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Research Article
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Evaluation of Iron, Zinc, Sodium and Phytate Contents of Commonly Consumed Indigenous Foods in Southwest Nigeria

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Abstract

The iron, zinc, sodium and phytate contents of commonly consumed indigenous foods in southwest Nigeria were evaluated.

Twelve dishes/foods were selected from the six states that constitute the southwest portion of Nigeria. These foods were obtained through a structured questionnaire that assessed the food ingredients availability, accessibility and affordability. The dishes were prepared in accordance with the recorded food standards of Oguntona and Akinyele, 1995. The food samples were prepared, homogenised, oven dried and grinded for analysis following standards from the Association of Official Analytical Chemist (AOAC).

The moisture and mineral contents were determined in compliance with AOAC standard procedures. The phytate content was, however, analysed using Wheeler and Ferrel's procedure. The results indicated that yam potage (1.9 ± 0.11), ebiripo (1.25 ± 1.00), and *eba (*1.23 ± 0.01), have high iron values, while *fufu* appeared relatively low in iron content (0.39+0.02 mg/percent). The zinc levels were significant in pounded yam, ebiripo and pound cocoyam, which measured (3.65 ± 0.03), (2.34 ± 1.01) and (2.30 ± 1.00), respectively. The phytate contents ranged from 0.26-4.61 mg/percent; however, some food roots, pulses and grains were relatively higher in phytate than most vegetables soups and staple foods. Sodium levels were relatively high in roots, such as *laafun, eba fufu* and *ikokore* (3.50-5.23 mg/percent).

Keywords: Micronutrients; Indigenous foods; Antinutrient; Nigeria

Introduction

Micronutrient deficiencies are a serious public health concern worldwide. Approximately 1 billion people, nearly everyone in developing countries, suffer from the effects of these deficiencies, and another billion are at risk. The risk for specific mineral deficiencies depends on a variety of factors, such as food intake, food processing practices, the presence of other dietary factors and other chemicals in foods, such as phytate, that may enhance or inhibit the mineral bioavailability, health and physiological status of an individual [1].

Iron, an essential nutrient, is a component of haemoglobin, myoglobin, other forms of iron in and several enzymes. An adult male loses approximately 1 mg/day of iron, and females lose approximately 1.5 mg/day during their reproductive years. The average availability of iron in food is approximately 10%. The absorption level of heme iron sources is >20%, but the absorption of non-heme sources is <10%. The absorption of non-heme iron is enhanced by the presence of protein and ascorbic acid consumed simultaneously [2]. Zinc-containing enzymes are involved in nucleic acid synthesis, and deficiency manifests as impaired wound healing, appetite and taste acuity. Heme sources of zinc are absorbed more readily than non-heme sources [3].

Sodium >1 g/day tend to aggravate a genetically determined susceptibility to hypertension, and intakes >7 g/day may induce hypertension even in individuals without a specific genetic susceptibility. Studies have confirmed that there are no known benefits of high sodium consumption. It is important to distinguish between the weights of sodium and salt: 5 g of salt contains approximately 2 g of sodium [4].

Phytic acid (myo-inositol 1,2,3,5/4,6-hexakis dihydrogen phosphate), a compound present only in plant food, has been found to reduce the bioavailability of dietary zinc by forming insoluble complex with the minerals in foods [3,5]. The phytic acid content of foods affects the bioavailability of several minerals, and the absolute effects of phytate on mineral bioavailability have long been known to depend on the relative levels of both the minerals and phytate in foods [6]. With particular reference to zinc bioavailability, the phytate zinc molar ratio is considered as a better predictor of zinc bioavailability than total phytate levels alone.

To a large extent, the food intake and consumption pattern of any community determines the nutritional status of a community [7]. Studies have confirmed that there is an interrelationship between diets, food habits and micronutrient deficiency diseases. This interrelationship requires urgent investigation of the nutrient content of traditional foods that are consumed in Nigeria [4,7].

Therefore, this study aimed to determine the iron, zinc, sodium and phytate contents of twelve commonly consumed indigenous dishes in the southwest region of Nigeria.

