NUTRIENT AND NUTRIENT-INHIBITOR COMPOSITIONS OF STANDARDIZED BAMBARA-NUT (*Vigna substerranea*) BASED DISHES COMMONLY CONSUMED IN NIGER STATE, NIGERIA

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ABSTRACT
The study standardized bambara nut based dishes commonly consumed in Niger State, Nigeria and assessed the nutrient and nutrient-inhibitor compositions of the dishes. Five bambara nut based dishes (bambara porridge, bambara ball, bambara moinmoin, bambara soup and bambara and rice) were selected from five different zones in Niger State, Nigeria using purposeful, random and snowball approaches and were standardized in accordance with the Standardization Procedures . The selected dishes were prepared using the standardized recipes and presented for consumer acceptability. The proximate, mineral, vitamin C and nutrient inhibitor composition were analyzed using standard methods. The dishes were also evaluated for microbiological quality using Aerobic Plate Count (APC). The result of the proximate composition of standardized bambara nut dishes were significantly different ($p < 0.05$) with the values ranging from 41.9 to 75.6%, 0.9 to 6.4%, 0.9 to 18.7%, 0.2 to 10.6%, 0.3 to 1.3%, 14.4 to 44.9% and 82.5 to 262.9% for moisture, crude protein, crude fat, crude fibre, ash, carbohydrate and energy value content respectively. Also, the results of mineral contents were significantly different ($p < 0.05$) with the values ranging from 3.1 to 110.1 mg/100g, 10.3 to 239.6 mg/100g, 13.8 to 70.0 mg/100g, 4.9 to 30.1 mg/100g, 0.0 to 27.0 mg/100g and 6.0 to 40.5 mg/100g for phosphorus, potassium, sodium, zinc, iron and calcium respectively while the vitamin C contents of the dishes ranged from 0.2 to 0.5mg/100g. The result for nutrient-inhibitor contents were significantly different ($p < 0.05$) with the values ranging from 94.2 to 202.6 mg/100g, 0.0 to 0.2 mg/100g and 1.8 to 8.0 mg/100g for phytate, tannin and oxalate contents respectively.

Key words: Standardization, nutrient composition, nutrient-inhibitor, bambara nut, dishes.

INTRODUCTION
The role of indigenous or traditional food crops in the improvement of food security in Nigeria cannot be over emphasized. Kunyanga, Imungiand & Vellingiri (2013) described indigenous foods as foods that have their origin in a region, are culturally acceptable and adapted to the local climatic conditions which have been consumed traditionally by the inhabitants as opposed to exotic foods which have been introduced from other regions of the world. It is necessary to sensitize Nigerian people about the need to promote the production and consumption of traditional food crops, neglecting them and their knowledge could lead to the loss of the entire gene of nutritive crop (Mwaura, 2004).

Bambara nut (*Vigna substerranea*) is important local food crop in the north central part of Nigeria where it is staple legume food. The people of Niger State in North Central Nigeria may consume Bambara nuts or their products thrice a day because these foods are palatable, cheap and easy to prepare (Alabi, 2007). The availability of these local foods in their socially acceptable forms, seem to be the key to overcoming the major constraints towards consumer utilization of locally available foods. With the abundance of local foods in the north central part of Nigeria, the goal of optimal nutrition is affordable and achievable.

The benefits in utilizing local foodstuffs was highlighted by FAO (1995) that traditional foods reduce problems related to seasonal fluctuation of food supplies as they are adapted to their environments and so can fill seasonal food gaps. This study therefore intends to generate both the baseline and additional information on these local dishes that will enable policy makers, researchers and developmental agencies to formulate policies, sustainable interventions and nutrition security through advocacy that will improve on the nutritional status of the people of Niger state, north central Nigeria. The study is aimed to standardize five bambara nut based dishes (bambara porridge, bambara ball, bambara moinmoin, bambara soup and bambara and rice) commonly consumed in Niger state of Nigeria and evaluate the nutrient and nutrient-inhibitor compositions of the dishes.

METHODOLOGY
Five bambara nut based dishes (bambara porridge, bambara balls, bambara and rice, bambara moinmoin, and bambara Soup) commonly consumed in Niger state were selected from five different zones in Niger state, Nigeria.. Bambara porridge, bambara balls, bambara and rice, bambara moinmoin and bambara soup was selected from Minna, Suleja, Kotangora, New Bussa and Bida respectively. All the ingredients used for the

preparation of dishes were purchased from Central Market, Bida, Niger state, Nigeria.

