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Proximate and anti-nutrient composition of white Guinea yam (*Dioscorea rotundata)* diets consumed in Ibarapa, South West region of Nigeria

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ABSTRACT

White Guinea yam (Dioscorea rotundata) 'ehuru' consumed in Ibarapa Local Government Area of Oyo State, South West region of Nigeria has been claimed to be responsible for the high incidence of multiple births in the area. This study assessed the proximate and anti-nutrient composition of yam diets in the form in which they are consumed as a baseline towards the evaluation of their effects on the prevalence of multiple births in experimental animals. The yams were harvested and purchased from local farmers and transported to the University of Calabar. The yams were prepared as boiled yam (BY), Pounded Yam, Soup and Stew (PYSS), Boiled Yam and Stew (BYS) and Fried Yam and Stew (FYS) and Boiled yam with Rat Chow (BYPo). The soup was prepared using the tender leaves of okro (Abelmuschus esculentus) known locally as "Ilasa". The samples were homogenized, pelleted, dried in an air oven at 55^{o}C for 24 hours, milled and analyzed in triplicates using standard procedures. Results of proximate composition showed crude protein ranging from 6.53±0.11%DM for boiled yam to 17.13±0.05%DM for PYSS, crude fat ranging from 1.00±0.03%DM for BY to 12.72±0.10%DM for FYS. Carbohydrate ranged from 41.86±0.15%DM for PYSS to 68.57±0.06%DM for BY. PYSS had significantly ($P<0.05$) higher protein level but lower carbohydrate and phytate levels. The rich protein content of the diets and low phytate implied that dietary protein may be available for new tissues to be built. Boiled yam contained the highest hydrocyanic level at 0.19±0.02mg/100g. Phytate levels ranged from 1.91±0.03mg/100g for PYSS to 2.37±0.01mg/100g for FYS. There were significant increases in the levels of total and soluble oxalate in all the diets compared to the boiled yam. The results showed that the various processing methods adopted reduced the hydrocyanic and phytate levels.

Keywords: *Dioscorea rotundata*, proximate composition, anti-nutrients *Abelmuschus esculentus.*

INTRODUCTION

Yam tubers constitute an important food crop in tropical countries including South America, the Asia and Africa. West Africa is the world's most prominent region for the production of yams, being only second to cereals in importance [1]. Yams are species of Dioscorea and belong to Dioscoreaceae family. Yams can be grown from seeds, but such cultivated varieties tend to be sterile not producing flowers and seeds [1,2]. Recently, on-farm trials of new yam growing technique was started by Nigerian farmers in collaboration with the International Institute of Tropical Agriculture (IITA) which involves propagating yam through vine cuttings on farmers' fields in Niger State of Nigeria [3]. White Guinea yam and water yam are the most important food yams in terms of cultivation and utilization [4]. This variety of yam is used by the Ijebu's of the South-West region of Nigeria to prepare a type of porridge 'Ikokore' which is peculiar to the area and is also used by the Efik/Ibibio people of the South-South region of Nigeria to prepare a delicacy known locally as 'ekpang nkukwo'. Yams are generally consumed boiled, with stew or sauce, palm oil and salt or with vegetables. They can also be roasted, fried or baked.

For domestic purposes, yam is also useful for feeding livestock especially the peel, for industrial starch, manufacture of gums and adhesives and in textile industry for finishing cloth and printing fabrics with paste made from starch and dye. It is also used in the paper industry during pulping [5,6,7].

Although regarded mainly as a source of carbohydrate, some species of yam are nearly as rich in protein as rice and maize [8]. Yam is of higher nutritional value than some other root and tuber crops such as cassava. Its protein content is about 3 to 5% as compared to 1 to 2% in cassava [9]. Dioscorea rotundata has been reported to be rich in vitamin C, dietary fibre, vitamin B6, potassium, manganese and low in saturated fat and sodium [10]. Peeling and frying are the processes that best preserve the chief nutrients in yams while grilling and preparation of 'biscuit' from yam flour result in largest losses of nutrient [11]. The fat levels of D. rotundata varieties has been reported to ranged from 0.1 to 0.9g/100g while the starch levels range from 72.4 to 80.9g/100g [11].

