# Fatty Acid Constituents, Amino Acid Quality and Haematological Moderation following Consumption of "Ntubiri" and "Ntiti-Ikpa" Traditional Foods.

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## ABSTRACT

The fatty acid constituents, amino acid quality and haematological moderation of "Ntubiri" and "Ntiti-Ikpa" traditional foods were investigated. Results obtained for fatty acids showed the presence of important saturated and unsaturated fatty acids in the studied foods. Essential and non-essential amino acids obtained compared favorably to those of reference proteins. Results of the protein quality obtained by using chemical score method revealed the order of the protein quality of the studied foods as reference protein quality > "Ntubiri" > "Ntiti-Ikpa". The studied foods affected RBC, Hb, WBC and lymphocytes significantly ($p<0.05$) in test rats against control 1 rats. MCH, and MCHC were insignificantly affected ($p>0.05$) in test rats against control 1 and control 2. The insignificant effect on mean corpuscular haemoglobin (MCH), and mean corpuscular haemoglobin concentration (MCHC) could mean that neither normocytic or hypochromic anemia; incorporation of haemoglobin into red blood cells nor the morphology; and osmotic fragility of the red blood cells can be possible by consumption of the studied foods in the system.

(Keywords: amino acid quality, fatty acid, haematology, nutrients, traditional foods)

## INTRODUCTION

The nutrient constituents of food determine its placement in the nutritional table (Olusanya, 2008). Nutrients in foods come in the form of chemical compounds (Alais, and Linden, 1999). The benefits of having food chemical compounds such as carbohydrates, proteins, and lipids in the body are enormous (Lillian, 2004; Olusanya, 2008).

Fats saturated lipids at room temperature and oils make up the lipid compounds found in food materials (Alais and Linden, 1999; Lillian, 2004; Okaka and Okaka, 2005). These compounds yield fatty acids and glycerol after digestion (Sarojini 1998). A lot of benefits have been credited to fatty acid compounds in relation to human health (Olusanya, 2008), including energy production; acting as dissolving medium for fat-soluble vitamins; and protection of some delicate parts of the body (Sarojini 1998). Recent research studies have linked dietary fatty acids to reduction of disease conditions such as heart attack, cancer, arthritis, asthma, etc. (Connor, 1994; Walker and McMahon, 2008). Unlike the misconception of the past, it is now known that fatty acids ensure proper fetal development during pregnancy, act as dissolving medium for some minerals, aid calcium mineral to penetrate the bones, etc. (Neuringer *et al*., 1986).

The importance of amino acids, the building blocks of proteins, in the body cannot be overstated. They come in different forms and each form has one or more functions to perform in the body (Walker and McMahon, 2008). Amino acid functions in the body include formation of enzymes, formation of haemoglobin, facilitating muscular contractions, formation of immunoglobulin, which plays important role in immunity, etc. (Walker and McMahon, 2008; Olusanya, 2008).

In recent times, there is a renewed interest in traditional foods. Traditional foods are defined as those foods prepared and consumed the way our ancestors prepared and ate them (Duru *et al.*, 2013). Different authors (Temple *et al*., 1996; Trichopoulou *et al*., 2007; Kpikpi *et al*., 2009) have noted that traditional foods possess excellent qualities and give the body numerous benefits following consumption. They have been linked with a lot of nutritional and health benefits

(Achi, 2005). Unlike conventional and fast foods, the fatty acid constituents and amino acid quality of most traditional foods are un-highlighted.

"Ntubiri" and "Ntiti-Ikpa" traditional foods are among the traditional foods with un-highlighted fatty acid constituents and amino acid quality. "Ntubiri" and "Ntiti-Ikpa" are part of the cultural heritage of Ikwerre ethnic national. Ikwerre people are found in Rivers State, South-Southern, Nigeria. They inhabit a substantial part of the northern half of Rivers State. Ikwerre lies roughly within the coordinates 4º50'*N*, 5º15'*N*, 6º30'*E* and 7º15'*E* covering a land mass of about 21,400 square kilometre (Nduka, 1993; Wahua, 1993). "Ntubiri" and "Ntiti-ikpa" are made from grown and processed crops within Ikwerre land.

