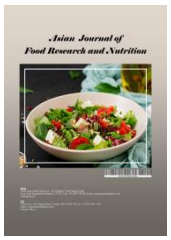

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Effect of Processing on the Chemical Composition and Sensory Properties of *Aku (*Winged Termite) Insect Foods in Anambra State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The study examined the effect of three processing techniques- raw, boiling and toasting on chemical composition of *Aku* and organoleptic acceptability of a dish based on rice and *Aku (*WINGED TERMITE) (*macrotemesbelliscous*) was assessed. The experiment was carried out in a-3x1 factorial design while data obtained from the laboratory analysis with significant means (*p ≤0.05*) were separated with Duncan Multiple range test and a-7-point hedonic scale of the sensory scales to evaluate the various rice samples were obtained. Results of proximate composition showed that boiling and toasting reduced the crude fat, moisture content and protein but increases the ash and fibre content. Vitamin B_1, B_2, B_3, B_6, Vitamin C, A, E and D ranged from 0.32-0.73, 0.36-0.42, 0.12-0.14, 0.06-0.08, 58.00-67.50, 0.99-2.01, 1.17-259.28, 26.20-259.28mg/100g respectively.

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The fatty acid profile of all the insect samples contain a higher amount of unsaturated fatty acid but total unsaturated fatty acid was raw winged termite (63%) = boiled (63%) > toasted (62%) while total saturated fatty acid of raw winged termite (57%) > boiled (33%) = toasted (33%). Toasted sample was least in moisture and crude fat to confer prolong shelf life with a higher organoleptic acceptability on the dish (jellof rice) to depict its high acceptable in terms of likeness compared to raw and cooked samples. The study therefore recommends toasting as best processing method for the preparation of African winged termite for a healthy diet.

Keywords: Chemical composition; rice enriched with winged termite; Aku; sensory properties; winged termites.

1. INTRODUCTION

Insects are part of diet for human and domesticated animals. Insects eating (entomophagy) is a widespread practice in many countries, all over the world and has been recorded that over 2 billion people eat insects on a regular basis [1]. In Africa, insect contribute to the livelihood and food security of households by generating significant income and creating employment for local communities.

"Insect often contain more protein, fat, and carbohydrates than equal amount of beef or fish, and a higher energy value than soybeans, maize, lentils and other beans" [2]. "Edible insect species that are considered unsuitable for consumption by human have also been used as ingredients to substitute conventional protein source such as fishmeal in protein, fish feed, and pig feed, thereby contributing indirectly to human diets" [3]. The edible insects commonly consumed in Nigeria include winged adult termite, adult cricket, African palm weevil, caterpillar and adult horned grasshopper [4].

"Winged termite (*macrotermesbellicious*) are fully developed adult stage of termite that are among the most widely consumed insects in Nigeria. Winged termites are known locally in various parts of Nigeria by different names such as 'aku' in Igbo, 'chinge' in Hausa and 'Esusu' in Yoruba and are regarded as traditional delicacies. They are valuable source of animal protein, essential minerals, and vitamins" [5]. Winged termite is seasonally available during rainy season between May to July [6] and are highly attracted by light which have reportedly facilitated the harvested by placing a bowl of water under the light source. After processing, the finished products are either eaten or sold in market as a snack [4].

Large scale of edible insect farm have been reported in Netherlands, USA, and other developed countries of the world [7]. Some of these countries have developed regulatory mechanism to mainstream the production and use of insects, including potential for animal feeds. In Nigeria, the edible insects are often collected from the wild during its season. Consequently, to maximize utilization of these seasonally available insects, the need for best or suitable processing techniques for high nutritional value cannot be overemphasized.

This is because processing methods of edible insects that reportedly include boiling, roasting, toasting, frying and drying or a combination of these [8] are capable of eliciting potential nutrient factors. Various studies have focused on studying nutritional composition of winged termite [9], nutritional and medicinal value of African palm weevil [10,11,4], microbial quality of raw and roasted African palm weevil have been revealed as readily cheap source of proteins, minerals and vitamins.

