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# Mineral Composition of Commonly Consumed Local Foods in Nigeria

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**ABSTRACT**

Appropriate levels of mineral nutrients are required to maintain optimal health as acute imbalances of these minerals can be potentially fatal. Therefore, dietary intake of micronutrients is of public health importance due to the consequences of the deficiency. This study analysed the selected minerals (Na, K, Mg, Ca, Fe, Zn, Cu, P, Cl and Mn) in the representative samples of 25 commonly consumed Nigerian dishes using appropriate procedures. New data generated on these local dishes demonstrates the inadequacy of some mineral elements in selected Nigerian local dishes relative to the recommended daily allowance. Sodium, potassium, magnesium, calcium and iron contents expressed as mg/100 g dry weight ranged from 5.0±0.20 to 17.4±0.42, 4.6±0.3 to11.2±0.5, 2.4±0.3 to 10.0±0.2, 7.08±0.03 to 19.78±0.14 and 6.32±0.25 to 24.01±0.87 respectively. The zinc, copper, phosphorous, chlorine and manganese contents were between 2.19±0.09 to 8.31±0.17, 0.63±0.03 to 3.45±0.14, 0.76±0.08 to 4.27±0.15, 54.8±3.35 to 2301±46.97 and 2.24±0.05 to 7.19±0.43 respectively. The physiologic roles of mineral nutrients are as varied as their composition and the deficiency of these micronutrients in Nigerian dishes and their possible health effects were highlighted in this study. These data will serve as an important tool in future national and international food consumption surveys to target provision of dietary advice, inform health workers, dieticians, clinicians and researchers among others.

**Keywords:** Micronutrients, Minerals, Nigerian foods, Sodium, Zinc, Iron, Copper

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## INTRODUCTION

Dietary minerals (also known as mineral nutrients) are the chemical elements required by living organism, other than the four elements of carbon, hydrogen, nitrogen and oxygen present in organic molecules. These minerals are present in virtually all cells of the body, ensuring our internal systems function efficiently. Appropriate levels of these chemical elements have been demonstrated to be required to maintain optimal health as acute imbalances of these minerals can be potentially fatal (WHO/ FAO, 2004). Therefore, dietary mineral intake must be sustained to maintain physical health. For instance, magnesium deficiency can result in low levels of calcium in the blood while impaired immunity, anaemia with altered iron metabolism and bone marrow changes are clinical features of copper deficiency (Champagne 2008). In addition, poor selenium status is also linked to poor immune system as well as increased risk of cancer and heart diseases (Brown and Arthur, 2001).

Dietary intake of micronutrients is of public health importance due to the consequences of the deficiency. In fact, epidemiological studies have shown that deficiencies of several mineral nutrients result in stunting and down regulate immune responsiveness. Hence, there is an increased in morbidity and mortality rate due to infections, particularly, among young children and adolescents residing in developing countries (WHO, 1998; Bhaskaram, 2001). In Nigeria, avoidable mineral nutrient deficiencies impact well-being and are pervasive especially among small children and pregnant women (UNICEF 2009). For instance, the rate of anaemia (largely resulting from inadequate intake of dietary iron) among preschool aged children and pregnant women are 76 % and 67 % respectively (WHO

2008). Although the data for most of the raw foods are available but given that food variation and food processing practices affect mineral bioavailability (Oberleas 2003), it is difficult to estimate the nutrient intakes based on the data from raw food components. Beside the work of Onabanjo and Oguntona (2003) that contains only a few dietary mineral data (iron, zinc and copper) on Nigerian local dishes, the mineral nutrient contents of these foods / dishes are even less available. Therefore, it is unknown if Nigerian local dishes contain adequate mineral nutrient for optimal health and if its intake can sufficiently provide the WHO Recommended Daily Allowance (RDA) for mineral nutrients.

