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AMINO ACID PROFILES, ANTINUTRIENTS, CONCENTRATIONS OF MINERALS AND ANTINUTRIENT-MINERAL MOLAR RATIOS OF "AKIDIAGWORAGWO" AND "NWAGBARAOTI" TRADITIONAL FOODS

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Key words: amino acid profiles, antinutrients, Mbano people, minerals, molar ratios, traditional foods.

Abstract

Amino acid profiles, anitnutrients, concentrations of minerals and antinutrient-mineral molar ratios of "akidiagworagwo" and "nwagbaraoti" traditional foods were investigated with standard methods. Results obtained for amino acids showed that the food samples contained nine of the ten essential amino acids and eight of the ten non-essential amino acids. Values of total amino acid groups showed that TAAs, TNEAAs, TEAAs with His, TEAAs without His, TNAAs, TNAAs, TBAAs, TBCAAs, and TArAAs were higher in "akidiagworagwo" than "nwagbaraoti". Higher leucine to isoleucine values and TBAA to TAAA ratio of less than one were observed for the foods. The food samples fall short of amino score requirements for isoleucine, sulphur containing amino acids, threonine and valine. Tryptophan was not found in both food samples. Minerals found in the studied foods were calcium, magnesium, zinc and iron with phytate and oxalate as antinutrients. The estimated bioavailability of the antinutrents to

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mineral ratios depicted bioavailability of minerals in the food samples to the body following consumption. The study has investigated amino acid profiles, antinutrients, concentrations of minerals and antinutrient-mineral molar ratio of "akidiagworagwo" and "nwagbaraoti" traditional foods.

Introduction

Food substances are known to furnish the body with nutrients that nourish it and are very important to the body (OLUSANYA 2008). The knowledge of food constituents is dated back to the days of our forefathers, who searched for foods with different constituents to eat (DURU et al. 2013a). The search for foods with different constituents then could be due to the inherent effects of such foods in the body following consumption (DURU et al. 2013b). Foods in their natural form are known to contain both nutritive and non-nutritive constituents (OKAKA and OKAKA 2005). The nutritive constituents found in foods are carbohydrates, proteins, vitamins, fats and oils, minerals, and water (OKAKA and OKAKA 2005, OLUSANYA 2008, DURU et al. 2013a, AGOMUO et al. 2017), while the non-nutritive constituents are phytochemicals and antinutritional factors (OKAKA and OKAKA 2005, OLUSANYA 2008, DURU et al. 2013b, AGOMUO et al. 2017). Nutritionally, carbohydrates, proteins, fats and oils are known as primary food substances whereas welfare food substances constitute vitamins and minerals (OLUSANYA 2008). Functionally, a lot has been reported on both the primary food substances as well as welfare food substances (OKAKA and OKAKA 2005, OLUSANYAN 2008, DURU et al. 2013a). The phytochemicals found in foods have been implicated to possess certain healthy and healing physiological activity to the body though depending on their concentrations while antinutritional factors have been reported to influence the bioavailability of minerals and other nutrients in foods to the body (SHAHIDI 1997, URGA and NARASIMBA 1998). In recent times, there is a renewed interest on traditional foods. Different authors have attempted to define traditional foods (ALBAYRAK and ERODOGAN 2010, DURU et al. 2015, AMADI et al. 2017, AMADI et al. 2018), and evaluate the constituents of those that have not gone into extinction (DURU et al. 2013b).

"Akidiagworagwo" and "nwagbaraoti" traditional foods are among those traditional foods that have not gone into extinction and deserve to be evaluated for their constituents. The foods are common to Mbano people of Imo State, Southeastern Nigeria. Mbano people transversed Isiala and Ehime Mbano Local Government Authorities in Imo State, located within coordinates 5.6677° north and longitude 7.2034° east. The people of Mbano

are mostly farmers though few are into trading. They speak Igbo language as native dialect. "Akidiagworagwo" and "nwagbaraoti" traditional foods are among the most important elements of cultural identity, unification and heritage for the people of Mbano. The foods also have positive effects on rural economies, and serve as effective instrument in preventing unfair competition and brand creation since some village dwellers prepare and sale the foods as sources of income within the locality.

According to ALBAYRAK and ERODOGAN (2010) protection of traditional foods allows the protection of cultural heritage, consumers, and local producers. The same authors also noted that protection of traditional foods allow job creation, and especially an increase of women's contribution to the economy. With the renewed interest on traditional foods, there is need to extend the study on such foods to accommodate "akidiagworagwo" and "nwagbaraoti" as to derive the positive effects of protecting traditional foods as noted by ALBAYRAK and ERODOGAN (2010) and as well to prevent them from going to extinction by informing the owners of the foods and other interested individuals with the outcome of the study and the need for their continued consumption.

