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***Full Length Research Paper***

# The Mineral and Vitamin Compositions of Black Walnuts using Roasting Toasting and Cooking

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***Abstract***

*The mineral and vitamin compositions of black walnuts processed by cooking, roasting and toasting were studied. The fresh walnuts were cooked, roasted and toasted at different temperatures and times. Cooking was done at 100°C for 30min, 40min and 50min; roasting was done at 120°C for 30min, 40min and 50min while toasting was done at 140°C for 30min, 40min and 50min respectively. At the end of the heat treatments, samples obtained were subjected to, mineral and vitamin contents analysis. On the Micronutrient composition, cooking for 40min best retained the nutrients. From the results of the mineral composition it was observed that cooking at 100C for 50min.reduced the mineral contents as against the control (untreated) sample. Eg. Sodium from 10.67mg to 9.62mg after cooking, while that of toasting reduced to 8.76mg. This reduction trend as a result of heat treatment was also observed in the Vitamins tested.*

***Key words:*** *Micronutrient composition, Cooking, Roasting and Toasting.*

## Introduction

Black walnut (*Juglans nigra*) is a common name for small flowering plants. It belongs to the family *juglandaceae* and genus of juglans. Walnut is classified as *Juglans regia* and the black walnut as *Juglans nigra* (1). The family contains about fifty nine (59) species; all of which are deciduous trees; flowering plants important for its nuts and timber, distributed primarily in the north temperate areas but with important extensions into tropical American and tropical African regions. In Nigeria it is found in Enugu, Oguta and Owerri in Imo state, Abakiliki in Ebonyi state, Umuahia in Abia, Lagos and Oyo states of Nigeria. In Imo and Abia states of Nigeria, walnut is known as 'Ukpa' and is popularly known as 'Awusa' or 'Asala' and 'Arinsa' in Yoruba speaking states.

Walnut is cultivated principally for the nuts which are cooked and consumed as snacks (2). A bitter taste is usually observed upon drinking water immediately after eating the nut. This could be attributed to the presence of some chemical substances present in the nuts such as alkaloids, oxalates, phylates and tannin in the raw *Juglans nigra* nut as identified by (3) and (4).

Black walnut has been found to be rich in nutrients and minerals. The nutritional content of black walnut is as follows: Calories 623%; water-20%; protien-15%; fat-49.32%; carbohydrate-15%; crude fiber-1.68%; Vitamin A-10.25IU; Vitamin $B_1$ – 0.057mg; Vitamin $B_2$ – 0.130mg; Vitamin $B_3$ – 0.470mg; Beta-carotenoid-6.00mcg; Vitamin E-1.10IU; Vitamin K-0.68g; Calcium-26.0mg; Iodine-2.25mg, Phosphorus -513mg; Potassium – 523mg; Sodium – 2mg, Iron – 3.12mg; and Magnesium-39.50mg (5; 6; 7).

The nuts of all species of walnuts are edible, rich in chemical and mineral contents and have so many food and other uses (7). They are rich in oil, and are widely eaten when cooked, roasted and made into flour form. The oil is expensive and consequently used most often in salad dressing. The oil from walnut is a major source of Omega-3 fatty acid (7). Also, walnut adds extra nutrition, flavor and crunch to one's meal as indicated by (8).

Different processing treatments have been used in the production and processing of walnut. Such methods like blanching, cooking, roasting, and toasting have different effects on the chemical composition and the micronutrients availability in this food and also have problems associated with them (3).

Walnut can be cooked and eaten, roasted or deep fried with the shell, blanched, dried and ground into flour, it can also be ground raw and pressed to squeeze out the oil (9). Though the nut is common and available; the consumption is not so popular probably because of its allergenic reactions on some individual or inadequate knowledge of the nutritional benefits (3).

Some of the problems associated with eating of walnuts include:

- Problem of bitter taste after chewing / eating.
- Loss of essential nutrients (thiamin) during roasting (2).

Though *Juglans nigra* nuts are generally eaten in Nigeria, very little work has been done on the proximate composition, the chemical composition and micronutrient composition of the nuts. Hence, because of inadequate work on this nut, it may get into extinction if nothing is done urgently. The main objectives of this research work therefore includes :a). To determine the mineral composition / vitamin contents of black walnuts; b). To investigate the effects of different processing treatments (cooking, roasting and toasting) on the chemical composition and micronutrient availability of black walnut;c).To ascertain the appropriate processing treatment that is good to retain the nutritional contents of the nut and therefore increase its utilization.