Considering the prevalence of nutrition-related health problems among Nigerians, there is therefore an increasing need for a more complete, accurate, reliable data on the nutrient content and nutritional value of local foods. This is to enable the recommendation of combinations of foods that will promote good health and reduce the risk of these non-communicable diseases. The aim of this study was to analyse the mineral composition of the commonly consumed local foods in Nigeria and fill the gaps in national food composition data. The objectives of this study were to: analyze and quantify the metal and non-metal minerals in Nigerian local foods / dishes; and evaluate the adequacy of mineral nutrients in Nigerian local dishes for optimal health and determine whether consumption of these local foods / dishes is sufficient to meet the WHO RDA for mineral nutrients.

## MATERIALS AND METHODS

### Prioritization of commonly consumed local foods

A list of twenty-five (25) local foods commonly consumed in Nigeria was generated based on the study of Onabanjo and Oguntona (2003) and modifying. Factors considered in the prioritization of the local dishes includes: size ethnic populations; market retail share; and sales from restaurants and takeaways. The foods are described in the Table 1.

**Table 1:**
Description of selected commonly consumed local foods in Nigeria

| | Food / Dish | Description |
|---|---|---|
| 1 | Akara | Deep fried ball made with ground beans and spices |
| 2 | Amala and Ewedu Soup | Cuisine made out of yam flour with jute leave soup |
| 3 | Amala and Gbegiri Soup | Cuisine made out of yam flour with mashed bean soup |
| 4 | Amala lafun | Cuisine made out of cassava flour |
| 5 | Beans and Plantain | Boiled beans with pepper, onions and fried plantain |
| 6 | Eba and Okazi Soup | Stiff dough made from garri with African Jointfir leave soup |
| 7 | Eba and Okro Soup | Stiff dough made from garri with lady finger / okra soup |
| 8 | Edikiakong Soup | Made with a generous amount of fresh fluted pumpkin and water leaves vegetables, dried fish and assorted meat. |
| 9 | Fufu | Cooked cassava flour dough |
| 10 | Fufu and Banga Soup | Cooked cassava flour dough with meat, fish and palm fruit and scented leave soup |
| 11 | Ikokore | Savoury water-yam porridge with pepper and crayfish |
| 12 | Jollof Rice | Cooked rice with tomatooes, pepper and onions |
| 13 | Ofada Rice and Stew | Local Nigerian rice with ayamase pepper stew |
| 14 | Ogbono Soup | Made with African mango seed, palm oil, chilli pepper and vegetables |
| 15 | Onugbu Soup | Made with bitter leaves, cocoyam paste, palm oil, pepper |
| 16 | Pap and Moin-moin | Cooked wet corn starch and steamed bean pudding made with bean flour, onions, pepper and oil |
| 17 | Pounded Yam and Egusi Soup | Cuisine made from pounded cooked yam with melon and vegetable soup |
| 18 | Rice and Beans | Cooked rice and beans |
| 19 | Semovita and Miyan-kuka Soup | Cooked semolina flour and Baobab leaf soup |
| 20 | Tuwo Shinkafa | Thick pudding made from mashed cooked rice |
| 21 | Vegetable Soup | Fresh leafy vegetable with palm oil and pepper |
| 22 | Waina | Crispy ommelete made from rice flour with onions |
| 23 | Wanke | Cooked rice and beans with fried fish |
| 24 | Yam and Egg | Cooked yam with fried egg |
| 25 | Yam porridge and Bean | Savoury yam porridge with pepper, oil, onion and cooked beans |