Standardization and preparation of bambara nut based dishes

Based on the information on the several local foods available in Niger State (Alabi, 2007; Fejiokwu, 1997; NBS, 2012), the five zones and the five local dishes produced from bambara nut were identified using purposeful, random and snowball approaches. These dishes formed the basis of the survey in all the zones under study which was based on the availability, accessibility and affordability of their ingredients in the markets and farms. The dishes were prepared with the standardized recipes using the procedures described by Okhiria (2010) and Folorunso (2015) at the kitchen facilities of the Department of Hospitality Management of the Federal Polytechnic, Bida, Niger State, with the assistance of selected native housewives who were well versed on the methods of preparation of the selected dishes.

Determination of Proximate composition of standardized bambara nut based dishes

The moisture, crude protein, crude fat, crude fibre and ash were determined by the methods of AOAC (2005) while carbohydrate content was determined by difference. Energy values were calculated according to method described by FAO/WHO (1998).

Determination of Mineral and Vitamin C contents of standardized bambara nut based dishes

Potassium and Sodium were determined by digesting the ash of sample with perchloric acid and nitric acid and readings were taken on digital flame photometer/spectronic 20 (Gallenkamp). Calcium, iron, zinc and phosphorus were determined spectrophotometrically by using 200 atomic absorption spectrophotometer (Buck Scientific, Norwalk) and compared with absorption of standards of these minerals (AOAC, 2005). Vitamin C content was determined using the method described by Harris (1997).

Determination of Nutrient-inhibitor contents and aerobic plate count of standardized bambara nut based dishes

The phytate, oxalate and tannin contents of the dishes were determined by method of AOAC (2005) while aerobic plate count was done using the procedure described by the International Organization for Standardization (2004).

Statistical analysis

Data obtained were subjected to analysis of variance (ANOVA) and where there is significant difference, means were separated using Duncan's multiple range test. Statistical analysis was carried out with the use of SPSS version 21.0 software.

RESULTS AND DISCUSSION

Proximate Composition of standardized bambara nut based dishes

Table 2 shows the proximate composition of standardized bambara nut dishes. The values were significantly different ($p < 0.05$) with the values ranging from 41.9 to 75.6%, 0.9 to 6.4%, 0.9 to 18.7%, 0.2 to 10.6%, 0.3 to 1.3%, 14.4 to 44.9% and 82.5 to 262.9% for moisture, crude protein, crude fat, crude fibre, ash, carbohydrate and energy value content respectively. The result showed that all the dishes generally had high moisture contents. The amount of moisture is dependent on the type of dish and also the amount of water used in the preparation (Aliyu & Muhammed, 2000). The range of crude protein content obtained was greater than the range of protein content (0.8 to 2.5%) reported for fast food and indigenous dishes by Mojekwu & Anyafulu (2014). Bambara ball had the highest crude fat content and this may probably due to the deep frying methods used in the cooking. The low values of ash contents in the dishes could be attributed to the method of processing or cooking which includes de-husking, soaking and heat treatment, and is in line with study reported by Aliyu & Muhammed (2000). A relatively high caloric value was observed in bambara and rice and this is in agreement with study reported by Aliyu & Muhammed (2000). Although most of dishes had low carbohydrate values, the caloric values of some dishes were high due to the contributions of other nutrients such as lipids.

Mineral and Vitamin C contents of standardized bambara nut based dishes

Table 3 shows the Mineral and Vitamin C content of standardized bambara nut based dishes. The values were significantly different ($p < 0.05$) with the values ranging from 3.1 to 110.1 mg/100g, 10.3 to 239.6 mg/100g, 13.8 to 70.0 mg/100g, 4.9 to 30.1 mg/100g, 0.0 to 27.0 mg/100g and 6.0 to 40.5 mg/100g for phosphorus, potassium, sodium, zinc, iron and calcium content respectively. The values of Vitamin C content were significantly different ($p < 0.05$) with the values ranging from 0.2 to 0.5 mg/100g. The dishes observed to have low ash content were also observed to generally have low mineral contents. The lower ash and consequently lower minerals contents as compared to the raw might be due to loss of vegetative parts of the crops during processing (Echendu et al., 2009). The selected dishes were high in sodium, iron and zinc contents; fair in phosphorus, and low in potassium and calcium when compared to the safe level of intake for various micronutrients in low-income countries (FAO, 1988). Otemuyiwa & Adewusi (2014) reported that zinc is an important trace

element whose function is associated with growth, normal embryogenesis, foetal growth and colostrum production during lactation. The vitamins C values were low in all the dishes.