Previous work on "Ntubiri" and "Ntiti-Ikpa" investigated sensory evaluation, minerals and amino acids (screening) of the traditional foods (Amadi *et al*., 2013). There is need to extend the studies on the foods. The present study therefore investigated the fatty acid constituents, amino acid quality, and haematological moderation following consumption of "Ntubiri" and "Ntiti-Ikpa" traditional foods.

## MATERIALS AND METHODS

The study of "Ntubiri" and "Ntiti-Ikpa" was carried out in Isiokpo in Ikwerre Local Government of Rivers State, South-South, Nigeria where they are produced for home consumption.

**Sample Collection:** The ingredients used in the preparation of "Ntubiri" and "Ntiti-Ikpa" were purchased from a local market in Isiokpo, Ikwerre Local Government Area of Rivers State, South-South, Nigeria.

"**Ntubiri" Preparation:** Six hundred and fifty grams (650g) of peeled water yam (*Dioscorea alata*) was properly washed and crushed by scraping with kitchen knife to a semi-molten form into a bowl. 220ml of water was heated in a cooking pot on a cooking stove and allowed to boil. 40g of ground prawn and 120g of dried tilapia fish were added to the pot and allowed to boil. After boiling for about 5min, 7g of ground dried pepper, 10g of salt, a cube of maggi, 20g of crayfish, 30g onion were added and allowed to boil for another 5min. 100ml of red palm oil (RPO) was added to the crushed water yam bowl to hold it together because of its adhesive properties and mixed thoroughly. Portions of the mixed, crushed water yam were collected with spoon and put into the boiling pot containing the ingredients, covered and allowed to boil for 20 mins.

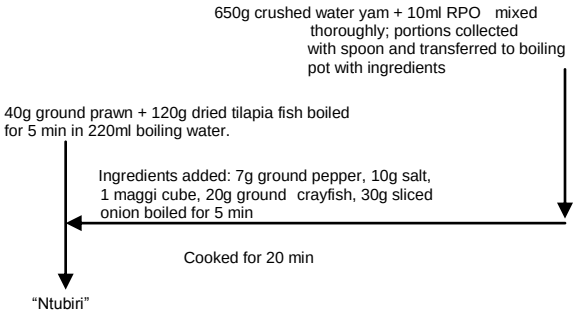


**Figure 1**: Flow-chart for Preparation of "Ntubiri".

**"Ntiti-Ikpa" Preparation:** Ground corn of 4,120g weight was put into a mixing bowl. 1,200g of peeled ripe banana was washed, meshed and transferred to mixing bowl containing the corn. They were both mixed with a turning ladle for 5min. 400ml of red palm oil (RPO) was added to the mixture of corn and banana and mixed thoroughly to a homogenous mixture. After mixing, 210g of sliced onion, 40g of ground crayfish and 15g of sliced fresh pepper were added separately to the mixture in the bowl and mixed thoroughly to a light consistency. 80g of salt was added to the contents of the bowel and also stirred continuously for 10min to get a smooth consistency. The mixture was put in fresh clean leaves of *Pandenus candelabrum* (etere) which were folded and tied with strings of rope. The wrapped samples were placed one by one into a cooking pot steaming with water on a cooking stove and allowed to steam for 30 min. After cooking, the contents were unwrapped and served.

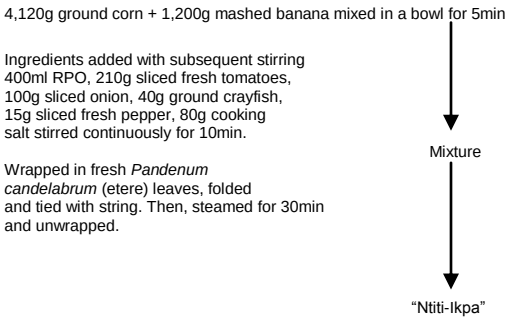


**Figure 2:** Flow-chart for Preparation of "Ntiti-Ikpa".

**Preparation of Samples for Analysis:** The prepared traditional food samples were dried in an oven for 70$^{o}$C for 48 hours. The dried samples were ground with a hand mill into powdered form and stored in air-tight sample containers at 4$^{o}$C until required for analysis.

