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Chemical Properties, *in vitro* Starch Digestibility and the Estimated Glycemic Index of Water Yam, Cocoyam, Sweet Potato and Cassava

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ABSTRACT

This study characterised the most cultivated and consumed roots and tubers (cocoyam, sweet potato and cassava-TMS 0581, except water yam) in Nigeria, based on their chemical composition, in vitro starch digestibility and the estimated glycemic index. Samples were analysed for proximate composition, resistant starch, amylose content, in vitro starch digestibility and the estimated glycemic index using standard analytical methods. The result showed that the moisture content of the samples ranged from 11.67 to 12.63% dry matter; ash content (3.20-3.98%); fat content (1.14-2.65%); crude fibre (1.03-2.34%); protein content (1.56-4.75%); carbohydrate content (86.28-92.99%); energy value (387.97-390.66 Kcal/ 100 g); amylose (21.30-32.67%) and resistant starch (4.73-15.23 g/ 100 g). The in vitro starch digestibility ranged from 1.34 mg/ g to 3.19 mg/ g and the estimated glycemic index from 53.57 to 63.79%. Water yam with the least values of in vitro starch digestibility and the estimated glycemic index can be used as a suitable and reliable low glycemic index food for diabetic patients because of its potential to undergo a slower but gradual release of glucose into the blood stream.

Key words:Water yam, cocoyam, cassava-TMS 0581, sweet potato, *in vitro* starch digestibility, estimated glycemic index

INTRODUCTION

The most common root and tuber crops of the tropics are cassava (*Manihot esculenta* Crantz), white yam (*Dioscorea rotundata*), water yam, (*Dioscorea alata*), sweet potato (*Ipomoea batatas* L.), potato (*Solanum* spp.) and cocoyam (*Colocasia* spp. and *Xanthosoma sagittifolium*) (Lebot, 2009). The food commodities are widely grown and consumed as subsistence staples in Africa (sub-Saharan), Asia, the Pacific Islands and Latin America. These are plants yielding starchy roots and tubers which contain 70−80% of water, 16−24% of starch and trace quantities of proteins and lipids (Huang *et al*., 2006). These root and tuber crops basically provide energy in the human diet in the form of carbohydrates and also contain some minerals and essential vitamins. More than 228 million metric tonnes of cassava was produced worldwide in 2007, of which 52% was credited to Africa. In 2007, Nigeria produced 46 million metric tonnes making it the world's largest producer (FAO, 1998 and Osundahunsi *et al*., 2014). The yields of sweet potato was 15−20 metric tonnes per hectare and cocoyam give 25−30 metric tonnes per hectare of corms depending on planting density, while water yam remains under-cultivated and under-utilised.

Starch is a polysaccharide that is majorly available in plant as storage carbohydrate and a major component of root and tuber crops. It is deposited in partially crystalline forms varying in morphology and structure between and within plant species (Blazek and Copeland, 2008). Most starch products contain a constituent that digests rapidly (rapidly digesting starch), a constituent that digests slowly (slowly digesting starch) and a fraction that is resistant to digestion (resistant starch) (Englyst *et al*., 1992). The digestibility of starch in foods varies and is greatly affected by physicochemical characteristics of starch, plant type and processing conditions (Ring *et al*., 1988). Root crops are not easily digested in the natural state and should be cooked before eaten. The digestibility and structure of starchy food is known to be altered by cooking method which, in turn, could influence glycemic response (Glen *et al*., 2005). Cooking improves digestibility, promotes palatability and improves the keeping quality as well as make the roots safer to eat (reduction in the antinutritional factors). During cooking and cooling of the root and tuber crops, two phenomenal changes do occur; gelatinisation and retrogradation.

