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Full Length Research Paper

Evaluation of the Proximate and Antinutritional Qualities of Black Walnut (*Junglans nigra*) Processed by Cooking Toasting and Roasting

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Abstract

The chemical and nutritional 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 proximate analysis and anti-nutritional contents determination. Results obtained showed that the moisture content of the walnut increased from 22.43% to 48.61% with cooking and decreased from 22.43% to 4.06% with toasting for 50min; the ash content decreased slightly in all the treatment with cooking having value from 3.68% to 3.20%. Protein content decreased from 15.30% to 8.62% with roasting for 50min. The anti-nutritional contents of walnuts were reduced greatly by each of the heat processing methods. For example roasting at 120°C for 50min reduced tannin in the nut from 0.15% to 0.02% and phytate from 0.16mg/g to 0.01mg/g while steroid was reduced from 0.34g to 0.02g and hemagglutinin was totally eliminated from the sample from 0.11g to 0.00g.

Keywords: *Proximate composition, anti nutrients, toasting, roasting, cooking*

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).

The nutritional content of black walnut is as follows: Calories 623%; water-20%; protien-15%; fat-49.32%; carbohydrate-15%; crude fiber-1.68% (5). The nuts of all species of walnuts are edible, rich in chemical and mineral contents and have so many food and other uses (5). 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 (5). Also, walnut adds extra nutrition, flavor and crunch to one's meal as indicated by (6).

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 (7). 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 during roasting (2). Though *Juglans nigra* nuts are generally eaten in Nigeria, very little work has been done on the proximate and antinutritional compositions of the nuts. This study was undertaken a) to investigate the proximate composition/ nutritional value of black walnut as affected by different processing treatments and b) to investigate the effects of different processing treatments on the anti-nutritional composition of black walnut.

Materials and Methods

Sample Collection

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.

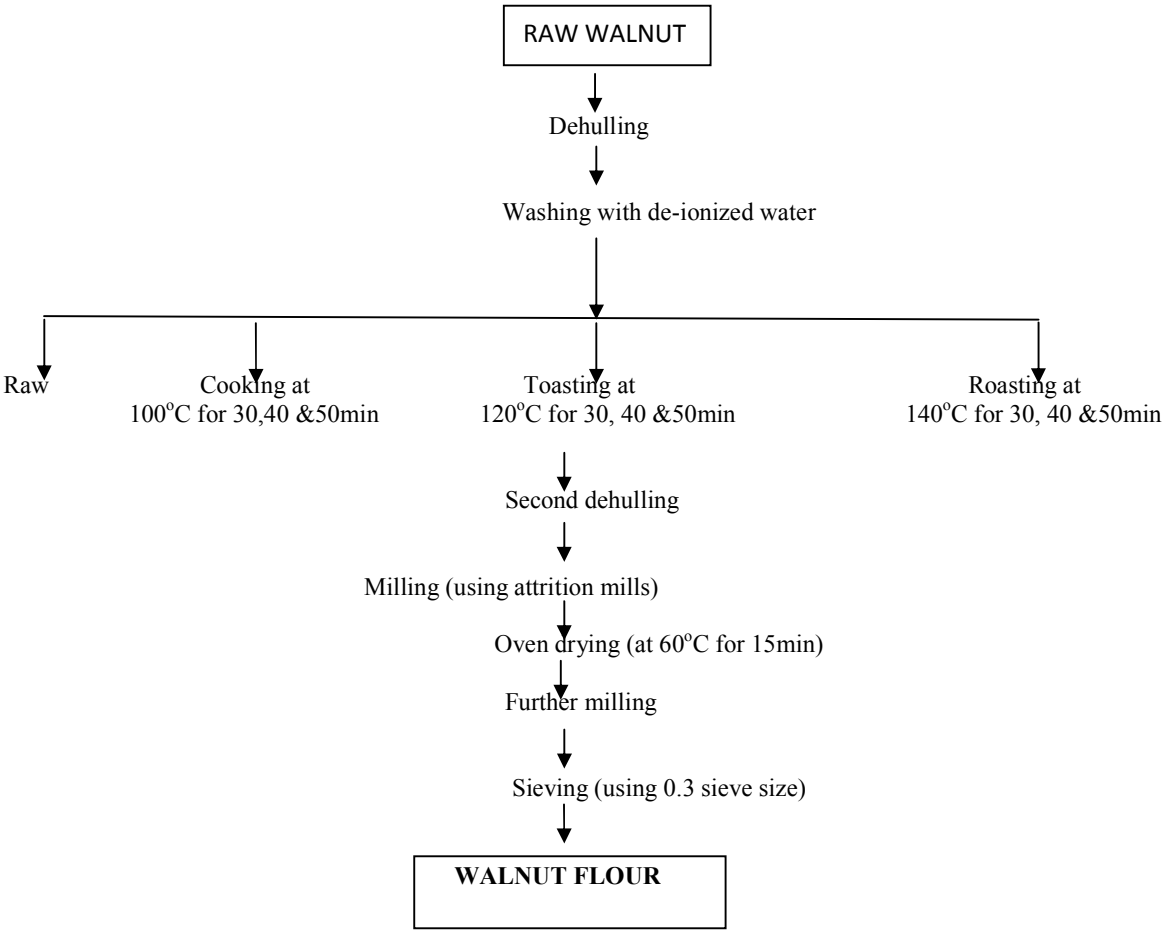

Fig 1: Flow Diagram for the Production of Walnut flour


Plate 1: Raw walnut


Plate 2: Cooked Walnut


Plate 3: Walnut Flour for analysis

Proximate Analysis
The proximate analysis was conducted in accordance with standard methods of (8) and (9).

