ABSTRACT

This study assessed minerals and phytate composition of selected indigenous food crops in Okigwe Local Government Area of Imo State, Nigeria. The selected food crops include Nchuawu (Ocimum gratissimum), Ukazi (Gnetum africanum), Utazi (Gongronema latifolium), Uziza (Piper guineensa), Ofe (Solanum macrocapon), Okwurubeke (Carica papaya), Ukpa (Tetracapidium conophorum) and Ugu (Telferia occidentalis) which were purchased from Eke Okigwe market in Okigwe Local Government Area of Imo state. The micronutrient and phytate composition of the food crops were determined by the official method of Association of Analytical Chemist and bioavailability calculated using molar ratio. Descriptive statistics such as mean and standard deviation were used to analyze the data variables. These indigenous food crops were found to be poor sources of these minerals (zinc, iron, and calcium) in terms of bioavailability as their molar ratio values when calculated were higher than the critical values for each of the mineral. There is a need to enlighten the residents in the area to consume the studied food crops alongside other food crops rich in these minerals to prevent hidden hunger. Also, biofortification strategy and appropriate food processing methods should be encouraged to reduce phytate composition of these food crops and thus improve mineral bioavailability.

Keywords: Food crops, minerals, vegetables, fruits, phytate, bioavailability
Vegetables and fruits are loaded with nutrients and essential phytochemicals (Hilou et al., 2006). In addition to high micronutrients, vegetables have little contribution to dietary energy, and hence cherished in limited energy diets. The beneficial effect of the phytochemical composition as it relates to cardiovascular diseases has been reported (Valvi & Rathod, 2011). Aside from these qualities, coupled with the abundance of vegetables particularly among farming communities in Nigeria, micronutrient malnutrition has been identified as a common problem with serious economic health penalties (NDHS, 2013). Minerals are revealed to be vital in human nutrition (Ibanga & Okon, 2009). They are important for the overall mental and physical well-being as well as an essential component of bones, teeth, tissues, muscles, blood, and nerve cells (Soetan et al., 2010). Additionally, they assist in the maintenance of acid-base balance, the response of the nerves to physiological stimulation, and blood clotting (Hanif et al., 2006).

Further, calcium, an important mineral, is an essential part of the bone. Its absorptions are needed for blood coagulation and the maintenance of intracellular cement substances; it also helps with teeth development (Gemede et al., 2015). Iron is another essential trace element for hemoglobin formation, normal functioning of the central nervous system, and in the oxidation of carbohydrates, protein, and fats. It also facilitates carbohydrates, protein, and fat to control body weight, which is a very important factor in diabetes (Moses et al., 2012). It plays a major role in oxygen transfer in the human body, as low iron content causes gastrointestinal infection, as well as nose bleeding myocardial infection (Ulah et al., 2012). Zinc is equally important, as it plays a vital role in various cell processes, including normal growth, brain development, behavioural response, bone formation, and wound healing (Eling et al., 2012). It also helps with protein and carbohydrate metabolism and facilitates the movement of vitamin A from its storage site in the liver and assists the synthesis of DNA and RNA needed for cell production. Zinc deficiency is often found in people suffering from Crohn's disease, hypothyroidism, gum disease, and probably plays a role
in predisposition to viral infections and diabetes mellitus. It can be useful in the treatment of prostate gland enlargement, rheumatoid arthritis, healing of wounds, acne, eczema, and stress (Kermanshah et al., 2014).

Bioavailability refers to how well nutrients can be quickly absorbed by the body to be used to reduce hidden hunger (Yang & Tsou, 2006). Hence, minerals bioavailability can be affected by the presence of the anti-nutritional factors such as phytate, tannins, and polyphenols in foods. The two most important techniques used to improve minerals bioavailability are reducing the phytate content in the foods or adding extra minerals in the fortification and blending process (Kayode, 2006). The study focused on phytate and mineral composition of some indigenous fruits and vegetables and their molar ratio as a predictor of bioavailability.