## Materials and Methods

### *Sources of Materials*

Fresh Walnuts were purchased from Orie Awo-Omanma Market in Oru East Local Government Area and from Anara in Isiala Mbano Local Government Area both in Imo State. All chemicals and equipment used for the analysis were obtained from the Department of Food Science and Technology Laboratory (FST Laboratory) and Crop Science Laboratory of the Federal University of Technology Owerri Imo State and the Department of Crop Science, National Root Crop and Research Institute (NRCRI) Umudike Umuahia, Abia state. The chemicals were of analytical grade.

### *Sample Preparation*

The nuts were dehulled and washed with de-ionized water and placed in a tray for the water to dry. The nuts were then divided into four (4) portions and labeled as samples, A, B, C and D (Control). Different processing treatments (Cooking, Roasting, and Toasting) were given to the different portions, while no treatment was given to the raw (control) sample. Each portion was further divided into three portions. The three portions of sample A were cooked at 100$^{o}$C for 30min, 40min and 50min respectively. The three portions of sample B were toasted at 120$^{o}$C for 30min, 40min and 50min and the three portions of Sample C were roasted at 140$^{o}$C for 30min, 40min and 50min after which the different portions were dehulled the second time to expose the walnut seed. The individual portions were milled using attrition mill. The purpose of milling was to expose more of the surface area of the nut for easy drying. After milling, each portion was dried in an oven at a temperature of 60$^{o}$C for 15min to constant weight; the process was closely monitored to avoid charring. After oven drying, the samples were further milled so as to further reduce the particle size. With the help of a 0.3mm sieve, the different samples were sieved gently and the walnut flour for analyses was obtained while the fiber was discarded. The walnut flour which was obtained was packaged in an airtight container ready for analysis. In all a total of Ten (10) samples were obtained including the raw sample that was used as a control sample.