Determination of the Anti-Nutritional Properties of Walnut
Determination of Tannins content of Black Walnuts
The Folin-Denis Spectrophotometric method was used as described by (10). A measured weight of each sample (1.0g) was dispersed in 10ml distilled water and agitated. This was left to stand for 30min at room temperature, being shaken every 5 min. At the end of the 30min the sample was centrifuged and the extract obtained. Then 2.5ml of the supernatant (extract) was dispersed into a 50ml volumetric flask. Similarly 2.5ml of standard tannic acid solution was dispersed into a separate 50ml flask. A 10ml Folin-Dennis reagent was measured into each flask, followed by 2.5ml of saturated Na_2CO_3 solution. The mixture was diluted to mark in the flask (50ml) and incubated for 90min at room temperature. The absorbance was measured at 250nm in a Genway model 6000 electronic spectrophotometer. Readings were taken with the reagent blank at zero.

The tannin content was given as follows:

$$\% \text{ Tannin} = \frac{Au}{As} \times C \times \frac{100}{W} \times \frac{Vf}{Va}$$

Where,
Au = absorbance of test sample, As = absorbance of standard solution
C = concentration of standard solution, W = weight of sample used
Vf = total of extract, Va = volume of extract analyzed.

Determination of Hydrogen Cyanide (HCN) of Black Walnuts
The method of (11) was used for the determination of HCN. (5g) of the sample was ground into a powder and dissolved in 50ml distilled H_2O in a conical flask. It was allowed to stay overnight, the solution was later filtered. (2ml) of the filtered solution was poured inside a conical flask and 4ml of alkaline primate solution was added and incubated in water bath for 5 min at 55^{o}C for colour development (reddish, brown) and absorbance was taken at 490nm. Also a blank was prepared using 2ml distilled water.

The cyanide content was extrapolated using a cyanide standard curve.

$$\textbf{HCN (mg/kg)} = \frac{Vf}{Va} \times \frac{1}{} \times \frac{100}{W}$$

Where Vf = Total vol. of extract
Va = Vol. of extract used
W = Weight of sample used

Oxalate Determination of Black Walnuts
The method used was as described by (12). The procedure involves three (3) steps, thus: digestion, oxalate precipitation and permanganate titration.

Digestion: Two grammes (2g) of the sample were weighed out and were dissolved in 190ml of distilled water in a 250ml volumetric flask. (10ml) of 6M HCL was added and the mixture digested in water both maintained at 100^{o}C for 1 hour. It was allowed to cool and then made up to 250ml after which it was filtered.

Precipitate*:* Here 125ml aliquot of the filtrate was measured out in a beaker and four drops of methyl red indicator was added followed by the addition of concentrated NH_40H solution drop wise until the solution changed from its salmon pink to a yellow colour (pH 4-4.5). Each mixture was then heated up to 90^{o}C, cooled and filtered to remove precipitate containing ferrous ion. It was again heated to 90^{o}C and 10ml of 5% $CaCl_2$ solution added with constant stirring. It was then left overnight at a temperature of 5^{0}C. The solution was then centrifuged at 2500 rpm for 5 min. The supernatant was decanted and the precipitate completely dissolved in 10ml of 20% (v/v) H_2SO_4 solution.

Permanganate Titration*:* After staying for a minimum of 12hours (overnight), the solution was then centrifuged at 2500rpm for 5min. The supernatant was decanted again and the precipitate completely dissolved in 100ml of 25% (^{V}/v) H_2SO_4. The solution was heated until it almost attained boiling and titrated again against 0.05N potassium permanganate ($KMnO_4$) solution to a faint pink colour that was permanent for 30min (11).

The Calculations was as follows:

$$(mg/100g) = \frac{T \times (Vme) \times Df \times 10^5}{(Me) \times Mf}$$

Where:
T = Titre value of $Kmn0_4$, Vme = Mass equivalent, Mf = mass of flour used
Df= Dilution factor, Me = Molar equivalent

Determination of Phytate content of Black Walnuts

This was determined using method described by (12). The sample was first extracted with 0.2N Hydrochlorie acid, 0.5ml of the extract solution was pipetted into a test tube fitted with a ground glass stopper. One milliliter ferric acid solution was added and the tube was covered well. The tube was later heated in a boiling water bath for 30min.

After heating, the tube was cooled in ice water for 15min and allowed to adjust to room temperature. The tube was then mixed and centrifuged for 30min at 3000rpm. Then, 1ml of the supernatant was transferred to another tube and 1.5ml of 2,2, bipyridine solution and the absorbance was measured at 519nm against distilled water.

