rd, Port Harcourt.

### 2.2. Methods

#### 2.2.1 Production of cooked African walnut flour

African walnut flour was prepared as shown in Fig 1. Fresh African walnut seeds were washed to remove sand then boiled for 45-1 h, shelled and cut into slices to ease drying. The sliced samples were oven dried at 70°C for 24 h in an air oven (Memmert Hot Air Oven, Btl 27, India). The dried slices were milled into flour and sieved using – 60 mm size mesh to obtain flour of uniform size. The flour was packaged in well labelled polyethylene bags and stored at room temperature until cookie preparation and analyses.



DOI:https://doi.org/10.5281/zenodo.15855360

**Fig.1 Production of African walnut (*T. Conophorum)* flour**

**2.2.1 Product development**

Wheat flour in muffin was replaced by cooked African walnut as described in treatments below;

**Table 1: Formula for muffin with different levels of cooked African walnut flour**

| Sample | T0 | T1 | T2 | T3 | T4 |
|---|---|---|---|---|---|
| Wheat flour (g) | 200 | 190 | 180 | 170 | 160 |
| Africa walnut flour | 0 | 10 | 20 | 30 | 40 |
| Salt (g) | 2 | 2 | 2 | 2 | 2 |
| Sugar (g) | 120 | 120 | 120 | 120 | 120 |
| Egg (g) | 70 | 70 | 70 | 70 | 70 |
| Bakery fat (g) | 40 | 40 | 40 | 40 | 40 |
| Milk (g) | 100 | 100 | 100 | 100 | 100 |
| Baking powder (g) | 3 | 3 | 3 | 3 | 3 |

Source: Harastani, James, Ghosh, Rosenthal, Woolley, (2021)

Where,

T0-100g wheat flour + 0 g cooked African walnut

T1-95g wheat flour + 5g cooked African walnut

T2-90g wheat flour + 10g cooked African walnut

T3-85g wheat flour +15g cooked African walnut

T4-80g wheat flour +20g cooked African walnut

2.3.1 **Muffin preparation**

A standard muffin formulation (Harastani, James, Ghosh, Rosenthal, Woolley, 2021) in which supplemented blends with control treatment as mentioned in Table 1 was followed: sugar and oil were manually mixed in mixing pan for 20 strokes with a wooden spatula then egg, flour and baking powder was added and shaken well until sugar grains dissolved completely. Liquid milk was added in pan and mixed for 2 min till viscous batter was obtained. Colour and flavour were added in batter. 34 to 44 g aliquots of batter were weighed into muffin pans lined with EZ Foil" baking cups. Muffins were baked at 190.5 ℃ (375 °F) for 15-20 min. The baked muffins were allowed to cool to ambient temperature (25-27°C) for 30 min on wire racks.

**2.2.1 Proximate analysis**

Proximate analysis of wheat flour and cooked walnut flour were performed according to method described in AOAC, (2019).

**2.2.1.1 Moisture content**

Five (5g) grams of the flour samples were taken into a previously weighed petri dish, weighed again and then placed in hot air oven (Memmert Hot Air Oven, Btl 27, India) for 2 h at 105˚C. At the end of 2 h, the sample was again weighed. The sample was put back to the oven till constant weight was obtained. Two replications were performed for all samples. Moisture content was calculated using the equation below:

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$$Moisture\ content\ (\%) = \frac{\text{Initial weight of sample} - \text{Dried weight of sample}}{\text{weight of sample}} \times 100 \text{------- } (1)$$

**2.2.1.2 Ash Content Determination**

To determine ash content, first the crucible was dried in the oven and then cooled in the desiccator. Two (2g) grams of sample was then weighed into the crucible, then placed in a muffle furnace set and maintained at 550°C for 45 min. At the end of set time, the crucible was removed and transferred to the desiccators, cooled and weighed. The percentage ash content was determined using below equation:

$$\text{Ash } (\%) = \frac{\text{weight of crucible + ash – weight of empty crucible} \times 100}{weight\ of\ sample} \text{ ----------------- } (2)$$

**2.2.1.3 Determination of Fat**

Filter paper was folded into a thimble shape and weighed then 2g (w) of the sample was placed into the filter paper and weighed. This was slipped into the thimble holder. 250cm$^3$ of petroleum ether was added using glass funnel from the top of the condenser. The heater switch and the condenser water were turned on, followed by extraction for minimum of 4h at condensation rate of 5-6 drops per second. After the extraction, the heater and water were turned off, and the ether (with the fat extract) was transferred into an empty beaker of known weight ($W_1$), the thimble was rinsed with more petroleum ether. The beaker was dried in oven at 70°C for about 30 min in order to remove any residual ether. The beaker was then allowed to cool and weighed ($W_2$). The fat content was calculated as shown in equation

$$\text{Fat } (\%) = \frac{W2 - W1}{w} \times 100 \text{ ----------------(3)}$$

Where;

W1 = weight of empty beaker

W2 = weight of beaker + fat

W = weight of sample

**2.2.1.4 Crude Fiber**

The flour samples were tested after fat extraction for crude fiber content as described in AOAC, (2019). Approximately, 2g fat free sample was taken in a 500 ml beaker and 200 ml of 1.25% sulphuric acid was added and boiled for 30 min. The contents was filtered followed by 2-3 washing with hot water until it becomes acid free. The residue was transferred to 500 ml beaker and again 200 ml of 1.25% NaoH was added. The contents were again boiled for 30 min. The contents were filtered and 2-3 washing with hot water were given until it became alkali free.