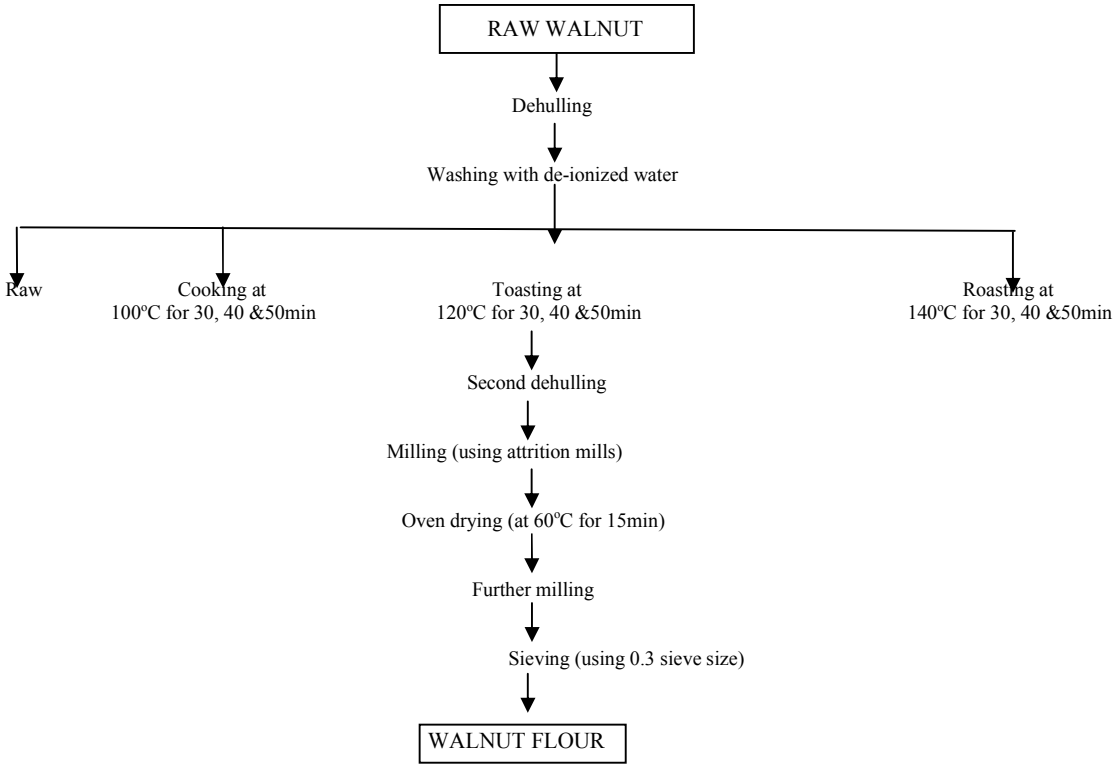


**Fig 1:** Flow Diagram for the Production of Walnut flour


Plate 1: Raw walnut


Plate 2: Cooked Walnut


Plate 3: walnut flour for analysis

**Determination of Micro Nutrients Using Atomic Absorption Spectrophotometer**

***Determination of Minerals of Black Walnuts***

**Acid Digestion:** The samples for the determination of the minerals elements of interest were subjected to acid digestion by weighing out 0.2g of the sample into a dried crucible. It was then ashed on a furnace until colorless, then, 5mls of Conc. Hydrochloric acid (HCL) was used to digest it. When cooled, distilled water was added and then filtered into 50ml volumetric flask with no 41 filter Whatman paper. The crucible was rinsed with 0.1N HCl and water to make up to mark. It was then filtered to get a clear solution free of particles. Subsequently, the different elements were determined using appropriate methods as described below by James (10).

***Determination of the phosphorus content of Black Walnuts***

Phosphorus in the sample was determined by the Vanado-mohybdates (yellow) Spectrometry method described by James (10). Also 1ml extract from each sample was dispensed into a test tube. Similarly, the same volume of standard phosphorus solution as well as water was put into other test tubes to serve as standard and blank respectively. The content of each tube was mixed with equal volume of the Vanado-mohybdate colour reagent. They were left to stand for 15minutes at room temperature before their absorbances were measured in Jenway electronic spectrophotometer at a wave length of 420nm. Measurement was given with the blank at zero.

Phosphorus content was given by the formula

mg/100g = 100/W x Au/As x c x Vf/Va

*where;*

*W = Weight of sample analyzed*
*Au = Absorbance of test sample*
*As = Absorbance of standard solution*
*Vf = Total volume of filtrate*
*c = Concentration of standard solution*
*Va = Volume of filtrate analyzed*

***Determination of Calcium and Magnesium content of Black***
**Walnuts**

This method as was described by (11) was used. Calcium and Magnesium contents of the test samples were determined by the Versanale EDTA complexiometric titration. Twenty milliliters of each extract was dispersed into a conical flask; pinches of the masking agents, hydroxyl tannin, hydrochlorate and potassium cyanide were added followed by 20ml of ammonia indicator solution pH 10.0 and a pinch of the indicator Erich Rome black was added and the mixture was shaken very well for about 10min. It was then titrated against 0.02N EDTA solution. The colour of the solution changed from a mauve colour to a permanent blue colouration. A reagent blank consisting of 20ml distilled water was also treated as described above. The titration gave a reading for combined Ca and Mg complexes in the sample. A separate titration was then conducted for calcium alone. Titration for calcium alone was a repeat of the previous procedure with slight change, 10% Na0H solution at pH 12.0 was used in place of the ammonia buffer, while solechrome dark blue (calcon) was used as indicator in place of erichrome black.

Total calcium and Magnesium content were calculated separately using the formula below:

$$\% \text{ Calcium or Mg} = \frac{100}{W} \times Ew \times \frac{N}{100} \times \frac{Vf}{Va} \times T$$

*Where;*

*W = Weight of sample analyzed*
*Ew = Equivalent weight*
*Vf = Total volume of extract*
*N = Normality of EDTA = 0.02N*
*Va = Vol. of extract titrated*
*T = Titer value less blank*

***Determination of Potassium and Sodium of Black Walnuts***

Potassium and sodium in the sample were determined by flame photometry. The instrument was set up according to the manufacturer's instruction. The equipment was switched on and allowed to stay for about 10min. The gas and air lets were opened

as the start Knob was turned on. The equipment being self igniting, the flame was adjusted to a non-luminous level (i.e. blue colour). Meanwhile standard K and Na solutions were prepared separately and each was diluted to concentration of 2, 4, 6, 8 and 10ppm. When analyzing for specific element like potassium (K), the appropriate filter was selected and the instrument flushed with distilled water. The highest concentration standard solutions were put in place and the reading adjusted to 100ml. Thereafter, starting with least concentration i.e. 2ppm, all the standard solutions were sucked into the instrument and caused to spray over the non luminous flame. The readings were recorded and later plotted into a standard curve which was used to extrapolate the potassium level in the sample. After the standard, the simple digits were siphoned in turns into the instrument, their readings recorded. The sample was repeated with sodium (Na) standard and the place of the K filter. The concentration of the test mineral in the sample was calculated with reference to the graph and obtained as follows.