Generally, most yams have excellent eating quality, although parts of it can be poisonous if ingested uncooked [8]. There are many non-nutrient substances present in roots and tubers. Some of these substances are potentially toxic or may adversely affect the bioavailability of nutrients [6]. Doubts have been expressed about the suitability of some species of yam as dietary staples, but processing eliminates the bitterness in some while others remain toxic and unsuitable for human consumption [13]. The soil on which yams are grown and ecological factors may affect nutritional contents. Same is true of the processing methods. It is probable that the proximate composition and anti-nutrient contents may from biochemical viewpoint provide basis for increase twinning rate upon consumption of the yam diet. This study therefore assessed the effect of processing methods on the nutrients and toxicant contents of the yam.

MATERIALS AND METHODS

Collection and transport of yam and vegetable samples

Freshly harvested Dioscorea rotundata/White Guinea yam were purchased from farmers in Igbo-ora, Ibarapa Local Government Area of Oyo State, Nigeria. The yams were wrapped in dry greaseproof paper packed into cartons and transported to Calabar by air. On arrival in Calabar, the yams were immediately conveyed to Biochemistry Department laboratory where the research was conducted.

Similarly, fresh young leaves of okro plant, *(Abelmuschus esculentus)* commonly called "Ilasa" by the people of Ibarapa Local Government Area of Oyo State, Nigeria were purchased from the farmers and wrapped in dry greaseproof paper for transportation to Calabar. The leaves were stored in a cool place in Calabar.

Treatment of vegetable and preparation "Ilasa" soup as traditionally prepared by the community using the recipe in table 1.

The soup was prepared following the traditional method of the Ibarapa people of Oyo State. About 300g of the fresh vegetable were rinsed in clean tap water to remove sand and dust particles. It was then drained of excess water in a colander and chopped with a kitchen knife into fine pieces on a wooden chopping board. Meanwhile, one litter of clean tap water was put into an aluminium pot and set on fire to boil. On boiling, the vegetable was added and allowed to boil for about 2 minutes before the melon, dawadawa (locust bean) and other ingredients were added. The pot was then left to boil for another 2 to 3 minutes with stirring occasionally before it was removed from the fire and allowed to cool (recipe as in Table 1).

Table 1: Recipe for Ilasa soup

Ilasa leaves	-	300g (finely chopped)
Dawadawa	-	22g (ground)
Melon (Egusi)	-	83g (ground)
Potash (Kaun)	-	3g (crushed)
Salt	-	9g
Water	-	1L
1 cubes of Knorr seasoning		

Preparation of the stew as traditionally prepared by the community using the recipe in table 2.

The stew was prepared using the traditional method of the Ibara people of Oyo State. The tomatoes, onions and pepper were blended together and set aside. About 155g of palm oil was placed in a stew pot and fried for about ten minutes, then the blended tomatoes, onions and pepper were added and allowed to boil for another 20 minutes. The meat and offals which were previously cleaned with tap water, salted and boiled until tender enough to homogenise were then added. The knorr maggi and salt were added for seasoning and the pot was allowed to boil again for a further 10 minutes before setting it down (recipe as in Table 2).

Table 2: Recipe for stew

Cow leg	-	180g
Meat	-	380g
Tripe	-	125g
Spleen	-	62g
Intestine	-	83g
Tomatoes	-	160g
Pepper	-	21g
Onions	-	12g
Palm Oil	-	155g
Knorr cube	-	2
Salt	-	7g

Treatment of yam samples for proximate and phytochemical analysis

The yams were divided into two main groups (the raw and the processed yam diet samples). For the first group, two tubers of yams were washed in clean tap water to remove sand. They were peeled with a kitchen knife and cut into thin slices and dried in a Gallenburg, England oven at 55^{o}C for 24 hours until crispy in consistency. The fresh dried samples (RY) were then homogenized into fine powder with mortar and pestle and stored in a dry bottle for proximate and anti-nutrient composition analysis. The second group, were stored in a cool dry place until ready for use for the preparation of the various local yam diets; pounded yam with stew and soup (PYSS); fried yam and stew (FYS), boiled yam and stew (BYS); boiled yam and palm oil (BYPo), and boiled yam (BY).