Materials and Methods

The following foods were used for the study:

(A) *obe eeru* with pound cocoyam (*Celtis austalis* spp)

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(B) *oshikiri* with *agidi* (*Vigna unguiculata*)

(C) *ikokore* (yam-based *Dioscorea alata*)

(D) ebiripo (cocoyam-based *Colocasia esculenta*)

(E) *marugbo* with *fufu* (*Musa paradisiaca* spp)

(F) *ila alasepo* with pounded yam (*Hibiscus esculentus* spp, and yam based

(G) *bokonisa* with *amala* (*Coriandrum sativum* spp) and yam flour

(H) *opoporu* and *eba* (*Vigna unguiculata* spp and cassava based)

(I) *obe isapa* and pound cocoyam (*Hibiscus sabdariffa* spp)

(J) *ogbono* soup with *elubo* (*Irvingia gabonensis*)

(K) *akara and agidi* and

(L) bean porridge and *ogi/koko* (Table 1).

Study Area

The study was conducted in southwest Nigeria, which is predominantly populated by the Yoruba people with different tribes and diverse cultures and dialects; the residents are bounded together by the same Yoruba language. They share the same food culture but have diverse dishes and dietary patterns. The states used for the study were Ogun, Lagos, Osun, Oyo, Ekiti and Ondo.

Sampling Technique

Two dishes were purposively selected from each state through structured questionnaires that assessed the dishes' availability, accessibility, affordability and consumption patterns. These considerations are essential because some indigenous ingredients have become extinct and are no longer available on farms or in local markets.

Twelve dishes/soups were obtained from the six states under study.

Root and Tubers	**a) a) Cassava and its products**
	- Cassava flour (laafun)
	- Farina (Eba) (steamed farina)
	- Fufu/akpu (cooked wet milled cassava)
	b) Yam *(Dioscorea rotundata)* and its products
	- yam flour (amala)
	- pounded yam (iyan)
	- yam pottage (asaro)
	c) Cocoyam *(Colocasia esculenta)* and its products
	- ebiripo (wet milled steamed cocoyam)
	- pounded cocoyam (cocoyam)
	d) Water yam (*Dioscorea alata*) and its products
	- ikokore (wet milled water yam, ingredients added & steamed)
Cereals and Grains	**Maize *(Zea mays)* products**
	- Eko/agidi
	- Ogi/koko
Legumes	**Cowpea (*Vigna unguiculata*) and its products**
	- osikiri (wet milled, steamed beans)
	- akara (fried blended beans)
	- bean porridge (stewed beans)
	- opoporu (stewed melon)
Vegetable soups	**Draw soups:**
	- bokonisa (Coriandrum sativum)
	- okro soup (Ila alasepo) *Hibiscus esculentus*
	Non-draw soups:
	- obe isapa
	- obe eeru
	- marugbo

Table 1: The food groups of the studied foods.

Preparation and Cooking of Dishes

The ingredients for preparing and cooking the dishes were processed as described by Oguntona and Adekoya, (1999) and Okhiria (2010). The ingredients were purchased from three major central markets in the study areas: the mile 12 market Ketu, Lagos, Ikare Akoko market and Lafenwa and Abeokuta market. The dishes were prepared using the kitchen facilities of the Department of Home & Hotel Management, Olabisi Onabanjo University, Yewa Campus, Ayetoro.

Preparation of Samples for Laboratory Analysis

The food samples were prepared in the laboratory by homogenising the large samples and subsequently reducing the sizes and amounts for analysis. The remaining portions were dried in a hot oven, grinded to a fine smooth-texture and kept in a labelled moisture-free container [8].

Moisture Content Determination

The moisture content of the samples was determined using the hot air oven method. The samples were dried at 70-80°C for 20 hours and at 105°C for another 2 hours to achieve constant weights. All of the moisture content analyses were performed in triplicates.

Determination of Mineral Content

The mineral contents of the food samples were determined using the dry ash digestion and analysis procedure and the Atomic Absorption Analysis, which was also used to analyse the sodium and zinc levels in duplicates.