However, the effects of these processing methods on the nutritional composition and organoleptic acceptability of these edible insects on those that consume them is not yet fully ascertained. Hence, there is the need to examine the effect of processing methods on proximate composition and fatty acid profile and organoleptic acceptability of these insects. This knowledge will be useful in determining the best processing techniques that are of high nutritional value, updating food composition tables and other purposes.

2. MATERIALS AND METHODS

2.1 Sample Collection and Preparation

Aku (Winged termite) was collected in from my house in Awka, capital of Anambra State. A bowl of water was placed under a light source and the insects were trapped. Those that were not

trapped in the bowl were hand-picked from the ground after the wings must have been shed. Upon preparation, the samples were washed thoroughly and divided in three parts and labeled as raw, boiled and toasted as shown in Plates 1, 2, and 3. The samples labeled boiled were placed in 500ml of water and allowed to boil for 5 min. The water added was allowed to dry before the insects were transferred on to an aluminum foil and left for 20 minutes to cool under room temperature (22–25ºC). The product was then packed in polyethylene zip-lock bags and stored in a freezer for analysis.

The sample labeled toasted was put into a clean dry frying pan and toasted for 5mins with constant stirring to avoid burning. The toasted samples were then transferred into an iron sieve and left to cool down. The sample was stored in freezer for analysis.

Plate1. Raw winged termite

Plate 2. Boiled winged termite

Plate 3. Toasted winged termite

2.2 Research Design

The research design is a 3 X 1 factorial experiment with the factors as processing techniques and insect food types. The processing techniques (3 levels) include unprocessed (raw), boiled and roasted. The factor being *Macrotermesbelliscosus (*Winged termite). From the research design, a total of three (3) treatments obtained are given in Table 1.

2.3 Chemical Analysis

The moisture, crude protein, fat, ash and crude fibre contents of the cookies were determined in triplicates according to standard analytical methods [12]. Carbohydrate was obtained by difference of moisture, protein, fat and ash from 100% [13]. The manganese, copper, zinc, magnesium, iron, and calcium were conducted using Varian AA240 Atomic Absorption Spectrophotometer according to the method of APHA [14].

The vitamin A, E, B_1, B_2, B_3, B_6, C, D and E contents of the insects' samples were determined using various standard analytical procedures. The vitamin A and E content of the sample was analyzed using the method of Rutkowski et al. [15], Ascorbic acid content of the sample was determined according to Klein [16]. The vitamin B_1 and B_2 content of the sample was analyzed using the method described by Okoh and Madu [17]. The vitamin B_3 and B_6 content was analyzed using the method described by Brickmann et al. [18] while Vitamin D was assayed according to the method of Brickmann et al. [18]. To determine the Fatty acid profile analyses, Oil was extracted from all the insect samples using soxhlet extraction method after which GC/FID method was used to determine the fatty acid present in all insect samples

Table 1. Treatments in a 3 X 1 factorial experiment

No	Sample code	Treatments
1	WT-Raw	Raw Winged termite
2	WT-Boiled	Boiled Winged termite
3	WT-Toasted	Toasted Winged termite

Field work (2022)
NB; WT = Winged termite

2.4 Sensory Evaluation

"A semi-trained 14 panelist made up of male and female staff as well as students of the Department of Food Science and Technology, Nnamdi Azikiwe University, Awka was used in the ratio of 4: 6: 4 male staff, female staff and students respectively. The panelists were educated on the respective descriptive terms of the sensory scales and requested to evaluate the various rice samples for overall acceptability using a-7-point hedonic scale, where 7 was equivalent to like very much and 1 equivalent to dislike very much. Presentation of coded samples was done randomly and portable water was provided for rinsing of mouth in between the respective evaluations" [19].

2.5 Statistical Analysis

The data were evaluated using analysis of variance (ANOVA) and significant means were separated using the Duncan multiple range test (DMRT) at 5% level of significance using SPSS version 23.0

3. RESULTS AND DISCUSSION

3.1 Effect of Processing on the Proximate Composition of *Aku* (Edible insects)

The proximate composition of raw, boiled and toasted *Aku* (winged termite) is presented in Table 2. Except for fibre content, processing had significant effects ($p \leq 0.05$) on the moisture, crude fat and crude protein contents of winged termite. Of remarkable importance are the fact that the crude fat and protein contents of *Aku*.

