Short Research Communication

Non-nutrient components of varieties of cassava, *Manihot esculenta*, crantz grown and consumed in Bayelsa State, Nigeria

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The importance of quantification of non-nutrient components of foods in the determination of the adequacy of such materials as food nutrients has continued to be well recognized. Samples of varieties of cassava – *Manihot esculenta* crantz were harvested fresh from farms in Okutukutu, Yenagoa region in Bayelsa state, Nigeria. Determination of alkaloids was done using gravimetric method of Harbone, while the tannins were analyzed using Folin-Denis Spectrophotometric method. Phytates and oxalates were determined using spectrophotometric and potassium permanganate methods respectively. Phytochemical studies showed that the non-nutritive components, alkaloids and tannins ranged from 2.37 – 3.39, and 9.65 – 9.99(%) respectively. Other anti-nutritional factors oxalates and phytates content were from 108.6 - 283.89 and 0.071 – 0.092 respectively (g/100g). Phytales levels were deemed low and should not pose any negative influence on the mineral nutrition of consumers of such cassava varieties. Since the phytochemicals and oxalates levels were deemed high in the raw cassava pulp, they should not be consumed as harvested, rather should be subjected to further processing so as to reduce the non-nutrient components to minimal acceptable levels before consumption.

**Key words:** Cassava- *Manihot esculenta*, alkaloids, tannins, phytates, oxalates, non-nutrient components.

INTRODUCTION

The need for studies into the non-nutrient components of foods and the roles of such components in health and disease is receiving increasing attention (Akande et al., 2010; Greenfield and Southgate, 2003; Temple, 1998). The recognition of the close relationship between diet and health has led to increased interest not only in the nutrient components but in the composition and the roles of the non-nutritive factors in food that accompany the nutrients. The non-nutritive components in foods range from phytochemicals to enzyme inhibitors, and other anti-nutritional factors that render the much desired essential nutrients contained in such foods unavailable. This fact underscores the indispensability of data of this sort in any comprehensive Food Composition Data (Greenfield and Southgate, 2003). It is noteworthy that the current move towards computerization of Food Composition Data Bases (FCDB) for various countries is well-designed to accommodate these and other information (Greenfield and Southgate, 2003) that govern good food choices for maintenance of good health and in the management of various ailments.

Alkaloids and tannins are among the non-nutrients or phytochemicals of food plants used medicinally. Alkaloids belong to a group of centrally acting drugs obtained from food plants. They exact their effects on the central nervous system, affecting the respiratory, vasomotor centers and the cardiovascular system; while others act on the peripheral nerves causing arteriolar vasodilation and increased diuresis by inhibition of renal tubular re-absorption ((Roberts and Wink, 1998; Briggs and Briggs, 1974). Howbeit a lot others have unspecified actions.

Tannins are also used as astringents and contribute to
organoleptic properties of industrial foods, being responsible for the tastes of wine, or unripe fruits (Ferrell and Thorington, 2006). However because tannins have the ability to precipitate proteins, starches, cellulose and carbohydrates they can act as anti-nutritional factors in plant foods. They can bind and precipitate proteins in the gut thereby reducing their digestibility, or, where such proteins are enzymes, inactivating them. Tannins are known tripisin, chymotripsin, amylase, and lipase inhibitors (Griffiths, 1979). Tannins present in food stuff can interfere with iron absorption by either binding and forming insoluble precipitates and rendering the iron unavailable for absorption (Linder, 1991), or precipitating out the protein which otherwise aids iron absorption by keeping it in solution. Although the presence of tannins could also cause browning or pigmentation problems of both fresh and processed foods, such characteristics have potentials for the food industry. Also they have the ability to reduce palatability due to its astringent constituents. Low palatability can decrease feed intake in livestock.

Cassava (*Manihot esculenta* crantz) (Euphorbiaceae), is a drought resistant tuberous crop with capacity to adapt to various soil and weather conditions – characteristics which make it a choice staple root for farmers. It is therefore a major source, not only of dietary but also, of industrial carbohydrates.