**Fatty Acid Analysis:** Fat was extracted from the food samples by the method of Erickson and Dunkey (1964) with hexane as the extraction solvent. The fatty acids in the total liquid were esterified into methyl ester by saponification with 0.5 methanolic KOH and trans-esterified with 1:4 HCL/methanol. The fatty acid methyl ester was injected into a gas chromatography to obtain the fatty distribution and a printout copy of the distribution was gotten from the Hewlett Packard Agilent 6890N model automated gas chromatograph (GC) equipped with a flame ionization detector (FID) and fitted with a HP-88 capillary column.

**Determination of Amino Acid:** The method of Speckman *et al*., [1958] was used for quantitative amino acid analysis of the investigated traditional foods.

**Determination of Protein Quality:** Chemical score method as described by Olusanya (2008) was used. The essential amino acids in the studied foods were compared to those of reference protein (usually, whole hen`s egg). Values obtained were expressed in percentage.

**Experimental Animals and Design:** A total of eighty (80) male wistar albino rats weighing between 100- 120g were purchased from the animal colony of Department of Biochemistry, Abia State University, Uturu, Abia State, Nigeria and kept in standard cages for 4 days to enable them adapt to their new environment. Pelletized commercial rat feed (Pfizer livestock Co. Ltd, Aba, Nigeria) and portable water was given to the rats *ad libitum* within this period. After adaption period, the rats were allocated to 10 groups of 8 rats each and their weights were equalized as nearly as possible. Two control groups were used in the present study. One group was on normal feed only while the other group was on normal feed and Nutrend$^{TM}$. The feed and water administration period lasted for sixty days after allocation.

Treatments for rats were as follows; Control group 1 = normal feed + portable water; Control group 2 (Reference control for this study only)= normal feed + nutrend $^{TM}$(commercial infant food from Nestle Nigeria PLC) + portable water; Group $I_a$= 5% of "Ntubiri" + 95% of normal feed + portable water; Group $I_b$ = 10% of "Ntubiri" + 90% of normal feed + portable water; Group $I_c$= 15% of "Ntubiri" + 85% of normal feed + portable water; Group $I_d$= 20% of "Ntubiri" + 80% of normal feed + portable water; group$1_e$ =5% of "Ntiti-Ikpa" + 95% of normal feed + portable water; Group $I_f$ = 10% of "Ntiti-Ikpa" + 90% of normal feed + portable water; Group $I_g$= 15% of "Ntiti-Ikpa" + 85% of normal feed + portable water;Group$1_h$ =20% of "Ntiti-Ikpa" + 80% of normal feed + portable water.

The treatment of experimental animals was in accordance to the National Institute of Health (NIH) guidelines for the care and use of laboratory animals (NIH, 1985).

**Blood Sample Collection**: At the end of the administration period (60days), rats from the various groups were reweighed and sacrificed after authanization in a closed container with chloroform. Blood was collected by direct cardiac puncture into heparin treated tubes for haematology analysis.

**Haematology Test :** The haematological parameters (red blood cell count (RBC), haemoglobin (Hb), packed cell volume (PCV), white blood cell count (WBC), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), and WBC differentials; neutrophils, lymphocytes and monocytes considered in this study were analysed according to the standard techniques described by Baker *et al*.(1998) and Cheesbrough (2000).

**Statistical Analysis:** Results obtained in the present study were presented as mean and standard deviation while Student`s t-test described by Pearson and Hartley [1966] and Steel and Torris [1960] were used for test of significance between the samples.

## RESULTS AND DISCUSSION

**Table 1:** Saturated Fatty Acid Composition of "Ntubiri" and "Ntiti-Ikpa" (%).

| Fatty Acid | "Ntubiri" | "Ntiti-Ikpa" |
|---|---|---|
| Caprylic acid (C8:0) | N.D | N.D |
| Capric acid (C10: 0) | N.D | N.D |
| Lauric acid (C12:0) | 0.25±0.10 | N.D |
| Myristic acid (C14:0) | 1.03±0.03 | 1.02±0.02 |
| Palmitic acid (C16:0) | 41.69±2.00 | 42.93±2.93 |
| Stearic acid (C18:0) | 4.77±1.77 | 3.84±1.36 |
| ∑SFA | 47.74 | 47.79 |

Values are mean and standard deviation of triplicate determinations.
ND= Not Detected
∑SFA= Sum of Saturated Fatty Acid.