Determination of Phytate Content

The phytate content in the food samples was determined with the Latta and Eskin procedure [9]. This process involves extracting phytate with 3% trichloroacetic acid and precipitating it as ferric phytate. The ferric phytate was then converted to ferric hydroxide $Fe(OH)_3$ precipitate and soluble sodium phytate by adding sodium hydroxide. The precipitate was dissolved in diluted acid, and the iron content was determined by colorimetry.

A reagent blank was used to process each set of samples. The $Fe(NO_3)_3$ standards were prepared, and the absorbance was read with a spectrophotometer. This sample was then used to prepare a standard curve from which the iron concentration was obtained. The phytate content was then calculated from the iron concentration by assuming a constant Fe level:p molecular ratio of 4:6 in the precipitate. The stated values are the means of six replicates [9].

Results

The selected mineral and anti-nutrient contents (iron, zinc, sodium and phytate) of some commonly consumed foods/dishes in southwest Nigeria are summarised in (Tables 2-4).

Table 2 shows the mean moisture, iron, zinc, sodium and phytate contents of the foods/100 g edible portion. The moisture content was highest in ebiripo (51.36 ± 0.2 g/percent) and lowest in *ikokore* (27.85 ± 1.2 g/percent). The iron content of yam pottage was highest (1.19 mg/percent), and *fufu* had the lowest (0.39 mg/percent). The zinc values ranged from 1.5-3.50 mg/percent among the root and tubers foods and

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Food Samples	Moisture (mg)	SD	Fe (mg)	SD	Zn (mg)	SD	Na (mg)	SD	Phytate (mg)	SD
Laafun	42.11	1.0	0.99	0.05	1.63	0.03	3.75	0.53	2.10	0.06
Eba	41.10	1.1	1.23	0.01	1.83	0.09	4.28	0.15	2.71	0.10
Fufu	42.10	1.1	0.39	0.02*	1.66	0.04	3.54	0.08	1.26	1.00
Yam flour	46.10	0.1	0.90	0.12	1.52	0.04	3.10	0.64	4.10	0.71
Pounded yam	42.11	1.2	1.04	0.07	3.67	0.03	4.42	0.81	4.50	0.16
Yam potage	44.83	0.1	1.91	0.11	1.57	0.12	3.36	0.04	4.50	0.11
Ebiripo	51.36	0.2	1.25	1.00	2.34	1.01	3.15	1.00	2.90	0.05
Pound cocoyam	41.12	1.0	1.15	1.10	2.30	1.00	3.13	1.10	2.50	0.15
Ikokore	27.85	1.2	1.01	0.01	1.38	1.11	3.75	1.11	1.35	1.05

*Significantly low

Table 2: Mean moisture, iron, zinc, sodium and phytate contents of roots and tubers/100 g.

Food Samples	Moisture (%)	SD	Fe (mg)	SD	Zn (mg)	SD	Na (mg)	SD	Phytate (mg)	SD
Eko/agidi	54.11	1.01	1.15	1.03	1.21	0.11	1.22	1.04	2.11	1.00
Ogi/koko	75.10	1.01	1.31	0.03	1.19	0.02	0.82	0.43	2.00	0.15
Osikiri	50.12	1.00	0.88	0.13*	1.67	0.18	3.72	0.18	4.10	0.1
Akara	40.10	1.10	2.48	0.15	1.43	0.07	7.10	0.22	4.11	1.11
Beans porridge	45.0	0.15	1.32	0.08	0.98	1.01	5.15	0.11	4.00	1.00
Opoporu	48.0	1.25	2.11	0.17	1.95	1.00	6.00	1.00	5.10	1.11

Table 3: Mean moisture, iron, zinc, sodium and phytate contents of cereals and legume foods products/100 g.

Food Samples	Moisture (%)	SD	Fe (mg)	SD	Zn (mg)	SD	Na (mg)	SD	Phytate (mg)	SD
Bokonisa	18.23	1.00	1.16	0.29	1.87	1.00	2.40	1.10	2.10	0.01
Okro	35.12	1.20	1.05	0.06	1.04	0.01	1.13	0.01	2.80	0.08
Obe isapa	28.10	1.25	1.12	1.01	1.15	0.05	2.25	1.01	2.11	1.02
Obe eeru	20.01	1.20	1.20	0.5	1.13	1.04	3.31	1.05	3.30	0.12
Marugbo	22.10	0.01	2.32	0.12	2.16	0.05	1.30	1.03	3.02	0.10