**Table 2:**
Recommended Dietary Allowances and Adequate Intakes for selected minerals.

| Life Stage | Group | Calcium | Copper | Iron | Magnesium | Manganese | Phosphorus | Zinc | Potassium | Sodium | Chloride |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (mg/d) | (µg/d) | (mg/d) | (mg/d) | (mg/d) | (mg/d) | (mg/d) | (g/d) | (g/d) | (g/d) |
| Children | (1-3 yr) | 700 | 340 | 7 | 80 | *1.2* | 400 | 3 | *3* | *1* | *1.5* |
| Children | (4-8 yr) | 1000 | 440 | 10 | 130 | *1.5* | 500 | 5 | *3.8* | *1.2* | *1.9* |
| Male | (19-50 yr) | 1000 | 900 | 8 | 420 | *2.3* | 700 | 11 | *4.7* | *1.5* | *2.3* |
| Female | (19-50 yr) | 1000 | 900 | 18 | 320 | *1.8* | 700 | 8 | *4.7* | *1.5* | *2.3* |
| Pregnancy | (19-50 yr) | 1000 | 1000 | 27 | 360 | *2* | 700 | 11 | *4.7* | *1.5* | *2.3* |
| Lactation | (19-50 yr) | 1000 | 1300 | 9 | 320 | *2.6* | 700 | 12 | *5.1* | *1.5* | *2.3* |

*This table presents Recommended Daily Allowance (RDA) in ordinary type and Adequate Intake (AI) in italics type. An RDA is the average daily intake level; sufficient to meet the nutrient requirement of nearly all (97-98%) health individuals in a group. If sufficient scientific evidence is not available to establish the RDA, an AI is usually developed. The AI is believed to cover the needs of all healthy individuals in the groups, but lack of data or uncertainty in the data prevent being able to specify with confidence the percentage of individuals covered by this intake.*
*The table was adapted from Dietary Reference intakes for Calcium, Phosphorus, Magnesium, Vitamin D and Flouride (1997); Dietary Reference intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromiun, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium and Zinc (2001); and Dietary Reference intakes for Water, Potassium, Sodium, Chloride, and Sulphates (2005). These reports may be accessed via www.nap.edu.*

**Sample collection and preparation**
For the analysis of these widely consumed local foods / dishes, multiple primary samples of each food were collected from three (3) major sources namely household, local canteen and upscale restaurant. Household foods are prepared by members of relevant ethnic groups; local canteen foods are prepared in makeshift bukateria, corner food-joints and ethnic canteen; and, upscale restaurant foods are obtained from high-end food courts and cuisines service centers.

The number of samples from each source is six (6) and each food collected was weighed on an electronic scale with sensitivity in grams and recorded. Equal amount of primary samples were mixed and homogenized with an electric blender (Thorn Emi Domestic Appliances, UK) to make a composite sample of approximately 300 g. Thereafter, an aliquot sample of 100 g was stored in zipper-lock bags, labeled and stored appropriately for analyses.

The values of daily intake, Recommended Dietary Allowances (RDA) or Adequate Intakes (AI), as well as the Upper Intake Levels (UL) recommended by the Food and Nutrition Board / Institute of Medicine (US) for the minerals analyzed were used as a reference for adults and elderly of both genders. For the purpose of this study, an adult was an individual between 19 and 50 years old (Table 2).

**Reagent and Standard**
All reagents were analytical grade. High purity deionized water (resistivity 18.2 mΩ) obtained using the Milli-Q water purification system (Millipore, Bedford, MA, USA) was used throughout. All glassware were cleaned by soaking in 20% (v/v) HNO3 for three hours, rinsed three (3) times with Milli-Q water and dried before use. For the standard curves, a multi element standard solution was prepared in 5% HCl (v/v) from stock solutions of 10,000 mg/L of Ca, K, Mg, Na (Merck, Darmstadt, Germany) and at 1,000 mg/L for Cu, Mn, Fe, Se, Zn (Merck, Darmstadt, Germany). The concentration ranges of the standard solutions were: 0.01 to 1 mg/L of Cu, Fe, Mn and Zn; 1.01 to 101 mg/L of Ca, Mg, K, P and Na; 0.01 to 0.5 mg/L of Se.

**Moisture content determination:** This was determined by drying samples to constant weight in an electric oven at 110 C (AOAC, 1990). Moisture content was then calculated as percentage water loss. The dried food samples were then pulverized (into a fine homogeneous powder) using an acid washed agate ball and mill.

