Research Article

Effects of boiling on the estimated Glycemic Index (eGI) and α-amylase/α-glucosidase inhibitory properties of two Bitter Yam (Dioscorea dumetorum) spp

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ABSTRACT: This study investigated the effects of boiling on estimated Glycemic Index (eGI), α-amylase and α-glucosidase inhibitory properties of peeled and unpeeled white and yellow bitter yam. The yams were cooked with and without the peel to an acceptable softness, dried till constant weight and pulverized into flour. The aqueous extracts were prepared (1:5 w/v) followed by the determination of total sugar, starch, amylose, amylopectin, phenolic contents as well as the eGI. The antioxidant parameters and enzymes (α-amylase, α-glucosidase) inhibitory effects were further determined. Cooking significantly increased sugar and starch contents, and GI of bitter yams. Unpeeled cooked yellow bitter (UCYB) had the highest sugar content (11.46 g/100 g) while peeled cooked yellow bitter yam (PCYB) had highest starch content (78.08 g/100 g), amylose and amylopectin contents (32.43 and 45.65 g/100 g respectively). Also, cooked bitter yam had the highest percentage GI (UCYB = 79.05 %). Furthermore, cooked white and yellow bitter yam had higher antioxidant properties than the raw interestingly; PCYB had the highest α-amylase and α-glucosidase inhibitory activities than raw. In conclusion, cooking improved the antioxidant potentials and α-amylase and α-glucosidase inhibitory effects of both yam varieties.

KEYWORDS: Bitter yam (White and Yellow), cooking methods, Glycemic index, α-amylase, α-glucosidase

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INTRODUCTION

The need to monitor blood glucose level necessitated the search for various foods that will help in the management of diabetes and associated changes in body weight. Carbohydrate constitutes the most important source of energy requirement of the body, and starch is the most abundant of all (Chung et al., 2006). Methods of food processing such as baking, roasting, etc., as well as cooking (boiling) are found to influence glycemic index/load (Adedayo et al., 2015). High or low blood glucose level has been implicated with various health threatening dietary related diseases.

Glycemic Index (GI) is a method of ranking carbohydrate-based food according to their postprandial blood glucose response compared to food standard such as glucose or white bread (Adelayo et al., 2015; Shanita et al., 2016); The knowledge of GI help in preventing or managing these dietary associated diseases such as obesity and diabetes (Meynier et al., 2015).

Previous studies have reported the effect of cooking method on some commonly Nigerian staple foods such as sweet potatoes, trifoliate yam, maize among others (Ukom et al., 2014; Guo et al., 2015) but little is known about the effect of cooking on the glycemic index of white and yellow bitter yam. Yam belongs to the family Dioscoreaceae within the genus Dioscorea (Coursey, 1983; Ayensu, 1972). It is a perennial vine plant that is mostly cultivated for its tubers for consumption and is also processed into powder, packaged, and sold for consumption (Hahn et al., 1987; Adelayo et al., 2015). Bitter yam (Dioscorea dumetorum), is one of the most important species of discorea. It grows well in drained, fertile and high textured soil with an annual rainfall ranging between 10 and 70 inches (Iwu and Nwakanma, 1990).

There are four common varieties of bitter yam of which two are edible, while the other two are toxic (Bevan et al., 1956). Yellowish - white is toxic to animal alone and the white toxic is toxic to both animal and man. The toxic variety has been shown to contain dihydrosycordiscorine iso-planes, a heart stimulant (Bevan et al., 1956) and dioscorcoretine, a hypoglycemic agent (Iwu and Nwakanma, 1990). Studies have suggested that preference of low glycemic foods over high glycemic foods will help greatly in the management of diabetes; hence low glycemic yam will be of therapeutic importance to the management of diabetics, obesity and weight control (Asinobi et al., 2016; Iwu and Nwakanma, 1990; Adelayo et al., 2015).

