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# NUTRIENT COMPOSITION OF SOME SELECTED TRADITIONAL FOODS OF IJAW PEOPLE OF BAYELSA STATE

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Key words: traditional foods, proximate composition, mineral contents, antinutrient composition, protein contents.

Abstract

This study evaluated the nutrient composition of traditional dishes of Ijaw people of Bayelsa State, Nigeria. The traditional dishes (Kekefiyai, Kiri-igina, and Opuru-fulou) were prepared using the traditional cooking methods and subsequently analyzed for proximate, antinutrient, and mineral contents, using standard methods. Kekefiyai had the highest carbohydrate content (32.5% ± 0.5) and fibre (31.79% ± 0.18) while Opuru-fulou had the highest protein content (33.69% ± 0.00) and ash (16.02% ± 0.12). Kiri-igina had the highest lipid and moisture content. The saponin, tannin, cyanogenic glycosides, and oxalate content occurred highest in Kiri-igina, while Kekefiyai had the highest alkaloid and phytate content. Opuru-fulou recorded the highest concentration of Mg, P, Mn, Cu, Zn, and Sulphate. Na and Ca occurred highest in Kekefiyai, and K, Fe, and Cl, occurred highest in Kiri-igina. The present study has shown that these selected traditional foods can provide substantial amounts of nutrients adequate to meet the daily requirement of Ijaw people in Bayelsa State.

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# KOMPOZYCJA SKŁADNIKÓW ODŻYWCZYCH W KILKU WYBRANYCH TRADYCYJNYCH POTRAWACH LUDU IJAW ZE STANU BAYELSA

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Słowa kluczowe: tradycyjne potrawy, podstawowy skład, związki mineralne, składniki antyodżywcze, zawartość białka.

Abstrakt

W pracy badano wartość odżywczą tradycyjnych potraw ludu Ijaw ze stanu Bayelsa w Nigerii. Tradycyjne potrawy (kekefiyai, kiri-igina, and opuru-fulou) były przygotowane według oryginalnych receptur i analizowane pod względem podstawowego składu chemicznego, zawartości związków mineralnych i składników antyodżywczych z zastosowaneim standardowych metod oznaczeń. Kekefiyai charakteryzowało się najwyższą zawartością węglowodanów (32.5% ± 0.5) i włókna pokarmowego (31.79% ± 0.18), podczas gdy opuru-fulou cechowało się najwyższą zawartością białka (33.69% ± 0.00) i popiołu (16.02% ± 0.12). Kiri-igina miało najwyższą zawartość lipidów i wilgotność. Saponiny, taniny, glikozydy cyjanogenne i szczawiany występowały w największej koncentracji w kiri-igina, podczas gdy Kekefiyai zawierało najwięcej alkaloidów i związków fitynowych. W przypadku opuru-fulou stwierdzono najwyższą koncentrację Mg, P, Mn, Cu, Zn i siarczanów. Na i Ca występowały w największej ilości w kekefiyai, natomiast K, Fe, i Cl w kiri-igina. W badaniach wykazano, że analizowane wybrane tradycyjne potrawy są w stanie dostarczyć znacznych ilości składników odżywczych odpowiednio do zapotrzebowania w dziennej racji pokarmowej ludu Ijaw ze stanu Bayelsa.

## Introduction

Man has always exhibited a unique survival instinct through his continuous affinity to search and discover foods (Marlowe 2005). Food has been defined by Uwakwe and Ayalogu (1998) as any edible substance that provides the required nutrients necessary for the proper functioning of the body. It has also been described as any material that gives energy to the body, promotes growth, and repairs worn out cells when ingested, digested and assimilated (Okaka and Okaka 2005, Olusanya 2008, Amadi et al. 2013). Food, a basic necessity of life (Okaka and Okaka 2001) exists in different types but can be firmly rooted on the customs and traditions of the people (Amadi et al.2013). The basic food nutrients, deriva-