**Mineral determination:** Two gram of powdered food samples was ashed at 550 C initially for 6 hours and then to a constant weight. The ashes were dissolved in 2.5 mL of concentrated HCl (Sigma, Germany) and diluted to 25 mL with deionized water. The sodium, calcium, potassium, magnesium, phosphorous, copper, manganese and zinc contents of all food samples were determined (on the aliquots solutions of the ash) by flame atomic spectrophotometry procedures (AOAC, 1990) using an Atomic Absorption Spectrophotometer. For iron, two grams of food samples were transferred into 25 ml volumetric flasks and 5 ml concentrated HCl was added. The flasks were shaken for 2 hours in an orbital shaker, thereafter; the solution was diluted to level with deionized water and filtered with a filter paper. All analyses were done in triplicates.

**Statistical Analysis:** The GraphPad Instat Version 3.05 for Window Vista (GraphPad Software, San Diego California, USA) was employed for data analysis. Results were expressed as mean ± standard error of mean (SEM).

## RESULTS

The moisture and mineral contents of the selected foods were determined and reported for 100g fresh weight of edible food as presented in Table 3a and 3b.

Dry weights varied from 7.8 g/100g in Tuwo Shinkafa to 45.5 g/100g in Jollof rice. The three foods with highest dry weight are: Jollof rice; Yam & egg; and Pounded yam & Egusi with 45.5 g/100g, 30.8 g/100g and 28.8 g/100g respectively. However, the three foods with the lowest dry weights are: Tuwo Shinkafa; Edikaikong; and Pap & Moinmoin with 7.8 ± 0.8, 12.4 ± 1.0 and 14.4 ± 0.8g/100 respectively.

**Table 3a:**
Moisture content, sodium, potassium, magnesium, calcium and iron contents of Nigerian dishes (mg/100g dry weight of the composite dish)