Glycemic index (GI) is the measure of immediate effect on blood glucose level after food consumption. The estimated glycemic index (eGI) is an *in vitro* measurement of the glycemic response of foods containing majorly carbohydrate, thus allowing the ranking of such foods on the basis of the rate of digestion and absorption of carbohydrates (glucose) contained (Jenkins *et al*., 1981; Englyst *et al*., 1992). The financial, ethical burden and experimental time involved in the assessment of glycemic index in human subjects led to an in vitro study on starch digestibility (Englyst *et al*., 1996, and Goñi *et al*., 1997). In vitro methods have also been used to classify foods based on digestion characteristics similar to the in vivo situation, and to identify the rate at which carbohydrate is released in food materials (Jenkins *et al*., 1982; Schweizer *et al*., 1988). Foodstuffs with GI values more than 70%, between 69% and 56% and lower than 55% are classified as high, medium and low GI foods, respectively (Brand-Miller *et al*., 2003). In view of the forgoing, the need for an adequate study and near accurate predictions of the *in vitro* starch digestibility and estimated glycemic index would provide useful information on the choice of roots and tubers with a higher nutritional and health benefits.

MATERIALS AND METHODS

Materials

Sources of materials: Cocoyam (*Colocasia esculenta*), sweet potato (*Ipomea batata*), water yam (*Dioscorea alata*) used for the research work were procured from the local markets in Akure, Ondo state, Nigeria. Cassava-TMS 0581 (*Manihot esculenta*) was obtained from the Teaching and Research farm of the Federal University of Technology Akure, Nigeria. Chemicals used were of analytical grade.

Method

Preparation of samples: The outer covering of the roots and tubers used were peeled off manually with kitchen knife, to expose the edible portions. The peeled samples were sliced into pieces, washed, boiled (45 min) and dried (4 h) in an air oven at 60 ^{o}C. Thereafter, the samples were milled and packed in sealed transparent polythene bags which were properly labelled and stored at room temperature (23.5- 24.5 ^{o}C) prior to analysis.

Proximate analysis

The moisture content, crude protein, fat, ash and crude fibre contents of the samples were determined using the standard methods of the Association of Official Analytical Chemists (AOAC, 2005). Carbohydrate content was determined by difference. The energy value of the samples was calculated using the Atwater factors (protein×4 + fat×9 + carbohydrate×4).

Determination of amylose content

The amylose content was determined using the method of Juliano (1971) and Hoover and Ratnayake (2002). A 100 mg sample was weighed into 100 ml volumetric flask and 1 ml of 99.7 to 100 % (v/v) ethanol and 9 ml of sodium hydroxide (NaOH) were carefully added and the mouth of the flask was covered with foil and the content was mixed. The sample was heated for 10 min in a boiling water bath to gelatinised, removed from the water bath and allowed to cool. It was filled up to the mark with distilled water and well shaken. About 5 ml of the mixture was pipetted into another 100 ml volumetric flask. One ml acetic acid and 2 ml of iodine solution were added and made up to mark with distilled water. Absorbance (A) was read using spectrophotometre (Spectrum 23A spectrophotometre, Gulfex medical and scientific, England) at 620 nm. The blank contained 1 ml of ethanol, 9 ml of sodium hydroxide, boiled and made up to the mark with distilled water. Five ml of the blank was pipetted into 100 ml volumetric flask. One ml of acetic acid and 2 ml of iodine were added and filled up to the mark with distilled water, this was used to standardise the spectrophotometre at 620 nm. The amylose content was calculated as

Amylose content (%) = (3.06) (A) (20) = 61.20 (A)…….Eq 1

Where, A = Absorbance value.

Determination of resistant starch

Resistant starch (RS) of the food sample was determined according to Goñi *et al*. (1996) method. A 100 mg sample was incubated with pancreatic α-amylase (10 mg/ ml) solution at 37 °C for 16 h with constant shaking to hydrolyse digestible starch. After hydrolysis, the sample was washed thrice with ethanol (99% v/v) followed by centrifugation. The hydrolysate was centrifuged and the residue (separated pellet) was solubilised with 2M KOH and incubated with amyloglucosidase (AMG) at 60 ^{o}C for 45 min to hydrolyse RS. The glucose released was measured using a glucose oxidase- peroxidase (GOPOD) reagent kit. The glucose content of the digested pellet was used in the calculation of resistant starch (RS) by multiplying with the factor 0.9.

