Anti-Nutrient Composition Of Aduh (Dioscorea bulbifera) 
And Its Performance As Wheat Substitute In Bread Production

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ABSTRACT
The study investigated the anti-nutrient composition of the aduh flour and functional properties of wheat-aduh composite flour. The composite flour samples were obtained by blending the wheat-aduh flour in the ratio of 100:0, 95:5; 90:10, 85:15, 80:20 and 75:25. The 100% wheat flour served as the control sample. Data obtained for anti-nutrient composition of the aduh flour showed that phytate, tannin, oxalate and hydrogen cyanide contents were 0.43mg/100g, 0.24mg/100g, 0.35mg/100 and 0.28mg/100g respectively. Also, data obtained for functional properties of the wheat-aduh flour ranged from 0.835% to 0.908%, 0.372% to 1.557%, 1.03% to 1.23%, 1.126% to 1.511% and 70°C to 80°C for bulk density, oil absorption capacity, water absorption capacity, swelling capacity and gelation temperature respectively. There were significant (p<0.05) differences between data obtained. It was observed that the aduh flour analyzed were low in anti-nutrients. The result obtained for functional properties of the wheat-aduh composite flour blends suggests that bread made from the different flour blends can compare favourably with conventional bread made from 100% wheat flour in quality in terms of functional properties up to 15% substitution of wheat flour with aduh flour.

Keywords: Anti-nutrients, Functional Properties, Wheat, Aduh, Composite

INTRODUCTION
“Aduh” also known as air potato or aerial yam is a member of the Dioscoreaceae family which is consumed among rural dwellers in parts of Eastern and Western Nigeria. It is called air potato because it produces potato-like aerial bulbs in the leaf axils of the twining stems. They are not commercially grown owing to their under-utilization. Aduh (Dioscorea bulbifera) consist of several varieties found in South Asia and Africa (Kayode et al., 2016). According to Schultz (1993), some varieties aduh (Dioscorea bulbifera) are edible and are cultivated as food crops in most hot humid tropical region of the world. Several researchers have reported some medicinal and therapeutic properties of D. bulbifera. Son et al. (2007); Yamada et al. (2009); Raju and Rao (2012) reported that this yam specie is rich in diosgenin, a steroid saponin believed to possess preventive and therapeutic properties against several ailments including arthritis, cancer, diabetes, gastrointestinal disorders, high cholesterol and inflammation. Diosgenin is a known major bioactive component of synthetic birth control pills. Duke et al. (1993) also recorded the use of the plant in folk medicine for treatment of diarrhea, dysentery, conjunctivitis and other ailments.

Bread is an important staple food in both developed and undeveloped countries, known for its taste, aroma and texture. It represents a staple food prepared by baking dough of flour and water (Osuji, 2006). Bread is described as a loaf made from wheat or rye flour (Amandikwa et al., 2015). Previous studies have shown the incorporation of non–wheat flours in bread production. Olapade and Oluwole (2013) replaced 10% of wheat flour with cowpea flour to produce bread loaves with acceptable functional
properties. Also, Adeyeye et al. (2019) replaced 30% of wheat flour with rice flour in bread and it compared favourably with bread produced from 100% wheat flour.

Similarly, Amandikwa et al. (2015) analyzed the physico-chemical properties of wheat-yam flour composite bread and recommended that substitution level of not more than 25% yam flour be used for yam/wheat composite bread production. Cultivation of aduh (*Dioscorea bulbifera*) has been low due to inadequate utilization of the crop and this has made product diversification with aduh (*Dioscorea bulbifera*) to be minimal. Hence, there is need to investigate the bread making potentials of aduh (*Dioscorea bulbifera*). Successful production of bread supplemented with aduh (*Dioscorea bulbifera*) flour will not only encourage improved cultivation of this crop but will also enhance the economic value of the crop. This study therefore is aimed to evaluate the anti-nutrient composition of the aduh flour and functional properties of wheat-aduh composite flour for bread production.

**MATERIALS AND METHODS**

**Sample Collection and Preparation**

Matured aduh (*Dioscorea bulbifera*) tubers and wheat flour used for the study were obtained from Ekeonunwa market located at Douglas Road, Owerri, Imo State. The processing equipment used for processing the sample was sourced from the laboratory of the Department of Food Science and Technology, Imo State University, Owerri.

The matured aduh (*Dioscorea bulbifera*) tubers were sorted, peeled and sliced with stainless kitchen knife and then washed. The sliced samples were subsequently oven-dried at 60°C for 30min. The dried samples were milled using attrition mill and sieved to obtain flour with uniform sizes and packaged in an air tight container pending usage.

**Formulation of Composite Flour Samples**

The composite flour samples for the study were obtained from blends of wheat flour and aduh (*Dioscorea bulbifera*) in the ratio of (100:0, 95:5; 90:10; 85:15, 80:20 and 75:25). The 100% wheat flour served as the control sample.