The moisture contents of the raw (43.01%) and boiled (40.01%) winged termites were quite high unlike the toasted ones (4.73%). The observed moisture content of the toasted winged termite of 4.73% is in line with the value (4.3%) obtained by Adepoju and Omotayo [9] on oven dried winged termite. However, the value (53.01%) for raw winged termite in this study was higher when compared to (45.0%) obtained by Adepoju and Omotayo [9]. The difference may be attributed to the substrate on which the winged termite fed on. Boiling and toasting the winged termite improve its shelf life. The reduction in moisture content of boiled WT could be advantageous in the reduction of microbial spoilage by improved quality for enhanced preservation.

The fat content ranged from 9.35% - 18.35%, with the raw sample (18.35%) having the highest fat content and the toasted the lowest (9.35%) fat content. From the results, toasting the winged termite significantly reduced the crude fat content ($p>0.05$). Reduction of fat during boiling and toasting could be related to loss of oil and evaporation of water (Igwe et al,). Notably, the fat content in the sample is contrary to the findings of Adepoju and Omotayo [9] which showed that toasting increases the fat content of toasted winged termite.

The carbohydrate content was determined in order to know the total energy content of the winged termite. The carbohydrate content was in the order of raw (10.02%), boiled (20.32%) and toasted (9.80%) respectively. The toasting methods significantly decreased the percentage carbohydrate content and the toasted sample ranked the lowest value of 9.80%. Notably, the carbohydrate content obtained in raw winged termite (20.20%) is similar with the value (20.73%) reported by Igwe et al ([20]) and low when compared to the value (43, 3%) reported by Banjo et al. [4]. However, the high carbohydrate content in the boiled sample indicates their suitability as a good source of energy to consumers.

The protein content of the winged termite ranged from 18.65% to 25.86% in the order of raw (25.86%), boiled (20.84%) and toasted 18.65%. Boiling and toasting significantly reduced the protein content of the winged termite. Manditsera et al. [21] reported a decrease in protein when the bettle (*Ebeji*) and the Cricket (*Mbuzu)* were boiled for 30-60mins. The decrease According to Stanley [22], when proteins are exposed to some heat treatment, digestibility may be reduced due to formation of disulphide bonds in the protein.

Ash content ranged from 1.48% - 14.78% the ash content indicates a measure of the mineral content of the sample. The increase in ash content during toasting indicated an increase in mineral content. Similarly, Adepoju and Omotayo [9] reported increase in ash content on toasting therefore suggesting that toasting may improve the mineral component of winged termite.

The crude fibre content of the winged termite ranged in the order of raw (1.39%), boiled (2.41%) and toasted (20.42%). The increase in fibre content was probably because boiling and toasting concentrated the polysaccharide, especially with concomitant loss of fat during the

process. However, the thermal treatment may also have resulted on an increase in total fibre by causing the formation of protein fibre complexes [23].

3.2 Effect of Processing on the Mineral Composition (mg/kg) of *Aku* (winged termite)

Table 3 shows the result of micro and macro mineral contents of raw, boiled and toasted winged termite.

The manganese level varied ranging from 0.27 – 1.14mg/kg. Boiled sample had the highest manganese content (1.14mg/kg) while the toasted sample had the lowest (0.27mg/kg). Notably, the manganese of toasted sample obtained was low to the value reported by Markmanuel and Jackson ([24])) in oven dried winged termite (0.81mg/kg). This variation may be attributed to influence of ecological factors and variation in species.

The copper content ranged from 0.003-0.005mg/kg with the raw having the highest concentration whereas toasted had the lowest (0.003mg/kg). These values are contrary to the finding of Igwe et al. [20] on oven dried winged termite which reported (77.77mg/kg). The differences are due to the geographical location and their feed habitat.