Determination of in vitro starch digestibility

The *in vitro* starch digestibility was estimated by the method described by Singh *et al*. (1982). Fifty milligram of the sample was dissolved in 1.0 ml of 0.2 M phosphate buffer (pH 6.9). Twenty milligram of pancreatic α amylase and amyloglucosidase were dispersed in 50 ml of the same buffer and 0.5 ml of both the sample and the enzymes were added to the sample suspension and incubated at 37 ^{o}C for 2 h. About 2 ml of 3-5 dinitrosalicyclic acid (10% acqeous solution) was added and the combination was heated for 5 min in a water bath. Upon cooling, the solution was made up to 25 ml with distilled water and filtered before measurement of absorbance at 540 nm. A blank was run simultaneously by adding 3-5 dinitrosalicyclic acid first to the same suspension before the addition of the enzyme solution and incubated at 37 ^{o}C for 2 h. Maltose was used for the standard curve determination and the *in vitro* starch digestibility values were expressed as mg/ g (concentration) of the starch present in the sample.

Estimation of glycemic index

The *in vitro*glycemic index (GI) of the food samples was determined according to the method described by Goñi*etal*. (1997) with little modifications. Glucose concentration was determined using a glucose oxidase-peroxidase (GOPOD) reagent kit and the colour reaction was measured in a spectrophotometer, model DU 70 (Beckman, USA), at 505 nm. Glucose digestion rate was enunciated through the percentage of glucose in each sample (mg glucose/100 mg sample) at each time interval (0, 30, 60, 90, 120, 150 and 180 min). Hydrolysis curves were built (disregarding the value at time 0) and the area under the hydrolysis curves was calculated (AHC). The hydrolysis index (HI) expressed in percentage for each sample was calculated as the ratio between the AHC of white bread, used as reference and the AHC of each sample. The glycemic index was calculated as follows:

$$GI = 39.71 + (0.549 \times HI) \quad \text{....Eqn 2}$$

Where GI = Glycemic Index (%); and HI = Hydrolysis Index (%).

Statistical Analysis: All determinations were done in triplicates and data generated were analysed by the one way analysis of variance (ANOVA) using SPSS (16.0) software. Means were separated by the Duncan's Multiple Range tests (DMRT); significance was accepted at the 5 % level.

RESULTS AND DISCUSSION

The result for proximate composition of the samples is shown in Table 1. The moisture content ranged from 11.67 to 12.63% dry matter and was highest in water yam and least in sweet potato. Protein content ranged from 1.56% in cassava to 4.75% in sweet potato. The fat and crude fibre contents ranged from 1.14 to 2.65% and 1.03 to 2.34% in cassava and sweet potato respectively. Ash content ranged from 3.20% in water yam to 3.98% in sweet potato. The carbohydrate content ranged from 86.28% (sweet potato) to 92.99% (cassava), while the energy value ranged from 387.97 kcal/ 100 g in sweet potato to 390.66 kcal/ 100 g in water yam.

The total starch, resistant starch and digestible starch contents are shown in Table 2; the *in vitro* starch digestibility and the estimated glycemic index values of the samples are shown in Table 3, while Figure 1 shows the amylose and amylopectin content of the samples. The resistant starch content ranged from 4.73 g/ 100 g in cocoyam to 15.23 g/ 100 g in water yam, while amylose content ranged from 21.30% (cocoyam) to 32.67% (water yam). The *in vitro* starch digestibility and glycemic index values of the samples ranged from 1.34 mg/ g (water yam) to 3.19 mg/ g (cocoyam) and 53.57% (water yam) to 63.79% (cocoyam) respectively.