Fatty acids can be said to be carboxylic acids (Walker and McMahon, 2008). Saturated fatty acids are among the varieties of fatty acids (Walker and McMahon, 2008). The saturated fatty acid composition of "Ntubiri" and "Ntiti-Ikpa" as present in Table 1 revealed that caprylic acid (C8:0), and capric acid (C10:0) were not present in the studied foods. Amadi *et al*. (2011) reported similar findings in a traditional food called "Onunu". Lauric acid (C12:0) was not detected in "Ntiti-Ikpa" but found in "Ntubiri" in the present study. Myristic acid (C14:0), palmitic acid (C16:0) and stearic acid (C18:0) were detected in the studied foods in comparable concentrations. Their concentrations in the present study compared favorably to those of "Onunu" and "Mgbam" traditional foods (Amadi *et al*., 2011). Nutritionally, these saturated fatty acids are very important in the body.

Unsaturated fatty acids are also among the existing types of fatty acids (Alais and Linden, 1999). From Table 2, myristoleic acid (C14:1) was not detected in the studied food samples. "Ntubiri" was significantly ($p<0.05$) higher in oleic acid (C18:1) than "Ntiti-Ikpa"; while "Ntiti-Ikpa" was significantly ($p<0.05$) higher in linoleic acid (C18:2) than "Ntubiri" food. The observed concentrations of oleic acid (C18:1) in the studied foods were higher than that of "Mgbam" but comparable to that of "Onunu" diet (Amadi *et al*., 2011). Unsaturated fatty acids can be monounsaturated or polyunsaturated (Walker and McMahon, 2008). The monounsaturated fatty acid of "Ntubiri" in the present study was higher than "Ntiti-Ikpa" whereas; polyunsaturated fatty acid of "Ntiti-Ikpa" was higher than that of "Ntubiri" food (Table 2).

**Table 2:** Unsaturated Fatty Acid Composition of "Ntubiri" and "Ntiti-Ikpa" (%).

| Fatty Acids | "Ntubiri" | "Ntiti-Ikpa" |
|---|---|---|
| Myristoleic acid ( C14:1) | N.D | N.D |
| Oleic acid (C18:1) | 40.65±0.65 | 37.73±2.10 |
| Linoleic acid (C18:2) | 10.32±1.20 | 12.75±3.12 |
| Linolenic acid (C18:3) | 1.27±0.27 | 0.61±0.42 |
| ∑MUFA | 40.65 | 37.73 |
| ∑PUFA | 11.59 | 13.36 |
| ∑UFA | 52.24 | 51.09 |

Values are mean and standard deviation of triplicate determinations.
ND= Not Detected.
∑MUFA: Sum of Monounsaturated Fatty Acid.
∑PUFA: Sum of Polyunsaturated Fatty Acid. .
∑UFA: Sum of Unsaturated Fatty Acid.

Sum of unsaturated fatty acid contents of the studied foods as observed in Table 2, are comparable. Generally, unsaturated fatty acids become important when their functions are considered in the body. Walker and McMahon ( 2008) noted that oleic acid (C18:1), linoleic acid (C18:2) and linolenic acid (C18:3) are omega -9 fatty acid, omega -6 fatty acid, and omega-3 fatty acid respectively. The same authors noted that omega-3 and omega-6 fatty acids are important for cardiovascular health. Omega-6 and omega-3 are polyunsaturated fatty acids while omega-9 is a monounsaturated fatty acid (Lisa and Paula, 2010). The benefits of having omega forms of fatty acids in the body include reduction of prostate cancer, lowering cholesterol, reducing risk for breast cancer, lowering risk for heart disease and stroke, less severe pain and stiffness for sufferers of rheumatoid arthritis, weight loss, reduction of belly fat, etc (Mary and Shawn, 2006; Lisa and Paula, 2010).

Proteins are absorbed in the body in form of amino acids (Sarojini, 1998). Amino acids can be essential or non-essential (Olusanya, 2008). The table of essential amino acid constituents of "Ntubiri" and "Ntiti-Ikpa" traditional foods (Table 3)

showed that apart from tryptophan; valine, isoleucine, methionine, leucine, phenylalanine, threonine, lysine, histidine and arginine were present in the studied foods. The concentrations of valine, Isoleucine, methionine, leucine, threonine and arginine in "Ntubiri" were significantly ($p<0.05$) higher than those of "Ntiti-Ikpa" in the present study. All put together, the essential amino acids of the studied foods compared favorably to those of reference foods of whole hen`s egg, casein and cow milk (Table 3).