$$mg/100g = \frac{100}{W} \times Vt \times \frac{1}{1} \times \frac{X}{10^3} \times D$$

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

Similarly,
For sodium concentration, it was given as:

$$Na(mg/100g) = \frac{100}{10} \times Vt \times \frac{1}{1} \times \frac{D}{10^3}$$

**Determination of The Vitamin Content Of Walnut**

***Determination of Riboflavin content of Black Walnuts***

The riboflavin content of the test sample was determined using the method (12).
Five grammes (5g) of the sample was extracted with 100 ml of 50% ethanol solution and shaken for one hour. This was filtered into a 100ml flask. Then 10ml of the extract was pipette into 50ml volumetric flask. Ten milliliters of 5% potassium permanganate and 10ml of 30% hydrogen peroxide ($H_2O_2$) were added and allowed to stand over hot water bath for about 30 minutes. Two milliliters (2ml) of 4% sodium sulphate was added. This was made up to 50ml mark and the absorbance measured at 510nm in a spectrophotometer.

***Vitamin A Determination of Black Walnuts***

This was determined using the method described by (13). Five grammes (5g) of the test sample was first homogenised using acetone solution with the aid of pestle and Mortar. The solution was filtered after crushing. The filtrate was then extracted with petroleum spirit, using separating funnel. Two layers of both aqueous and solvent layer were obtained.

The upper layer which contains vitamin A was washed very well with distilled water in order to remove residual water; it was later poured out to the 50ml volumetric flask through the tap of the separating funnel and made up to mark. The absorbance of the solution was recorded using spectrophotometer at wavelength of 450nm calculation.

**Vitamin C Determination of Black Walnuts**

Vitamin C content of the nut was determined using the method of (14) titrimetric method. Five grammes (5g) of each processed sample was homogenized in 100ml of EDTA/TCA solution by blending for 5min in a blender (national brand). The homogenate was filtered and the filtrate used for the analysis. The filtrate for each test sample was passed through a packed cotton wool containing activated charcoal to remove the colour. The volume of the filtrate was adjusted to 100ml by washing with more of the extract solution. (20mls) of the filtrate was measured into a conical flask. Two grammes (2g) of 20% potassium iodide solution was added to each of the flasks followed by 5mls of starch (indicator). The mixture was titrated against a $CuSO_4$ solution. Titration was done to an end point marked by black specks of the brink of the wall.
Vitamin C content was given by the relationship of 1ml of 0.01 mol $CuS0_4$ and 0.88mg Vit C.
Therefore, Vit. C content:

$$mg/100g \text{ sample} = \frac{100}{W} \times Vf \times \frac{0.88T}{Va}$$

*Where W = weight of the sample analyzed*
*Vf = total volume of extract*
*Va= Vol. of extract titrated*
*T = Titer values*