A lot of literature exists on the non-nutrient or anti-nutritional components of cassavas (Blagbrough et al., 2010; Ebuehi et al., 2005; Osagie and Eka, 1998). Particularly much attention had been paid to the cyanogenic glycosides content in cassavas (Umubese and Okeke, 2004; Egah et al., 1998; Akintonwa et al., 1994). Already the cyanogenic glycosides content of the present varieties in this study have also been documented, (Madukosiri and Amos-Tautua, 2010). However little or no information exists on the phytochemicals, and non nutrient components of these cassava varieties traditionally named Agric Rowaina (Ag.R), Accra (Ac), Oguru (Og), Yomugh (Yo), Agric (Ag), Janet (Ja) and Rowaina (Ro),(Figure1) grown and consumed in Bayelsa state, Nigeria ( Amos-Tautua and Madukosiri,2010). The present study focuses on quantification of some phytochemical components and anti-nutritional factors alkaloids, tannins, oxalates and phytates in some of these cassava varieties.

**MATERIALS AND METHODS**

**Collection and Preparation of Samples**

Seven different varieties of Cassava (*Manihot esculenta* crantz) roots roots viz: Agric Rowaina (Ag. R), Accra (Ac), Oguru (Og), Yomugh (Yo), Agric (Ag), Janet (Ja), and Rowaina (Ro) were obtained from farms in Okutukutu, Yenagoa Region of Bayelsa state between the months of April and June 2013. These varieties had been identified by a taxonomist in earlier studies (Amos-Tautua and Madukosiri,2010). Samples were cleaned, washed with...
distilled water, chopped into cube sizes and dried to constant weight in an oven to obtain the moisture content. Raw weights of roots, outer peels and pulp edible portion were obtained using Electronic balance, while morphological measurements were obtained with an inelastic tape.

**Determination of Alkaloids**

Determination of alkaloids was done by the gravimetric method of Harbone (1973). In this procedure alkaloids were extracted from 5.0g milled sample using 50mls of 10% acetic acid solution in methanol, shaken, and allowed to stand for four hours before filtering with filter paper number 40. To the filtrate which was evaporated to about a quarter of its original volume was added drop-wise concentrated ammonium hydroxide, to precipitate the alkaloids. These were in turn filtered off a weighted filter paper, washed with 1% NH₄OH solution and dried to constant weight at 60°C for 30 minutes in the oven. The quantity of alkaloids was determined by weight difference and expressed as a percentage of the sample weight analyzed.

**Determination of Tannins**

Folin-Denis Spectrophotometric method described in Pearson (1976) was used for the determination of tannins. Extraction of tannins was carried out using 1.0g milled sample in 10mls distilled water, shaken every 5minutes for 30minutes and centrifuged at 2000 rpm to separate the extract. About 2.5mls of supernatant was placed into a 50ml volumetric flask into which was added 1.0ml Folin-Denis reagent and 2.5mls saturated sodium carbonate (Na₂CO₃) solution, made up to mark with distilled water and incubated for 90 minutes at room temperature before absorbance reading in a UV /Spectrophotometer at 250nm against a reagent blank. About 2.5mls standard tannic acid was treated in the same way; while the tannins content of sample was expressed as a percentage of the sample weight analyzed.

**RESULTS**

The present work presents the morphological parameters and the non-nutritive components of varieties of cassava - *Manihot esculenta* crantz roots, traditionally named Agric Rowaina, Accra, Oguru, Yomugha, Agric, Janet and Rowaina, grown and consumed in Bayelsa state, Nigeria.

The moisture content, tuber weight, tuber diameter and tuber length determined ranged from 12.70 – 31.47%, 119.54 – 943.65(g), 5.75 – 25.62(mm), and 5.68 – 41.99(mm) respectively (Table 1, Figure 1).

Alkaloids levels determined were from 2.38 ± 0.01 to 3.34 ± 0.05(%) (lowest to highest values) in Agric and Accra varieties respectively. Tannic acid values were from 0.969 ± 0.03 to 0.996 ± 0.03 (%), (lowest to highest values), Agric and Agric Rowaina varieties respectively, (Table 2). The other components were from 134.4 ± 25.8 to 280.2 ±