Therefore, this study investigated the effects of cooking (boiling) on the estimated glycemic index and α-amylase, α-glucosidase inhibitory properties of two varieties of bitter yam (Dioscorea dumetorum) white and yellow.

MATERIALS AND METHODS

Sample Collection

Two varieties of bitter yam tubers (White and Yellow), locally called 'Esuru' were obtained from Oja-Oba’s market, Akure, Ondo State, Nigeria. The samples were identified in the Department of Crop Soil and Pest (CSP), Federal University of Technology, Akure, Nigeria.

Sample Preparation

The bitter yam (White and Yellow) samples were washed. A portion was peeled and sliced before being oven-dried; while some portions were peeled and cut before cooking in water and then oven dried. The third portion was washed and cooked in water in the normal traditional way before being dried. All the samples (Raw, Peeled and Unpeeled) were milled in a blender after drying before being used for further analysis.

Chemical and Reagents

All other chemicals used were of analytical grade and the water was glass distilled.

Preparation of aqueous extracts

One gram of the powdered samples was soaked in 20 ml of distilled water and shaked vigorously with the aid of orbital shaker for 3 h before centrifuged at 3000 rpm for 10 min to obtain a clear supernatant which was then kept in freezer at -4°C until further analysis.
Determination of total starch and sugar

The starch content was investigated according to Astolfi-Filfo et al. (1986). Extracts were taken at time intervals to examine the starch concentration in the reaction solution. Extracts (3 ml), iodine solution (I\textsubscript{2}), and 5 ml (0.5 % KI and 0.15 % I\textsubscript{2}) were mixed. The mixture final volume was made up to 15 ml with distilled water. Thereafter, the absorbance was taken at 550 nm against a blank containing 5 ml of iodine solution and 10 ml of distilled water. Using standard curve, absorbance was converted to starch concentration. The supernatant of the residual starch was used to determine the sugar content using the phenol-sulphuric method.

Determination of amylose and amylopectin

The amylose content of the starch was investigated (Williams et al., 1970). The starch extract of the yams was taken, afterwards 10 ml of 0.5 N KOH was added. The mixture was transferred and made up to 100 ml with distilled water in volumetric flask. An aliquot of 10 ml of the mixture was added into a 50 mL volumetric flask with a pipette afterwards 5 ml of 0.1 N HCl followed by 0.5 ml of iodine reagent was added respectively. The absorbance was read at 625 nm. The standard curve developed was used in estimating the amylose and amylopectin contents.

Determinations of estimated Glycaemic Index (eGI)

Samples (25 mg) were weighed into a beaker thereafter 5 ml stomach solution (KCl – HCl buffer pH 1.5) was added and then incubated in shaker bath for 60 min at 40°C. It was then diluted with phosphate buffer pH 6.9 before the addition of 2.5 ml α-amylase solution and incubated at 37°C. 200 µl of the digest was taken into test-tube at 30min interval (0, 30, 60, 90, 120, 150 and 180) min. The aliquots were boiled for 15 minutes before addition of 500 µl Sodium acetate pH 4.75 followed by 5 µl of α-glucosidase solution and then incubated for 45 min at 60°C. DNSA solution (200 µl) was added and incubated for 5 minutes at 100 ⁰C follow by addition of 2 ml distilled water and then centrifuge at 3000 rpm for 5 minutes. The supernatants were decanted and read the absorbance at 540 nm. The sum of area under curve for each sample was divided by the sum of area under curve for standard glucose and multiplied by 100. The absorbance value was then converted into starch by multiplying the amount of glucose by 0.9.