MATERIALS AND METHODS

Chemical Analysis

The digest of the ash of each sample was washed into the 100ml volumetric flask with deionized or distilled water and made up to mark as a way to determine the Fe, Zn, and Calcium. This diluent was aspirated into the Buck 200 Atomic Absorption Spectrophotometer (AAS) through the suction tube. Each of the minerals was read at their respective wavelengths with their respective hollow cathode lamps using appropriate fuel and oxidant combination. The meter reading for each element was used to calculate for the concentration of each element using the formula: Ppm or mg/kg
(any of the elements) = Meter reading x Slope or Gradient x dilution factor. Percent (% of any of the elements) = ppm or mg/kg divided by 1000 (Association of Analytical Chemist [AOAC], 2005).

**Phytate Determination**

Phytate was determined by a photometric method. Five (5) grams of each sample was extracted with 2.4% HCl,

0.1M NaCl was added to elude inorganic phosphorus, and 0.7 MNaCl added to remove Phytate and readings of the spectrophotometers were taken at a wavelength of 500nm on a spectrophotometer (AOAC, 2005).

**Data Analysis**

Statistical Package for Social Science (SPSS) software was used to analyze the data. Descriptive statistics such as mean and standard deviation were used to analyze the variables.

**RESULTS**

Calcium content in the eight vegetables is shown in Table 1. The concentration of calcium in the dry sample varied from 0.24 (Lowest) - 1.65 (Highest) mg/100g in’ Ukpa’ (conophor) and “Utazi,” respectively. Utazi had the highest calcium content (1.65 mg/100 g) which was significantly (P < 0.05) higher than the calcium composition of others, whereas Ukpa had the lowest calcium content (0.24 mg/100 g). The contents of iron varied from 0.33 (lowest) - 4.9 (highest) mg/100 g. The iron content of Ukazi was the highest (4.9 mg/100 g) and differ significantly (P < 0.05) from others, whereas Uziza had the lowest iron concentration (0.33mg/100 g). The zinc composition varied between 0.10-0.18 mg/100 g. Zinc content of Utazi was highest (0.18 mg/100 g) and differ significantly from other fruits, and vegetable analyzed while Ugu/Ukpa and garden egg had the lowest zinc concentration (0.10 mg/100 g) but this did not differ significantly.
Table 1: Zinc, iron, calcium and phytate composition of selected fruits and vegetables (mg/100g).

<table>
<thead>
<tr>
<th>Local Name</th>
<th>Zinc(mg/100g)</th>
<th>Iron(mg/100g)</th>
<th>Calcium(mg/100g)</th>
<th>Phytate(mg/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nchuanwu</td>
<td>0.17±0.1(^b)</td>
<td>1.10±0.1(^d)</td>
<td>0.28±0.1(^e)</td>
<td>19.0±2.0(^f)</td>
</tr>
<tr>
<td>Ukazi</td>
<td>0.15±0.1(^c)</td>
<td>4.90±0.1(^a)</td>
<td>0.31±0.0(^d)</td>
<td>66.0±3.0(^a)</td>
</tr>
<tr>
<td>Utazi</td>
<td>0.18±0.1(^a)</td>
<td>0.76±0.1(^d)</td>
<td>1.65±0.1(^a)</td>
<td>27.3±2(^d)</td>
</tr>
<tr>
<td>Uziza</td>
<td>0.13±0.1(^d)</td>
<td>0.33±0.2(^g)</td>
<td>0.15±0.1(^h)</td>
<td>19.0±2(^f)</td>
</tr>
<tr>
<td>Efe</td>
<td>0.10±0.0(^c)</td>
<td>2.00±0.1(^c)</td>
<td>1.60±0.0(^b)</td>
<td>32.0±4(^c)</td>
</tr>
<tr>
<td>Okwurubeke</td>
<td>0.13±0.1(^d)</td>
<td>0.62±0.5(^f)</td>
<td>0.47±0.1(^c)</td>
<td>16.5±1(^g)</td>
</tr>
<tr>
<td>Ukpa</td>
<td>0.10±0.0(^e)</td>
<td>3.75±0.1(^b)</td>
<td>`0.24±0.0(^g)</td>
<td>46.5±3(^b)</td>
</tr>
<tr>
<td>Ugu</td>
<td>0.10±0.1(^c)</td>
<td>0.48±0.1(^e)</td>
<td>0.26±0.0(^f)</td>
<td>19.8±2(^e)</td>
</tr>
</tbody>
</table>