Zinc content of winged termite samples exhibited a range spanning from 0.15-0.37mg/kg. The highest recorded value was in raw sample (0.37mg/kg) whereas the toasted sample (0.15mg/kg). Notably, these results were lower than the Zn levels documented by Adepoju and Omotayo [9] on raw samples (18.0mg/kg and toasted (31.8mg/kg). However, zinc level in all samples showed no significant differences ($p \geq 0.05$).

Magnesium is a major nutrient required daily in high amount in human diet. Magnesium content ranged from 1.33- 1.48mg/kg with the boiled sample having the highest value and the toasted the least (1.33mg/kg). Notably these values were very low when compared to the report of Adepoju and Omotayo [9] of which the raw sample of *Aku* was 100mg/kg while the toasted was 23.60mg/100g. Igwe et al (2014) also reported a high value of 600.6mg/kg on oven dried winged termite. This variation can be attributed to ecological factors and variation in species Adeyemo et al. [25]. Magnesium is needed for more than 300 biochemical reactions in the body. It helps to maintain normal muscle and nerve function, keeps heart rhythm steady, supports a healthy immune blood and regulates blood sugar levels [26].

Significant difference was not observed in the iron content across all the *Aku* samples with the levels ranging from 0.001- 0.003mg/kg. However, these values did not align with the recommended iron intake established by United State Department of Agriculture which stands at 0.008mg/kg. iron play an important role as a heme molecule in red blood cells as it permits oxygen transport (WHO, 2006) but excessive intake can be a serious problem enhancing free radical activity in the body Ekop et al. [27].

Calcium is a major mineral nutrient required in human diet. The calcium content for raw, boiled and toasted *Aku* was 0.75mg/kg, 1.01g/kg and 1.06mg/kg respectively. Boiling and toasting significantly increased the calcium content of the sample. Calcium is essential for the building of bones and teeth, helps in muscle contraction and relaxation, nerve function, blood pressure regulation, immune system health and as a messenger in cell signaling Ukoroije and Abali [28].

3.3 Effect of Processing on the Vitamin Content of Winged Termite (*Edible* insects)

The vitamin composition of winged termite samples is shown in Table 4. Vitamin B_1 (Thiamine) contents of raw boiled and toasted *Aku* samples were 0.47mg/100g, 0.32mg/100g and 0.72mg/100g respectively. Notably these results were high compared to the values obtained by Ahmad et al. [29] on raw beef (0.06mg/100g), raw bacon (0.39mg/100g), and raw mutton (0.14mg/100g). This implicates winged termite as a good source of vitamin B_1 than cattle, goat and pig. The value 0.36mg/100g of raw winged termite in this study is similar to the value 0.32mg/100g obtained by Adepoju and Omotayo [9] on raw winged termite.

Vitamin B_2 (Riboflavin) contents were in the order of raw (0.36mg/100g) boiled (0.42mg/100g) toasted (0.40mg/100g) respectively. There was increase in vitamin B_2 content on boiling and toasting and this result did not align with the trend of (36) which reported a general decrease in all the vitamins content evaluated from fresh, toasted, fresh dried and toasted dried samples of

winged termite. Adepoju and Omotayo [9] furthermore reported a decrease in raw (0.32mg/100g) and toasted (0.01mg/100g) when winged termite was toasted. Therefore, differences in sample preparation and analytical methods complicate direct comparison.

Vitamin B_3 (Niacin) contents were in the order of raw (0.14mg/100g) boiled (0.12mg/100g) toasted (0.14mg/100g) respectively with no significant differences ($p \geq 0.05$). The value obtained in toasted sample (0.14mg/ 100g) was lower than the value (2.74mg/100g) reported by some authors [20] on oven dried winged termite. Also, Kinyuru [30] reported a value of 2.80mg/100g, 2.20mg/100g, and 2.07mg/100g and 1.66mg/100g 0n fresh, toasted, fresh dried and toasted dried samples of winged termite respectively. The differences may not be unconnected with the differences in geographical location and feed habitat.