The present study therefore evaluated the amino acid profiles, antinutrients, concentrations of minerals and antinutrient-mineral molar ratios of "akidiagworagwo" and "nwagbaraoti" traditional foods.

Materials

Collection of materials used in the preparation of "akidiagworagwo" and "nwagbaraoti" traditional foods

The study on "akidiagworagwo" and "nwagbaraoti" traditional foods was carried out within Isiala and Ehime Mbano Local Government Areas of Imo State, Southeastern, Nigeria where the foods are produced for domestic consumption. The major raw materials and ingredients used in the preparation of "akidiagworagwo" and "nwagbaraoti" traditional foods for this study were purchased from three local markets (Orie Amaraku, Ekezeala and Orie Nsu markets) within Mbano locality.

Preparation of "akidiagworagwo" traditional food

One hundred and fifty (150) grams of "ugbakala" (sliced fermented cooked seed of *Pentaclethra macrophylla*), 700 g of "akidi" (*Vigna unguiculate*), 250 g of fresh yellow maize (*Zea mays*); ten grams of "ose nkirisi"

(*Capsicum* spp.), 150 mL of red palm oil (*Elaeis guineensis* oil), and 5000 mL of water were used for the preparation of "akidiagworagwo". Required quantity of "akidi" was put in cooking pot with 5000 mL of water and cooked by application of heat for one and half hour till the "akidi" was confirmed soft. Fresh yellow maize was added, and the cooking continued for thirty minutes more before the remaining ingredients were added and mixed properly to form "akidiagworoagwo" ready to be served (Figure 1).

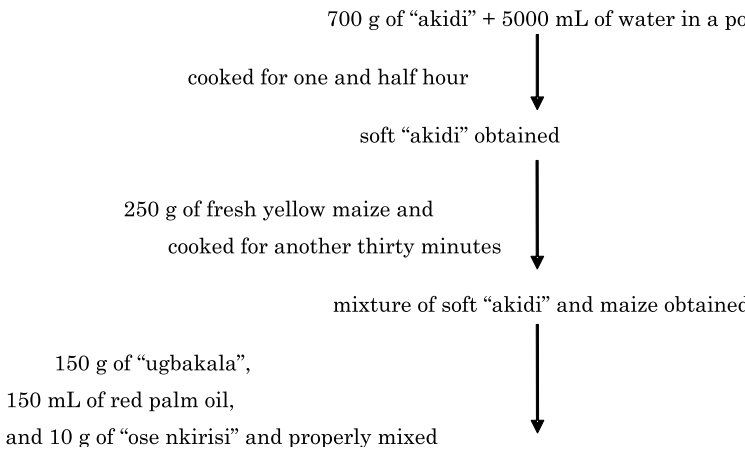

Fig. 1. Flow-chart showing preparation of "akidiagworoagwo"

Preparation of "nwagbaraoti" traditional food

Five hundred (500) grams peeled "egusi" (*Citrullus* spp.); 50 g of "eru-usu"; 30 g of "ose nwabakala" (*Capsicum* spp.); and water were used for the preparation of "nwagbaraoti". The measured peeled "egusi", "ero--usu", and "ose nwabakala" were mixed and pounded together with local mortar and pestle into a smooth oily paste. 200 mL of water were added into the mixture as the pounding continue to produce a smooth and softer oily paste which was mixed properly. The smooth and softer oily paste was then rolled into slightly flattened small balls for faster and even distribution of heat during cooking. The balls were wrapped with "ugu" (*T. occidentalis*) leaves and cooked by steaming in a cooking pot under medium heat. The cooking lasted for one hour thirty minutes, after which delicious and tasty "nwagbaraoti" was ready to be served (Figure 2).

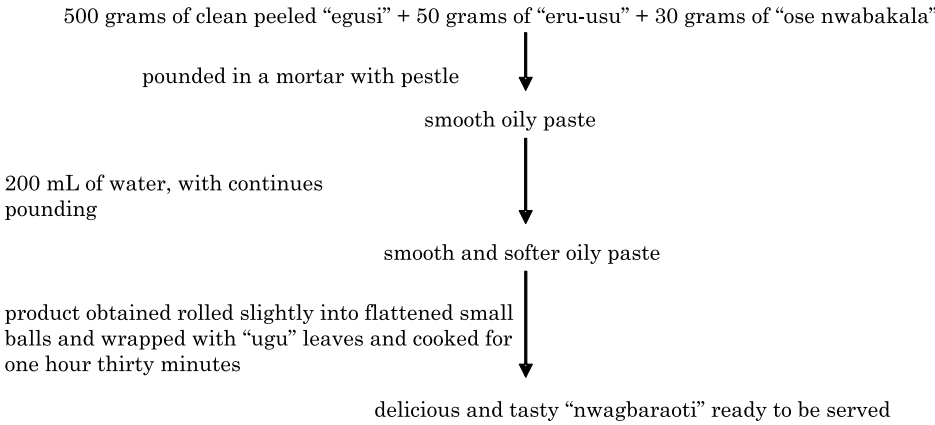

Fig. 2. Flow-chart for the preparation of "nwagbaraoti"