Proximate composition

In this study, significant difference ($p \leq 0.05$) in the proximate composition of the roots and tubers (cocoyam, sweet potato, cassava and water yam) was observed (Table 1). The moisture content of water yam (12.63% dmb), being higher than the other roots and tubers agrees with the report of Riley *et al*. (2004) which stated that, moisture content in water yam is usually higher than other

Table 1: Proximate composition of samples (dry basis) (%)

% Composition	Cocoyam	Sweet potato	Cassava	Water yam
Moisture	12.30 ± 0.20ab	11.67± 0.20c	12.19± 0.21b	12.63± 0.25a
Protein	4.14± 0.19b	4.75± 0.11a	1.56± 0.06d	3.12± 0.18c
Crude fat	2.10± 0.12b	2.65± 0.07a	1.14± 0.13d	1.83± 0.13c
Crude fibre	1.57± 0.12b	2.34± 0.11a	1.03± 0.07c	1.40± 0.13b
Ash	3.84± 0.19a	3.98± 0.06a	3.29± 0.13b	3.20± 0.10b
CHO	88.34± 0.49c	86.28± 0.22d	92.99± 0.32a	90.46± 0.34b
Energy	388.91± 0.12b	387.97± 0.14c	388.39± 0.32bc	390.66± 0.71a

Data represent the mean of three replicates and Standard deviation.
Means with different superscript in the same row are significantly different ($p \leq 0.05$).

Table 2: Total starch, resistant starch and digestible starch contents (g/ 100 g) of the sample

Sample	Total starch	Resistant starch	Digestible starch
Water yam	56.00 ± 1.00[c]	15.23 ± 0.29[a]	40.77 ± 0.96[d]
Cassava	58.33 ± 2.08[c]	9.31 ± 0.12[b]	49.02 ± 1.97[c]
Sweet potato	64.67 ± 2.52[b]	7.54 ± 0.05[c]	57.13 ± 2.48[b]
Cocoyam	70.67 ± 1.53[a]	4.88 ± 0.10[d]	65.79 ± 2.26[a]

Data represent the mean of three replicates and Standard deviation.
Means with different superscript in the same column are significantly different ($p \leq 0.05$).

Table 3: *In vitro* starch digestibility (IVSD) and the estimated glycemic index (eGI) of the sample

Sample	*in vitro* digestibility (mg/g)	Estimated glycemic index (%)
Cocoyam	3.19 ± 0.03[a]	63.79 ± 0.34[a]
Sweet potato	1.87 ± 0.84[b]	62.37 ± 0.02[b]
Cassava	1.38 ± 0.02[c]	60.29 ± 0.03[c]
Water yam	1.34 ± 0.02[c]	53.57 ± 0.13[d]

Data represent the mean of three replicates and Standard deviation.
Means with different superscript in the same column are significantly different ($p \leq 0.05$).