Means not followed by the same superscript letters in the same column are significantly different \((P < 0.05)\).

Data are expressed as Mean ± SD of replicate determinations.

The phytate content of pawpaw (16.5 mg/100 g) was the lowest and highest in Ukazi (66.0 mg/100 g). The calculated Phy: Ca, Phy: Zn, Phy: Fe and [Ca] [Phy]/[Zn] molar ratios of the eight fruits and vegetables are shown in Table 2. The values in this study were Nchuanwu (0.41), Ukazi (12.90), Utazi (1.0), Uziza (7.68), garden egg (1.21), which indicates poor zinc bioavailability. However, the values obtained for Nchuanwu, Utazi, Uziza, and pawpaw (2.13), Ukpa (11.74) and Ugu (4.62) which were higher than the reported critical molar ratio of Phytate to calcium, indicating poor absorption of calcium in all the fruits and vegetables. The values in Ukazi (43.30), garden egg (31.52), Ukpa (45.80) and Ugu (19.50) are higher than the critical molar ratios of Phy: Zn, Pawpaw were lower than the critical value and thus possess good zinc bioavailability.
Table 2: Calculated molar ratio Phy: Ca, Phy: Fe, Phy: Zn, and [Ca][Phy]/[Zn] molar ratios of Selected Fruits and Vegetables.

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Nchuanwu</td>
<td>11.00</td>
<td>15</td>
<td>1.47</td>
<td>1</td>
<td>0.41</td>
<td>0.24</td>
<td>0.001</td>
<td>0.5</td>
</tr>
<tr>
<td>Ukazi</td>
<td>43.30</td>
<td>15</td>
<td>1.14</td>
<td>1</td>
<td>12.90</td>
<td>0.30</td>
<td>0.003</td>
<td>0.5</td>
</tr>
<tr>
<td>Utazi</td>
<td>14.93</td>
<td>15</td>
<td>3.04</td>
<td>1</td>
<td>1.00</td>
<td>0.24</td>
<td>0.003</td>
<td>0.5</td>
</tr>
<tr>
<td>Uziza</td>
<td>14.39</td>
<td>15</td>
<td>4.89</td>
<td>1</td>
<td>7.68</td>
<td>0.24</td>
<td>0.015</td>
<td>0.5</td>
</tr>
<tr>
<td>Efe</td>
<td>31.52</td>
<td>15</td>
<td>1.36</td>
<td>1</td>
<td>1.21</td>
<td>0.24</td>
<td>0.002</td>
<td>0.5</td>
</tr>
<tr>
<td>Okwurubeke</td>
<td>12.50</td>
<td>15</td>
<td>2.26</td>
<td>1</td>
<td>2.13</td>
<td>0.24</td>
<td>0.004</td>
<td>0.5</td>
</tr>
<tr>
<td>Ukpa</td>
<td>45.80</td>
<td>15</td>
<td>1.05</td>
<td>1</td>
<td>11.74</td>
<td>0.24</td>
<td>0.018</td>
<td>0.5</td>
</tr>
<tr>
<td>Ugu</td>
<td>19.50</td>
<td>15</td>
<td>3.5</td>
<td>1</td>
<td>4.62</td>
<td>0.24</td>
<td>0.007</td>
<td>0.5</td>
</tr>
</tbody>
</table>

DISCUSSION

- The calcium composition of Utazi appeared to be lower than the calcium contents reported by Adetuyi et al. (2011). The result above showed that Ukazi is a rich source of iron. Also, the values of zinc composition obtained in this study are lower than the values reported by Adetuyi et al. (2011).