Vitamin B_6 (Pyridoxine) content were in the order of raw (0.06mg/100g) boiled (0.08mg/100g) toasted (0.7mg/100g) respectively with no significant difference of $p \leq 0.05$. Notably these results were low when compared to the values obtained by Ahmad et al. [29] on raw beef (0.3mg/100g), raw bacon (0.3mg/100g), and raw mutton (0.3mg/100g). Vitamin B_6 helps in the synthesis of the neurotransmitters and important in the synthesis of heme iron, a component of hemoglobin.

The analysis of vitamin C (Ascorbic Acid) content in winged termite revealed a range from 58.00 - 66.00 µg/g in the order of raw (66.00 mg/100g), boiled (67.50 mg/100g) and toasted (58.00 µg/g). This result showed that winged termite has higher vitamin C content in compared with the report of some authors *(*Igwe et al 2014) (17.76 mg/100g) on oven dried winged termite.

One of the most important benefits derivable from vitamin C is the basic role as antioxidants and oxygen free radical scavengers. Unfortunately, vitamin C is highly susceptible to heat and light, leading to a reduction by toasting compared to the raw and boiled samples. Vitamin C maintains blood vessels flexibility and improves circulation in the arteries of people including smokers as reported in Alamu et al [6].

Vitamin A (Retinol) content in raw, boiled and toasted winged termite was 1.3Mg/100g, 1.19 Mg/100g, and 1.27Mg/100g. notably Banjo et al., reported a value of 2.89 on dried winged termite which is in close range with raw winged termite. The result also agreed with Adepoju and Omotayo [9] that reported winged termite to be a good source of vitamin A (330.42 µM). Boiling and toasting reduced the vitamin A content and according to similar findings by Nishmune et al. [31] Dehydration of food may result in loss of vitamins and others depending on the heating time and temperature. Vitamin A is an antioxidant which prevents cells from damage by free radicals, essential for maintaining eye and skin, need for normal growth and reproduction promotion of health immune system.

The result in Table 4 showed that winged termite is a good source of vitamin E and D especially the boiled and toasted samples. The high vitamins content of edible insects presents them as a highly potential, good source of food supplement for malnourished people and animal. Vitamin B6 is the lowest vitamin found in the sample.

3.4 Effect of Processing on the Fatty Acid Contents of *Aku* (Winged termites)

Table 5 gives an overview of the type of fatty acid present in the insect samples. The total unsaturated fatty acid was raw winged termite (63%), boiled (63%) and toasted (62%) while the total saturated fatty acid of raw winged termite is (57%), boiled (33%) and toasted (33%). This result is similar to the value reported by Igwe et al. [20] that the total saturated fatty acid content of the oven dried winged termite was 39.35% compared to the unsaturated fatty acids (60.64%). However, Gerber et al. [32] reported that the total saturated, unsaturated and polyunsaturated fatty acids of beef muscles decreased significantly by grilling due to the melting of fat during cooking. Ono et al. [33] stated that unsaturated fatty acids are less affected by cooking since these are constituent part of the membrane structure.

The oleic acid content on the raw boiled and toasted winged termites are 26.73%, 42.34% and 31.36% respectively. Winged termite has also been reported to be rich in oleic acid (52.45%), and linoleic acid (7.57%). The high level of unsaturated fatty acid makes winged termite useful to lower high cholesterol level and good for a healthy heart. Saturated fatty acids found in the sample even though low are lauric acid, (raw (0.78%), boiled (5.10%) toasted (5.40%) and myristic (raw (4.50%), boiled (7.45), toasted (7.36) Saturated fatty acids are not good for

human consumption as a result of earlier implications in certain cardiovascular disorders such as atherosclerosis, cancer and aging. Therefore, low saturated fatty acid makes winged termite a choice food component particularly for individuals with blood cholesterol content and may be at risk of cardiovascular disease.