The percentage phytic acid was calculated as follows:

$$\textbf{(mg/g)} = \left[\frac{Vf}{Vx} \times \frac{100}{W} \times X \right]$$

Where,

V_f = Total volume of extract, Vx = Volume of extract used
W = Weight of sample used, X = ppm of Curve

Determination of Alkaloids content of Black Walnuts

The gravimetric method (13) was adopted. A measured weight (5.0g) of each sample was dispersed in 50ml of 10% acetic acid solution in ethanol. The mixture was shaken and allowed to stand for 4 hours before it was filtered. The filtrate was evaporated to one quarter ($^1/_4$) of its original volume. Concentrated NH_4OH was added drop-wise to precipitate the alkaloids. The precipitate was filtered off and was washed with 1% NH_4OH solution. The filtering was done with a weighed filter paper. The precipitate in filter paper was dried in the oven at 60^0C for 30min and re-weighed. By weight differences, the weight of alkaloid was determined and expressed as a percentage of the sample weight analyzed. The alkaloid content was given as follows:

$$\% \text{ Alkaloids} = \frac{w_2 - w_1}{w} \times \frac{100}{1}$$

Given that,
w =weight of sample, w_1 = weight of empty filter paper, w_2 = weight of paper + precipitate

Determination of Saponin: The method used as described by (14). (5.0g) of the dry ground sample was weighed into a thimble and transferred into the Soxhlet extractor chamber fitted with a condenser and a round bottomed flask. Some quantity of acetone, enough to cause a reflux was poured into the flask. The sample was exhaustively extracted of its lipid and interfering pigments for 3 hours by heating the flask on the hot plate and the solvent distilled off. This was the first extraction. For the second extraction, a pre-weighed round/ flat bottomed flask was fitted into the Soxhlet apparatus (bearing the sample containing the thimble) and the methanol poured into the flask. The methanol should be enough to cause a reflux. The saponin was then exhaustively extracted for 3 hours by heating the flask on the hot plate, after which the solvent was distilled off. The flask was reweighed. The difference between the final and initial weight of the flask represent the weight of the saponin extracted.

$$\% \text{ Saponin} = \frac{\text{wt of saponin}}{\text{wt of Sample}} \times \frac{100}{1}$$

Determination of Hemagglutinin by Spectrophotometric method: 0.5gm of the sample was weighed out and dispersed in a 10ml normal saline solution buffered at pH 6.4 with 0.01M phosphate buffer solution. The solution was allowed to stand at room temperature in a spectrophotometer for 30min and then centrifuged to obtain the extract. To 0.1ml of the extract diluents in a test tube, 1ml of trypsinized rabbit blood was added. The control sample with test tube containing only the blood cell was mounted; both tubes were allowed to stand for four (4) hours at room temperature. (1ml) of normal saline was then added to all the test tubes and allowed to stand for 10min after which the absorbance was read with the absorbance meter at 620nm (11). The tube containing only the blood cells and normal saline then served as the blank. The result is expressed as haemagglutinin unit per milligram of the sample. Hemagglutinin unit/mg = (b-a) x F

Where a = absorbance of test sample solution
b = absorbance of the blank (control)
F = experimental factor, given by:
F = $(1/w \times V_f / V_a) \times D$

Where: w = *weight of sample*
V_f = *total volume extract*
V_a = *volume of extract used in the experiment*
D = *dilution factor (if any)*

The dilution factor D = 1ml to 10ml and 0.1ml out of the 10ml. That is ((10 x10) / 0.1) = 100ml.

Determination of Trypsin Inhibitor of Black Walnuts: The trypsin inhibitor activity (TIA) was determined using spectrophotometric method described by (15). The samples were extracted by weighing out 1.0g of the test sample and dispersing it in 50ml of 0.5M NaCl solution, stirred for 30min at room temperature and centrifuged. The supernatant was filtered through No.41 Whatman filter paper. The filtrate (extract) was used for the assay. The trypsin inhibitor activity is expressed as the number of trypsin units inhibited (TUI) per unit weight (g) of the sample analyzed.

Thus:
TUI/ mg = (Absorbance of sample / Absorbance of standard) x 0.01F
TUI/mg = ((b – a) / 0.01) x F
Where a = absorbance of test sample aolution
b = absorbance of the blank (control)
F = experimental factor, given by:
F = 1/w x Vf / Va x D
Where: w = *weight of sample*
Vf = *total volume extract*
Va = *volume of extract used in the experiment*
D = *dilution factor (if any)*

Statistical Analysis
Data obtained were subjected to statistical analysis using ANOVA on SASS analytical tool on windows 2007. Means were separated using the least significant difference (LSD) at 95% level of confidence.

Results
This chapter presents the detailed results of the analysis of the individual samples as obtained.

Discussion
Effects of Different Processing Treatment on the Proximate Composition of walnut (Table 1)
The mean values of proximate composition of walnut as affected by different processing treatment are shown in Table 1. The moisture content of the raw (control) sample is 22.43% which agrees with the value in the work done by (16) which gave an average value as 22.34%. There was a significant difference ($P \leq 0.05$) between the values of samples cooked at 100^0C for 30min and 40min (30.76% and 39.42%) from the control (22.43%) and also, there was a significant difference ($P \leq 0.05$) between the control sample and that cooked for 50min (48.61% and 22.43%) (Table 1). There was an increase in moisture as the time of cooking increased. The values increased from 22% to 48.61% which could be attributed to water absorption during cooking of cereals as reported in the work of (17). Also the samples that were roasted at 120^oC showed that a significant difference existed ($P \leq 0.05$) between the values obtained for 30min and 40min of roasting respectively, while no significant difference ($P \geq 0.05$) was observed between value of the samples roasted for 40min and 50min (12.49% and 11.42%) respectively. These values are in agreement with the work of (5) which showed that roasting is a good method of moisture removal in cereals and nuts. Also, the decrease in moisture during roasting could be attributed to high heat treatment which led to loss of moisture as it was reported by (3) that moisture can be reduced by an increase in pro cessing temperature. The samples toasted at 140^0C showed that a significant difference ($P \leq 0.05$) existed between the values obtained at 30min, 40min and 50min (8.76%, 6.44% and 4.06%) respectively, an indication that increases in time of toasting from 30min to 50min affects the level of moisture removal, which is in agreement with the work of (5) which noted that the rate of moisture evaporation during toasting is affected by the length of time of exposure. The values showed that the highest moisture was obtained during cooking for 50min (48.61%), while the lowest moisture was during toasting for 50min (4.06%).