Residues were carefully transferred to a petri dish and dried in an oven at 100˚C for 3-4 h until constant weight was attained. Then the sample was placed in a muffle furnace at 550˚C for 4 h until a grey ash was obtained, then cooled in desiccator and weighed. The difference in weight was calculated as crude fiber using the following fformula:

$$\text{Crude fiber } (\%) = \frac{weight\ of\ residue\ after\ drying - weight\ on\ ignition}{weight\ of\ sample} \text{ --------------------- } (4)$$

**2.2.1.5 Crude Protein Determination**

The crude protein was determined using the micro – kjeldahl technique. Zero point five (0.5 g) gram portion of the sample was weighed into filter paper and added into the dry digestion kjedahl flask, followed by addition of 0.12 g of copper sulphate ($CuSO_4$); 2.5 g of sodium sulphate ($Na_2SO_4$); and 25ml of concentrated sulphuric acid ($H_2SO_4$) with 3 g selenium catalyst and a few anti–bumping chips.

DOI:https://doi.org/10.5281/zenodo.15855360

**Digestion**: The digestion of the samples was carried out by heating in the fume chamber until the solution became clear. The solution was cooled to room temperature after which it was transferred to a 100 volumetric flask and distilled water added to make up to mark.

**Distillation:** The digestion flask was mounted on the distiller and 10 ml digest in the volumetric flask was added followed by addition of 50 ml distilled water, 60 ml of 40% NaOH and few anti–bumping chips was added in the kjeldahl flask before distilling into a conical flask containing 25 ml 2% boric acid and two drops of methyl red indicator.

**Titration:** One hundred 100 ml distillate was collected and titrated with 0.1 N of HCl until colour changes. The same procedure was carried out for the blank sample.

**Calculation**

The amount of nitrogen was calculated using the equation below as described in AOAC, (2019).

$$\% \text{ N of sample} = \frac{\text{Titer} - \text{blank x Normality of acid x Nfactor (14.07)}}{\text{weight of sample}} \text{-------------------------(5)}$$

Where,

Weight of sample =0.5g

Volume of $H_2SO_4$ required for titration = Titer – blank (ml)

Normality of $H_2SO_4$ = N

Crude protein = % N x 6.25

**2.2.1.6 Determination of carbohydrate**

Total carbohydrate was estimated according to FAO, (2015).

% carbohydrate =100 – %( protein + fat + fibre + ash +moisture content)

**2.3. Statistical Analysis**

Data obtained were analyzed using analysis of variance (ANOVA) and means separated by Duncan Multiple range test at 5% level of probability using a computer software package (Minitab 18).

**2.4. Results and Discussion**

**Results**

Proximate composition of wheat flour and cooked walnut flour are shown in Table 2. Moisture content, ash and fat varied between 9.68 and 15.20%, 1.30 and 3.52%, 1.82 and 45.34%, respectively, for wheat flour and cooked African walnut samples; likewise, crude fiber, protein and carbohydrate were 1.00 and 1.14%, 10.34 and 24.13, 74.09 and 15.38% correspondingly.

**Table 2: Proximate values of wheat flour and cooked African walnut flour**

| Parameters | Wheat flour (%) | Cooked African walnut (%) |
|---|---|---|
| Moisture | 9.68±0.07$^b$ | 15.20±0.00$^a$ |
| Ash | 1.30±0.06$^b$ | 3.52±0.07$^a$ |
| Fat | 1.82±0.04$^a$ | 45.34±0.04$^a$ |
| Crude fiber | 1.00±0.02$^b$ | 1.14±0.07$^a$ |
| Crude protein | 10.34±0.12$^b$ | 24.13 ± 0.16$^a$ |
| Carbohydrate | 74.09±0.11$^e$ | 15.38±0.01$^b$ |

DOI:https://doi.org/10.5281/zenodo.15855360

*Means bearing the different superscript down the row are significantly different (p<0.05)* Proximate analysis of muffin from blends of wheat- cooked African walnut flour (Table 3) showed that moisture content ranged from 9.68-24.17% with the highest and lowest moisture content observed in sample T0 and T4. Ash, fat and crude fibre content varied from 1.301.88%, 1.82-19.54% and 1.00-1.68% respectively, for muffin produced from 100% wheat flour and muffin from different blends of wheat-cooked African walnut flour. Similarly, protein and carbohydrate content showed values in the range 10.34-22.44% and 54.66-74.11% respectively, for muffin from 100% wheat flour and muffin made using different blends of wheat- cooked African walnut flour.