ble after the consumption of foods at different concentrations include proteins, carbohydrates, mineral, vitamins, lipids etc (OKAKA and OKAKA 2001). Food is comprised of various chemicals that combine in various properties to provide color, flavor, shape and taste to foods. Previously, the popular conception from some researchers (KYLE and COLE 2001, AMADI et al. 2011) was that the type of food consumed by a group, community, or locality, determines their nutritional status, but nowadays, the existence of quick food makes that idea a very debatable one. However, it is a clear fact especially in Nigeria that the agricultural output of a particular geographical location largely depends on some climatic factors and the vegetative zone, which thus influences the dietary status of the citizenry. Most African foods are peculiar cuisines utilized specifically by a group of people but can also be known with country and continental names like Nigerian foods and African foods (CAYOT 2007). Further, some foods can be attributed to a community, locality or ethnic group. Such foods are referred to as traditional foods. Traditional foods are ancient foods with ancestral heritage rooted on strong foundation of customs, culture and natural environment. They are foods with old historical background continuously evolving to retain the cutlery tradition of the people and to surmount the monotony in the diet (VIJAYALAKSHMI et al. 2005). An obvious advantage of traditional foods is a wide rate of acceptance within the society. This advantageous attribute plays a key role when developing food products and during the establishment of nutritional programs. Further a good knowledge of the nutritive value of traditional foods helps to expand the consumption of these foods. Apart from the primary nutrients derivable from foods, studies have revealed the presence of non-nutritive chemicals with disease preventive and immune boosting properties. These chemicals are referred to as phytochemicals (SOFOWORA 1980, OKAKA and OKAKA 2001). At elevated levels, phytochemicals can act as antinutrients and become harmful to the human body. DURU et al. (2014) have observed that though natural and synthetic foods contain nutrients, the occurrence of phytochemicals is greater in natural foods.

Bayelsa State is a state in Southern Nigeria with a rich cultural heritage and Ijaw as one of the inhabitant ethnic groups. The Bayelsan people have very rich cuisines that include ceremonial dishes, normal day to day delicacies and traditional snacks. Among the numerous rich cuisines of the Bayelsan people, are the "Kekefiyai", "Kiri-igina", and "Opuru-fulou". These delicacies are peculiar to the Ijaw ethnic group, and as well, unify and showcase their great culture. Despite the tremendous potentials of traditional foods to improve both nutrition and food security among the populace, FAO (1995) observed that some traditional foods cause concerns

as a result of microbial contamination and food poisoning through the use of additives and other adulterants.

Bayelsa is a state located in the Niger Delta region of Southern Nigeria between Delta State and Rivers State. Bayelsa was created in 1996 and has Yenagoa as its State capital. The name Bayelsa was coined from a concatenation of the initials of three former comprising local government areas. Bayelsa State is geographically located at latitude $45^0 45^l$ north and longitude $6^0 05^l$ west covering an area of 9415.8 $km^2$ and a population of 1704515, and population density of 158 people/$km^2$ accounting for 1.2% of Nigeria's total population (EDOUMIEKUMO et al.2014). Bayelsa has an estuarine and riverine setting, thus making many of the communities not accessible by road due to large amount of water bodies that surround them. Predominantly, four of the ten languages, Izon, Nembe, Ogbia, and Epie--Atissa are among the languages spoken by the comprising ethnic groups that include Ijaw, Kolokunu, Ekpetiama, Igbiriran, Atissa, and Biseni. Christianity is regarded as the dominant religion, notwithstanding the practice of traditional religion by few. Bayelsa State is one of the largest petroleum producing state in Nigeria because of the massive deposition of crude oil and natural gas in the state. Despite this, the majority of the inhabitants have a poor living status due to an inexistent commerce caused by inadequacy of transportation, education, health, and other infrastructures. Hence, many rural dwellers subsistently and commercially engage in fishing.

Historically, the Niger Delta Ijaw ethnic group is seen as one of the major ethnic group in Nigeria and was given a separate province during the colonial administration. The Ijaw people are considerable regarded as being of antiquity in Niger Delta. They mainly inhabit the local government of Bomadi, Patani, Burutu, Warri South, Warri North, and South--west Warri. Many researchers have postulated that the Ijaws originated from the central Delta but must have migrated towards the west bordered by Delta, and east which is the present day Rivers State.

Therefore, considering the central roles these foods play for the people of Ijaw community in terms of food security, there is need to evaluate the nutritional composition of these three traditional foods. Hence, this study was carried out to evaluate the nutritional properties of Kekefiyai, Kiri-igina, and Opuru-fulou.

## Materials and Methods

### Preparation of Kekefiyai and starch

The ingredients used for the preparation of the Kekefiyai, Kiri-igina, and Opuru-folou were purchased from the local market in Opolo community Yenagoa Local Government Area of Bayelsa State.