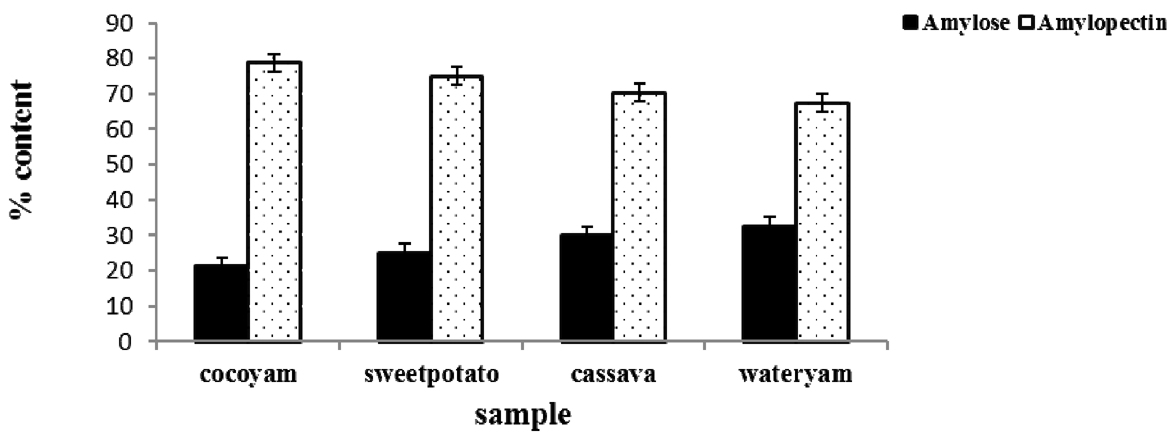

Figure 1: Amylose and Amylopectin content in the samples

root and tuber crops. In addition, the moisture contents of water yam and cocoyam (12.30%) were higher than the 10.46% and 11.60% moisture contents of boiled oven dried water yam and cocoyam respectively reported by Adegunwa *et al*. (2011). Sweet potato had moisture content of 11.67%. The moisture content of cassava on dry basis (12.19%) is in conformity with the findings reported by Charles *et al*. (2005) that the moisture content of cassava on dry basis ranged from 9.2% to 12.3%. The variations in the moisture content of the roots and tubers can be associated with such factors as cultivar, location, climate, soil type, incidence of pests and diseases, and cultivation practices (Bradbury and Holloway, 1988). The protein content of the samples, ranged from 1.56% (cassava) to 4.75% (sweet potato) on dry basis. Cassava with the least protein content conforms with the observation of Charles *et al*. (2005), who stated that the protein content of processed cassava (boiled) can be as low at between 1.2% to 1.8% on a dry matter basis. The protein content of 3.12% for water yam is lower than 4.93% to 5.17% (dry basis) reported by Ogunlakin *et al*. (2012). The protein level as recorded in cocoyam is similar to the values for cocoyam (4.00%–5.12%) reported by Sefa- Dedeh and Agyir-Sackey (2004). Also, the protein contents of water yam and cocoyam were slightly lower, compared to the values reported by Adegunwa *et al*. (2011) for water yam and cocoyam (3.41% and 4.56% respectively). The variation in the protein values may be attributed to the cultivars and the level of denaturation of protein in the roots and tubers with respect to heat treatment. The amount of ash content in tuber depends on the moisture content, the type of soil from which it was harvested and the maturity of the crop (Osagie, 1992). Water yam, with the least ash content (3.20%) is in line with the findings of Lebot *et al*. (2005) which noted that the higher the moisture content, the lower the ash content, as in the case of water yam with value ranging from 2.50% to 4.90%. The ash content of cocoyam (3.84%) is higher than the reported value (3.30%) by Adegunwa *et al*. (2011). The carbohydrate contents of sweet potato and cassava were 86.28% and 92.99% respectively. These values representing the least and highest carbohydrate contents are in agreement with the work of Ogbuagu (2008) which reported that the dry matter of most roots and tubers is made up of about 60– 90% carbohydrate. Water yam with 90.46% (carbohydrate) and 1.40% (crude fibre) is lower than the report of Ihediohanma *et al*. (2012) for water yam with 91.3% and 41.3% (carbohydrate and fibre respectively). The fat content of the roots and tubers (cocoyam, cassava, sweet potato, and water yam) was low, ranging from 1.14% to 2.65%, confirming the report of Afoakwa and Sefa-Dedeh (2001) that identified 0.05% to 2.8% in root and tuber crops on dry weight basis. The fat content in cassava (1.14%) and water yam (1.83%) are in conformity with the studies of Osagie and Opute (1981) and Bradbury and Holloway (1988). In addition, the fat contents of 0.50% and 0.24% for water yam and cocoyam respectively as reported by Adegunwa *et al*. (2011), were lower than the values of water yam (1.83%) and cocoyam (2.10%). The energy content of water yam and cocoyam (390.78 kcal/ 100 g and 388.91 kcal/ 100 g, respectively) were higher than the energy content in other samples. However, the estimated metabolised energy registered from the samples (387.97 kcal/ 100 g to 390.66 kcal/ 100 g) are lower than the energy recorded in root crop varieties (1451 kcal/ 100 g to 1574.7 kcal/ 100 g) by Polycarp *et al*. (2012).

Amylose content

Amylose is an important part of starch composition with about 30% in content, while amylopectin consists of the remaining 70% (Behail and Howe, 1995). The amylose content to a large extent determines the degree of starch digestibility in foods. Previous report (Riley *et al*., 2004) has shown that the amylose content plays a key role in the digestion of starches, as starches with low amylose content are more digestible than starches with high amylose content. Thus, foods with a high amylose are digested more slowly than foods with low amylose, which are less likely to increase blood glucose.