Table 1: Sugar, starch, amylose and amylopectin content of the (cooked and raw) white and yellow bitter yam (g/100g)

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>Soluble Sugar</th>
<th>Starch</th>
<th>Amylose</th>
<th>Amylopectin</th>
</tr>
</thead>
<tbody>
<tr>
<td>RWB</td>
<td>4.78±1.10</td>
<td>31.03±1.45</td>
<td>13.41±0.67</td>
<td>17.61±0.16</td>
</tr>
<tr>
<td>RYB</td>
<td>5.08±0.82</td>
<td>33.67±1.65</td>
<td>11.08±0.82</td>
<td>22.58±0.11</td>
</tr>
<tr>
<td>UCWB</td>
<td>8.69±0.97</td>
<td>56.61±0.86</td>
<td>14.88±0.61</td>
<td>41.72±0.31</td>
</tr>
<tr>
<td>PCWB</td>
<td>10±1.06</td>
<td>62.79±1.11</td>
<td>24.19±0.26</td>
<td>38.60±0.84</td>
</tr>
<tr>
<td>UCYB</td>
<td>11.46±1.35</td>
<td>76.02±0.74</td>
<td>30.44±0.62</td>
<td>45.58±0.11</td>
</tr>
<tr>
<td>PCYB</td>
<td>11.46±0.65</td>
<td>78.08±0.82</td>
<td>32.43±1.32</td>
<td>45.65±0.21</td>
</tr>
</tbody>
</table>

Values represented mean± standard deviation of triplicate readings. Values with the same superscript along the same column are not significantly different (p<0.05). RWB, Raw White Bitter Yam; RYB, Raw Yellow Bitter Yam; UCWB, Unpeeled Cooked White Bitter Yam; PCWB, Peeled Cooked White Bitter Yam; UCYB, Unpeeled Cooked Yellow Bitter Yam; PCYB, Peeled Cooked Yellow Bitter Yam.
Determination of total phenol content

The total phenol contents of the yam extracts were determined as described by Singleton et al. (1999). The yam extracts (0.2 ml) was mixed with 2.5 ml of 10 % Folin-Ciocalteau’s reagent in addition with 2 ml of 7.5 % Sodium carbonate. Later on extracts aliquot (1 ml) or a standard solution of gallic acid was added to a 25ml volumetric flask containing 9ml of distilled water. The resultant solution was subsequently incubated at 45°C for 40 min, and the absorbance was read at 765 nm in a spectrophotometer. The amount of phenols in the bitter yam extract was expressed as gallic acid equivalent (GAE).

Antioxidant assay (radicals scavenging and Fe$^{2+}$ chelating abilities)

The reducing property of the yam extracts was determined as described by Pulido et al. (2000). The radicals scavenging and Fe$^{2+}$ chelating abilities were subsequently calculated. The scavenging ability of the extracts against DPPH (1,1-diphenyl–2-picrylhydrazyl) and ABTS$^-$ (2, 2’-azino-bis (3-ethylbenzthiazoline-6- sulphonic acid) radicals were determined according to the method of Re et al. (1999) and Akomolafe et al. (2016)

α-Amylase inhibition assay

The yam aqueous extracts dilution (500 µl) and 500 µl of 0.02 M sodium phosphate buffer (pH 6.9 with 0.006 M NaCl) containing Hog pancreatic α-amylase (EC 3.2.1.1) (0.5 mg/ml) were incubated at 25°C for 10 min. Afterwards, 500 µl of 1% starch solution in 0.02 M sodium phosphate buffer (pH 6.9 with 0.006 M NaCl) was added to each tube. The mixture obtained was incubated at 25°C for 10 min and terminated with 1.0 ml of dinitrosalicylic acid colour reagent. Thereafter, the mixture was incubated in a boiling water bath for 5 min, and cooled to room temperature. Distilled water (10 ml) was used to dilute the mixture and absorbance read at 540 nm. The percentage (%) enzyme inhibitory activity of the phenolic extracts was calculated Worthington (1993).

α-Glucosidase inhibition assay

The dilution of the yam aqueous extracts (50 µl) and 100 µl of α-glucosidase solution (1.0 U/ml) in 0.1 M phosphate buffer (pH 6.9) was incubated at 25°C for 10 min. Then, 50 µl of 5 mM p-nitrophenyl-α-D-glucopyranoside solution in 0.1 M phosphate buffer (pH 6.9) was added. The mixtures were incubated at 25°C for 5 min, and absorbance was read at 405 nm in the spectrophotometer. The α-glucosidase inhibitory activity was expressed as percentage inhibition. The percentage (%) enzyme inhibitory activity of the phenolic extracts was calculated (Apostolidis et al. 2007).