The traditional method was used for the preparation of Kekefiyai. It is a pottage made with 500 g of unripe plantain washed, chopped into bits and eventually pounded, and then cooked with 4920 ml of water in a cooking pot for about 50 minutes. As it boils, the following ingredients were added and mixed: 200 g of dried fish, 90 g of sliced onions, 50 g of ground crayfish, 1 g of table salt, 10 g of ground fresh pepper, 100 ml of red palm oil, and a local seasoning called Onga. The mixture was allowed to boil for 10 mins (Figure 1).

The starch was prepared by adding 100 g starch gotten from cassava root to 50 ml water and turned homogenously in a cooking pot. Twenty five milliliters (25 ml) of red palm oil was added before boiling and continuously stirred on a cooking gas until the mixture turned into a paste. This paste is served alongside Kekefiyai for a complete diet.

***a*** ***b***

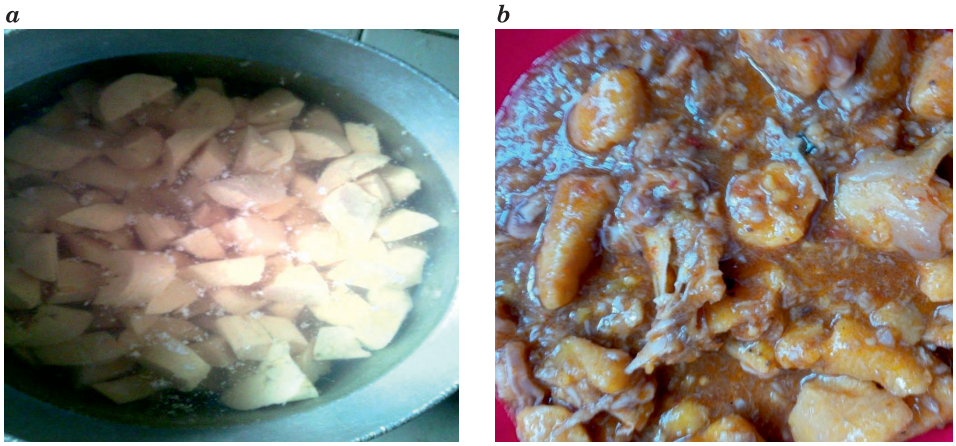

**Fig. 1.** Kekefiyai before (*a*) and after (*b*) preparation

### Preparation of Kiri-igina

This is a special type of soup prepared without cooking on fire. The soup was prepared using the traditional method. One hundred and twenty milliliters (120 ml) of water was boiled in a cooking pot and transferred into a wooden mortar. About 20 g of ground roasted Ogbono (*Irvingia*

*gabonensis* seeds) was added to the contents of the mortar and stirred using a cooking spoon. Two hundred grams (200 g) of smoked fish, 10 g of ground fresh pepper, 90 g of sliced onions, and 1 g of table salt were added successively to the mixture in the mortar and eventually stirred for 3 minutes. The soup is used to serve 'eba' or 'fufu' for a complete dish (Figure 2).

**Fig. 2.** Kiri-igina

## Preparation of opuru-fulou (prawn soup)

This peculiar delicacy is cooked mostly during flood seasons due to the availability of fresh prawns deposited at the water sides after flooding. The soup is normally prepared with sufficient quantities of fresh prawns (Opuru) from where the soup name is gotten. The soup was prepared using the traditional method. The head of one hundred and fifty grams (150 g) of prawn was cut off, washed and blended slightly. This blended prawn head was mixed with 200 ml of water and then filtered using a locally made mesh. The filtrate was transferred into a cooking pot and allowed to boil.

**Fig. 3.** Opuru-fulou before (*a*) and after (*b*) preparation

The remaining part of the prawn was added to the boiling filtrate, and the following ingredients were added: 200 g dried fish, 1 g of table salt, 50 g of ground crayfish, 90 g of sliced onions, and 10 g of ground fresh pepper. The mixture was allowed to boil for 20 minutes after which 120 ml of red palm oil was added and allowed to boil for another 10 minutes. About 150 g of Ogbono (*Irvingia gabonensis* seeds) was added to the mixture and allowed to cook further for 15 minutes, and the soup was ready to be served (Figure 3).

## Preparation of samples for analysis

**Determination of proximate and antinutrient composition.**

The food samples were oven dried individually at $70^0$C for 4 hours. These dried samples were ground into flour using a hand mill machine and then transferred into an airtight container prior to analysis

Proximate analysis of the samples for carbohydrate, crude fat, ash, crude protein, fiber and moisture contents were carried out according to standard methods of AOAC (1990).