Fig. 3. Prepared "akidiagworagwo" in a glass plate sourrended by the raw the materials used in its preparation

Fig. 4. Prepared balls of "nwagbaraoti" inside ceramic plate sourrounded by raw materials used in its preparation

Methods

Preparation, preservation, and analysis of food samples

The prepared samples of "akidiagworagwo"and "nwagbaraoti" foods were dried in an oven at 55ºC for 48 hours. The dried samples were ground with a hand mill into powdered form and stored in air tight container at 40ºC until required for analysis.

Amino acid determination

The total amino acid (AA) compositions of the food samples were quantified using the ion-exchange chromatography-based Technicon Sequential Muti-sample (TSM) amino acid analyser (Technicon Instruments Corporation, New York) method described by SPACKMAN et al. (1958). Dried ground samples of the foods were defatted, hydrolysed, evapourated in a rotary evapourator and then loaded into the Technicon Sequential Muti-sample (TSM) amino acid analyser. Two grams each of the samples were weighed into the extraction thimbles and the fats were extracted with chloroform/methanol (2:1 mixture) using soxhlet extraction apparatus as described by AOAC (2006). The extraction lasted for 15 hours. The defatted samples weighing 0.7491 g were put into a glass ampoules and 7 mL of 6 M HCl was added. Oxygen was liberated by passing nitrogen into the ampoules (this was to avoid possible oxidation of some amino acids during hydrolysis). The glass ampoules were then sealed with Bunsen burner flame and put in an oven preset at 105±5°C for 72 hours. The ampoules were allowed to cool before breaking them open at the tip and the content filtered to remove the humus. Their filtrates were then evapourated to dryness at 40°C under vacuum in a rotary evapourator. The residues obtained were dissolved with 5mL of acetate buffer (pH 2.0) and stored in plastic specimen bottles and kept in the freezer till needed for analysis. Ten micro litres (10 μL) of each sample was dispensed into the cartridge of the analyser. The TSM analyser is designer to separate and analyse free acidic, neutral and basic amino acids of the hydrolysate. The values for the individual amino acids expressed in g/100 g protein were calculated using chromatogram peaks generated.

Estimation of total amino acid groups, percentages of amino acid groups, and amino acids scores

Total Amino Acid (TAA) group was estimated by summing up all the amino acids observed in the food samples. Total Non-Essential Amino Acid (TNEAA) was estimated by adding all the observed non-essential amino

acids in the food samples. Total Essential Amino Acid with histidine (TEAA with His) was calculated by adding all the observed essential amino acids in the food samples with histidine. Total Essential Amino Acid without histidine (TEAA without His) was estimated by adding all the observed essential amino acid in the studied samples without histidine. Total Neutral Amino Acid (TNAA) was estimated by adding all the neutral amino acids (glycine, alanine, valine, leucine and isoleucine) of the studied samples. Total Acidic Amino Acid (TAAA) was calculated by adding all the acid amino acids (aspartic acid and glutamic acid) observed in the samples. Total Basic Amino Acid (TBAA) was estimated by adding all the basic amino acids (lysine, arginine, and histidine) observed in the studied samples. Total Sulphur-containing Amino Acid (TSAA) was calculated by adding all the sulphur-containg amino acids (methionine and cysteine) observed in the food samples. Total Branched Chain Amino Acid (TBCAA) was calculated by all the branched amino acids (leucine, isoleucine and arginine) observed in the food samples. Total Aromatic Amino Acid (TArAA) was estimated using all the aromatic amino acids (phenylalanine, tyrosine, and tryptophan) of the food samples. Percentages of amino acid groups were estimated following the methods as described by IBEGBULEM et al. (2012). Estimation of amino acid scores of the food samples were calculated as the ratio of the actual mount (mg) of each amino acid involved per g of the protein to the required amount [mg] of the amino acid [mg] per g of a reference protein as described by FAO/WHO (1973) and WARDLAW and KESSEL (2000) using FAO/WHO/UNU provisional scoring pattern as provided by HARPER (2017).