Nutrient-inhibitor content and aerobic plate count contents of standardized bambara nut based dishes

Table 4 shows the nutrient-inhibitor content of standardized bambara nut based dishes. The values were significantly different ($p < 0.05$) with the values ranging from 94.2 to 202.6 mg/100g, 0.0 to 0.2 mg/100g and 1.8 to 8.0 mg/100g for phytate, tannin and oxalate content respectively. Table 5 shows the aerobic plate count contents of standardized bambara nut based dishes with the values ranging from 4.0×10^4 to 3.90×10^6. Phytate content were significantly low in bambara nut-based dishes. This trend of decreased phytate contents are in line with the study reported by Echendu et al (2009). Tannin is located mainly in the seed coat of bambara-nut; therefore domestic food processing techniques can reduce tannin content in bambara nut foods. The low levels of tannins in bambara nut-based dishes showed that the anti-nutrient could be reduced to safe level in foods using cooking and fermentation processing techniques and this is in lines with study reported by Echendu et al. (2009). The lower values might also be due to the breakdown of tannin -protein and tannin-enzyme complexes by enzymes of fermenting organisms and subsequent leaching out of free toxin (Obizoba & Atil, 1994). Oxalate contents were also low in bambara-based diets. The low level of nutrient inhibitor factors and toxicants in the dishes make them safe for consumption even in high quantity. Table 5 shows the aerobic plate count of bambara-based diets. Microbiology contamination leading to infections and poor nutrients associated with local foods consumption may contribute significantly to deaths (Oluwafemi & Ibeh, 2011).

In Nigeria, due to poor food-handling, poor storage facilities (power outage), and unhygienic practices by the food hander, foods can easily be contaminated within short period of time before getting to the consumer. Among the dishes, only Bambara *moinmoin* got contaminated within twenty-four hours of preparation. The sources of contamination might be attributed to poor handling, risk foods and cross-contamination (Oluwafemi & Ibeh, 2011).

CONCLUSION

The study showed that the bambara nut dishes have low nutrient-inhibitor composition; this is an indication that the dishes can make the essential nutrients available for the body use and the dishes were also safe for human consumption.

Table 1. **Standardized recipe for bambara nut based dishes**

Dishes/ingredients	Converted weight/ volume	Local weight/ volume
Bambara porridge		
Roasted Bambara nut powder	250g	3 milk cups
Liquid milk/Nunu	225g	1½ milk cups
Sugar	50g	½ milk cup
Water	950ml	5½ milk cups
Ground potash	5g	½ teaspoon
Bambara ball		
Dehulled Bambara nut	262.5g	2½ milk cups
Chopped Onions	75g	1 small size
Chopped Red pepper	100g	3 medium sizes
Groundnut oil	200ml	½ beer bottle
Salt	15g	To taste
Bouillon cube	1cube	1cube
Bambara moinmoin		
Dehulled bambara-nut	350g	3 milk cups
Fresh pepper	100g	3 medium sizes
Fresh onion	110g	2 small sizes
Groundnut oil	75ml	2 table spoons
Salt	10g	to taste
Whole Cray fish	15g	½ milk cup
Water	200ml	1 milk cup
Bouillon cubes	2 cubes	2 cubes
Ground potash	5g	½teaspoon
Bambara Soup		
Dehulled bambara nut	350g	3 milk cups
Fresh red pepper	100ml	3 medium pieces
Fresh onion	75g	1 small size
Fresh tomatoes	50g	2 small pieces
Smoked fish	350g	4 medium pieces
Locust bean	25g	2 table spoons
Bouillon cubes	2cubes	2 cubes
Potash powder	5g	½ teaspoon
Red palm oil	100g	¼ beer bottle
Whole cray fish	15g	½ milk cup
Salt	15g	To taste
Water	1650ml	10 milk cups
Bambara and rice		
Rice	350g	2½ milk cups
Bambara nut	175g	1½ milk cups
Water	1650ml	10 milk cups
Onion	75g	1 small size
Salt	15g	to taste