**RESULTS**

**Table 1:** Mean values of the mineral composition of walnut as affected by different processing methods.

| SAMPLES | TIME | Na (mg/g) | K (mg/g) | P(mg/g) | Mg (mg/g) | Fe (mg/g) |
|---|---|---|---|---|---|---|
| | **0min** | 10.67±0.33$^{b}$ | 477.28±1.53$^{a}$ | 437.06±2.51$^{a}$ | 125.17±0.47$^{a}$ | 1.57±0.05$^{a}$ |
| **Cooked** | **30min** | 11.36±0.00$^{a}$ | 237.35±5.10$^{b}$ | 265.24±0.81$^{b}$ | 119.70±1.03$^{b}$ | 1.35±0.05$^{b}$ |
| **@** | **40min** | 10.26±0.00$^{c}$ | 226.99±11.0$^{c}$ | 259.81±0.33$^{c}$ | 117.11±0.35$^{c}$ | 1.22±0.03$^{c}$ |
| **100$^{0}$** | **50min** | 9.62±0.29$^{d}$ | 220.02±0.94$^{d}$ | 248.23±0.63$^{d}$ | 115.40±1.18$^{d}$ | 1.21±0.05$^{c}$ |
| **LSD** | | **0.24** | **3.65** | **2.56** | **1.63** | **0.06** |
| | **0min** | 10.67±0.33$^{c}$ | 477.28±1.53$^{a}$ | 437.06±2.51$^{a}$ | 125.17±0.47$^{a}$ | 1.57±0.05$^{a}$ |
| **ROASTED** | **30min** | 11.60±0.30$^{a}$ | 234.44±0.27$^{b}$ | 276.18±0.92$^{b}$ | 124.04±2.47$^{a}$ | 1.41±0.12$^{b}$ |
| **@** | **40min** | 11.59±0.50$^{a}$ | 224.64±1.14$^{c}$ | 258.81±8.12$^{c}$ | 116.07±1.10$^{b}$ | 1.33±0.01$^{c}$ |
| **120$^{0}$C** | **50min** | 10.98±0.10$^{b}$ | 218.21±0.85$^{d}$ | 246.96±2.28$^{d}$ | 114.88±4.81$^{b}$ | 1.24±0.03$^{d}$ |
| **LSD** | | **0.25** | **3.31** | **2.50** | **1.70** | **0.05** |
| | **0min** | 10.67±0.33$^{a}$ | 477.28±1.53$^{a}$ | 437.06±2.51$^{a}$ | 125.17±0.47$^{a}$ | 1.57±0.05$^{a}$ |
| **TOASTED** | **30min** | 8.80±0.40$^{b}$ | 124.97±1.27$^{b}$ | 198.57±0.50$^{b}$ | 123.91±0.50$^{a}$ | 1.21±0.05$^{b}$ |
| **@** | **40min** | 8.80±0.06$^{b}$ | 111.90±2.85$^{c}$ | 176.26±0.70$^{c}$ | 114.28±1.10$^{b}$ | 1.20±0.02$^{b}$ |
| **140$^{0}$C** | **50min** | 8.78±0.80$^{c}$ | 111.01±0.00$^{c}$ | 156.89±0.20$^{d}$ | 105.02±0.70$^{c}$ | 1.17±0.05$^{c}$ |
| | **LSD** | **0.25** | **3.73** | **2.68** | **1.61** | **0.05** |

- *Mean Values with the same superscript in the same column are not significantly different at (P≤0.05)*

**Table 2.** Mean values of the vitamin composition of walnut as affected by different processing methods.

| SAMPLES | TIME | Vit B 1 (mg) | Vit B 2 (mg) | Vit B 3 (mg) | Vit C (mg) | Vit A (IU) |
|---|---|---|---|---|---|---|
| | **0min** | 0.98±0.00$^{a}$ | 0.25±0.01$^{a}$ | 1.64±0.01$^{a}$ | 4.23±0.01$^{a}$ | 2.43±0.00$^{a}$ |
| **Cooked** | **30min** | 0.42±0.02$^{b}$ | 0.21±0.01$^{b}$ | 1.34±0.01$^{b}$ | 3.88±0.01$^{b}$ | 1.97±0.01$^{b}$ |
| **@** | **40min** | 0.16±0.01$^{c}$ | 0.17±0.02$^{c}$ | 1.22±0.01$^{c}$ | 3.20±0.06$^{c}$ | 1.88±0.01$^{c}$ |
| **100°** | **50min** | 0.12±0.01$^{d}$ | 0.10±0.01$^{d}$ | 1.21±0.01$^{c}$ | 2.46±0.01$^{d}$ | 1.32±0.01$^{d}$ |
| **LSD** | | **0.02** | **0.01** | **0.02** | **0.04** | **0.04** |
| **ROASTED** | **0min** | 0.98±0.00$^{a}$ | 0.25±0.01$^{a}$ | 1.64±0.01a | 4.23±0.01$^{a}$ | 2.43±0.00$^{a}$ |
| **@** | **30min** | 0.41±0.01$^{b}$ | 0.22±0.01$^{b}$ | 0.81±0.01$^{b}$ | 2.12±0.01$^{b}$ | 0.64±0.00$^{b}$ |
| **120$^{0}$C** | **40min** | 0.37±0.01$^{c}$ | 0.19±0.00$^{c}$ | 0.77±0.01$^{c}$ | 2.01±0.01$^{c}$ | 0.56±0.01$^{c}$ |
| | **50min** | 0.31±0.00$^{d}$ | 0.11±0.01$^{d}$ | 0.33±0.01$^{d}$ | 2.00±0.01$^{c}$ | 0.37±0.02$^{d}$ |
| **LSD** | | **0.03** | **0.01** | **0.02** | **0.02** | **0.05** |
| **TOASTED** | **0min** | 0.98±0.00$^{a}$ | 0.25±0.01$^{a}$ | 1.64±0.01$^{a}$ | 4.23±0.01$^{a}$ | 2.43±0.00$^{a}$ |
| **@** | **30min** | 0.37±0.01$^{b}$ | 0.17±0.01$^{b}$ | 0.87±0.01$^{b}$ | 2.32±0.01$^{b}$ | 0.13±0.00$^{b}$ |
| **140$^{0}$C** | **40min** | 0.31±0.01$^{c}$ | 0.14±0.01$^{c}$ | 0.43±0.01$^{c}$ | 2.15±0.01$^{c}$ | 0.12±0.01$^{c}$ |
| | **50min** | 0.11±0.01$^{d}$ | 0.11±0.01$^{d}$ | 0.21±0.01$^{d}$ | 2.08±0.01$^{d}$ | 0.10±0.01$^{c}$ |
| | **LSD** | **0.04** | **0.01** | **0.03** | **0.03** | **0.02** |