Determination phytate

The method of GRIFFITH and THOMAS (1981) was used for phytate determination. The two grams of defatted sample was extracted for 1 hour in 50 mL of 0.18 M trichloro acetic acid (TCA) at room temperature. The suspension was centrifuged and an aliquot (10 mL) was added to 5 mLs of 0.036 M ferric chloride solution and placed in boiling water. After 45 minutes, the precipitated ferric phytate was collected by centrifugation, washed twice with 30 mL of the trichloroactic acid and once with 50 mL of water. The precipitate obtained was suspended in 3 mL of 1.5 M NaOH, diluted to 30 mL with water, and the resulting ferric hydroxide coagulated by heating. The ferric hydroxide was then centrifuged, washed with water and dissolved in 50 mL of 3.2 M HNO_3 and made up to 100 mL with water. The iron content was then determined by spectrophotometry. This was repeated for each studied sample. Amount of phytate in the sample was calculated.

Determination of oxalate

The method as described by ONWUKA (2005) was adopted. Two grams of the sample were extracted three times by warming (50ºC) and stirring with magnetic stirrer for one hour in 20 mL of 3 M HCL. The combined extract was diluted to 100 mL with water and used for total oxalate estimation. The extract of 5 mL volume was made alkaline with 1 mL of 5 M ammonium hydroxide. This was made acid to phenolphalein (2 or 3 drops of this indicator) by drop wise addition of glacial acetic acid. Then, 1 mL of 5% calcium chloride was added and the mixture was allowed to stand for 3 hours after which it was centrifuged at 3000 rpm for 15 minutes. The supernatant was discarded and the precipitate washed 3 times with hot water with thorough mixing and centrifuging each time. To each tube was added 2 mL of 3 M H_2SO_4 and the precipitate dissolved by warming in a water-bath (70ºC). The content of each tube was titrated with freshly prepared 0.01 M $KMnO_4$. Titration was carried out at room temperature until the pink colour appeared throughout the solution which was allowed to stand until the solution was colourless. The solution was then warmed to 70ºC and titration was continued until a pink colour persisted for at least 30 seconds indicating end point. Oxalate in samples was calculated using molarity relationship.

Determination of calcium, magnesium, iron, and zinc in the food samples; and estimation of antinutrient-mineral molar ratios of the food samples

Two (2) grams of each sample were wet-digested with heat and concentrated HNO_3/H_2SO_4 (7.5 mL and 5 mL respectively) solution. After the materials begin to char; digestion continued with only HNO_3 until a light yellow liquid was obtained. Calcium, magnesium, iron, and zinc concentrations were determined with the aid of atomic absorption spectrophotometer (Analyst 700 series, Parkin Elmer. Germany) according to the manufacturer`s instruction. Antinutrient-mineral ratios were estimated following the relationships as described by IGWE et al. (2013) and GEMEDE et al. (2016).

Statistical analysis

Results for amino acid constituents, total and % total amino acid groups, ratios of some amino acids and amino acid groups, minerals and antinutrients of “akidiagworagwo” and “nwaogbaraoti” traditional foods were presented as mean and standard deviations of six determinations while

amino acid scores and antinutrient-mineral molar ratios were presented as mean of six determinations. Data were analyzed using Students` t-distribution test of significance. Values were considered significant at ($p < 0.05$).

Results

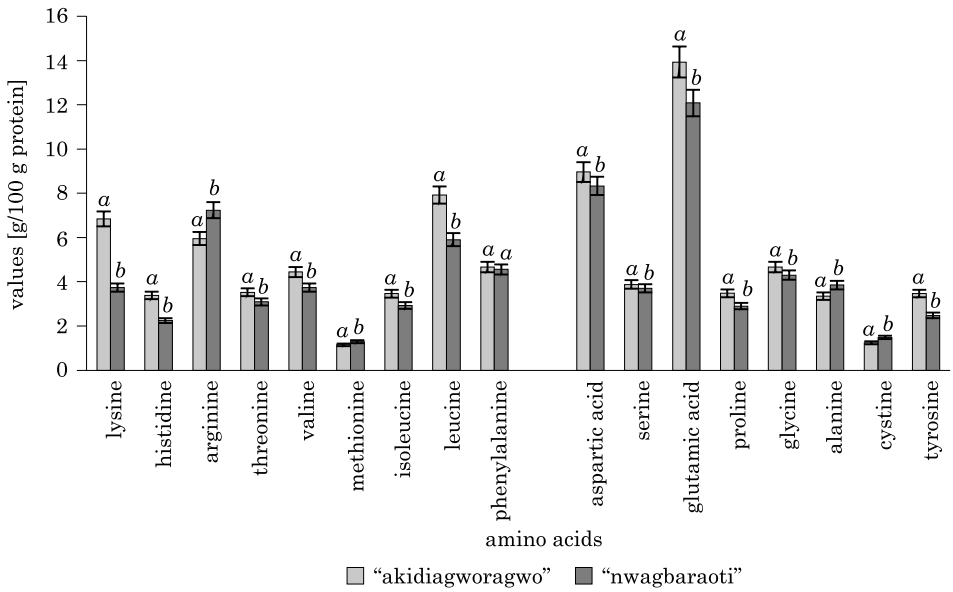

Fig. 5. Amino acid constituents of "akidiagworagwo" and "nwagbaraoti" traditional foods