There was significant difference ($p \leq 0.05$) in amylose content among the samples. The amylose content of the samples ranged from 21.30% (cocoyam) to 32.67% (water yam). The highest amylose content (32.67%) as recorded in water yam is in line with the findings of Lebot *et al*. (2005) who observed that water yam (*Dioscorea alata*) cultivar with good eating quality are characterised by high amylose content. Also, the amylose value obtained from water yam, agrees with the findings of Adegunwa *et al*. (2011) in which the highest value (33.28%) was found in boiled-oven dried water yam as compared to white yam and cocoyam. In addition, amylose contents between 27.6% and 38.2% have been reported for water yam (*D. alata*) (Mcpherson and Jane, 1999; Hoover, 2001; Moorty, 2001; Peroni *et al*., 2006). The amylose value (29.82%) as observed in cassava is higher than 19.8% reported by Peroni *et al*. (2006). Cocoyam and sweet potato with amylose contents of 21.30 and 25.08% respectively are higher than the reported values of 20.80% (cocoyam) and 22.60% (sweet potato) by Peroni *et al*. (2006).

Resistant starch content

Foods with low percentage of resistant starch (RS) content often have a high degree of digestibility. Low digestibility in relation to higher percentage of RS, offers health benefits. Resistant starch is a component of the total starch that cannot be digested by amylase and absorbed in the human digestive tract, but can be degraded through glycolysis by microorganism in the colon. The resistant starch content in sweet potato (7.54 g/ 100 g) is higher than the value (1.00%) in boiled sweet potato reported by Goñi *et al*. (1997). The resistant starch content of sweet potato is however, lower than the reported ranged value of 14.2 to 17.2% on dry weight basis by Suraji *et al*. (2013). Water yam with the highest value of resistant starch (15.47 mg/ 100 g) agrees with the observation of Moongngarm (2013), which listed water yam with the highest resistant starch when compared to the other roots and tubers.

In vitro starch digestibility

The *In vitro* method for measuring the rate of hydrolysis of starch has been suggested as an inexpensive and time-saving method compared to *in vivo* starch digestion (Jenkins *et al*., 1987). The *in vitro* starch digestibility (IVSD) observed from the samples correlates with the findings of Nadnapis *et al*. (2012) that showed a linear relationship between, the amylose content, resistant starch content and digestibility, indicating that the resistance to enzymatic digestion of the samples comes from the amylose content and the resistant starch content. In fact, Arvidson-Lenner *et al*. (2004) have promulgated that the difference in digestibility is due to starch content such as amylose vs amylopectin, resistant starch and his granular structure. Cocoyam with the IVSD value (3.19 mg/ g) and amylose content (21.30%) among the other samples agree with the findings of Riley *et al*. (2004) which stated that food sample with low amylose contents are more digestible than food samples with high amylose content. This implies that food sample which are digested and absorbed at a faster rate would produce more blood glucose,

which may necessitate greater insulin and other endocrine responses (Wolever *et al*., 1992; Jenkins *et al*., 1982).
The higher the amylose content, the lower the starch digestibility as reflected by the influence of amylose content on starch digestibility (Goddard *et al*., 1984), Juliano and Goddard (1986) and Miller *et al*. (1992) affirmed the result obtained from water yam with the highest value of amylose content (32.67%) and the lowest IVSD value (1.34 mg/ g). In addition, water yam with the highest amylose content and the lowest IVSD agrees with the observation of Hoover and Sosulski (1985) which indicated that high amylose starch have greater resistance to digestive enzymes.