The qualitative detection of antinutrients in the samples was carried out following the description of SOFOWORA (1980) and HARBORNE (1973).

Quantitative determination of oxalates, phytates, tannins saponins and cyanogenic glycosides were determined following the method of AOAC (1990).

**Mineral Content Determination.**

Wet digestion of samples (5 ml) using a mixture of concentrated $HNO_3$ and 60% (v/v) $HClO_4$ was carried out according to the method of AOAC (1990) where the organic matter in the sample was digested and afterwards diluted to a final volume of 25 ml with deionized distilled water. The levels of Na, K, Ca, Fe, Mg, P, Mn, Cu, and Zn in the samples were thus evaluated using an atomic absorption spectrophotometer (Buck Scientific model 210 VGP) and flame photometer (Jenway model).

The sulphate contents of the food samples were determined turbidimetrically according to AOAC (1984).

The chloride level was determined titrimetrically using the method of AOAC (1984).

The mineral ratios were determined as described by DAVID (2010). Reference values and ranges used for this study was obtained from DAVID (2010).

## Statistical analysis

All data were subjected to statistical analysis. Values are reported as Mean ± Standard deviation, while one way ANOVA was used for significance testing among the three foods, using Statistical Package for Social Sciences (SPSS) version 20. The results were considered significant at p-values of less than 0.05 ($p < 0.05$).

## Results and Discussion

The carbohydrate content (Table 1) of the cooked sample of the traditional food Kekefiyai, was the highest (32.57%±0.50) followed by Kiri-igina (20.57% ± 0.51) while Opuru-fulou (14.96% ± 0.03) was the lowest. The variations observed in the carbohydrate content were due to the amount and type of different ingredients used in the preparations of the food.

Table 1

Proximate composition of Kekefiyai, Kiri-igina, and Opuru-fulou

| Parametrs | Kekefiyai | Kiri-igina | Opuru-fulou |
|---|---|---|---|
| Carbohydrate [%] | $32.57±0.50^a$ | $20.57±0.51^b$ | $14.96±0.03^c$ |
| Crude protein [%] | $10.94±0.20^a$ | $26.88±0.36^b$ | $31.69±0.00^c$ |
| Lipid [%] | $20.48±0.32^a$ | $31.44±0.01^b$ | $29.20±0.13^b$ |
| Fibre [%] | $29.79±0.18^c$ | $4.75±0.16^b$ | $6.19±0.15^b$ |
| Moisture [%] | $2.82±0.98^a$ | $4.60±0.46^b$ | $2.60±0.11^a$ |
| ASH [%] | $5.40±0.16^a$ | $12.02±0.17^b$ | $16.02±0.12^b$ |

Values are mean ± standard deviation of triplicate determinations. Values in the same row bearing the same superscript letter (*a*, *b*) are not significantly different at 5% level

The reason for the high carbohydrate content of Kekefiyai could be attributed to the basic ingredient starch which is mixed with the dish after preparing the food (shown in Figure 1) and is known to be high in carbohydrate content and provides a good source of energy, while the reason for the equally high carbohydrate content in Kiri-igina could be caused by the ingredient (Ogbono) used in the preparation of the food (Figure 2). The crude protein content of the traditional foods in Table 1, ranged from 10.94% ± 0.20 (Kekefiyai) to 31.69% ± 0.00 (Opuru-fulou). The protein content of Opuro-fulou was significantly higher than those of the other food samples. The high protein content of Kiri-igina could be attributed to the protein content of the ingredients, prawn, smoked fish (Tilapia) ad crayfish (*Cambaridae*