The problem with phytate in food is that it can bind some essential mineral nutrients in the digestive tract which can lead to mineral deficiencies (Bello et al., 2008). The phytate composition of the sample might not threaten health when compared with a phytate diet of 10–60 mg/100 g which if consumed over a long period has been stated to decrease the bioavailability of minerals (Elinge et al., 2012). On the other hand, recent studies have established that dietary phytate at a low level may be advantageous as an antioxidant, anticarcinogens and likely play a vital role in controlling hypercholesterolemia and atherosclerosis (Woldegiorgis et al., 2015). The result of this study is lower than the value reported by Adetuyi et al. (2011). The molar ratios for calcium, zinc, iron, and phytate were calculated to evaluate the effects of elevated levels of
Phytate in the bioavailability of dietary minerals. Bioavailability is the ability of the body to digest and absorb the nutrient in the food consumed (Fekadu et al., 2013). The calculated values are also compared with the reported critical toxicity values for these ratios. Phytic acids evidently reduce Ca bioavailability and the Phy: Ca molar ratio has been proposed as an indicator of Ca bioavailability. The critical molar ratio of [phy]: [Ca] of < 0.24 indicating good calcium bioavailability (Woldegiorgis et al., 2015). Phytate begins to lose its inhibitory effect on iron absorption when phytate: iron molar ratios are less than 1.0, although even ratios as low as 0.2 put forth some adverse outcome (Gemede et al., 2015).

The phytate: iron molar ratios greater than 0.15 suggests poor iron bioavailability (Gemede et al., 2015). This result indicated that, the phytate: iron molar ratios of all the fruits and vegetables are higher than the critical value, which implies the absorption of iron in all will be inhibited by phytate and as a result the bioavailability of iron in the samples is poor. The importance of foodstuff as a source of dietary zinc depends on both the total zinc content and the level of other constituents in the diet that affect zinc bioavailability. Phytate could decrease the bioavailability of dietary zinc by forming insoluble mineral chelates at a physiological pH (Bhandari & Kawabata, 2004) and the formation of the chelates depends on relative levels of both zinc and phytic acid. Hence, the phytate: Zn molar ratio is considered a better indicator of zinc bioavailability than total dietary phytate levels alone (Woldegiorgis et al., 2014).

The potentiating effect of calcium on zinc absorption in the presence of high phytate intakes has led to the suggestion that the [Phy][Ca]/[Zn] millimolar ratio may be a better index of zinc bioavailability than the [Phy]/[Zn] molar ratio alone. High calcium levels in foods can promote the phytate-induced decrease in zinc bioavailability when the [Ca][phytate]/[Zn] millimolar ratio exceeds 0.5 mol/kg (Adetuyi et al., 2011). In this study, the values of [Ca][Phy]/[Zn] ratios of all the fruits and vegetables were found less than the critical level.
CONCLUSION
The study revealed that Utazi had the highest Zinc (Ugu/Ukpa has composition of iron (Uziza has lowest). Also, Ukazi had the highest Phytate composition whereas it was lowest in pawpaw. All the fruits and vegetables had poor bioavailability for the three micronutrients analyzed as their molar ratio values were higher than the critical values. Therefore, other foods rich in micronutrient should be consumed alongside the selected food crops.

RECOMMENDATION
Further study should be carried out on the use of different food processing methods to reduce anti-nutrients composition of the fruits and vegetables commonly consumed in the study area. Biofortification strategy and food processing methods should be encouraged to reduce the antinutrient composition of the selected food crops. Other foods rich in micronutrients should be consumed alongside this selected fruits and vegetables to avoid hidden hunger.
REFERENCES