Glycemic index

The Glycemic Index (GI), is a dietary measuring system (Brand-Miller *et al*., 2003b) that grades carbohydrate-containing foods and compares the rate at which the blood sugar is raised after two hours or more of consuming the food (post-prandial glycemia) to a reference food, usually glucose, though white bread may be used instead (Wolever, 1993; Anon, 2006). GI is expressed as percentages on an absolute scale. Carbohydrate-containing foods are graded as either having a high, medium (intermediate) or low GI depending on the rate at which blood sugar level rises (Mendosa, 2000), which in turn is compared to the rate of digestion and absorption of sugars and starches available in that food (FAO/UN, 1998).
There were significant differences ($p \leq 0.05$) in the glycemic indices of the samples. The estimated glycemic index (eGI) of cocoyam, sweet potato and cassava were 63.79%, 62.37%, 60.29% respectively while water yam had 53.57%. Therefore, it can be readily summarised using standard criteria (Brand-Miller *et al*., 2003a) that water yam (*D. alata*) is a low glycemic food (Ihediohanma *et al*., 2012), while cocoyam (*C. esculenta*), sweet potato (*I. batata*) and cassava (*M. esculenta*) are intermediate glycemic foods. This implies that water yam (*D. alata*) will move glucose into the blood 0.54 (54/100) times slower than straight glucose (100/100), while cocoyam (*C. esculenta*), sweet potato (*I. batata*) and cassava (*M. esculenta*) will move glucose 0.64 (64/100), 0.62 (62/100), 0.60 (60/100) times slower respectively compared to straight glucose (100/100). Wateryam, having the least eGI value (53.57%), agrees with the work of Ihediohanma *et al*. (2012) that recorded the lowest GI value (24.06) for water yam. The lowest GI as recorded in water yam, is in line with the findings of Frei *et al*. (2003) that listed the lowest estimated GI for the high amylose (26.9%) cultivar. Also the low GI of the sample agrees with the low GI of the Cultivar Kustiyam, with a relatively high resistant starch content (Frei *et al*., 2003). It is also noteworthy to consider other suggested explanations for the lower glycemic response of high amylose starches including incomplete gelatinization of amylose under normal cooking conditions (Bjorck, 1996). In addition the glycemic indices of cocoyam, sweet potato and cassava with the corresponding amylose and resistant starch content (21.30% and 4.88 g/ 100 g ; 25.08% and 7.54 g/ 100 g ; 29.82% and 9.31 g/ 100 g respectively), when compared to the low value recorded in water yam, correlate with the observation of Goddard *et al*. (1984), Juliano and Goddard (1986), Jiraratsatit *et al*. (1987) and Tanchoco *et al*. (1990), which stated that low amylose, low resistant starch rice, had higher glycemic indices than those with high amylose, high resistant starch.

The correlation between the *in vitro* starch digestibility (IVSD) and the glycemic indices as recorded in the analysis of the samples, with the highest IVSD having the highest eGI (cocoyam), and the lowest IVSD having the least eGI (water yam) is in line with the findings of Bornet *et al*. (1989), which stated that the percentage starch hydrolysed*in vitro* within 30 min, strongly correlates with the glycemic index of starch in Human. The variations in the glycemic index exhibited by the different roots and tubers may have been caused by the type of starch (amylose: amylopectin ratio) rather than the quantity of available carbohydrate (Bymes *et al*., 1995). Another possibility could be as a result of the effect of the proportion of resistant Starch (RS) developed within the tubers during the cooking and cooling process the tubers undergo during preparation (Wolever *et al*., 2003).

CONCLUSION

The result showed that high amylose content sample had high resistant starch with a low IVSD and low eGI and vice-versa. Water yam had the least IVSD (1.34 mg/ g) and the lowest eGI (54%), while cocoyam had the highest IVSD (3.19 mg/ g) and eGI (63.79%). Thus, water yam can be classified as a low glycemic food.
The knowledge of the *in vitro* starch digestibility and glycemic indices (GI) of these commonly consumed roots and tubers (cocoyam, sweet potato, cassava, and water yam) may aid in evidence-based meal planning and optimum food selection in Nigeria and West-Africa as a whole. It is of particular importance that low and intermediate GI foods commonly consumed in Nigeria be identified and promoted for consumption. In line with the result obtained, water yam (*Dioscorea alata*) is the most preferred to be recommended for diabetics, obese (fat) people while healthy people could consume cocoyam, sweet potato, and cassava.

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