Table 2: Percentage (%) Glycemic Index content and Amylose/Amylopectin ratio of two varieties Dioscorea dumetorum

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>Glycemic Index (%)</th>
<th>Amylose/Amylopectin Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>RWB</td>
<td>58.95±0.81</td>
<td>0.76±0.01</td>
</tr>
<tr>
<td>RYB</td>
<td>56.25±0.81</td>
<td>0.49±0.01</td>
</tr>
<tr>
<td>UCWB</td>
<td>79.05±0.73</td>
<td>0.35±0.02</td>
</tr>
<tr>
<td>PCWB</td>
<td>73.23±1.03</td>
<td>0.62±0.03</td>
</tr>
<tr>
<td>UCYB</td>
<td>72.75±0.74</td>
<td>0.66±0.01</td>
</tr>
<tr>
<td>PCYB</td>
<td>74.40±0.95</td>
<td>0.71±0.01</td>
</tr>
</tbody>
</table>

Values represented means ± standard deviation of triplicate readings. Values with the same superscript along the same column are not significantly different (p<0.05). RWB, Raw White Bitter Yam; RYB, Raw Yellow Bitter Yam; UCWB, Unpeeled Cooked White Bitter Yam; PCWB, Peeled Cooked White Bitter Yam; UCYB, Unpeeled Cooked Yellow Bitter Yam; PCYB, Peeled Cooked Yellow Bitter Yam
Statistical analysis

The results were expressed as mean ± SEM for three to four independent experiments performed in triplicate and were analysed by appropriate analysis of variance, followed by Duncan’s multiple-range test. Differences between groups were considered significant when p<0.05.

RESULTS

The sugar and starch contents of the two varieties of bitter yam (white and yellow) are presented in Table 1. The result revealed that the raw white, bitter yam (RWB) and raw yellow bitter yam (RYB) has low amount of sugar and starch content, while the boiled samples has higher sugar and starch content, with the peeled, cooked yellow bitter yam (PCYB) having the highest amount of sugar (11.46 g/100 g) and starch (78.08 g/100 g) contents.

The amylopectin and amylose values were also presented in Table 4. The result showed that boiled bitter yam had higher amylopectin and amylose contents than the raw samples while the PCYB had highest amylose content (32.43) than UCYB (30.44) but of the same amylopectin content.

Table 2 shows the percentage glycemic index and amylose/amylopectin ratio of the two varieties of bitter yam (white and yellow). The result revealed that the raw white-bitter yam (RWB) and raw yellow bitter yam (RYB) has low eGI while the boiled samples had higher eGI with UCYB giving the highest amount of eGI value (79.05 %). Raw yellow bitter yam (RYB) has the highest amylose/amylopectin ratio value (0.76) compared to UCWB (0.35).

The result of the total phenol content of the studied two varieties of bitter yam (white and yellow) revealed that total phenol contents of raw bitter yam differ with each other, with RYB of higher amount (26 mg GAE/g) than RWB (24 mg GAE/g) but when compared with the boiled samples both were of fewer amounts, while UCWB and PCYB showed similarities in phenolic content as presented in Table 3.
Table 3: Total Phenol, FRAP and ABTS Scavenging ability of Two Varieties of Bitter yam (yellow and White)