**ANALYSES**

**Determination of Anti-nutrient Composition**

The anti-nutrient compositions of the flour samples which include tannin, oxalate, hydrogen cyanide and phytate contents were determined using methods described by Onwuka (2005).

**Determination of Functional Properties**

The functional properties of the flour samples; bulk density, oil absorption capacity, water absorption capacity, swelling capacity and gelation temperature were determined using methods described by Onwuka (2005).

**Statistical Analyses**

Each experiment was performed in triplicates. Results obtained from the analyses were computed into means and the analysis of variance (ANOVA) was carried out using Statistical Package for Social Scientists (SPSS) version 22. Significantly different means were separated using Fishers Least Significant Difference (LSD) at 95% confidence level (p< 0.05).

**RESULTS AND DISCUSSION**

**Anti-Nutrient Composition of the Aduh (*Dioscorea bulbifera*) Flour Sample**

The result of the anti-nutrient composition of the aduh (*Dioscorea bulbifera*) flour sample is presented in Table 1.

The tannin content of the aduh flour sample was found to be 0.24mg/100g. The tannin content recorded in this present study was similar to the 0.22mg/100g reported by Princewill-Ogbonna and Ibeji (2015) for aerial yam but higher than the 4.62mg/100g reported by Ifeanacho et al. (2017) for *Dioscorea bulbifera* from Rivers State. It was also observed that the tannins content of the studied yam samples was comparatively lower than reported values in cocoyam (*Colocasia esculenta (L)*) (Lewu et al., 2010). Also, these values are relatively lower than those of 20-255 mg/100g reported on various under-utilized
Dioscorea tubers by Arinathan et al. (2009). According to WHO, tannin level in foods below 5mg/100g are safe for human consumption. Tannins have been reported to form complexes with proteins and reduce their digestibility and palatability (Eka, 1998). However, their contents in foods are known to reduce through cooking (Lewu et al., 2010). The bitter principles of aduh (D. bulbifera) may be due to the presence of tannins in them (Okwu and Ndu, 2006). The small quantities of tannin available in the tubers act as a repellants against rot in yams. The oxalate content of the aduh flour sample was found to be 0.35mg/100g. The amount of oxalate (0.35mg/100g) recorded in the aduh flour sample analyzed was far below the toxic level of 2.5g reported by Onimawo and Akubor (2012). Oxalic acid and oxalate occur naturally in plants but they have little or no useful effect on human health as high levels in diets lead to irritation of the tissues, the digestion system, particularly the stomach and kidney (Ogbuagu, 2008). The hydrogen cyanide content of the aduh flour sample was found to be 0.28mg/100g. The 0.28mg/100g value reported for hydrogen cyanide of the aduh sample analyzed in this present study was found to conform to the range of 0.09mg/100g to 0.32mg/100g reported by Arinathan et al. (2009) for some under-utilized tubers. Onwuka (2005) reported 50mg/kg as a critical concentration of the toxic substance in foods. Ingestion of foods that are high in hydrogen cyanide can be harmful to the nervous system (Chung et al., 1998).

The phytate content of the aduh flour sample was found to be 0.43mg/100g. Value obtained for aduh (Dioscorea bulbifera) flour sample in this present work was found to lower than those reported by Wanasundera and Ravindran (1994) for D. alata (0.89 mg/100g) and D. cayenensis (4.16 mg/100g). This value is also much lower than the values of 400-2060 mg/100 g reported for cereals and grain legumes by Reddy et al. (1982). Phytates limit the availability of some notable minerals like magnesium, iron, and even calcium. Phytic acid has also been implicated in the removal of phosphorus and causing indigestion and flatulence in human system (Groff et al., 1995). Ingestion of 2.5g or more of phytic acid per day has been reported to cause reduction in bioavailability of calcium, iron and zinc (Onimawo and Akubor, 2012).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Composition (mg/100g)</th>
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<tbody>
<tr>
<td>Tannin</td>
<td>0.24 ± 0.00</td>
</tr>
<tr>
<td>Oxalate</td>
<td>0.35 ± 0.00</td>
</tr>
<tr>
<td>Hydrogen cyanide</td>
<td>0.28 ± 0.00</td>
</tr>
<tr>
<td>Phytate</td>
<td>0.43 ± 0.11</td>
</tr>
</tbody>
</table>

Values are Mean ± SD of duplicate determinations

**Functional Properties of the Composite Flour Blends**

Table 2 shows the functional properties of the wheat- aduh (Dioscorea bulbifera) composite flour blends. The result from the analysis showed that the bulk density of flour samples ranged from 0.835g/ml to 0.908g/ml with flour from 100% wheat flour recording the highest (0.908g/ml) value. It was observed that the substitution of wheat flour with aduh (Dioscorea bulbifera) significantly (p<0.05) reduced the bulk density of the flour samples. Similar result has been reported by Igyor et al. (2004). They reported a range of 0.50 – 0.62 g/ml for the raw flour samples of D. cayenensis, D. bulbifera and D. rotundata. Bulk density gives indication of the relative volume of packaging material required. Generally, higher bulk density is desirable for greater ease of dispersibility and reduction in paste thickness (Udensi and Eke, 2000). Low bulk density of flour are good physical attribute when determining transportation and storability since the product could be easily transported and distributed to required locations (Agubiade and Sanni, 2001). It implies that high bulk density of the composite flour suggest their suitability for use in food preparation.