The Ash content of the raw sample was 2.43%, which showed a slight difference from the value obtained by (18), which gave the ash of the raw sample as 1.98%. There were significant differences ($P \leq 0.05$) between the values obtained at 100^0C of cooking for 30min and 40min with that of the control (3.68%, 3.41%, and 2.43% control) respectively, while no significant difference ($P \geq 0.05$) existed between the value of 40min and 50min (3.41% and 3.20%). As the time of cooking increased, the level of ash obtained decreased from 3.68% - 3.20%. The level of ash value obtained by roasting at 120^0C showed a significant difference ($P \leq 0.05$) between 30min to 50min of roasting (2.33%, 2.28% and 2.11%) respectively. The samples toasted at 140^0C showed that significance difference ($P \leq 0.05$) existed at 30min and 40min (2.28% and 2.16%) while no significant difference ($P \geq 0.05$) existed between 40min and 50min (2.16%, and 2.10%).

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

SAMPLES	TIME	MOISTURE %	ASH %	CRUDE FAT %	CRUDE FIBER %	PROTIEN %	CHO %
Control	0min	22.43^{d} ±0.50	2.43^{c} ±0.05	11.98^{c} ±0.47	2.10^{c} ±0.00	15.30^{a} ±0.23	45.76^{a}±0.18
Cooked	30min	30.76^{c} ±0.58	3.68^{a} ±0.11	30.35^{b} ±0.17	3.43^{a} ±0.06	13.87^{b} ±0.03	17.91^{b} ±0.02
@	40min	39.42^{b} ±0.58	3.41^{b} ±0.02	30.80^{a} ±0.13	2.85^{b} ±0.00	12.89 ^{c} ±0.06	10.63^{c} ±0.03
100°C	50min	48.61^{a} ±0.58	3.20^{b} ±0.05	31.99^{a} ±0.33	1.56^{d} ±0.06	12.59^{d} ±0.42	3.05d ±0.57
LSD		0.35	0.25	0.20	0.25	0.26	2.39
	0min	22.43^{a} ±0.50	2.43^{a} ±0.05	11.98^{d} ±0.47	2.60^{b} ±0.00	15.30^{a} ±0.23	45.76^{a}±0.18
Roasted	30min	14.07^{b} ±0.57	2.33^{b} ±0.23	33.37^{c} ±1.17	2.83^{a} ±0.06	9.43^{b} ±0.01	37.97^{b} ±0.32
@	40min	12.49^{c} ±0.58	2.28^{c} ±0.05	41.67^{b} ±0.39	1.16^{c} ±0.03	8.73^{cd} ±0.01	33.67^{c} ±0.53
120°C	50min	11.42^{c} ±0.35	2.11^{d} ±0.05	48.86^{a} ±0.50	0.16^{d} ±0.02	8.62^{d} ±0.02	28.83^{d} ±0.54
LSD		1.44	0.04	4.48	0.12	0.15	0.84
	0min	22.43a ±0.50	2.43^{c} ±0.05	11.98^{d} ±0.47	2.10^{c} ±0.00	15.30^{a} ±0.23	45.76^{a}±0.18
Toasted	30min	8.76^{b} ±0.08	2.28^{b} ± 0.11	32.41^{c} ±1.03	3.13^{a} ±0.06	9.33^{b} ±0.01	44.09^{c} ±0.32
@	40min	6.44^{c} ±0.06	2.16^{a} ±0.23	34.14^{b} ±0.02	2.56^{b} ±0.40	8.95^{c} ±0.01	45.75^{a} ±0.47
140°C	50min	4.06^{d} ±0.01	2.10^{a} ±0.01	38.47^{a} ±0.23	1.64^{d} ±0.01	8.90^{c} 2±0.02	44.83^{b} ±0.25
LSD		1.45	0.10	2.53	0.24	0.17	0.70

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

Table 2: Mean values of the anti-nutritional properties of walnut as affected by different processing methods.