Non-essential amino acid constituents of "Ntubiri" and "Ntiti-Ikpa" foods in Table 4 revealed the presence of aspartic acid, serine, glutamic acid, proline, glycine, alanine, cystine and tyrosine. "Ntubiri" was significantly ($p<0.05$) higher in concentrations of aspartic acid, glutamic acid, proline, alanine, cystine and tyrosine than "Ntiti-Ikpa" in this study. The observed non-essential amino acids of the present study were comparable to those of reference foods of whole hen`s egg, casein, and cow milk (Table 4).

The quality of a protein is determined by its ability to promote growth. This ability to promote growth is dependent on the amino acid composition of the protein. For growth to be achieved, all the amino acids must be present in the body and in adequate amount for specific purpose (Olusanya, 2008). A protein source which contain all the essential amino acids is said to be of good quality or high biological value (Olusanya, 2008) while one which lack one or more essential amino acids is of poor quality or low biological value (Olusanya, 2008). Table of protein quality of this study (Table 5) showed that chemical scores of essential amino acids such as valine, isoleucine, methionine, leucine, threonine, and arginine were significantly ($p<0.05$) higher in "Ntubiri" than "Ntiti-Ikpa" food. This could be indication that "Ntubiri" is of better protein quality than "Ntiti-Ikpa". The chemical scores of all essential amino acids in "Ntubiri" and "Ntiti-Ikpa" foods were lower than those of reference protein quality of whole hen`s egg. From the results presented in Table 5, the protein quality of the present study followed the order of whole hen`s egg>"Ntubiri">"Ntiti-Ikpa foods.

The haematological parameters are used to evaluate the blood relating functions of consumable substances in animals (Yakubu *et al*., 2008). Haematological parameters have been associated with indices and are of diagnostic significance in the routine clinical evaluation of the state of health (Hoff brand and Pettit, 2000; Yakubu *et al*., 2007). The red blood cell (RBC) levels of the test rats ($I_a$ to $I_d$) placed on "Ntubiri" were higher than control 1, but lower than control 2 (Table 6).

The red blood cell levels of test rats ($I_e$ to $I_h$) placed on "Ntiti-Ikpa" compared favourably to that of control 2. Haemoglobin (Hb) levels also followed the same order as red blood cell (RBC) levels in this study. Okaka and Okaka (2005) noted that glycine is a part of the porphyrin ring of haemoglobin and along with serine, provides part of the structure of the purines and pyrimidines bases of nucleic acids. The observation made on red blood cell and haemoglobin levels in the present study could be related to higher glycine and serine contents of "Ntiti-Ikpa" food to "Ntubiri" in this study. This observation may be that the rate at which Ntiti-Ikpa" food facilitate erythropoiesis in the body is comparable to that of nutrend $^{TM}$.

Increase in the number of white blood cell (WBC), is attributed to normal reaction of the body to foreign substances (Celik and Suzek, 2008). Leucocytosis observed in the present study (Table 6) revealed significant ($p<0.05$) increase in white blood cell (WBC) of rats placed on nutrend $^{TM}$ (control 2) and the test rats (group $I_{a\ to\ d,}$ and group $I_{e\ to\ h}$) against control 1 rats. It could be due to stimulation of the immune system of the rats by nutrend $^{TM}$ and the studied foods. The implication could be increase in immunity of test rats against infection.

The white blood cell differentials such as neutrophil, lymphocyte, and monocyte are among the components of white blood cell (WBC) that help facilitate white blood cell functions in the body. "Ntubiri" and "Ntiti-Ikpa" foods facilitated lymphocytosis in the body of test rats against control 1 rats, but did not facilitate neutrophil and monocyte production in this study (Table 6). Increase in haemoglobin level is normally associated with corresponding increase in packed cell volume (PCV).This was also observed in the present study. Mean corpuscular haemoglobin (MCH), and mean corpuscular haemoglobin concentration (MCHC) are related to individual red blood cells, and are used to determine future disease state of blood (Adebayo *et al.,* 2005; Abiodun *et al.,* 2010). Keele *et al*., (1983) associated normocytic and hypochromic anemia to reduction of MCH and MCHC respectively.