*cambarus*) used in the preparation of the traditional diets. The high level of protein content in Opuru-fulou and Kiri-igina may show that they can be sufficient for the daily requirement for children, adults, as well as individuals suffering from protein deficiency diseases and disorders (ONIGBINDE 2005). Crude lipid content of the food samples was highest in Kiri-igina (31.44% ± 0.01), followed by Opuru-fulou (29.20% ± 0.13) and the lowest in Kekefiyai (20.48% ± 0.32). The fact that prawns, the main ingredient in Opuru-fulou (Figure 3), are particularly rich in protein and oil can be used to explain the high crude lipid content in Opuru-fulou. Since high crude fibre of ingredients reduce digestibility, and can also improve digestive health, fibre also plays a role in the prevention and treatment of disease such as obesity, diabetes, cancer and gastrointestinal disorders. There is also evidence that dietary fibre improves glucose tolerance and is therefore beneficial in treating maturity preset diabetes (OLUSANYA 1991). The moisture contents of the traditional foods assessed showed the highest value for Kiri-igina (4.60% ± 0.46), followed by Kekefiyai (2.82% ± 0.98) and Opuru-fulou (2.60% ± 0.11) as shown in Table 1. However, the moisture content of all the traditional food samples studied were low, compared to that of 'Kantong' (32.47%) as reported by KPIKPI et al. (2009). The relatively low moisture content of these samples, suggests that they may not be liable to bacterial spoilage, during storage. High moisture content of foods has been showed to encourage microbial growth. The ash contents of these evaluated traditional foods, ranged from 5.40% ± 0.16 in Kekefiyai to 16.02%±0.12 in Opuru-fulou. Therefore, Opuru-fulou, has the highest measure of total mineral content, which is a good nutritional attribute. This might be due to the higher proportion of prawn in the diet (Figure 3). The ash content of the traditional food studied were high compared to those of some traditional recipes reported by DAS et al.(2009), and some traditional Kuwati dishes reported by DASHTI et al.(2011). The ash content of all the foods were more than 3.0% and are therefore of more nutritional importance as previous reports (DAS et al.2009) has shown that when leaves are used as food for humans, they should contain an ideal quantity of around 3.0% for ash content.

The saponin content of the cooked samples of Kiri-igina (24.60mg/100 g) and Opuru-fulou (21.86mg/100 g) shown in Table 2 was high, while that of Kekefiyai (15.06mg/100 g) was comparably lower. The decrease in the saponin content of the cooked sample was significant in Kekefiyai. This can be attributed to the effect of an integrated approach that combines a variety of the traditional food processing and preparation practices (HOTZ and GIBSON 2007), such as thermal processing plus household pounding in the case of Kekefiyai (Figure 1). Although without toxicity, saponins are very poorly

absorbed by the body, and so tends to pass through without causing harm (SEZGIN and ARTIK 2010). Alkaloids occurred highest in in Kekefiyai (64.86 ± %0.10) and equal in both Opuru-fulou and Kiri-igina (Table 2). The phytate content in Kekefiyai was found to be (41.25% ± 0.10), while in Kiri-igina and Opuru-fulou, occurred below detection levels (Table 2).

Table 2

Antinutrient [mg/100 g] content of Kekefiyai, Kiri-igina, and Opuru-fulou

| Antinutrients | Keke-fiyai | Kiri-igina | Opuru-fulou |
|---|---|---|---|
| Saponin | $15.06 \pm 0.20^a$ | $26.40 \pm 0.10^b$ | $21.86 \pm 0.10^b$ |
| Alkaloid | $64.86 \pm 0.10^a$ | $16.34 \pm 0.30^b$ | $16.34 \pm 0.20^b$ |
| Phytate | $41.25 \pm 0.10^a$ | ND | ND |
| Tanin | $37.5 \pm 0.10^a$ | $44.03 \pm 0.10^b$ | $31.10 \pm 0.10^c$ |
| Cyanogenic glycosides | $14.67 \pm 0.25^a$ | $22.67 \pm 0.20^b$ | $21.00 \pm 0.20^b$ |
| Oxalate | $82.41 \pm 0.30^b$ | $87.96 \pm 0.20^b$ | $70.40 \pm 0.10^a$ |

Values are means ± standard deviation of triplicate determinations. Values in the same row bearing the same subscript letter (s) (*a*, *b*) are not significantly different at 5% level.