Amino acid constituents of "akidiagworagwo" and "nwagbaraoti" traditional foods as presented in Figure 5 revealed the presence lysine (6.84–3.74 g/100 g protein), histidine (2.25–3.39 g/100 g protein), arginine (5.95–7.23 g/100 g protein), threonine (3.09–3.52 g/100 g protein), valine (3.74–4.44 g/100 g protein), methionine (1.15–1.29 g/100 g protein), isoleucine (2.93–3.46 g/100 g protein), leucine (5.90–7.92 g/100 g protein), phenylalanine (4.65–4.66 g/100 g protein), aspartic acid (8.33–8.96 g/100 g protein), serine (3.70–3.88 g/100 g protein), glutamic acid (12.08–13.93 g/100 g protein), proline (2.90–3.48 g/100 g protein), glycine (4.30–4.66 g/100 g protein), alanine (3.35–3.85 g/100 g protein), cystine (1.24–1.48 g/100 g protein), and tryrosine (2.48–3.47 g/100 g protein).

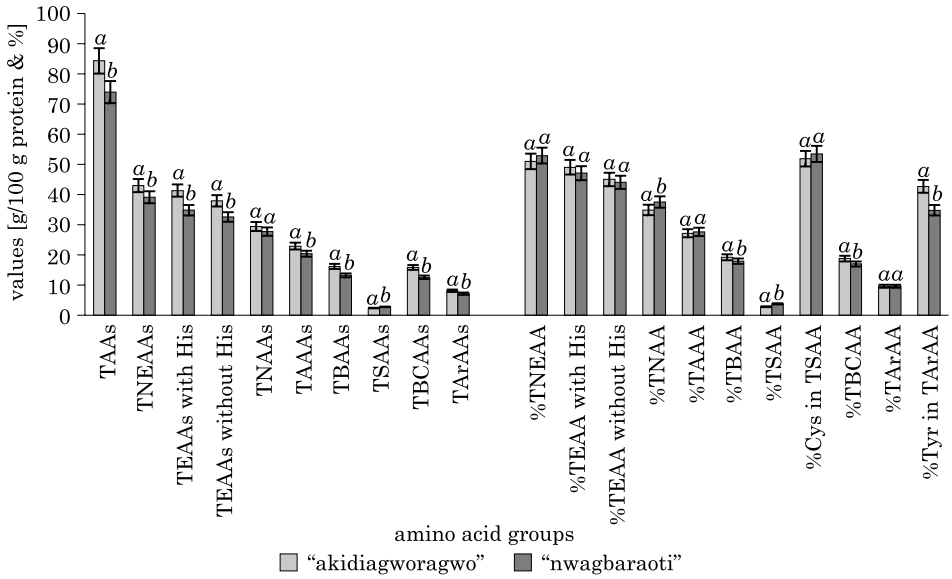

Fig. 6. Total and %total amino acid groups of "akidiagworagwo" and "nwaogbaraoti" traditional foods

TAAs – total amino acids; TNEAAs – total non-essential amino acids; TEAAs with His – total essential amino acids with histidine; TEAAs without His – total essential amino acids without histidine; TNAAs – total neutral amino acids; TAAAs – total acidic amino acids; TBAAs – total basic amino acids; TSAAs – total sulphur containing amino acids; TBCAAs – total branched chain amino acids; and TArAAs – total aromatic amino acids; % TNEAA – percentage total non-essential amino acid; % TEAA with His – percentage total essential amino acid with histidine; % TEAA without Histidine – percentage essential amino acid without histidine; % TNAA – percentage total neutral amino acid; % TAAA – percentage acid amino acid; % TBAA – percentage basic amino acid; % TSAA – percentage sulphur-containing amino acid; % Cys in TSAA – percentage cystine in total sulphur amino acid; % TBCAA – percentage branched-chain amino acid; % TArAA – percentage total aromatic amino acid; % Tyr in TArAA – percentage tyrosine **i**n total aromatic amino acid.

Figure 6 is based on Figure 5; bars of an amino group with different letters of alphabet are statistically significant at ($p < 0.05$).