**Table 3:** Essential Amino Acid Constituent of "Ntubiri" and "Ntiti-Ikpa" Foods Compared to those Reference Foods (mg/g nitrogen).

| Amino Acid | "Ntubiri" | "Ntiti-Ikpa" | Whole hen`s egg | Casein | Cow Milk |
|---|---|---|---|---|---|
| Valine | 350.00±10.00 | 260.00±20.00 | 482.00 | 438.00 | 362.00 |
| Isoleucine | 350.00±5.00 | 290.00±30.00 | 393.00 | 345.00 | 295.00 |
| Methionine | 150.00±13.00 | 76.00±3.00 | 210.00 | 178.00 | 157.00 |
| Leucine | 675.00±20.00 | 604.00±4.00 | 551.00 | 607.00 | 596.00 |
| Tryptophan | N.D | N.D | N.D | N.D | N.D |
| Phenylalanine | 386.00±7.00 | 402.00±2.00 | 358.00 | 334.00 | 336.00 |
| Threonine | 280.00±30.00 | 205.00±1.00 | 320.00 | 297.00 | 278.00 |
| Lysine | 278.00±10.00 | 340.00±30.00 | 436.00 | 518.00 | 487.00 |
| Histidine | 210.00±10.00 | 228.00±8.00 | 152.00 | 186.00 | 167.00 |
| Arginine | 561.00±3.00 | 489.00±12.00 | 381.00 | 239.00 | 205.00 |

Values are means ± standard deviations of triplicate determination.
Reference Foods sourced from OAU (1972).

**Table 4:** Non-essential Amino Acid Constituent of "Ntubiri" and "Ntiti-Ikpa" Foods Compared to those Reference Foods (mg/g nitrogen).

| Amino Acid | "Ntubiri" | "Ntiti-Ikpa" | Whole hen`s egg | Casein | Cow Milk |
|---|---|---|---|---|---|
| Aspartic acid | 907.00±7.00 | 766.00±2.00 | 601.00 | 455.00 | 481.00 |
| Serine | 205.00±2.00 | 316.00±11.00 | 478.00 | 385.00 | 362.00 |
| Glutamic acid | 1121.00±56.00 | 925.00±35.00 | 796.00 | 1406.00 | 1390.00 |
| Proline | 180.00±5.00 | 128.00±4.00 | 260.00 | 738.00 | 571.00 |
| Glycine | 230.00±4.00 | 261.00±15.00 | 207.00 | 126.00 | 123.00 |
| Alanine | 350.00±5.00 | 290.00±7.00 | 370.00 | 196.00 | 217.00 |
| Cystine | 125.00±5.00 | 108.00±9.00 | 152.00 | 23.00 | 51.00 |
| Tyrosine | 300.00±25.00 | 290.00±17.00 | 260.00 | 337.00 | 297.00 |

Values are means ± standard deviations of triplicate determination.
Reference Foods sourced from OAU (1972).

**Table 5:** Protein Quality of "Ntubiri" and "Ntiti-Ikpa" Foods Compared to those Whole Hen`s egg as Reference Protein (mg/100g).

| Amino Acid | "Ntubiri" | "Ntiti-Ikpa" | Whole hen`s egg |
|---|---|---|---|
| Valine | 81.77±1.77 | 60.74±0.00 | 428.00 |
| Isoleucine | 89.05±2.05 | 73.79±1.09 | 393.00 |
| Methionine | 71.08±0.59 | 34.52±1.47 | 210.00 |
| Leucine | 122.50±0.20 | 109.62±9.00 | 551.00 |
| Phenylalanine | 107.82±7.00 | 112.37±4.23 | 358.00 |
| Threonine | 87.50±1.30 | 64.06±0.00 | 320.00 |
| Lysine | 63.76±12.16 | 77.98±2.00 | 436.00 |
| Histidine | 138.16±2.11 | 150.00±5.00 | 152.00 |
| Arginine | 147.29±0.00 | 128.35±1.03 | 381.00 |

Values are means ± standard deviations of triplicate determination.
Protein Quality of Reference Foods sourced from OAU (1972).