3.5 Effect of Processing on the Organoleptic Acceptability of Winged Termite Insect-Foods

The raw, boiled and toasted insect samples of winged termite were used to prepare Jollof rice as replacement for the conventional condiment (crayfish) in the food and a-crayfish containing meal as control. Thus a sensory evaluation survey was conducted. The food samples were coded and administered to 14 semi-trained Panelists to give a score of the overall likeness of the Jollof rice using a-7-point Hedonic scale.

Table 6 showed the result of sensory scores of jollof rice cooked with raw, boiled, toasted Aku (winged termite) and control which is jollof rice cooked with only crayfish.

The general acceptability of the sample showed that jollof rice cooked with raw winged termite had the lowest value (2.80) while jollof rice cooked with crayfish had the highest value (6.17) but not significantly different ($p \leq 0.05$) when compared with the jollof rice cooked with toasted winged termite (6.12) and boiled winged termite (5.53) despite its protein, mineral and fatty acid advantage. The likeness of the control that scored highest could be due to conversance of the panelists with the taste of food cooked with crayfish. This finding agrees with Akullo et al. [34] that reported sensory evaluations of crackers enriched with winged termite as most preferred than crackers enriched with cricket. Also, Kaurimska and Adamkova [35] reported that the taste and flavor of food have most pronounced effect on consumer's acceptance of food. The high acceptability of toasted winged termite may not be unconnected with the fact that toasting produced detectable flavours. The result from this study showed that toasted winged termite have good amount of nutrients compared to the raw winged termite. Furthermore, since insect is a supplement to predominant staple food such as corn, cassava, rice when incorporated to improve the nutrient content, the toasted sample therefore constitutes the best processing method for winged termite [36,37].

Table 2. Effect of processing on the proximate composition (%) of winged-termite

	Type	Moisture	Crude fat	Crude protein	Carbohydrate	Ash content	Fiber
1	Raw Aku (WT)	43.01±2.24^{a}	18.35±7.73^{a}	25.86±1.30^{a}	10.02±6.28^{b}	1.54±0.31^{b}	1.39±0.47^{b}
2	Boiled Aku (WT)	40.01±0.01^{b}	12.96±2.22^{a}	20.84±0.22^{b}	20.32±2.77^{a}	1.48±0.18^{b}	2.41±0.55^{b}
3	Toasted Aku (WT)	4.73±0.30^{c}	9.35±0.34^{b}	18.65±0.65^{c}	9.80±1.48^{c}	14.78±0.67^{a}	20.42±0.50^{a}

Values are Means ± standard deviation of triplicate determinations. Means with different superscript in the same column are significantly different ($p \leq 0.05$)
The key: WT = Winged termite

Table 3. Effect of processing mineral content in parts per million (PPM) of winged-termite

S/N	Type	Manganese	Copper	Zinc	Magnesium	Iron	Calcium
1	Raw WT	1.04±0.55^{a}	0.005±0.01^{a}	0.37±0.18^{a}	1.43±0.07^{a}	0.03±0.01^{a}	0.75±0.08^{b}
2	Boiled WT	1.14±0.10^{a}	0.003±0.00^{a}	0.31±0.01^{a}	1.48±0.02^{a}	0.02±0.00^{a}	1.01±0.01^{a}
3	Toasted WT	0.27±0.33^{b}	0.003±0.00^{a}	0.15±0.13^{a}	1.33±0.13^{a}	0.07±0.06^{a}	1.06±0.05^{a}

Values are Means ± standard deviation of triplicate determinations. Means with different superscript in the same column are not significantly different ($p \geq 0.05$)
The key: WT = Winged termite

Table 4. Effect of processing on the vitamin contents of winged termite

Winged Termite (WT)	Vitamins							
	B1 (mg/100g)	B2 (mg/100g)	B3 (mg/100g)	B6 (mg/100)	C (mg/100g)	A (mg/100g)	D (mg/100g)	E (Mg/100g)
Raw	0.47±0.13^{ab}	0.36±0.11^{a}	0.14±0.01^{a}	0.06±0.04^{a}	66.00±8.00^{a}	2.01±1.56^{a}	1.17±0.02^{b}	26.20±6.00^{b}
Boiled	0.32±0.08^{b}	0.42±0.11^{a}	0.12±0.00$_{a}$	0.08±0.00^{a}	67.50±4.50^{a}	1.54±0.81^{a}	1.27±0.00^{b}	224.29±24.58^{a}
Toasted	0.72±0.27^{a}	0.40±0.01^{a}	0.14±0.01^{a}	0.07±0.00^{a}	58.00±3.00^{b}	0.99±0.83^{a}	259.28±22.95^{a}	259.28±22.95^{a}