Results of total and % total amino acid groups of "akidiagworagwo" and "nwaogbaraoti" traditional foods as presented in Figure 6 revealed TAAs (73.94–84.30 g/100 g protein), TNEAAs (39.12–42.97 g/100 g protein), TEAAs with His (34.82–41.33 g/100 g protein), TEAAs without His 32.57–37.94 g/100 g protein), TNAAs (27.74–29.41 g/100 g protein), TAAAs (20.41–22.89 g/100 g protein), TBAAs (13.22–16.18 g/100 g protein), TSAAs (2.39–2.77 g/100 g protein), TBCAAs (12.57–15.82 g/100 g protein), TArAAs (7.13–8.13 g/100 g protein), % TNEAA (50.97–52.91%), % TEAA with His (47.09–49.03%), % TEAA without His (44.05–45.01%), % TNAA (34.89–37.52%), % TAAA (27.15–27.67%), % TBAA (17.88–19.19%), % TSAA (2.84–3.75%), % Cys in TSAA (51.88–53.43%), % TBCAA (17.00––18.77%), % TArAA (9.64–9.64%), and % Try in TArAA (34.78–42.68%).

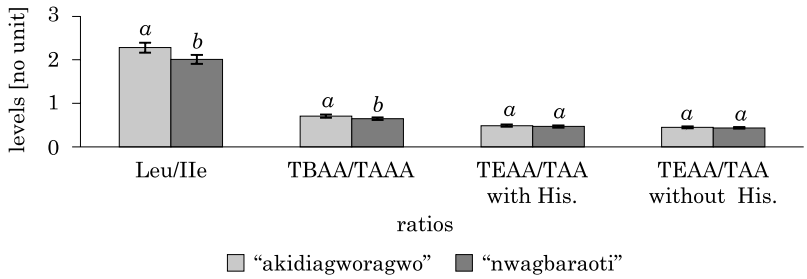

Fig. 7. Ratios of some amino acids and amino acid groups of "akidiagworgawo" and "nwagbaraoti" traditional foods

Leu/IIe – leucine: isoleucine; TBAA/TAAA – total basic amino acids: total acid amino acids; TEAA/TAA with His – total essential amino acid: total amino acids with histidine; TEAA/TAA without His – total essential amino acids: total amino acid without histidine.

Figure 7 is based on Figure 5 and Figure 6; bars of an amino ratio with different letters of alphabets are statistically significant at ($p < 0.05$).

Ratios of some amino acids and amino acid groups of "akidiagworgawo" and "nwagbaraoti" traditional foods presented in Figure 7 reveals Leu/IIe (2.01–2.28), TBAA/TAAA (0.65–0.71), TEAA/TAA with His (0.47–0.49), and TEAA/TAA without His (0.44–0.45).

Table 1

Amino acid scores of "akidiagworagwo" and "nwagbaraoti" traditional foods based on FAO/WHO/UNU (1981) provisional amino acid scoring pattern [mg g^{-1}]

Amino acid	"Akidiagworagwo"	"Nwagbaraoti"	FAO/WHO/UNU (1981)
Isoleucine	0.88	0.73	40
Leucine	1.13	0.84	70
Lysine	1.24	0.68	55
Methionine + cystine	0.68	0.79	35
Phenylalanine + tyrosine	1.36	1.19	60
Threonine	0.88	0.77	40
Tryptophan	NA	NA	10
Histidine	NC	NC	NA
Valine	0.89	0.75	50
Total	7.06	5.75	360

Results are mean of six determinations. Legend: NA – not available; NC – not considered

Table of amino acid scores of "akidiagworgawo" and "nwagbaraoti" traditional foods (Table 1) revealed isoleucine (0.73–0.88 mg g^{-1}), leucine (0.84–1.13 mg/100 g), lysine (0.68–1.24 mg/100 g), methionine + cystine (0.68–0.79 mg g^{-1}), phenylalanine + tyrosine (1.19–1.36 mg g^{-1}), threonine (0.77–0.88 mg/100 g), and valine (0.75–0.89 mg/100 g).

Table of minerals, antinutrients, and antinutrients-mineral molar ratios of "akidiagworagwo" and "nwagbaraoti" traditional foods (Table 2) showed the presence of Ca (30.00–96.00 mg/100 g), Mg (9.14–18.63 mg/100 g), Zn (0.71–1.40 mg/100 g), phytate (0.80–1.78 mg/100 g), oxalate (0.12–0.32 mg/100 g), [Oxa.]/[Ca] ($1.52 \cdot 10^{-3}$–$1.82 \cdot 10^{-3}$), [Oxa.]/[Ca+Mg] ($1.31 \cdot 10^{-3}$–$9.00 \cdot 10^{-4}$), [Phyt.]/[Fe] ($3.76 \cdot 10^{-2}$–$7.17 \cdot 10^{-2}$), [Phyt.]/[Ca] ($5.06 \cdot 10^{-4}$–$3.60 \cdot 10^{-3}$), [Phyt.]/[Zn] ($1.259 \cdot 10^{-1}$–$1.89 \cdot 10^{-1}$) and [Ca×Phyt.]/Zn ($9.4 \cdot 10^{-2}$–$4.5 \cdot 10^{-1}$ mol kg^{-1}).