The occurrence of phytate in Kekefiyai was high when compared to some sweet potatoe dishes in Kwara State Nigeria (ABUBAKAR et al.2010) and dishes of *Afzelia africana* processed using different methods (ODENIGBO and OBIZOBA 2010). However, the values are comparably lower than those of some dishes such as potato kuba, lentil soup, and falafel (DASHTI et al. 2011). The high phytate content of Kekefiyai might be attributed to the presence of plantain, one of the basic ingredients used in the preparation of the diet that is known to be very high in its phytate content. PERIAS and GIBSON (2002) reported that soaking cereals in water can result in passive diffusion of water soluble Na, K, or Mg phytate, which can then be removed by decanting the water. There may also be the effect of thermal processing. Phytic acid forms very stable complexes with mineral ions, thereby rendering them unavailable for intestinal uptake because the first step in mineral absorption requires the mineral remains in ionic state (LOPEZ et al. 2002) thus inducing mineral deficiency. The results of the tannin content of the traditional foods in Table 2 showed that Kekefiyai was 37.50mg/100 g, Kiri-igina (44.03mg/100 g) and Opuru-fulou (31.10mg/100g). These values are quite high when compared to those of some sweet potato diets consumed in Kwara State Nigeria that ranged from 0.22mg/100g to 0.86 mg/100g (ABUBAKAR et al.2010). Tannins are reported to have possible anticarcinogenic effect (BUTLER 1989). Also dietary proanthocyanidins (tannins) can contribute to an improved animal health by reducing the

detrimental effects of internal parasites as observed in sheep (NIEZEN et al.1995). The cyanogenic glycosides contents of the cooked samples ranged from 14.67 mg/100 g in Kekefiyai to 22.67 mg/100 g in Kiri-igina which were comparably higher than those of the Beniseed soup cooked for 15, 30, 45, and 60 minutes, that ranged from 0.58 mg/100 g to 0.97 mg/100 g (AGIANG et al. 2010). High dose of HCN pose a serious inhibitory effect on the respiratory cytochrome oxidase activity (ONIGBINDE 2005). The oxalate content in the cooked diets ranged from 70.4 mg/100g in Opuru-fulou and 87.96 mg/100g in Kiri-igina, and these values were higher than the oxalate contents of some sweet potato dishes consumed in Kwara State Nigeria (ABUBAKAR et al. 2010) and Beniseed soup (AGIANG et al. 2010). Oxalate is of concern because high oxalate diets can increase the risk of renal calcium absorption (OSAGIE 1998) with a reported toxic level of soluble oxalate in a range of 2.0–5.0 g.

Table 3

Mineral contents (mg/100g) of Kekefiyai, Kiri-igina", and Opuru-fulou

| Minerals | Keke-fiyai | Kiri-igina | Opuru-fulou |
|---|---|---|---|
| Sodium (Na) | 90.77 ± 0.10$^{a}$ | 26.21 ± 0.10$^{b}$ | 22.66 ± 0.10$^{b}$ |
| Potassium (K) | 68.93 ± 0.20$^{b}$ | 76.60 ± 0.30$^{a}$ | 65.10 ± 0.20$^{b}$ |
| Calcium (Ca) | 261.3± 0.20$^{a}$ | 26.51 ± 0.25$^{b}$ | 35.90 ± 0.20$^{c}$ |
| Iron (Fe) | 27.07 ± 0.05$^{a}$ | 63.63 ± 0.20$^{b}$ | 41.58 ± 0.20$^{c}$ |
| Magnesium (Mg) | 44.89 ± 0.50$^{a}$ | 86.12 ± 0.20$^{b}$ | 91.59± 0.10$^{b}$ |
| Phosphorus (P) | 49.9 ± 0.20$^{a}$ | 55.3 ± 0.10$^{b}$ | 55.3 ± 0.20$^{b}$ |
| Manganese (Mn) | 0.33±0.03$^{a}$ | 2.39±0.12$^{b}$ | 7.74±0.38$^{c}$ |
| Copper (Cu) | 0.26±0.03$^{a}$ | 1.34±0.04$^{b}$ | 3.73±0.44$^{c}$ |
| Zinc (Zn) | 1.70±0.21$^{a}$ | 2.44±0.42$^{a}$ | 5.98±0.21$^{b}$ |
| Sulfate | 213.28 ± 0.10$^{a}$ | 333.68 ± 0.25$^{b}$ | 426.56 ± 0.20$^{c}$ |
| Chloride | 239.20 ± 0.20$^{a}$ | 302.11 ± 0.25$^{b}$ | 216.11± 0.20$^{a}$ |

Values are mean ± standard deviation of triplicate determinations. Values in the same row bearing the same superscript letter(s) (*a*, *b*, *c*) are not significantly different at 5% level