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>Total Phenol (mg GAE/g)</th>
<th>FRAP (mgAAE/g)</th>
<th>ABTS (mmol TEAC/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RWB</td>
<td>0.24±0.02(^a)</td>
<td>1.4±0.03(^a)</td>
<td>10.04±0.10(^b)</td>
</tr>
<tr>
<td>RYB</td>
<td>0.26±0.01(^a)</td>
<td>1.2±0.02(^a)</td>
<td>9.09±0.21(^a)</td>
</tr>
<tr>
<td>UCWB</td>
<td>0.42±0.01(^c)</td>
<td>2.4±0.07(^a)</td>
<td>13.84±0.21(^c)</td>
</tr>
<tr>
<td>PCWB</td>
<td>0.34±0.01(^c)</td>
<td>2.0±0.21(^d)</td>
<td>16.37±0.17(^b)</td>
</tr>
<tr>
<td>UCYB</td>
<td>0.39±0.01(^c)</td>
<td>1.6±0.14(^d)</td>
<td>17.27±0.07(^a)</td>
</tr>
<tr>
<td>PCYB</td>
<td>0.42±0.01(^c)</td>
<td>1.8±0.06(^d)</td>
<td>16.37±0.16(^b)</td>
</tr>
</tbody>
</table>

Values represented mean± standard deviation of triplicate readings. Values with the same superscript along the same column are not significantly different (p<0.05). RWB, Raw White Bitter Yam; RYB, Raw Yellow Bitter Yam; UCWB, Unpeeled Cooked White Bitter Yam; PCWB, Peeled Cooked White Bitter Yam; UCYB, Unpeeled Cooked Yellow Bitter Yam; PCYB, Peeled Cooked Yellow Bitter Yam

Figure 2: α-Amylase inhibitory activity of aqueous extract of raw and cooked (white and yellow) bitter yam. RWB, Raw White Bitter Yam; RYB, Raw Yellow Bitter Yam; UCWB, Unpeeled Cooked White Bitter Yam; PCWB, Peeled Cooked White Bitter Yam; UCYB, Unpeeled Cooked Yellow Bitter Yam; PCYB, Peeled Cooked Yellow Bitter Yam
Table 4: EC$_{50}$ values for DPPH radical scavenging ability, $\alpha$-Amylase and $\alpha$-Glucosidase inhibitory activity (ug/mL) of two varieties of Bitter yams

<table>
<thead>
<tr>
<th>Sample</th>
<th>DPPH</th>
<th>$\alpha$-Amylase</th>
<th>$\alpha$-Glucosidase</th>
</tr>
</thead>
<tbody>
<tr>
<td>RWB</td>
<td>18.21±0.11$^a$</td>
<td>2.32±0.07$^a$</td>
<td>3.65±0.01$^d$</td>
</tr>
<tr>
<td>RYB</td>
<td>16.46±0.21$^a$</td>
<td>2.22±0.01$^a$</td>
<td>3.72±0.01$^a$</td>
</tr>
<tr>
<td>UCWB</td>
<td>13.72±0.46$^a$</td>
<td>1.85±0.02$^c$</td>
<td>2.47±0.03$^b$</td>
</tr>
<tr>
<td>PCWB</td>
<td>10.72±0.40$^a$</td>
<td>1.68±0.01$^b$</td>
<td>2.94±0.01$^c$</td>
</tr>
<tr>
<td>UCYB</td>
<td>12.70±0.45$^c$</td>
<td>1.88±0.01$^c$</td>
<td>2.50±0.07$^b$</td>
</tr>
<tr>
<td>PCYB</td>
<td>11.18±0.06$^b$</td>
<td>1.60±0.01$^a$</td>
<td>1.83±0.01$^a$</td>
</tr>
</tbody>
</table>

Values represented mean± standard deviation of triplicate readings. Values with the same superscript along the same column are not significantly different (p<0.05). RWB, Raw White Bitter Yam; RYB, Raw Yellow Bitter Yam; UCWB, Unpeeled Cooked White Bitter Yam; PCWB, Peeled Cooked White Bitter Yam; UCYB, Unpeeled Cooked Yellow Bitter Yam; PCYB, Peeled Cooked Yellow Bitter Yam