SAMPLES	TIME	TANNIN %	HCN (mg/kg)	OXALATE (mg/g)	PHYTATE (mg/g)	ALKALOID %	SAPONINS (%)	HEAMG (g)	STERIOD (g)	TRYPSIN INHIBI.(mg/g)	PHENOL (mg/g)
CONTROL	**0min**	0.15±0.01^{a}	0.89±0.01^{a}	0.59±0.05^{a}	0.16±0.01^{a}	0.31±0.00^{a}	4.31±0.00^{a}	0.11±0.00a	0.34±0.00^{a}	2.20±0.01^{a}	18.31±0.00^{a}
Cooked	**30min**	0.10±0.01^{b}	0.45±0.01^{b}	0.32±0.01^{b}	0.13±0.01^{b}	0.16±0.01^{b}	3.15±0.01^{b}	0.06±0.01^{b}	0.25±0.01^{b}	1.93±0.01^{b}	16.23±0.01^{b}
@	**40min**	0.07±0.01^{c}	0.35±0.01^{c}	0.10±0.00^{c}	0.09±0.00^{c}	0.16±0.00^{b}	3.10±0.00^{c}	0.05±0.00^{b}	0.24±0.00^{b}	1.34±0.12^{c}	15.12±0.01^{c}
100°	**50min**	0.06±0.01^{c}	0.24±0.01^{d}	0.09±0.02^{c}	0.07±0.00^{c}	0.14±0.01^{c}	2.44±0.01^{d}	0.03±0.01^{c}	0.08±0.01^{c}	1.23±0.01^{d}	14.42±0.01^{d}
LSD		**0.02**	**0.05**	**0.02**	**0.02**	**0.01**	**0.03**	**0.01**	**0.03**	**0.02**	**0.02**
CONTROL	**0min**	0.15±0.01^{a}	0.89±0.01^{a}	0.59±0.05^{a}	0.16±0.01^{a}	0.31±0.00^{a}	4.31±0.00^{a}	0.11±0.00^{a}	0.34±0.00^{a}	2.20±0.01^{a}	18.31±0.00^{a}
ROASTED	**30min**	0.12±0.01^{b}	0.16±0.01^{b}	0.09±0.01^{b}	0.04±0.01^{b}	0.09±0.02^{b}	2.09±0.02^{b}	0.03±0.02^{b}	0.08±0.02^{b}	1.10±0.01^{b}	14.06±0.01^{b}
@	**40min**	0.05±0.01^{c}	0.13±0.01^{c}	0.05±0.01^{c}	0.02±0.01^{c}	0.06±0.01^{bc}	2.06±0.01^{c}	0.02±0.01^{bc}	0.05±0.01^{c}	0.90±0.02^{b}	14.05±0.01^{c}
120^{0}C	**50min**	0.02±0.01^{d}	0.12±0.01^{c}	0.03±0.00^{c}	0.01±0.00^{c}	0.04±0.02^{c}	1.04±0.02^{d}	0.01±0.02^{bcd}	0.04±0.02^{c}	0.75±0.01^{c}	13.00±0.01^{d}
LSD		**0.02**	**0.02**	**0.03**	**0.01**	**0.03**	**0.01**	**0.02**	**0.02**	**0.02**	**0.02**
CONTROL	**0min**	0.15±0.01^{a}	0.89±0.01^{a}	0.59±0.05^{a}	0.16±0.01^{a}	0.31±0.00^{a}	4.31±0.00^{a}	0.11±0.00^{a}	0.34±0.00^{a}	2.20±0.01^{a}	18.31±0.00^{a}
TOASTED	**30min**	0.08±0.00^{b}	0.23±0.01^{b}	0.16±0.00^{b}	0.06±0.33^{b}	0.22±0.01^{b}	1.20±0.01^{b}	0.03±0.01^{b}	0.05±0.01^{b}	0.65±0.01^{b}	12.56±0.01^{b}
@	**40min**	0.07±0.01^{b}	0.11±0.01^{c}	0.13±0.01^{c}	0.03±0.00^{c}	0.19±0.01^{c}	1.15±0.01^{c}	0.01±0.01^{c}	0.04±0.01^{b}	0.64±0.04^{b}	12.55±0.01^{b}
140^{0}C	**50min**	0.04±0.01^{c}	0.06±0.01^{d}	0.12±0.01^{c}	0.01±0.01^{d}	0.18±0.01^{c}	1.13±0.01^{d}	0.00±0.01^{c}	0.02±0.01^{c}	0.34±0.02^{c}	11.76±0.01^{c}
LSD		**0.02**	**0.02**	**0.02**	**0.01**	**0.02**	**0.02**	**0.01**	**0.01**	**0.01**	**0.03**

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

The values of the crude fat obtained showed that the raw sample contained 11.98% of fat. The values do not agree with that obtained by (18) who reported a value of 59% fat, this may be from difference in species of walnut or difference in the methods of processing. There was a significant difference (P≤ 0.05) between the values of samples cooked at 100^{0}C for 30min and 40min (30.35% and 30.80%), agreed with the work of (6) that species of walnut are rich in oil and are good source of Omega-3 fatty acid . No significant difference (P≥0.05) existed between the samples cooked for 40min and 50min which suggests that increase in time of cooking affects the leaching out of oil during cooking. There was a significant difference among the values of the samples toasted at 140^{0}C, for 30min, 40min and 50min. The amount of fat increased as the time of toasting increased from 30min to 50min, (32.41% - 38.47%). This figure is in agreement with the work of (6) which reported that Walnut is an excellent source of Omega-3 fatty acid, a special type of protective fat the body cannot manufacture. The sample toasted at 140^{0}C for 50min gave the highest value of crude fat of 38.47% and the fat can be good for domestic use as reported in the work of (5), that walnut oil is rich and expensive and consequently is used most often in salad dressing.