Discussion

The studied food samples possessed nine of the ten essential amino acids (Figure 5). They also possessed eight of the ten non-essential amino acids. These amino acids become very important when their functions are considered in the body, following consumption. Different authors have reported the functions of these amino acids in the body (Uwakwe and Ayalogu 1998, Wardlaw and Kessel 2002, Olusanya 2008, Wu 2009, Connolly 2011, Ibegulem et al. 2012, Westerterp-Plantenga et al. 2012, Wu et al. 2013). Essential amino acids such lysine, histidne, valine, isoleucine, and leucine as well as non essential amino acids such as aspartic acid, serine, glutamic acid, proline, glycine, and tryrosine were significantly ($p < 0.05$) higher in "akidiagworagwo" when compared to those of "nwagbaraoti". It could be that "akidiagworagwo" may offer these amino acids to the body more than "nwagbaraoti" when consumed. The studied food samples have more TNEAAs than TEAAs with or without His. This could imply that the foods may not be good sources of essential amino acids to the body when compared to other traditional foods, though they surpassed the 1.7 g essential amino acids of egg white as reported by Connolly (2011). TNEAAs of the food samples also surpassed the 2.1 g of egg white (Connolly 2011). The benefits of amino acids under the acronym TEAAs, TNAAs, BCAAs have been reported by different authors (Fernstrom 1994, Fernstrom 2013, Layne 2017). The obtained values of total amino acid groups (Figure 6) showed that TAAs, TNEAAs, TEAAs with His or without His, TNAAs, TAAAs, TBAAs, TBCAAs, and TArAAs were significantly higher ($p < 0.05$) in "akidiagworagwo" than "nwagbaraoti". Percentages of amino acid groups placed the food samples as having more % TNEAA than % TEAA with or without His. It has been noted that 40 to 45% of total amino acid content in most high quality proteins represent essential amino acids. With or without His, the % total essential amino acids (% TEAA) of the two traditional foods were higher than 40%.

Table 2

Minerals, antinutrients and antinutrient-mineral molar ratios of "akidiagworagwo" and "nwagbaraoti" traditional foods

Specification	Minerals [mg/100 g]				Antinutrients [mg/100 g]		Antinutrient-mineral molar ratios					
Food	Ca	Mg	Fe	Zn	Phyt.	Oxa.	[Oxa.]/[Ca]	[Oxa.]/[Ca + Mg]	[Phyt.]/[Fe]	[Phyt.]/[Ca]	[Phyt.]/[Zn]	[Ca · Phyt.]/Zn (mol./kg)
"Akidiagwo-ragwo"	96.00 ± 3.03^a	9.14 ± 0.47^a	1.80 ± 0.10^a	0.71 ± 0.04^a	0.80 ± 0.03^a	0.32 ± 0.02^a	$1.52 \cdot 10^{-3}$	$1.31 \cdot 10^{-3}$	$3.76 \cdot 10^{-2}$	$5.06 \cdot 10^{-4}$	$1.89 \cdot 10^{-1}$	$4.5 \cdot 10^{-1}$
"Nwagba-raoti"	30.00 ± 1.61^b	18.63 ± 0.96^b	2.10 ± 0.11^b	1.40 ± 0.59^b	1.78 ± 0.10^b	0.12 ± 0.01^b	$1.82 \cdot 10^{-3}$	$9.00 \cdot 10^{-4}$	$7.17 \cdot 10^{-2}$	$3.60 \cdot 10^{-3}$	$1.259 \cdot 10^{-1}$	$9.4 \cdot 10^{-2}$

Results are mean and standard deviation of six determinations. Values with different letters of alphabets along the same column are statically significant at ($p < 0.05$). Phyt. – Phytate; Oxa. – Oxalate