Figure 3: $\alpha$-Glucosidase inhibitory activity of aqueous extract of raw and cooked (white and yellow) bitter yam. RWB, Raw White Bitter Yam; RYB, Raw Yellow Bitter Yam; UCWB, Unpeeled Cooked White Bitter Yam; PCWB, Peeled Cooked White Bitter Yam; UCYB, Unpeeled Cooked Yellow Bitter Yam; PCYB, Peeled Cooked Yellow Bitter Yam
The results of the ferric reducing property and ABTS⁺ scavenging ability of the two varieties of bitter yam (white and yellow) were also presented in Table 3. The result revealed that the boiled samples had higher reducing power than raw samples, and UCWB had highest ferric reducing power (2.4 mgAAE/g). Also cooked samples had higher scavenging ability than raw samples; in which UCYB had the highest radical scavenging ability (17.27 mgAAE/g). The result of DPPH radical scavenging ability of the two varieties of bitter yam (yellow and white) (Figure 1) revealed that both samples scavenged DPPH radical in concentration depended manner. According to the EC₅₀ (Table 4), values the cooked samples have the highest among all.

The result (Figure 2) of the α-amylase inhibitory effect of the samples showed all the samples inhibited α-amylase in a concentration dependent manner. As observed from the EC₅₀ value, the raw yellow and white, bitter yam had low α-amylase inhibitory effect, while the cooked samples had highest, with UCYB having the highest (1.82 µg/mL) (Table 4). The result of α-glucosidase inhibitory effect of the studied samples in a concentration dependent manner is presented in Figure 3. Also, the cooked yam had significantly higher α-glucosidase inhibitory effect than raw yellow and white bitter yam (Table 4).

DISCUSSION

Cooking methods had been linked as one of the various factors that affect after-meal blood glucose levels, which, if unchecked, could result to hyperglycemia and consequently lead to diabetes and its complications (Sacks et al., 2014). Most of the staple foods such as tubers are cooked to release the starch from starch granular, for easy digestion and quick absorption, and for palatability (Khan, 2006; Darandakumbura et al., 2013). The results of the sugar and starch contents of the two varieties of bitter yam as presented in Table 1, indicated lower amount of sugar and starch contents in raw compared to cooked bitter yam, which could be caused by the rapturing of starch granules, addition of water and heat application which collapsed the intermolecular forces holding together the starch granules and released the contents (Allen et al., 2012). The starch content was significantly higher in peeled bitter yam than the unpeeled. This slight difference could be due to absorption of more water by peeled yam sample during boiling and the protective properties of the unpeeled yam skin. Heating influence the degradation of starch granules to the degradability of amylose and amylopectin by pancreatic α-amylase and cause increased glycemic index in yam, potatoes etc. (Allen et al., 2012). The starch content of cooked bitter yam (78.08%) agrees with the work of (Ogbuagu, 2008).

The cooked bitter yam samples were significantly higher in both amylose and amylopectin and this could be due to hydration of starch granules and heating effect which had been noted to take place at the temperature above 70°C (Jing-ming and Sen-lin, 1990). Cooking also caused a significant increase (p < 0.05) in the amylopectin content of the bitter yam than amylose and white bitter yam had more amylopectin content than yellow bitter yam. This observed difference is in agreement with the work of (Adedayo et al., 2015) who reported that amylopectin contents were more in all the varieties of yam tested and also concurred with the report of Yotsawijmonwat et al. 2008 that amylopectin is the main components in most starchy food. The amylopectin and amylose have a tendency to join together after heating (that is, on cooling) to form gel; this prevents α-amylase from hydrolyzing the starch thus affect the glycemic index due unreleased glucose. Factors such as time, temperature, amylose/amylopectin ratio affect gel formation (Annison and Topping, 1994). The result revealed that cooking significantly decreased the amylose/amylopectin ratio of the studied yam sample. Amylose/amylopectin ratio had been implicated as one of the factors that influence the rate of amylose and amylopectin gel formation as well as glycemic index.