| Sample Dish | MC (%) | Na | K | Mg | Ca | Fe |
|---|---|---|---|---|---|---|
| Akara | 75.0 ± 0.3 | 16.7 ± 0.80 | 8.2 ± 0.4 | 6.3 ± 0.3 | 8.21 ± 0.30 | 9.96 ± 0.23 |
| Amala and Ewedu Soup | 79.4 ± 0.5 | 11.2 ± 0.10 | 5.2 ± 0.1 | 8.4 ± 0.2 | 8.11 ± 0.54 | 11.16 ± 1.26 |
| Amala and Gbegiri Soup | 81.6 ± 1.5 | 10.6 ± 0.33 | 8.0 ± 0.2 | 5.0 ± 0.4 | 7.60 ± 0.29 | 9.53 ± 0.35 |
| Amala lafun | 73.2 ± 0.4 | 5.1 ± 0.43 | 7.5 ± 0.3 | 5.4 ± 0.2 | 14.59 ± 0.42 | 11.46 ± 0.32 |
| Beans and Plantain | 73.2 ± 0.4 | 13.8 ± 0.36 | 7.9 ± 0.2 | 4.2 ± 0.2 | 7.08 ± 0.03 | 9.30 ± 0.26 |
| Eba and Okazi Soup | 85.0 ± 1.4 | 9.0 ± 0.24 | 11.2 ± 0.5 | 10.0 ± 0.2 | 14.17 ± 0.47 | 19.55 ± 0.45 |
| Eba and Okro Soup | 76.8 ± 2.2 | 21.6 ± 0.20 | 7.7 ± 0.1 | 9.6 ± 0.1 | 10.07 ± 0.08 | 10.02 ± 0.2 |
| Edikiakong Soup | 87.6 ± 1.0 | 14.0 ± 0.29 | 6.8 ± 0.2 | 7.7 ± 0.1 | 8.08 ± 0.06 | 7.90 ± 0.36 |
| Fufu | 86.4 ± 1.0 | 5.9 ± 0.34 | 10.0 ± 0.1 | 5.1 ± 0.1 | 11.18 ± 0.15 | 16.91 ± 0.64 |
| Fufu and Banga Soup | 72.4 ± 0.5 | 7.9 ± 0.53 | 9.2 ± 0.3 | 4.1 ± 0.1 | 10.30.± 0.13 | 9.37 ± 0.29 |
| Ikokore | 74.4 ± 2.7 | 6.9 ± 0.16 | 9.0 ± 0.3 | 5.2 ± 0.1 | 10.48 ± 0.25 | 11.63 ± 0.40 |
| Jollof Rice | 54.6 ± 2.0 | 10.6 ± 0.21 | 9.2 ± 0.2 | 5.0 ± 0.1 | 7.59 ± 0.35 | 6.32 ± 0.25 |
| Ofada Rice and Stew | 84.4 ± 1.3 | 6.8 ± 0.14 | 10.2 ± 0.2 | 7.0 ± 0.1 | 10.91 ± 0.10 | 10.02 ± 0.18 |
| Ogbono Soup | 75.6 ± 1.7 | 17.0 ± 0.50 | 7.2 ± 0.2 | 5.7 ± 0.2 | 7.29 ± 0.22 | 7.5 ± 0.08 |
| Onugbu Soup | 86.8 ± 1.0 | 9.2 ± 0.27 | 9.6 ± 0.3 | 4.4 ± 0.5 | 12.70 ± 0.58 | 17.66 ± 0.83 |
| Pap and Moin-moin | 86.2 ± 0.8 | 5.9 ± 0.19 | 8.9 ± 0.2 | 2.4 ± 0.3 | 9.64 ± 0.15 | 10.64 ± 0.35 |
| Pounded Yam and Egusi Soup | 75.2 ± 2.2 | 12.0 ± 0.39 | 6.0 ± 0.2 | 8.6 ± 0.2 | 7.38 ± 0.15 | 9.75 ± 0.11 |
| Rice and Beans | 74.5 ± 1.3 | 11.0 ± 0.20 | 7.7 ± 0.14 | 9.69 ± 0.14 | 13.69 ± 0.12 | 24.01±0.87 |
| Semovita and Miyan-kuka Soup | 84.0 ± 0.4 | 9.2 ± 0.12 | 5.5 ± 0.2 | 6.0 ± 0.3 | 10.75 ± 0.18 | 9.31 ± 0.24 |
| Tuwo Shinkafa | 92.2 ± 0.8 | 6.8 ± 0.29 | 10.8 ± 0.1 | 8.9 ± 0.2 | 10.31 ± 0.14 | 8.93 ± 0.12 |
| Vegetable Soup | 81.6 ± 1.5 | 10.4±0.63 | 6.7 ± 0.3 | 5.4 ± 0.2 | 19.78 ± 0.14 | 10.41 ± 0.32 |
| Waina | 73.8 ± 0.6 | 8.6 ± 0.34 | 10.6 ± 0.3 | 5.0 ± 0.1 | 11.89 ± 0.70 | 14.81 ± 0.55 |
| Wanke | 78.0 ± 0.3 | 13.0 ± 0.60 | 4.6 ± 0.3 | 6.5 ± 0.3 | 10.10 ± 0.27 | 12.15 ± 0.19 |
| Yam and Egg | 69.2 ± 1.1 | 5.0 ± 0.20 | 7.9 ± 0.2 | 4.2 ± 0.2 | 7.14 ± 0.75 | 10.34 ± 0.73 |
| Yam porridge and Bean | 76.0 ± 1.2 | 17.4 ± 0.42 | 6.9 ± 0.2 | 8.1 ± 0.3 | 14.78 ± 0.18 | 22.21 ± 0.49 |