Table 4: Mean moisture, iron, zinc and sodium and phytate contents of indigenous vegetable soups/100 g.

dishes. The zinc content was highest in the pounded yam and lowest in *ikokore*; however, the phytate content was also high in the pounded yam. Table 3 shows the mean moisture, iron, zinc, sodium and phytate found in the cereal and legumes products/% g edible portion. In grams, the moisture, Fe, Zn, Na and phytate contents in *eko/agidi* were (54.11 ± 0.1), (1.15 ± 0.03), (1.21 ± 0.11), (1.22 ± 1.04) and (2.11 ± 1.00), respectively.

Table 3 also shows the result of the analysis of the indigenous legumes dishes. The mean iron, zinc, sodium showed that opoporu had highest iron content (5.1 ± 1.11 mg/percent); zinc levels were also highest in opoporu (1.95 ± 1), and akara had highest sodium level (7.10 mg/percent). In all legumes, the sodium levels ranged from 3-7.32 mg/percent. The phytate contents ranged from 4-6.11mg/percent among the legumes.

Table 4 highlights the mean moisture, zinc, sodium, iron and phytate contents of indigenous vegetable soups per 100 g edible portion. The moisture content was <50% in all of the vegetable soups ranging from 17-36 g/percent. The iron content ranged from 0.99-2.44 mg/percent, zinc was 0.99-2.24 mg/percent, while sodium ranged from 1-4.38 mg/percent among the soups. The phytate content was at least 2 mg in all of the analysed soups.

Discussion

Studies have confirmed that the wide ranges in the micronutrient contents of many Nigerian indigenous dishes have been associated with differences in the inherent characteristics of the samples' environmental conditions as well as the handling methods before purchase and during cooking of the dishes [10,11]. *Laafun*, yam flour *(amala)* and *fufu* appeared relatively low in iron contents. The low values may be connected to the handling and processing methods normally used in the preparation of these foods.

However, these values are closer to the values found by Sanusi et al [12], which confirmed the possible loss of some indigenous food nutrients through processing. Roots and tuber products, such as *eba*, pounded yam, yam pottage and *ikokore*, have high iron values. Several studies [13,14] and Nigerian studies [7,11,12] have suggested that most foods and dishes are rich in iron [6], although few studies have evaluated the availability of such high dietary iron levels [5,11].

Studies have confirmed that in the intestine, phytic acid forms insoluble chelates (which are unavailable for absorption) with iron [2]. Therefore, it is not known to what extent the iron present in the foods would meet the iron requirements of the Nigerian population.

Pounded yam, ebiripo and pound cocoyam seem higher in zinc values. Others foods, such as *eba, fufu and amala,* also have appreciable zinc contents. Past studies have shown that zinc is more readily available from animal products than in vegetarian diets [15,16]. This availability is primarily attributed to the phytate and fibre content of a plant based diet, which inhibits the intestinal absorption of zinc by forming insoluble chelates [3]. Zinc levels are highest in pounded cocoyam and ebiripo (both cocoyam based) [15,16], which confirms that cocoyam is a good source of Zn. Obe eeru, isapa and bokonisa vegetable soups showed safe sodium levels. O' Deli [1] confirmed that there are no known benefits of high sodium consumption. Sodium intakes >1 g/day tend to aggravate a genetically determined susceptibility to hypertension, and intakes above >7 g/day may induce hypertension even in individuals who have no specific genetic susceptibility.

The phytate contents in food roots, pulses, and grains are relatively higher than in other foods. This result was consistent with Onabanjo and Oguntona as well as O' Deli [1,6].

O' Deli observed that regardless of the absolute amount of phytate or zinc in the diet, the phytate:zinc molar ratio was as low as 10:1 and 15:1, and these levels could induce marginal zinc deficiency. However, this study did not investigate bioavailability but phytate content in this study is consistent with those of others in Africa [7,12,17-19]

Conclusion

This study evaluated the micronutrients contents of some common indigenous foods in southwest Nigeria. Many of these foods are high in iron and zinc levels, and the root tubers and vegetables have safe sodium levels.

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