- *Mean Values with the same superscript in the same column are not significantly different at (P≤0.05)*

**Result**

Are shown in Table above

**Discussion**

***Effects of Different Processing Treatments on the Mineral Composition of Walnut (Table 1)***

The mean value of mineral composition of walnut as affected by different processing treatments is shown in table1 above. The sodium content of the raw (control) sample was found to be 10.67mg which is greater than 4.0mg value in literature as reported in (3). The values of the samples cooked at 100$^{o}$C showed that a significant difference (P≤0.05) existed between the values obtained. The sample cooked at 100$^{o}$C for 30min had a value of (10.36mg) which is lower than that of the control (10.67mg), while 50min of cooking had a lower value (9.62mg) which may be as a result of nutrient loss during cooking as reported by (15). There was no significant difference (P≥0.05) between the values of the sample roasted at 120$^{o}$C for 30min and 40min (11.60mg and 11.59mg) respectively. This suggests that the level of sodium content will be the same when roasted at the same condition and time. However, there was a significant difference (P≤0.05) between the values of samples roasted for 40min and 50min (11.59mg and 10.98mg). The reduction in value is in agreement with the work reported in Encarta (2008), which showed that roasting cereals for a much longer time affects its mineral contents. There was no significant difference (P≥0.05) between the values of the samples toasted at 140$^{o}$C for 30min and 40min (8.80mg), a significant difference (P≤0.05) existed at 50min of toasting at 140$^{o}$C. The slight decline in value of sodium toasted at 140$^{o}$C is in agreement with the work of Meteljan (2009) that increase in temperature and time of processing can lead to a reduction in nutrient content of food as a result of heat denaturation of nutrients.

The mean value of the control (raw) sample for Potassium was 477.28mg. The value of the potassium samples cooked at 100$^{o}$C for 30min showed a significant difference (P≤0.05) among the other samples. The values decreased as the time of cooking increased from 30min to 40min and to 50min (237.35mg, 226.99mg and 220.02mg) respectively which suggest that increase in time of cooking will reduce the amount of potassium obtained. There was a significant difference (P≤0.05) between the values of the roasted samples at 120$^{o}$C (234.44mg, 224.64mg and 218.21mg) respectively. There was a reduction in the values of roasted samples when compared to control sample of (477.28mg) which indicates that heat has an effect in the potassium content. The sample toasted at 140$^{o}$C also showed a significant difference (P≤0.05) among the values obtained at 30min and 40min (124.97mg and 111.90mg), while there was no significant difference between the value obtained at 40min and 50min (111.90mg and 111.01mg). Toasting for 50min had a lower value (111.01mg) from that toasted for 30min (124.97mg). The values obtained suggest that all the processing treatments and time used had an effect on the potassium content of the walnut with cooking having the highest value of potassium (237.35mg) and toasting having the lowest value of 111.01mg.

The value of sample (raw) for Phosphorus was 437.06mg. The value of the sample cooked at 100$^{o}$C for 30min was 265.24mg, hence there was a significant difference (P≤0.05) between the values of the samples obtained for cooking at 100$^{o}$C for different times. The values decreased as the time of cooking increased which is in agreement with the work of (16). The decrease in the value of phosphorus with increased time of cooking is in affirmative with the work of (17) which states that increase in heat and time of cooking of cereals affects their mineral contents. There was a significant difference (P≤0.05) in the values reported for roasting at 120$^{o}$C for 30min, 40min and 50min (276.18mg, 258.81mg and 246.96mg) respectively. There was a significant difference (P≤0.05) between the values of the samples toasted at 140$^{o}$C for 30min, 40min and 50min (198.57mg, 176.26mg and 156.89mg) respectively. Both roasting and toasting are high heat treatments, therefore the reduction in the values (198.57mg, 176.26mg and 156.89mg) when compared to literature (513.00mg) and control (437.06mg) suggest that phosphorus content and other minerals may be affected by heat treatment which agrees with the work of (16) that high heat treatment reduces the minerals and nutrient contents of cereals.