The results for the micronutrient content of the traditional dishes assessed in this study, were presented in Table 3. The sodium content of the traditional foods ranged from 22.66 mg/100g in Opuru-fulou to 90.77mg/100 g in Kekefiyai. The sodium content of the foods in this present study is considered higher than Ikwerre traditional foods evaluated by AMADI et al.(2012). The potassium contents of the diets ranged from 65.10 mg/100 g in Opuru-fulou to 76.60 mg/100 g in Kiri-igina. These values were considered normal compared to those reported in some Came-

roonian household foods (SOP et al. 2008). The potassium levels observed in Opuru-fulou may not be unconnected to the main ingredient (Prawn) – Figure 3. Potassium helps to maintain the osmotic pressure and the acid base balance of the body (OLUSANYA 2008). The calcium content of the traditional foods ranged from 26.50mg/100 g in Opuru-fulou to 261.3 mg/100 g in Kekefiyai. The high level of calcium in Kekefiyai may be as a result of the use of plantain during its preparation. The values were considered moderate when compared to those of some regional recipes reported by DAS et al. (2009) but higher than those for some Cameroonian household foods (Kana Sop et al.2008). The iron contents of the diets were much higher in comparison to those reported by AMADI et al. (2012) for some traditional diets of South Southern Nigeria that ranged from 0.21 mg/100 g to 6.03 mg/100 g. HALLBERG et al. (1979) have reported that 90% of iron taken as food in developing countries is non-haem. Majority of Nigerians consume more of plant foods because of their socio-economic status. LITTER and RIVER (2003) further stated that the absorption state of non--haem iron can be enhanced with the intake of vitamin C rich foods. The magnesium contents of these tradition diets ranged from 44.89 mg/100 g in Kekefiyai to 91.59 mg/100 g in Opuru-fulou. These values are high when compared to some Ikwerre traditional foods that ranged from 38.0 gmg/100 g to 85.04 mg/100 g (AMADi et al. 2012). The phosphorus contents of these evaluated foods ranged from 49.90 mg/100 g in Kekefiyai to 55.30 mg/100 g in Kiri-igina which were found normal when compared to some values of some Ikwerre traditional diets as reported by AMADI et al. (2012). The high level of phosphorus observed in Opuru-fulou may be due to the fact that phosphorus is abundantly found in the main ingredients. In addition, it was observed that Opuru-fulou had the greatest amount of Mn, Cu, and Zn among the three traditional dishes assessed in this study.

Table 4

Mineral element ratio of Kekefiyai, Kiri-igina, and Opuru-fulou

| Ratio | Kekefiyai | Kiri-igina | Opuru-fulou | Reference | Range |
|---|---|---|---|---|---|
| Na/K | 1.32 | 0.34 | 0.35 | 2.4 | 1.4–3.4 |
| Ca/P | 5.32 | 0.48 | 0.64 | 2.6 | 1.8–3.6 |
| Ca/K | 3.79 | 0.35 | 0.55 | 4.2 | 2.2–6.2 |
| Zn/Cu | 6.54 | 1.82 | 1.60 | 8.0 | 4.0–12 |
| Na/Mg | 2.02 | 0.30 | 0.24 | 4.0 | 2.0–6.0 |
| Ca/Mg | 5.82 | 0.31 | 0.39 | 7.0 | 3.0–11.0 |
| Fe/Cu | 104.11 | 47.48 | 11.15 | 0.9 | 0.2–1.6 |

The Na/K ratio in the body is of great concern for prevention of high blood pressure, and Na/K ratio < 1 is recommended (OLAOFE et al. 2009). The Na/K ratios of all the three diets shown in Table 4, were more than 1 hence the food samples may not be considered adequate in reducing the incidence of high blood pressure. If the Ca/P ratio is low (low calcium and high phosphorus intake), a great amount of calcium may be lost in the urine, decreasing the calcium levels in the bone. Food is considered poor if the ratio is less than 0.5 while Ca/P above 2 helps to increase the absorption of calcium in the small intestine (OLAOFE et al. 2009). Only the Ca/P ratio in Kiri-Igina was below 0.5 while in Kekefiyai and Opuru-fulou the Ca/P ratio occurred above 0.5, which suggests that these foods may be considered rich sources of calcium. Also, the result for the mineral element ratio showed that the Fe/Cu ratio of all the three foods evaluated, fell above the standard ranges and values shown in Table 4. This is a worrisome outcome because elevated Fe/Cu ratio can compromise normal cellular activity and lead to mitochondrial damage through increase in free radical production (DAVID 2010).

## Conclusion

These findings show that the traditional diets can provide substantial amounts of nutrients to meet the normal daily dietary requirements of the Bayelsan people.

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