Table 2. Proximate Composition (% DM) of standardized Bambara nut based dishes

Sample	Moisture	Crude protein	Crude fat	Crude fibre	Ash	carbohydrate	Energy (Kcal)
Bambara porridge	67.7±2.9^{b}	0.9±0.1^{c}	1.3±0.0^{c}	2.9±0.3^{d}	0.8±0.3^{b}	24.8±0.1^{b}	115.0±3.3^{c}
Bambara ball	45.8±3.0^{c}	6.1±1.4^{a}	18.7±0.0^{a}	10.6±0.4^{a}	1.3±0.0^{a}	17.6±4.2^{c}	262.9±12.1^{a}
Bambara moinmoin	75.6±0.8^{a}	3.2±0.4^{b}	1.3±0.0^{c}	4.5±0.5^{c}	0.6±0.2^{bc}	14.4±0.3^{c}	82.5±2.9^{d}
Bambara Soup	70.1±1.4^{b}	1.1±0.2^{c}	1.8±0.0^{b}	0.2±0.0^{e}	0.3±0.4^{c}	26.5±1.2^{b}	126.4±5.5^{c}
Bambara and rice	41.9±1.1^{c}	6.4±0.9^{a}	0.9±0.0^{d}	5.6±0.0^{b}	0.3±0.0^{c}	44.9±1.9^{a}	213.5±4.5^{b}

Means with different superscripts in the same column are significantly different ($p<0.05$)

Table 3. Mineral and Vitamin C contents (mg/100g) of standardized bambara nut based dishes

Sample	Phosphorus	Potassium	Sodium	Zinc	Iron	Calcium	Vitamin C
Bambara porridge	3.1±0.0^{e}	239.6±0.9^{a}	13.8±0.3^{e}	30.1±0.1^{a}	24.2±6.9^{b}	35.1±0.5^{b}	0.2±0.1^{d}
Bambara ball	110.1±0.0^{a}	25.1±0.0^{b}	54.4±0.3^{b}	12.4±0.0^{c}	12.0±0.4^{c}	40.1±0.0^{a}	0.3±0.0^{c}
Bambara moinmoin	5.3±0.1^{d}	10.3±0.0^{d}	39.9±0.2^{c}	4.9±0.0^{e}	0.0^{d}	40.5±0.0^{a}	0.4±0.0^{b}
Bambara Soup	8.0±0.3^{c}	19.0±2.0^{c}	70.0±0.1^{a}	6.5±0.0^{d}	27.0±0.3^{a}	6.0±0.7^{d}	0.3.0±0.0^{c}
Bambara and rice	85.0±0.0^{b}	27.0±0.0^{b}	36.0±0.0^{d}	20.2±0.1^{b}	0.0^{d}	15.0±0.0^{c}	0.5±0.0^{a}

Means with different superscripts in the same column are significantly different ($p<0.05$)

Table 4. Nutrient-inhibitor (mg/100g) contents of standardized bambara nut based dishes

Sample	Phytate	Tannin	Oxalate
Bambara porridge	116.8±4.1^{c}	0.2±0.0^{a}	7.7±0.3^{b}
Bambara ball	202.6±1.1^{a}	0.0^{c}	1.8±0.0^{c}
Bambara moinmoin	113.2±3.1^{c}	0.1±0.0^{c}	6.7±0.1^{b}
Bambara Soup	94.2±2.6^{d}	0.1±0.0^{b}	1.8±0.0^{c}
Bambara and rice	167.6±4.6^{b}	0.0^{d}	8.0±0.0^{a}

Means with different superscripts in the same column are significantly different ($p<0.05$)

Table 5. Aerobic plate count of standardized Bambara nut based dishes

Sample	Number of colony (Cfu/g)
Bambara porridge	3.2 x 10^{6}
Bambara ball	TNTC
Bambara moin-moin	1.6 x 10^{6}
Bambara Soup	4.0 x 10^{4}
Bambara and rice	3.9 x 10^{6}

TNTC - Too numerous to count
Cfu/g -Colony forming units/gram

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