MC connotes the moisture content

Table 3b:
Zinc, copper, phosphorous, chloride and manganese contents of Nigerian dishes (mg/100g dry weight of the composite dish)

| Sample Dish | Zn | Cu | P | Cl | Mn |
|---|---|---|---|---|---|
| Akara | 2.4 ± 0.36 | 2.37 ± 0.21 | 2.43 ± 0.28 | 142.09 ± 1.81 | 6.41 ± 0.22 |
| Amala and Ewedu Soup | 5.01 ± 0.14 | 1.50 ± 0.21 | 1.72 ± 0.21 | 288.61 ± 8.11 | 7.19±0.16 |
| Amala and Gbegiri Soup | 2.65 ± 0.26 | 1.38 ± 0.24 | 3.49 ± 0.29 | 152.97 ± 4.29 | 3.17 ± 0.10 |
| Amala lafun | 4.06 ± 0.05 | 3.19 ± 0.15 | 0.91 ± 0. 04 | 74.46 ± 3.03 | 2.93 ± 0.07 |
| Beans and Plantain | 3.03 ± 0.08 | 1.10 ± 0.12 | 3.07±0.06 | 1260.11 ± 33.21 | 5.91±0.19 |
| Eba and Okazi Soup | 8.31 ± 0.17 | 2.04 ± 0.04 | 0.94 ± 0.05 | 104.81 ± 3.25 | 6.99 ± 0.09 |
| Eba and Okro Soup | 3.92 ± 0.22 | 2.64 ± 0.07 | 3.85 ± 0.24 | 555.56 ± 18.02 | 6.68 ± 0.14 |
| Edikiakong Soup | 3.01 ± 0.19 | 0.63 ± 0.03 | 2.7 ± 0.12 | 2301. 58 ± 46.97 | 6.17 ± 0.10 |
| Fufu | 3.85 ± 0.12 | 1.95 ± 0.09 | 1.58 ± 0.13 | 119.02 ± 9.45 | 3.21 ± 0.14 |
| Fufu and Banga Soup | 5.00 ± 0.06 | 2.51 ± 0.16 | 1.85 ± 0.13 | 124.02 ± 1.57 | 3.83 ± 0.13 |
| Ikokore | 4.63 ± 0.20 | 0.91 ± 0.12 | 1.06 ± 0.08 | 121.90 ± 0.90 | 4.18 ± 0.10 |
| Jollof Rice | 2.19 ± 0.09 | 1.09 ± 0.11 | 4.27 ± 0.15 | 137.16 ± 1.62 | 3.08 ± 0.04 |
| Ofada Rice and Stew | 4.24 ± 0.28 | 2.22 ± 0.24 | 1.09 ± 0.05 | 127.49 ± 1.22 | 3.71 ± 0.24 |
| Ogbono Soup | 3.07± 0.19 | 1.27 ± 0.17 | 2.52 ± 0.06 | 445.35 ± 25.60 | 4.52 ± 0.15 |
| Onugbu Soup | 5.39 ± 0.27 | 1.18 ± 0.09 | 1.86 ± 0.13 | 119.42 ± 0.81 | 3.99 ± 0.10 |
| Pap and Moin-moin | 3.62 ± 0.19 | 1.92 ± 0.17 | 0.91 ± 0.03 | 93.80 ± 2.01 | 4.10 ± 0.07 |
| Pounded Yam and Egusi Soup | 1.83 ± 0.28 | 1.81±0.19 | 1.83±0.49 | 457.30 ± 18.67 | 5.38±0.13 |
| Rice and Beans | 7.39 ± 0.20 | 1.12 ± 0.05 | 2.25 ± 0.05 | 136.50 ± 9.47 | 7.19 ± 0.43 |
| Semovita and Miyan-kuka Soup | 4.05 ± 0.06 | 1.13 ± 0.03 | 1.02 ± 0.03 | 98.98 ± 2.02 | 4.00 ± 0.13 |
| Tuwo Shinkafa | 3.08 ± 0.07 | 0.96 ± 0.06 | 1.9 ± 0.07 | 132.60 ± 1.72 | 4.93 ± 0.27 |
| Vegetable Soup | 3.81±0.69 | 1.04 ± 0.03 | 1.22 ± 0.29 | 164.06 ± 2.77 | 6.39 ± 0.20 |
| Waina | 6.06 ± 2.09 | 1.26 ± 0.24 | 1.69 ± 0.13 | 122.41 ± 1.08 | 4.13 ± 0.08 |
| Wanke | 3.23 ± 0.22 | 2.12 ± 0.14 | 1.42 ± 0.04 | 178.09 ± 5.63 | 4.14 ± 0.16 |
| Yam and Egg | 1.77 ± 0.21 | 0.98 ± 0.03 | 0.76 ± 0.08 | 54.80 ± 3.35 | 2.24 ± 0.05 |
| Yam porridge and Bean | 4.53 ± 0.12 | 3.45 ± 0.14 | 2.04 ± 0.17 | 197.83 ± 2.02 | 6.64 ± 0.15 |