The magnesium content of the control (raw) sample was 125.17mg which differs slightly from the value in the work reported in (3) which was 176mg. The values of the cooked sample showed that significant difference (P≤0.05) existed between the values of samples cooked at 100$^{o}$C for 30min, 40min and 50min (119.70mg, 117.11mg, and 115.40mg) respectively the values obtained for roasting at 120$^{o}$C for 30min, 40min and 50min (124.04mg, 116.07mg and 114.88mg) respectively and toasting at 140$^{o}$C for 30min, 40min and 50min (123.91mg, 114.28mg and 105.02mg) respectively showed that a significant difference (P≤0.05) existed among the values, but no significant difference existed between the control and that toasted for 30min (125.17mg and 123.91mg). Magnesium is one of the minerals that may be lost during processing by heat and time of treatment as reported in the work of (18)

The iron content of the control (raw) sample was 1.57mg. There was a significant difference (P≤0.05) among the values of sample of Iron cooked at 100$^{0}$C for 30min, 40min and the control sample; while no significant difference (P≥0.05) existed between the values obtained at cooking for 100$^{0}$C for 40min and 50min (1.22mg/g and 1.21mg/g). The values of samples cooked at 100$^{o}$C for 30min, 40min and 50min showed the presence of high iron content (1.35mg, 1.22mg and 1.21mg) which is very close to the figure of the control. This indicates that cooking walnut at 100$^{o}$C for 30min is good in preserving the mineral content like iron. There was a significant difference (P≤0.05) among the values of samples obtained by roasting at 120$^{o}$C for 30min, 40min and 50min and control (1.41mg/100, 1.33mg/100, 1.24mg/100 and 1.57mg/100) respectively. The values showed a slight decrease as the time of roasting increased from 30min to 50min. There was no significant difference (P≥0.05) among the samples toasted at 140$^{o}$C for 30min and 40min (1.21mg/g and 1.21mg/g),

however a significant difference existed between the control sample and that toasted for 50min (1.57mg/g and 1.17mg/g) from that of 30min and 40min. Toasting walnut at 140$^{o}$C for 50min showed that the iron content was reduced drastically from 1.57mg/g to 1.17mg/g which agrees with the work of (16), that toasting and roasting are important household food processing methods, as a thermal process, boiling/cooking could enhance tenderization.

***Effects of Different processing treatments on the Vitamin Composition of Walnut.*** **(Table 2)**

The mean values of vitamin composition of walnut as affected by different processing treatments are shown in Table 2. The vitamin $B_1$ content of the control (raw) sample was found to be 0.98mg which is higher than the figure quoted by (1) which is 0.057mg. There was a significant difference (P≤ 0.05) between the values of samples cooked at 100$^{o}$C for 30min, 40min and 50min and the control (0.42mg, 0.16mg, 0.12mg and 0.98mg) respectively, (Table 2). There was a decrease in the available vitamin $B_1$ as the time of cooking progressed. This could be attributed to loss of vitamins in water during cooking/boiling as reported by (15). Also the samples that were roasted at 120$^{o}$C showed that a significant difference (p≤0.05) existed between the values obtained (0.41mg, 0.37mg and 0.31mg). There was also a significant difference (p≤0.05) between the values of the toasted samples at 140$^{o}$C; toasting for 30min and 40min had 0.37mg and 0.31mg, while toasting for 50min gave a very low value of vitamin $B_1$ (0.11mg). These results showed that toasting walnut at 140$^{o}$C for 50min will reduce if not totally eliminate the vitamin $B_1$ content. As a result, it should not be toasted at very high temperature if Vitamin $B_1$ is a major required nutrient.