<table>
<thead>
<tr>
<th>Cassava Varieties</th>
<th>Moisture Content</th>
<th>Mean Tuber Weight</th>
<th>Mean Tuber Diameter</th>
<th>Mean Tuber Length</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% Edible Portion (Pulp)</td>
<td>(g)</td>
<td>(mm)</td>
<td>(mm)</td>
</tr>
<tr>
<td>AgR</td>
<td>31.47</td>
<td>300±100.00</td>
<td>15.75±10</td>
<td>22.83±8.0</td>
</tr>
<tr>
<td>Ac</td>
<td>12.70</td>
<td>391.67±87.80</td>
<td>22.50±3.12</td>
<td>22.33±7.37</td>
</tr>
<tr>
<td>Og</td>
<td>15.59</td>
<td>206.25±25.00</td>
<td>18.00±1.00</td>
<td>18.00±1.00</td>
</tr>
<tr>
<td>Yo</td>
<td>22.22</td>
<td>335.00±204.06</td>
<td>16.55±1.98</td>
<td>19.3±13.65</td>
</tr>
<tr>
<td>Ag</td>
<td>24.15</td>
<td>275.00±155.46</td>
<td>13.38±2.56</td>
<td>25.00±6.56</td>
</tr>
<tr>
<td>Ja</td>
<td>28.53</td>
<td>425.00±253.72</td>
<td>16.00±5.51</td>
<td>27.00±8.00</td>
</tr>
<tr>
<td>Ro</td>
<td>15.82</td>
<td>623.33±320.32</td>
<td>16.83±3.69</td>
<td>28.67±13.32</td>
</tr>
</tbody>
</table>

Tabulated values were means (±SD) of three determinations.
Table 2. Alkaloids and Tannins Content of Seven Varieties of Cassava – *Manihot esculenta* Tubers Grown and Consumed in Bayelsa state Nigeria (Mean±SD)

<table>
<thead>
<tr>
<th>Cassava Varieties</th>
<th>Alkaloids % Dry Edible Portion</th>
<th>Tannins % Dry Edible Portion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ag.R</td>
<td>2.93±0.02</td>
<td>9.96±0.03</td>
</tr>
<tr>
<td>Ac</td>
<td>3.34±0.05</td>
<td>9.82±0.03</td>
</tr>
<tr>
<td>Og</td>
<td>2.39±0.10</td>
<td>9.75±0.04</td>
</tr>
<tr>
<td>Yo</td>
<td>2.93±0.02</td>
<td>9.80±0.02</td>
</tr>
<tr>
<td>Ag</td>
<td>2.38±0.01</td>
<td>9.69±0.03</td>
</tr>
<tr>
<td>Ja</td>
<td>3.07±0.05</td>
<td>9.85±0.02</td>
</tr>
<tr>
<td>Ro</td>
<td>3.06±0.01</td>
<td>9.82±0.03</td>
</tr>
</tbody>
</table>

(Agric Rowaina (Ag. R), Accra (Ac), Oguru (Og), Yomugha (Yo), Agric (Ag), Janet (Ja), and Rowaina (Ro).
Tabulated values were means (±SD) of three determinations

Table 3. Oxalates and Phytates Content of Seven Varieties of Cassava – *Manihot esculenta* Tubers Grown and Consumed in Bayelsa state Nigeria (Mean±SD)

<table>
<thead>
<tr>
<th>Cassava Varieties</th>
<th>Oxalates (mg/100g) Dry Edible Portion</th>
<th>Phytates(g/100g) Dry Edible Portion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ac</td>
<td>148.5±1.3</td>
<td>0.071±0.02</td>
</tr>
<tr>
<td>Og</td>
<td>239.2±1.3</td>
<td>0.092±0.07</td>
</tr>
<tr>
<td>Yo</td>
<td>134.4±25.8</td>
<td>0.084±0.03</td>
</tr>
<tr>
<td>Ag</td>
<td>280.2±3.6</td>
<td>0.078±0.02</td>
</tr>
<tr>
<td>Ja</td>
<td>248.8±22.8</td>
<td>0.090±0.06</td>
</tr>
<tr>
<td>Ro</td>
<td>152.2±15.6</td>
<td>0.078±0.02</td>
</tr>
</tbody>
</table>

(Agric Rowaina (Ag. R) (was unavailable), Accra (Ac), Oguru (Og), Yomugha (Yo), Agric (Ag), Janet (Ja), and Rowaina (Ro).
Tabulated values were means (±SD) of three determinations

3.6 (mg/100g) oxalates in Yo and Ag (lowest to highest level) respectively; and 0.071 ± 0.02 to 0.092 ± 0.07 (g/100g) phytates in Ac and Og varieties in that other, (Table 3).

DISCUSSION

Non-nutrient components of cassava

The present study has determined the phytochemical components and anti-nutritional factors alkaloids, tannins, oxalates and phytates content of varieties of cassava *M. esculenta* grown and consumed in Bayelsa state. This is done with the understanding that high content of the anti-nutrient components could not only determine the availability of the nutrients contained in the food samples but, to a large extent, pose dangers to health of the consuming organism. The results of the present work should also offer a guide to the extent and type of processing required (if any) for these cassava varieties before consumption.