The sodium content was found to be highest in Eba & Okro (21.6 mg/100g); Yam porridge & Bean (17.4 mg/100g); and Ogbono soup (17 mg/100g) while Yam & Egg (5 mg/100g); Amala lafun (5.1mg/100g); and Pap & Moinmoin (5.9 mg/100g) account for food with the lowest sodium content. The top three dishes with iron content are Rice & Beans (24.01mg/100g), Yam porridge (22.21mg/100g) and Eba & Okazi (19.55 mg/100g) while the Jollof rice (6.32 mg/100g), Ogbono soup (7.5 mg/100g) and Edikaikong soup (7.9 mg/100g) contains the least amount of iron mineral.

Zinc mineral was found to be highest in Eba& Okazi (8.31 mg/100g), Rice and Bean (7.39 mg/100g) as well as Waina (6.06 mg/100g); however, Yam & Egg (1.77 mg/100g), Pounded Yam (1.83 mg/100g) and Jollof rice (2.19 mg/100g) appear to contain the least amount of Zinc. The Copper content was found to be highest in Yam porridge & Bean (3.45 mg/100g); Amala lafun (3.19 mg/100g); and Eba & Okro (2.64 mg/100g) while Edikaikong (0.63 mg/100g); Ikokore (0.91mg/100g); and Tuwo Shinkafa (0.96 mg/100g) account for food with the lowest sodium content. The amount of mineral in the food analyzed showed large variations. Such variation could be due to a many factors such as the processing and agronomic conditions but also include different ingredients in recipes. The lack of relevant mineral data on these Nigeria's local food in literature forecloses the comparison of data with that from other studies. However, the present data were determined using standardized methods and appropriate quality assurance guidelines strictly adhered to during analyses to ensure validity and reliability of results obtained.

## DISCUSSION

Studies that have analyzed minerals in Nigerian local dishes on a composite-meal basis that could be used to compare with the results of the present study are scarce; nonetheless, the present study demonstrates the inadequacy of the mineral contents of the widely consumed local dishes. Due to the wide sociological, geographical and economic differences, food consumption level varies and consequently influences nutrient contents of dishes and nutrient intake.

Sodium is essential for the control of blood pressure. It is an electrolyte that controls the extracellular amount of fluid in the body and is needed for hydration. In addition, sodium stimulates the muscles and nerves. The sodium content of most dishes analysed can be considered relatively low compared with the RDA of 1.5 g/day. Barring excessive use of dietary salt and sodium-containing compounds such as monosodium glutamate (MSG) used in cooking, consumption of these dishes cannot be an issue of concern or a risk factor for for cardiovascular disease (CVD). Excessive sodium intake has been associated with high blood pressure and stiffening of arterial walls and therefore a risk factor for CVD (Ha 2014).

Calcium is the most abundant mineral in the body and it function include regulating muscular contractions including heartbeat, blood clotting and formation of strong bones and teeth (WHO 2004a and b). The supply of calcium is considered to be insufficient in all the dishes studied with the lowest level in Beans with plantain, Yam with egg omelet as well as Jollof rice; however, the highest level of calcium was found in vegetable soup. This data highlight potential health benefits of dishes with considerable amount of vegetable.