The Vitamin $B_2$ content in the control (raw) sample is given as 0.25mg which is not in affirmation with the figure quoted by (1) which is 0.13mg. There was a significant difference (p≤0.05) between the values of the samples cooked at 100$^{o}$C for 30min, 40min and 50min (0.21mg, 0.17mg, and 0.10mg) respectively. The values showed a decrease as the time of cooking progressed. There was a significant difference (p≤ 0.05) between the values of the samples roasted at 120$^{o}$C for 30min, 40min and 50min (0.22mg, 0.19mg and 0.11mg) respectively. Roasting for 50min reduced the value of $B_2$ in the sample from 0.22mg to 0.11mg which agrees with the work of (15) that heat affects the value of minerals and vitamins in cereal products. Also the samples toasted at 140$^{o}$C for 30min, 40min and 50min showed that significant difference (p ≤ 0.05) existed between the values of the samples (0.17mg, 0.14mg and 0.11mg). This agrees with the work of (7).

The vitamin $B_3$ content in the control (raw) sample is given as 1.64mg which is higher than the figure quoted by (1) which is 0.43mg. There was a significant difference (p≤ 0.05) between the values of the samples obtained for vitamin $B_3$ from the raw sample and by cooking walnut at 100$^{o}$C for 30min and 40min (1.34mg and 1.22mg). This is an indication that cooking for 30min and 40min time intervals will not have much effect on the availability of Vitamin $B_3$ in the sample. However, there was no significant difference (p≥0.05) between the values of the samples cooked for 40min and 50min (1.22mg and 1.21mg). The values were in agreement with the work of (1). There was a significant difference (p≤0.05) between the values obtained for roasted samples at 120$^{o}$C for the time intervals of 30min, 40min, 50min and the control (0.81mg, 0.77mg, 0.33mg and 1.64mg) respectively. The values obtained for toasting at 140$^{o}$C for the same time shows that a significant difference (p≤0.05) existed between the values and that of the control (0.87mg, 0.43mg, 0.21mg and 1.64mg). The reduction in the values as noted here agrees with the work of (7) on the effect of high heat application on the nutrient composition of foods.

The value of vitamin C in the control (raw) sample is given as 4.23mg. There was a significant difference (p≤ 0.05) among the values of the samples cooked at 100$^{o}$C for 30min, 40min and 50min and control (3.88mg, 3.20mg and 2.46mg and 4.23mg). There was a slight decrease in the values obtained when compared to control sample of 4.23mg. This could be attributed to loss of vitamins and minerals following the effect of cooking as reported by (16) that cooking affects the level of mineral content of foods. There was a significant difference (p≤ 0.05) between the control sample and the values obtained for the sample roasted for 30min and 40min (4.23mg, 2.12mg and 2.01mg), while no significant difference (P≥0.05) existed between the value of the sample roasted at 40min and 50min (2.01mg and 2.00mg). The reduction in the value may be as a result of heat treatment. There is a significant difference (P≤ 0.05) between the values of the toasted sample. The level of vitamin C obtained was reduced when compared to control as a result of heat treatment. This suggests that walnut should be processed by boiling for a shorter time.

The Vitamin A content of the control (raw) sample of walnut is given as 2.43IU which shows a slight variation from the work of (1) which was 2.23IU. There was a significant difference (P≤0.05), between the value of the samples cooked at 100$^{o}$C for 30min, 40min, 50min and from the control sample (1.97IU, 1.88IU, 1.32IU and 2.43IU) respectively. The values had a slight decrease from the control which was affected by the effect of boiling and leaching. There was a significant difference between the values of the samples roasted at 120$^{o}$C for 30min, 40min and 50min (0.64mIU, 0.56IU and 0.37IU) respectively. The samples had a great reduction in its values of Vitamin A which is as a result of heat denaturation. Toasting at 140$^{o}$C showed that a significant difference (P≤0.05) existed between the values of the sample obtained from the control and those of 30min and 40min (2.43IU, 0.13 IU and 0.12 IU). There was a significant difference between the samples toasted for 40min and 50min (0.12IU and 0.10IU). The samples toasted for 50min had a very low value of vitamin A (0.10IU) which was as a result of the high heat and method of treatment applied. The reduction in value could be attributed to heat which led to loss of minerals and vitamins as reported in the work of (7).

## Conclusion

On the basis of this study within the limits of experimental errors, it could be deduced that walnut is one of the highly nutritious plants that have much nutritional and health benefits. Also, the result of this work showed that walnut is best prepared by cooking at 100$^{o}$C for 40min to retain the vitamins and minerals.It is therefore advised that walnut should be used in supplementation of diets low in Vitamins and Minerals to improve the nutritional status of the population.

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