The oil absorption capacity of the flour samples ranged from 0.372ml/g to 1.557ml/g with flour sample obtained from 100% wheat flour recording the lowest (0.372ml/g) value while flour from blends of wheat and aduh (Dioscorea bulbifera) flour recorded the highest (1.557ml/g) value. It was observed that the
substitution of wheat flour with adult (Dioscorea bulbifera) significantly (p<0.05) increased the oil adsorption capacity of the flour samples. Result obtained in this present study conforms to that of Amandikwa et al. (2015) in their work on the physico-chemical properties of wheat-yam flour composite bread when a significant (p<0.05) increase was observed when wheat flour was blended with flours from different species of yam for bread production. The result obtained in this present study suggests that composite flours from wheat- adult (Dioscorea bulbifera) may give better palatability and better flour retention compared to the control sample (100% wheat flour). Oil gives soft texture and good flavour to food. Therefore, the absorption of oil by food products improves mouth feel and flavour retention (Adedeji et al., 2014).

The result obtained for the water absorption capacity revealed that the water absorption capacity of the flour ranged from 1.03ml/g to 1.23ml/g. It was observed that substitution of wheat flour with adult (Dioscorea bulbifera) flour significantly (p<0.05) increased the water absorption capacity of the flour. The increased in the water absorption capacity of the composite flours implies that the flours can be used in formulation of some foods such as sausage, dough, processed cheese and bakery products.

The gelation temperature of the flour samples ranged from 70°C to 80°C. The gelation capacity tends to increase more as the proportion of adult (Dioscorea bulbifera) flour increased in the blend. The variation in the gelation temperature of flours could be attributed to the relative ratio protein, carbohydrates and fat that makes up the flour and interaction between such components (Sathe et al., 1982).
### Table 2. Functional Properties Of The Flour Samples

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>LSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk density (g/ml)</td>
<td>0.908±0.014&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.885±0.053&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.847±0.007&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.839±0.014&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.835±0.005&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.835±0.007&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.02</td>
</tr>
<tr>
<td>Oil absorption (ml/g)</td>
<td>0.372±0.630&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.855±0.053&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>0.861±0.047&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>0.947±0.053&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>1.221±0.053&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.557±0.000&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.73</td>
</tr>
<tr>
<td>Water absorption (ml/g)</td>
<td>1.03±0.058&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.10±0.000&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>1.13±0.058&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>1.17±0.058&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.17±0.050&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.23±0.058&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.14</td>
</tr>
<tr>
<td>Swelling capacity</td>
<td>1.126±0.016&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.205±0.008&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.219±0.058&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>1.267±0.067&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.419±0.017&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.511±0.038&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.12</td>
</tr>
<tr>
<td>Gelation temperature</td>
<td>70±0.02&lt;sup&gt;c&lt;/sup&gt;</td>
<td>71±0.02&lt;sup&gt;c&lt;/sup&gt;</td>
<td>71±0.02&lt;sup&gt;c&lt;/sup&gt;</td>
<td>73±0.04&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>78±0.02&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>80±0.02&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.94</td>
</tr>
</tbody>
</table>

Mean in the same row with the same superscript are not significantly different at p<0.05. The means were separated using least significant difference (LSD).

**KEY:**
- **A** = 100% wheat flour bread (control)
- **B** = 95% wheat flour + 5% aduh (*Dioscorea bulbifera*) flour
- **C** = 90% wheat flour + 10% aduh (*Dioscorea bulbifera*) flour
- **D** = 85% wheat flour + 15% aduh (*Dioscorea bulbifera*) flour
- **E** = 80% wheat flour + 20% aduh (*Dioscorea bulbifera*) flour
- **F** = 75% wheat flour + 25% aduh (*Dioscorea bulbifera*) flour
CONCLUSION

Results from this work have shown that aduh (Dioscorea bulbifera) flour is low in anti-nutrients and could be used for substituting wheat flour for food production judging by the result obtained from the functional properties analysis. Thus suggesting that aduh (Dioscorea bulbifera) may be useful in food formulations where these characteristics are of great importance. Also, the result obtained for functional properties of the wheat- aduh composite flour blends suggests that bread made from the different flour blends can compare favourably with conventional bread made from 100% wheat flour in quality in terms of functional properties up to 15% substitution of wheat flour with aduh flour.

RECOMMENDATION

It is therefore recommended that extensive cultivation and utilization of aduh (Dioscorea bulbifera) should be encouraged since they could serve as useful substitute for composite bread production. Also, further research should be carried out to ascertain the behaviour of these composite flours during bread production and how shelf stable the resulting products are.

REFERENCES