The crude fiber content of the raw sample was 2.1%. There was no significant difference (P≥0.05) among the values of the samples cooked at 100^{0}C for 30min, 40min and 50min. There was a reduction in the fiber content of the samples cooked from 30min to 50min (3.43% -1.58%) which may be as a result of effect of cooking on the nuts. The value of the samples roasted at 120^{0}C showed that a significant difference (P≤0.05) existed between the values obtained and the value agrees with the figure in the work of (18). The increase in fiber may be attributed to the medium of toasting which absorbs most of the heat.

The Protein value showed that a significant difference (P≤0.05) existed between the values of the sample cooked at 100^{o}C for 30min and 40min. The values obtained (13.87%-12.89%) is below the value reported by (18) which is 15.67%. There was a significant difference (P≤0.05) between the values of nuts cooked for 40min and 50min. The variation in value may be attributed to the absorption of water which diluted the solids in the nut (19). There was a significant difference (P≤0.05) among the values of the sample roasted at 120^{o}C for 30min, 40min and 50min (9.43%, 8.73% and 8.62%). The value of the protein obtained reduced from 15.30% in the raw sample to 8.62% in the sample roasted for 50min which is equally far below that quoted by (18) as 21%. Also a significant difference (P≤0.05) existed among the value of the samples toasted at 140^{o}C for 30min and 40min from that of the control (9.33%, 8.95% and 15.30%) respectively, while no significant difference (P≥0.05) existed among the values obtained at 40min and 50min (8.95% and 8.90%) . The sharp difference in the value of the samples cooked from those roasted and toasted may be attributed greatly to the denaturation effect of (dry) heat on protein content of foods as reported by (17).

The Carbohydrate value of the raw sample was calculated to be 45.76%. There was a significant difference (P≤0.05) between the values of the cooked samples for 30min, 40min and 50min (17.91%, 10.63% and 3.05%). There was a significant difference (P≤0.05) between the value of the samples roasted at 120^{o}C for 30min, 40min and 50min (37.97%, 36.67% and 28.83%) respectively, the decrease in the values of the samples may be as a result of processing factors and influence of other parameters like nature of oven and processing equipment. The samples toasted at 140^{o}C showed that a significant difference existed between the values obtained from the control and the value by toasted for 30min and 50min (45.76%, 44.09% and 44.83%), while no significant difference existed between the value obtained at 40min from the control (45.75% and 45.76%). The toasted samples have the highest carbohydrate value, an indication that increase in heat (temperature) decreases the level of other available nutrients in cereals as reported by (17)

The difference in the result of the proximate composition of the walnut may be due to the difference in specie, experimental errors and or environmental conditions.

Effects of Different processing treatments on the Anti-Nutritional Properties of Walnut (Table 2)

The mean values of the anti-nutritional properties of walnut as affected by different processing treatment are shown in table 2. The tannin content of the control (raw) sample is given as 0.15% which is slightly lower than the figure in Encarta (2009) which is 0.20%. There was a significant difference (P≤0.05) between the values obtained from the raw and from the sample cooked at 100^{o}C for 30min and 40min (0.15%, 0.10%, and 0.07%), while no significant difference existed between 40min and 50min of cooking (0.07% and 0.06%). The difference may be attributed to increase in time of cooking which affects the anti-nutritional properties as reported in the work of (20), that boiling and roasting reduces the anti-nutritional contents of some food products. There was a significant difference (P≤0.05), between the values of the sample roasted at 120^{o}C for 30min, 40min and 50min intervals (0.12%, 0.05% and 0.02%), the decrease in the available anti-nutritional factors is in agreement with the work of (22) that most of the anti-nutrients becomes ineffective by simple processing measures such as heating, roasting or autoclaving. There was no significant difference (P≥0.05) among the values of the samples obtained by toasting at 140^{o}C for 30min and 40min respectively (0.08%, 0.07%), but there was a significant difference (P≤0.05) among the values of the sample obtained by toasting at 140^{o}C for 40min and 50min respectively (0.07%, 0.01%). A great reduction occurred in the values recorded which agrees with the work of (22), that anti-nutritional factors are heat labile, hence may be inactivated by processing methods involving heat generation.

The Hydrogen Cyanide (HCN) content of the control (raw) sample is given as 0.89mg/kg. There was a significant difference ($p \leq 0.05$) between the values of the sample at 30min, 40min and 50min (0.45mg/kg, 0.35mg/kg and 0.24mg/kg) respectively. An indication that it can be cooked for the same time. The HCN reduced from 0.89mg/kg in control to 0.35mg during cooking for 40min down to 0.24mg/kg in cooking for 50min, which may be attributed to the tenderization of cotyledons of legume during cooking as was reported by (23). There was a significant difference ($P \leq 0.05$) among the values of the samples obtained by roasting at 120^{o}C. The values obtained had a great reduction (0.16mg/kg. 0.13mg/kg and 0.12mg) when compared to control and that of literature of 0.89mg/kg and 0.31mg/kg respectively. There was a significant difference ($P \leq 0.05$) in the values of the samples toasted at 140^{o}C for 30min, 40min and 50min (0.23mg/kg, 0.11mg/kg and 0.06mg/kg) when compared to control (0.89mg/kg), these agreed with the work of (20), that boiling/cooking and roasting are important household food processing methods, that as a thermal process, boiling/cooking legumes could enhance tenderization of cotyledons thereby increasing palatability and nutritional value by inactivating endogenous toxic factors.