**Table 3: Nutrient composition of muffin from wheat- cooked African walnut flour**

| Parameter | T0 | T1 | T2 | T3 | T4 |
|---|---|---|---|---|---|
| Moisture (%) | $9.68\pm0.02^{e}$ | $16.28\pm0.07^{d}$ | $19.78\pm0.07^{c}$ | $20.43\pm0.07^{b}$ | $24.17\pm0.07^{a}$ |
| Ash (%) | $1.30\pm0.06^{e}$ | $1.62\pm0.11^{d}$ | $1.73\pm0.13^{c}$ | $1.83\pm0.00^{b}$ | $1.88\pm0.07^{a}$ |
| Fat (%) | $1.82\pm0.04^{e}$ | $5.11\pm0.07^{d}$ | $15.76\pm0.05^{c}$ | $17.63\pm0.07^{b}$ | $19.54\pm0.05^{a}$ |
| Crude fiber (%) | $1.00\pm0.02^{e}$ | $1.30\pm0.01^{de}$ | $1.56\pm0.01^{cb}$ | $1.64\pm0.02^{a}$ | $1.68\pm0.07^{a}$ |
| Crude protein (%) | $10.34\pm0.12^{e}$ | $12.22\pm0.11^{d}$ | $15.54\pm0.03^{c}$ | $18.65\pm0.04^{b}$ | $22.44\pm0.07^{a}$ |
| Carbohydrate (%) | $74.11\pm0.11^{e}$ | $64.66\pm0.07^{d}$ | $62.26\pm0.07^{c}$ | $57.58\pm0.07^{b}$ | $54.66\pm0.07^{b}$ |

*Means bearing the different superscript down the row are significantly different (p<0.05)* Where,
T0-100g wheat Flour + 0 g cooked African walnut
T1-95g wheat Flour + 5g cooked African walnut
T2-90g wheat Flour + 10g cooked African walnut
T3-85g wheat Flour +15g cooked African walnut
T4-80g wheat Flour +20g cooked African walnut

## Discussions

According to Table 2, there were significant differences (p<0.05) in moisture content of the wheat flour samples and the cooked African walnut, high moisture content was recorded in the cooked African walnut whereas, wheat flour had low moisture. Low moisture shows possibility the food product will have longer shelf life. Food material such as flour and starch with more than 12% moisture may have less storage stability than those with lower moisture content, moisture content of 10% is generally specified for flour products (Eddy, Udofia & Eyo, 2007). The ash content of the T4 was significantly higher than that of muffin made from 100% wheat flour; however, there was no significant difference between the ash content of other samples (Table 3). High ash content in the muffin as a result of cooked African walnut flour addition to the wheat flour could imply increased quantity of minerals in the flour samples.

From Table 3 the fat content ranged from 1.82% - 19.54%. The fat content recorded in muffin from different blends were significantly different (p < 0.05). The highest fat content was observed in T4-80g wheat flour +20g cooked African walnut flour followed by sample T3-85g wheat flour +15g cooked African walnut flour, the least fat content of 1.82% was observed in muffin from 100% wheat flour. High fat content could be attributed to the high percentage of oil in African walnut flour (Ndie, Nnamani & Oselebe, 2010).

The inclusion of cooked African walnut increased the fibre content of muffin samples from 1.00 in muffin from 100% wheat flour - 1.68% in muffin from T4 (80g wheat flour +20g cooked African

DOI:https://doi.org/10.5281/zenodo.15855360

walnut). Fibre is the indigestible portion of food derived from plants which has been reported to help in reducing risk of chronic diseases, obesity and cardiovascular disease (Lonită-Mîndrican, Ziani, Mititelu, Oprea, Neacs, ---Negrei, 2022).

As can be seen from Table 3 protein content increased with increase in cooked African walnut substitution. A similar result was observed by Oguntuase, Ijarotimi, Oluwajuyitan & Oboh, (2022), while using bambara groundnut and walnut to supplement wheat flour in the production of bread.

Carbohydrate content ranged from 54.66% (T4) to 74.11% (T0). The carbohydrate content of the muffin samples was significantly different ($p<0.05$). There was a corresponding decrease in carbohydrate content with increase in cooked walnut flour in the muffin production.

However, Muffins are high in complex carbohydrates.

## Conclusion

Result from the study shows that the addition of cooked African walnut to wheat flour in muffin production resulted in considerable improvement in the protein and fat content of the flour. The result indicates that muffin produced from formulation of 80% wheat flour and 20% cooked African walnut flour gave better result in terms of nutritional composition This could be attributed to the high percentage of protein and fat content of the cooked African walnut flour. Hence, this blend can find useful application in baked products like biscuit and other snacks.

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