The levels of alkaloids and tannins determined were on the higher levels of some reported literature values for cassavas / vegetable products (Ebuehi et al., 2005; Monago and Akhidue, 2002; Osagie and Eka, 1998). However values in the cited references were determined from other cassava varieties obtained from different geographical locations or environment. For example values reported by Ebuehi et al, (2005) were obtained from a variety *M. esculenta* L from the south-west part of the country having a different terrain from the south-south area where the present study was conducted. Wide differences in published values had long been observed and were attributed to geographical and seasonal variations (Osagie and Eka 1998). For example several authors determined values (from cassavas) ranging from 0.5 – 632.95 for oxalate, 1.1 – 161.4 for phytates, 3.0 – 900.0 for tannins (mg/100g), 1.60 – 4.36 for alkaloids (%) (Eleazu et al, 2011; Sarkiyayi and Agar, 2010; Temple, 1998), and these variations were attributed to seasonal/ geographical and ecological changes, apart from factors of Innate genetic disposition of plants themselves which determine their bioaccumulation.

Alkaloids and Tannins

The alkaloids content determined was according to the decreasing order Accra > Janet > Rowaina > Ag. Rowaina > Yomugha > Oguru > Agric varieties. Alkaloids content of 20mg/100g was considered lethal and therefore deemed toxic as they could give rise to intestinal upset and neurological disorders (Osagie and Eka, 1998). The present determinations from raw unfermented varieties were above that recommendation. This is an indication that these varieties should not be consumed as harvested but should be subjected to further processing to reduce the toxicant
level before consumption. Hopefully when adequately processed the toxicant content should be reduced to minimal and acceptable levels. Several processing methods have been successfully employed by processors of cassavas to reduce the toxicant levels and they include peeling, soaking and fermentation, boiling, drying, and frying. Future studies should determine which method could best achieve a significant toxicant reduction.

Also the values for tannins content of cassava determined in the present study were higher than some values reported in the above cited references from the south-west of Nigeria (Ebuehi et al., 2005; Osagie and Eka, 1998). All varieties studied contained similar levels of tannins ranging from 0.966 – 0.999%.

**Oxalates and Phytates**

Besides the phytochemicals, it had been shown that other anti-nutritional factors such as oxalates and phytates present in various plant foods can bind essential mineral nutrients including calcium, inorganic iron, and manganese making them unavailable for absorption. Phytates are also known to interfere with the absorption of other divalent cations, zinc and magnesium, (Linder, 1991). In the present study oxalates and phytates content follow the decreasing orders Ag> Ja> Og> Ro> Ac> Yo; and Og>Ja>Yo>Ag> and Ro>Ac respectively. It appears Yo and Ac varieties are better food-stuff in terms of their lower toxicant content. It is recalled that these two (together with Og) were the three varieties from which higher starch yield had been reported (Madukosiri, 2013). However before embarking on food recommendation for producers and consumers alike, future studies should examine the functional and sensory characteristics so as to determine what governs the choices made by users over these varieties.

**CONCLUSION**

Some phytochemicals and anti-nutritional factors in varieties of cassava *Manihot esculenta* crantz, grown and consumed in Bayelsa State, Nigeria, are presented. The alkaloids and tannins levels are deemed high and so the crops should be subjected to further processing before consumption; otherwise the high levels could be further explored for medicinal and industrial purposes. Oxalate values determined were comparable to literature report while the phytate components were found to be lower than those references. This report is positive in terms of mineral bioavailability in nutrition. The varieties Yomugha and Accra, due to their lower toxicant content, are more promising in terms of uses as nutrient sources. Information of this sort could find application in Food Composition Data Base in the area of nutrient availability, and crop/food identification.

Future studies should determine an adequate processing method to reduce the non-nutrient components to minimal levels without compromising the nutrient concentration. Also factors governing the preference of these cassava varieties by farmers and consumers in Bayelsa state should be determined. This information is useful for development of improved cultivars. There is need for the respective government agencies to monitor the cassava products pushed into the markets so as to ensure that good finished products, low in anti-nutritional factors, are available for consumers.

**REFERENCES**


Linder MC (1991). Nutritional biochemistry and