**Table 6:** Result of Haematology Studies of "Ntubiri" and "Ntiti-Ikpa" Foods.

| | | | "Ntubiri" | | | | "Ntiti-ikpa" | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Groups / Parameters | Control 1 | Control 2 | $I_a$ | $I_b$ | $I_c$ | $I_d$ | $I_e$ | $I_f$ | $I_g$ | $I_h$ |
| RBC ($x10^{12}$/L) | 3.65 ± 0.04 | 5.80 ± 0.20 | 4.11 ± 0.20 | 4.28 ± 0.10 | 4.33 ± 0.08 | 4.39 ± 0.31 | 5.19 ± 0.04 | 5.46 ± 0.84 | 5.49 ± 0.20 | 5.64 ± 0.20 |
| Hb (g/dl) | 11.47 ± 0.90 | 13.61 ± 0.38 | 12.18 ± 0.01 | 12.21 ± 0.90 | 12.25 ± 0.18 | 12.31 ± 0.02 | 13.07 ± 0.28 | 13.19 ± 0.10 | 13.18 ± 0.15 | 13.30 ± 1.04 |
| WBC ($x10^{14}$/L) | 63.12 ± 1.05 | 73.20 ± 1.13 | 70.69 ± 2.05 | 70.81 ± 1.17 | 71.30 ± 0.09 | 71.28 ± 0.95 | 72.05 ± 1.30 | 72.90 ± 0.81 | 72.10 ± 0.67 | 73.55 ± 1.29 |
| *Neutrophil (%) | 24.18 ± 0.41 | 25.83 ± 0.27 | 25.80 ± 0.53 | 25.10 ± 0.30 | 25.19 ± 0.20 | 25.21 ± 0.33 | 25.20 ± 0.28 | 24.99 ± 0.75 | 25.27 ± 0.40 | 25.30 ± 0.64 |
| *Lymphocyte (%) | 73.08 ± 1.06 | 76.04 ± 0.70 | 75.46 ± 1.38 | 75.10 ± 1.49 | 74.45 ± 1.28 | 75.88 ± 0.91 | 76.17 ± 1.10 | 76.33 ± 1.09 | 76.14 ± 0.91 | 76.24 ± 1.20 |
| *Monocyte (%) | 0.40 ± 0.19 | 0.42 ± 0.10 | 0.41 ± 0.09 | 0.41 ± 0.01 | 0.42 ± 0.04 | 0.42 ± 0.10 | 0.42 ± 0.18 | 0.42 ± 0.10 | 0.43 ± 0.02 | 0.43 ± 0.07 |
| PCV (%) | 34.52 ± 0.53 | 41.23 ± 0.30 | 36.78 ± 0.60 | 36.75 ± 0.42 | 37.12 ± 0.94 | 37.30 ± 0.66 | 39.61 ± 0.20 | 39.97 ± 0.18 | 39.95 ± 0.42 | 40.30 ± 0.21 |
| MCH (pg) | 3.14 ± 0.80 | 2.35 ± 0.23 | 2.96 ± 0.91 | 2.28 ± 0.40 | 2.83 ± 0.59 | 2.80 ± 0.72 | 2.52 ± 0.93 | 2.42 ± 0.28 | 2.40 ± 0.74 | 2.36 ± 0.61 |
| MCHC (%) | 0.33 ± 0.09 | 0.34 ± 0.02 | 0.33 ± 0.07 | 0.33 ± 0.03 | 0.33 ± 0.05 | 0.33 ± 0.01 | 0.32 ± 0.00 | 0.32 ± 0.11 | 0.32 ± 0.10 | 0.33 ± 0.02 |

Values are means ± standard deviations of eight determinations.

The insignificant effect ($p>0.05$) observed in MCH and MCHC of rats given "Ntubiri" and "Ntiti-Ikpa" against control 1 and control 2 (Table 6) according to Keele *et al*., (1983), could mean that consumption of the studied foods may not result in normocytic or hypochromic anemia.

Adebayo *et al*., (2005) associated MCH and MCHC to the incorporation of haemoglobin into red blood cells nor the morphology, and osmotic fragility of the red blood. The insignificant effect ($p>0.05$) observed in MCH and MCHC of rats given "Ntubiri" and "Ntiti-Ikpa" against control 1 and control 2 in this study could mean that neither incorporation of haemoglobin into red blood cells nor the morphology; and osmotic fragility of the red blood cells was altered by the studied foods.

## CONCLUSION

The present study has shown the fatty acid constituents, amino acid quality and haematological moderation of "Ntubiri" and "Ntiti-Ikpa" traditional foods.

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