This could be indication that the foods may contain a complete protein. The % total neutral amino acids (% TNAA) of the food samples (Figure 2) were below 50% and could be indication that their proteins maybe charged. The observed values were lower than 59.36, 59.33 and 59.98% reported for raw, boiled, and fermented *P. african* respectively by IGWE et al. (2013). Values of % TNEAA, % TEAA with His or without His, % Cys in TSAA, % TAAA and % TArAA in "akidiagworagwo" were insignificantly ($p > 0.05$) affected when compared to those of "nwagbaraoti". The values of % cyteine for the studied food samples are in line with the statement of ADEYEYE et al. (2007), who noted that protein from plant source contribute substantially more cysteine than methionine in TSAA. The % TBCAA of 18.77% for "akidiagworagwo" and 17% of "nwagbaraoti" could be indication that upto 20% of their amino acid contents could be available for energy production. This is more than required 10% from proteins as noted by WARDLAW and KESSEL (2002). The % TBCAA value of "akidiagworagwo" in the present study is comparable to that of *R. hookeri* but lower than that *E. guineensis* (IBEGBULEM et al. 2012) whereas that of "nwagbaraoti" is lower than those of *R. hookeri* and *E. guineensis* (IBEGBULEM et al. 2012). The values of both % TArAA and % Tyr in TArAA could be indication that over 40% of phenylalanine contents of the studied food samples undergo sparing action by tyrosine. % tyrosine is higher in "akidiagworagwo" than "nwagbaraoti" traditional food. The observed values for % tyrosine in the present study were higher than those of *R. hookeri and E. guineensis* wines (IBEGBULEM et al. 2012).

The ratios of leucine to isoleucine revealed higher leucine contents for the food samples (Figure 7). According to IGWE et al. (2013), metabolic antagonism especially on trypsin and niacin may set in. TBAA to TAAA ratio of less than one for the two food samples could be indication that the foods may contain acid proteins (Figure 7) and their amino acids could also serve as acids at physiological pH (SCHULTZ et al. 2006). The less than one observation of TBAA/TAAA in the present study is in line with the earlier report by IBEGBULEM et al. (2012) on wines of *R. hookeri and E. guineensis*. IBEGBULAM et al. (2012) noted that edible material with TEAA/TAA ratio of more than 50% could support protein synthesis. The observed TEAA/TAA ratios (with or without His) for "akidiagworagwo" and "nwagbaraoti" were lower than 50%, and may not support protein synthesis as noted by IBEGBULAM et al. (2012).

The amino acid score determines the effectiveness with which absorbed dietary nitrogen can meet the indispensable amino acid requirement at safe level of protein intake (FAO/WHO/UNU 2002). In recent times, prediction of protein quality using Protein Digestibility Corrected Amino Acid

Score (PDCAAS) has been established. PDCAAS is a method of evaluating the protein quality based on both the amino acid requirements of humans and their ability to digest it. PDCAAS has a relationship with digestibility and amino acid score (FAO/WHO/UNU 2002). The amino acid scores as presented in Table 1 revealed that leucine, lysine and aromatic amino acids in "akidiagworagwo" surpassed their requirement by 13, 24 and 36% respectively, while aromatic acids in "nwagbaraoti" surpassed its requirement by 19%. Isoleucine, sulphur containing amino acids, threonine, and valine fall short of their requirements in "akidiagworagwo" by 12, 32, and 11% respectively whereas isoleucine, leucine, lysine, aromatic amino acids, threonine, and valine fall short of their requirements in "nwagbaraoti" traditional food by 27, 16, 32, 21, 23, and 25% respectively. Aromatic amino acids for "akidiagworgawo" and lysine for "nwagbaraoti" are the limiting amino acids for having the least provisional scores (AMADI and DURU 2014) in the present study.

Different authors (SHAHIDI 1997, OKAKA and OKAKA 2005, OLUSANYA 2008, DURU et al. 2013ab, AMADI et al. 2013, AMADI et al. 2018) have reported the importance of minerals such as Ca, Mg, Zn, and Fe found in food materials to the body. URGA and NARASIMHA (1998) noted that the nutritional value of diet in terms of macro and micro minerals is dependent on the amount of mineral that is bioavailable for physiological processes in the organism much more than the content in the diet. The ability of dietary phyate and oxalate to complex important minerals such as Ca, Mg, Zn, and Fe and prevent them from being available to the body has been reported (GRIFFITH and THOMAS 1981, ONWUKA 2005, IGWE et al. 2013, GEMEDE et al. 2016). The observed minerals and antinutrients were significantly ($p < 0.05$) affected in "akidiagworagwo" when compared to those of "nwagbaraoti". To predict the bioavailability of minerals such as calcium, iron and zinc; antinutrients to mineral molar ratios were calculated and presented in Table 2. The ratios were lower than their individual critical values signifying mineral elements bioavailability in the studied food samples to the body.

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Conclusion

"Akidiagworagwo" and "nwagbaraoti" traditional foods possessed nine of the ten essential amino acids and eight of the ten non-essential amino acids with less than one TBAA to TAAA ratio, which means that they can serve as acids at physiological pH. They fall short of amino acid scores for isoleucine, threonine, and valine. The antinuteint-mineral molar ratios for the two foods revealed availability of nutrients. This study has shown the amino acid profiles, anutinutrients, concentrations of minerals and antinutrient-mineral molar ratios of "akidiagworagwo" and "nwagbaraoti" traditional foods.

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