Similarly, the glycemic index result of the two varieties of bitter yam was also presented in Table 2. The result revealed that boiling significantly increased the glycemic index which range from 56.25% to 58.95% for the raw and 72.5% to 79.05% for the cooked which according to the Brand-Miller et al. (2003) ranking of glycemic index foods falls under high glycemic index food values; nevertheless most of the yams consumed in Nigeria and Africa in general are eaten with oil, vegetables, stew, meat, fish and beans which are rich in lipids and proteins and could also lower the high glycemic index of these yams through the gastric inhibitory peptide and insulin response which amount to lowered postprandial glucose levels and reduced glycemic response (Kouassi et al., 2009, Al Dhaheri et al., 2015). The difference in glycemic index of the two varieties of yams tested could be due to variation in species starch content. Raw starch is not easily attacked by α-amylase and have low glycemic index unlike
gelatinized starch which is easily attacked by α-amylase resulting into high glycemic index response. Recrystallization of starch after cooling inhibits α-amylase activity which lower glycemic index unlike freshly gelatinized starch which enhances the action of α-amylase in breakdown of starch with high glycemic index response (Jenkins et al., 1987; Bjorck et al., 1994; Fernandes et al., 2005).

The total phenol content, FRAP and ABTS⁺ radical scavenging ability of the (cooked and raw) white and yellow bitter yam are presented in Table 3. According to the result cooking increased phenolic content of white and yellow bitter yam compared with the raw sample. The observed difference could be due to the liberation of some phenolic compounds as a result of the heat process associated with the cooking of the raw bitter yam. The phenolic compounds of the bitter yams are capable of protecting the body from free radical activities known to damage cellular organelles due to their antioxidant properties (Amic et al., 2003). The reducing powers of the sample’s extracts were assessed based on their ability to reduce Fe³⁺ to Fe²⁺, the result indicated increased reducing power of the extract due to cooking and this could be attributed to phytochemicals present in the bitter yam. The ABTS radical scavenging ability of the two varieties of bitter yam indicate varied increased free radical scavenging ability due to cooking of the tested sample. This observed difference could be effect caused by the heat liberated compounds during cooking. The effect of cooking on the DPPH radical scavenging ability of the samples as presented (Figure 1 and Table 4) shows that cooking enhance the radical scavenging ability of the sample. The observed trend in the results agree with the phenolic contents and Fe reducing ability, where the cooked white and yellow bitter with higher phenolic content had higher antioxidant activity as correlations between phenolic content and antioxidant capacity of plant foods has been established (Oboh and Shodehinde, 2009).

The result of the interaction of the extracts with α-amylase and α-glucosidase activates is presented in Figure 2 and 3 respectively. All the extracts inhibited the activities in concentration dependent manner. The EC₅₀ values (Table 4) indicated that inhibitory effect of extracts significantly increased due to cooking. This inhibitory effect could be attributed to the phenolic contents of the yam extracts (Guo et al., 2015), thereby could slow down the breakdown of disaccharide to simple glucose, hence reducing the amount of glucose absorbed in the blood (Kwon et al., 2006). Both extracts had higher inhibitory effect on α-glucosidase than their corresponding α–amylase inhibitory activity; this mild inhibition of α-amylase and strong inhibition of α-glucosidase is of great pharmacological importance in addressing some of the side effects associated with the drugs (acarbose and voglibose) such as abdominal distention, flatulence, meteorism and possibly diarrhea (Bischoff, 1994). These side effects could be caused by the strong pancreatic α-amylase inhibition resulting in the abnormal bacterial fermentation of undigested saccharides in the colon (Bischoff, 1994; Oboh et al., 2006).

Conclusion
This study revealed that boiling had significant effects on the sugar and starch composition of white and yellow bitter yam and also on their antioxidant properties, glycemic index response,α-amylase and α-glucosidase inhibitory properties as well as considerable losses of vitamin C due to a longer time of boiling. Therefore, our findings could be of therapeutic importance in management of diabetics and other related diseases.

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REFERENCES