Iron is the most common micronutrient deficiency in the world. Women of childbearing age are the highest-risk group because of menstrual blood losses, pregnancy, and lactation. Iron conveys the capacity to participate in redox reactions to a number of metalloproteins such as haemoglobin, myoglobin, cytochrome enzymes, and many oxidases and oxygenases. It is required for many proteins and enzymes, notably haemoglobin to prevent anaemia. Anaemia has been shown to be linked maternal mortality and premature child birth (Carriaga et al. 1991). With the exception of Jollof rice, nearly all the dishes analyzed contain adequate proportion of iron when compared with RDA of 18 mg. Thus, dietary iron is best supplied by consumption of foods like Yam porridge with Bean as well as Onugbu soup.

Low potassium is associated with a risk of high blood pressure, heart disease, stroke, arthritis, cancer, digestive disorders, and infertility. For people with low potassium, improved diets -- or potassium supplements -- to prevent or treat some of these conditions may be recommended. Potassium was below the recommended levels in the analysed food samples. There is abundant evidence that a reduction in dietary sodium and increase in potassium intake decreases BP, incidence of hypertension, and morbidity and mortality from CVD (Whelton and He 2014).

The supply of Zinc was sufficient compared with the recommendation of 11 mg/d in the dishes studied. Zinc is a component of more than 100 enzymes, among which are DNA polymerase, RNA polymerase, and transfer RNA synthetase. Zinc deficiency has its most profound effect on rapidly proliferating tissues with growth retardation in children with mild deficiency. More severe deficiency results in growth arrest, teratogenicity, hypogonadism and infertility, poor wound healing, diarrhea, dermatitis on the extremities and around orifices, glossitis, alopecia, loss of dark adaptation, and impaired cellular immunity (Ringsted et al.1990). Zinc supplements in diet reduced diarrhoea in infants (Sazawal et al. 1996) while Zinc showed an inverse relationship with dental carries.

A component of several metallo-enzymes, most manganese is in mitochondria where it is a component of manganese superoxide dismutase. Manganese deficiency in the human has not been conclusively demonstrated. It is said to cause hypocholesterolemia, weight loss, hair and nail changes, dermatitis, and impaired synthesis of vitamin K–dependent proteins. The supply of Manganese was sufficient compared with the recommendation of 2.3 mg/d in the dishes studied.

Copper, being an essential micronutrient for man, it is a constituent of specific cupero-enzymes such as cytoplasmic superoxide dismutase, cytochrome c oxidase, dopamine-B-monoxygenase and tyrosinase. It is involved in lipid metabolism, bones development, and maturation of connective tissue. Dietary deficiency is rare; it clinical manifestations include depigmentation of skin and hair, neurologic disturbances, leukopenia, hypochromic microcytic anemia, and skeletal abnormalities. Anemia arises from impaired utilization of iron and is therefore a conditioned form of iron deficiency anemia. The result of the present study indicates that copper content is sufficient in most Nigerian dishes analysed. A WHO (1996) report has earlier suggested that people living in many developing countries do not get enough copper even in the absence of an apparent sign of deficiency.

In conclusion, micronutrients are a diverse array of dietary components necessary to sustain health. The physiologic roles of micronutrients are as varied as their composition; some micronutrients are used in enzymes as either coenzymes or prosthetic groups, others as biochemical substrates or hormones; in some instances, the functions are not well defined. Under normal circumstances, the average daily dietary intake for each micronutrient that is required to sustain normal physiologic functions is measured in milligrams or smaller quantities. Deficiency of some essential micronutrients in the Nigerian diet and their possible health problems are highlighted in this study. The deficiency of I, Fe and Zn is graver among young children and women of childbearing age. Remedial measures for combating their deficiency include recommendation for the consumption of supplements or fortified foods, fortification of flour and other essential food components. This in the long run would help in successfully mitigating human suffering from micronutrient deficiency disorders as well as in maintaining sustainable human health in Nigerian societies.

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