The value of Oxalate in the raw sample was found to be 0.59mg/g. There was a significant difference ($P \leq 0.05$) between the values of the samples obtained from raw sample and by cooking at 100^{o}C for 30min and 40min (0.59mg/g, 0.32mg/g and 0.10mg/g), however, there was no significant difference ($P \geq 0.05$) between 40min and 50min (0.10mg/g and 0.09mg/g). The values reduced from 0.32mg/g at 30min to 0.09mg/g at cooking for 50min. The reduction could be attributed to the effect of cooking on the anti-nutritional value as reported by (23). There was a significant difference ($P \leq 0.05$) among the values of roasted samples of walnuts for 30min and 40min, while no difference existed at 50min of roasting. Similarly, a significant difference existed ($p \leq 0.05$) between the values obtained by toasting at 140^{o}C for 30min and 40min (0.16mg/g, 0.13mg/g) while no significant difference ($p \geq 0.05$) existed between 40min and 50min (0.13mg/g and 0.12mg/g). The value obtained by toasting for 50min showed a great reduction when compared to control sample of (0.59mg/kg).

The value of the control (raw) sample for Phytate is 0.16mg/g which is slightly lower than that from literature (0.89mg/g). The samples cooked at the different times showed that significant differences ($p \leq 0.05$) existed between the values obtained for control, 30min and 40min (0.16mg/g, 0.13mg/g and 0.09mg/g), while no significant differences ($p \geq 0.05$) existed at 40min and 50min 0f cooking (0.09mg/g and 0.07mg/g). These values showed a decrease from that of control sample (from 0.16mg/g to 0.07mg/g) signifying the effect of cooking on the samples. There was a significant difference ($p \leq 0.05$) between the values of the sample obtained from roasting. The values showed a decrease from 0.04mg/g at 30min to 0.02mg/g at 40min then to 0.01mg/g at 50min in the values of phytate as time of roasting increased which agrees with the work reported by (24) on a time dependent reduction in phytate, tannins and trypsin inhibitor contents of foods following cooking and roasting. Furthermore, a significant difference ($p \leq 0.05$) existed between the values obtained by toasting for 30min and 40min, but no difference existed at 50min; the value reduced to 0.06mg, 0.03mg and 0.01mg, in support of the values obtained is the work of (20).

The Alkaloid content of the control (raw) samples was found to be 0.31%. There was no significant difference ($p \geq 0.05$) between the values of the sample cooked at 100^{o}C for 30min and 40min (0.16% and 0.16%) respectively. However, a significant difference ($p \leq 0.05$) existed at 50min (0.14%), which showed a reduction in the value of the alkaloid in the sample. There was a significant difference ($p \leq 0.05$) between the values obtained for roasting at 120^{o}C for 30min and control sample, while no significant difference existed between 30min and 40min (0.09% and 0.06%) and equally between 40min and 50min (0.06% and 0.04%) respectively, the values showed a reduction as the time of roasting increased. There was no significant difference ($p \geq 0.05$) between the values obtained by toasting at 140^{o}C for 30min and 40min (0.22% and 0.19%) respectively. However, there was a significant difference ($p \leq 0.05$) at 50min of toasting (0.18%), the values showed great reduction when compared to the control sample of 0.31%.

The Saponin content of the raw (control) sample was found to be 4.31%. There was a significant difference ($p \leq 0.05$) between the values of the samples obtained by cooking at 100^{o}C for 30min, 40min and 50min (3.15%, 3.10% and 2.44). The values showed a reduction in value from 3.15% to 2.44% in the cooked sample as the time of cooking increased. The reduction could be attributed to the effect of cooking on the anti-nutritional value as reported by (23). The values of the samples roasted at 120^{o}C for 30min, 40min and 50min showed that there was a significant difference ($p \leq 0.05$) between the values obtained (2.09%, 2.06% and 1.04%). There was a slight reduction in the values obtained which agrees with the work of (22) which stated that anti-nutritional factors are heat labile, hence may be inactivated by processing methods involving heat generation. The samples toasted at 140^{o}C showed that a significant difference ($p \leq 0.05$) existed between the values obtained at 30min (1.20%) and that of 40min (1.15%) and 50min of toasting (1.13%), the change in value agrees with the work of (22), on the effect of heat on the anti-nutritional factors of foods.

The Heamaglutinin value of the control (raw) sample was found to be (0.11g). The values obtained in the samples cooked at 100^{o}C for 30min and 40min (0.06g and 0.05g) showed that no significant difference ($p \geq 0.05$) existed between them, while a significant difference ($p \leq 0.05$) existed between these values and that obtained by cooking for 50min (0.03g). The values agreed with that reported in (22) on the effect of heat treatment on the anti-nutritional properties of foods. There was no significant difference ($p \geq 0.05$) between

the samples that were roasted at 120^0C for 30min, 40min and 50min. The values (0.03g. 0.02g and 0.01g), showed a decrease from the control sample which could be attributed to the effect of heat on phytochemical composition of nuts as recorded by (25). The values of the samples toasted at 140^0C for 30min, 40min and control (0.03g, 0.01g and 0.11g) respectively showed that a significant difference ($p \leq 0.05$) existed between them, while a significant difference ($p \geq 0.05$) did not exist between the values obtained at 40min and 50min (0.01g and 0.00g). It could be deduced that, the different heat treatments affected the level of the Heamaglutinin present in the walnut; at the point of toasting for 50min all the heamaglutinin was completely eliminated.