Fieldwork (2022)

Values are Means ± standard deviation of triplicate determinations. Means with different superscript in the same column are significantly different ($p \leq 0.05$)

The key: WT is winged termite

Table 5. Percentage Fatty Acids Contents of Aku (Winged termites)

No	FATTY ACID TYPE	Carbon chain length	Raw WT	Boiled WT	Toasted WT
I.	**Saturated fatty acids**				
1	Lauric acid	12	0.78±0.01[b]	5.10±0.37[a]	5.40±1.20[a]
2	Myristic acid	14	4.52±0.99[b]	7.43±1.10[a]	7.35±0.50[a]
3	Stearic acid	18	27.35±0.43[a]	21.38±0.65[b]	22.59±3.45[b]
II.	**Unsaturated fatty acids**				
5	Oleic acid	C18:1	26.72±0.22[c]	42.34±0.88[a]	31.36±5.00[b]
6	Linoleic acid	C18:2	5.510±0.30[b]	0.00±0.00[c]	7.37±0.10[a]
7	Linolenic acid	C18:3	13.10±3.56[b]	10.10±2.08[c]	15.36±4.25[a]
8	Unidentified fatty acid	C20:3	1.11±0.12[b]	2.38±0.67[a]	0.00±0.01[c]
9	Arachidonic acid	C20:4	8.56±1.02[a]	4.34±0.30[b]	0.30±0.10[c]
10	Eicosapentaenoic acid	C20:5	3.19±0.99[a]	0.00±0.00[b]	0.00±0.00[b]
11	Unidentified fatty acid	C22:6	4.32±0.28[b]	4.31±0.21[b]	7.78±1.02[a]

Fieldwork (2022)

Values are Means ± standard deviation of triplicate determinations. Means with different superscript in the same column are significantly different (p≤0.05)

The key: WT is winged termite

Table 6. Sensory scores of Jollof rice cooked with Aku of different processing treatments

S/N	Jollof rice sample	Overall likeness
1	Jollof rice cooked with raw Aku (Winged termite)	2.80± 1.82[b]
2	Jollof rice cooked with boiled Aku (Winged termite)	5.53± 1.06[a]
3	Jollof rice cooked with toasted Aku (Winged termite)	6.12± 0.94[a]
4	Jollof rice cooked with only crayfish (Control)	6.17± 0.74[a]

Fieldwork (2022)

Mean ±SD values with different superscripts along the column differ significantly (p≤0.05)

4. CONCLUSION

The study examined the effect of local processing methods on chemical and organoleptic quality on African winged termite in Anambra State, Nigeria. The nutritional value of some processed insects remained high while some were low on winged termite, with boiling and toasting reduced the crude fat, moisture content and protein but increases the ash and fibre content. The decrease in moisture content led to increase in ash which indicates increase in mineral content. Toasted winged termite was found to be low in moisture and crude fat which led to decrease in microbial activities thereby prolonging the shelf life.

Furthermore, toasted samples also contained a good amount of proteins, unsaturated fatty acid and vitamins when compared to raw and boiled sample. The highest vitamin E content of winged termites are in toasted samples. The total saturated fatty acid of toasted winged termite is 35.31% while unsaturated fatty acid content are 62.18% respectively. The high level of unsaturated fatty acid coupled with a low level of saturated fatty acid content makes the fat content a desirable and health promoting one.

However, the result on effect of processing on organoleptic acceptability on jollof rice cooked with African winged termite revealed that the jollof rice cooked with the toasted samples received the overall acceptability ratings. Therefore, toasting could be recommended as the best processing method for the preparation of African winged termite for a healthy diet.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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