The value of steroid in the control (raw) sample was 0.34g. The samples that were cooked at 100^0C for 30min, 40min and 50min showed that significant difference ($p \geq 0.05$) did not exist between 30min and 40min (0.25g and 0.24g), but a significant difference ($p \leq 0.05$) existed at 50 min (0.08g). This agreed with the work of (20) that boiling reduces the steroid contents of foods as the time of cooking increased. There was a significant difference between the values of the steroid obtained by roasting at 120^0C for 30min and 40min (0.08g and 0.05g). The values showed a decrease as the time of roasting progressed showing that as time of roasting increased, the level of the steroid content of walnut decreased. The samples that were toasted at 140^0C showed that no significant difference ($p \geq 0.05$) existed among the values obtained at 30min and 40min (0.05g, and 0.04g), while a significant difference ($p \leq 0.05$) existed between 40min and 50min of toasting (0.04g and 0.02g). The values decreased drastically, agreeing with the work of (21) that, an anti-nutritional property becomes inefficient with increase in heat of processing.

The value of the Trypsin Inhibitor in the control (raw) sample was 2.20mg/g which is slightly different from literature (3.89mg/g). The sample cooked at the different times showed that a significant difference ($p \leq 0.05$) existed between the values obtained at different times 100^0C for 30min, 40min and 50min (1.93mg/g, 1.34mg/g and 1.23mg/g) respectively. These values showed slight decrease from that of control sample (from 2.20 to 1.23mg) signifying the effect of cooking on the samples. There is a significant difference ($p \leq 0.05$) between the values of the Trypsin Inhibitor obtained from the control sample and that roasted at 120^0C for 30min (2.20mg/g and 1.10mg/g), while there is no significant difference between the values obtained at 30min and 40min (1.10mg/g and 0.90mg/g). There was a significant difference ($p \leq 0.05$) between the values of the Trypsin Inhibitor obtained by roasting at 120^0C for 40min and 50min (0.90mg/g and 0.75mg/g). The values showed a decrease to 0.75mg, in the values of trypsin inhibitor as time of roasting increased which agrees with the work reported by (24), on a time dependent reduction in phytate, tannins and trypsin inhibitor contents following cooking and roasting. Furthermore, there was no significant difference ($p \geq 0.05$) between the values of the samples obtained at 30min and 40min of toasting at 140^0C (0.65mg/g and 0.64mg/g), however a significant difference ($p \leq 0.05$) existed between the values obtained by toasting for 50min, the value reduced to 0.34mg, in support of the values obtained in the work of (20).

The phenol content of the control (raw) samples was found to be 18.31mg/g. There existed a significant difference ($p \leq 0.05$) between the values of the sample cooked at 100^oC for 30min, 40min, 50min and control (16.23mg/g, 15.12mg/g, 14.42mg/ and 18.31mg/g) respectively. The values obtained showed a reduction in the value of the phenol when compared to control sample. There was a significant difference ($p \leq 0.05$) between the values obtained in roasting at 120^oC for 30min, 40min and 50min (14.06mg/g, 14.05mg/g and 13.00mg/g) respectively. The values showed a reduction as the time of roasting increased as reported in the work of (26). There was a significant difference ($p \leq 0.05$) also between the values obtained in the control sample and toasting at 140^oC for 30min (18.31mg/g and 12.56mg/g). However, there was no significant difference ($p \geq 0.05$) between the values obtained by toasting at 140^oC for 30min and 40min (12.56mg/g and 12.55mg/g) respectively. Also, there was a significant difference ($p \leq 0.05$) between the value obtain at 40min and 50min of toasting (12.55mg/g and 11.76mg/g). The values showed great reduction when compared to the control sample (18.31mg/g) which could be attributed to the effect of heat treatment on the anti-nutritional properties of cereals as reported by (25) on the effect of heat on phytochemical composition of nuts. The reduction and or near elimination of these anti-nutritional properties agreed with the work of (27), that roasting and toasting reduced anti- nutrients activity following the heating effects.

The present study demonstrated significant reduction of the studied anti-nutrients in a time and temperature dependent manner and also with the method of processing. This seemingly suggests that increasing the processing time and temperature for each of the processing methods may ensure complete elimination of these anti-nutrients in walnut. In apparent support of the present study is the work of (24) which reported a time dependent reduction in phytate, tannin and trypsin inhibitors contents following cooking, roasting and toasting as far as it does not adversely affect the nutritional composition of the food in question.

Conclusion

The result suggests that cooking should be preferred to toasting and roasting. The present study demonstrated significant reduction of the studied anti-nutrients as the time increases. This seemingly suggest that increasing the processing time and temperature for roasting and toasting methods may ensure complete elimination of these anti-nutrients in walnut while retaining the nutrients at 30min. From the results of the proximate composition it could be deduced that walnut is one of the highly nutritious plants that have high nutritional and health benefits and as such, the seed could be a good source for formulating infant foods.

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