Pounded yam with soup and stew Diet: 10kg of yam were washed in clean tap water to remove sand, peeled with a kitchen knife and cut into chunks. This was boiled in tap water in an aluminium pot without salting until it was soft enough to pound. It was then pounded with a local mortar and pestle before the soup "*Ilasa*" and stew were added and then homogenized, dried in Gallenburg oven at 55^{0}C for 24 hours, cooled and used for proximate and anti-nutrient analysis.

Boiled yam and stew Diet: The same quantity of yams were washed in clean tap water to remove sand, peeled with kitchen knife, cut into slices and boiled in salted water until soft enough to eat. The yam was then homogenized with another pot of prepared stew, dried in the same oven at 55^{o}C for 26 hours, cooled and used for proximate and anti-nutrient analysis

Fried yam and stew Diet: 10kg of yams were washed to remove sand, peeled with kitchen knife and cut into medium slices for quick frying. 300g of palm oil was allowed to fry in a deep frying pan and the yam slices were added in small quantity at a time. 200mls of water was added to the frying oil and yam at interval to soften the yam and fried until golden brown. The fried yam was then homogenized with the already prepared stew and the homogenate dried in the same oven at 55^{o}C for about 24 hours, cooled and used for proximate and anti-nutrient analysis

Boiled yam with palm oil: 10kg of yam were washed in clean tap water to remove sand. The yams were then peeled with kitchen knife, washed again before cutting into slices. It was then put in an aluminium pot, salted and boiled until soft enough to eat after which it was homogenized with 126g of palm oil. This was dried in the oven at 55^{o}C for 24 hours, cooled and used for proximate and anti-nutrient analysis

Boiled yam: 10kg of yams were washed, peeled and cut into slices. It was then put in an aluminium pot; water added and boiled until soft enough to eat. The yam was further cut into small pieces dried in the same oven at 55^{o}C for 24 hours, cooled and used for proximate and anti-nutrient analysis

Group 1: raw yam which served as control
Group 2: boiled yam
Group 3: pounded yam, soup and stew
Group 4: boiled yam with stew
Group 5: fried yam with stew
Group 6: boiled yam with palm oil

Determination of Proximate composition

The proximate composition of the yam samples was determined according to the methods described by the Association of Official Analytical Chemists (2006).

Determination of some toxicant composition

The levels of some toxicants, including hydrocyanic, phytic and oxalic acids were determined according to the methods described by [14-16] respectively.

Statistical analysis

The experimental data were analyzed for statistical significance by one-way analysis of variance (ANOVA) using the SPSS computer-based programme. All data were expressed as mean ± SEM and the probability tested at 95% level of significance (P<0.05) so as to establish research hypothesis.

RESULTS

The results of this present study are presented in Tables 3 and 4. These results showed that the proximate and anti-nutrient composition of white Guinea yam (*Dioscorea rotundata)* diets vary greatly with the processing methods. The crude protein (17.13 ± 0.05, 15.14 ± 0.08, 14.63 ± 0.05%DM), ash (6.02 ± 0.01, 5.13 ± 0.02, 4.84 ± 0.03%DM), crude fat (11.22± 0.21, 10.79± 0.03, 12.72± 0.10%DM,) and caloric energy (336.88± 1.72, 354.38± 1.12, 395.24± 0.79 kcal/100g) contents obtained respectively for PYSS, BYS, FYS were significantly higher (P<0.05) compared to the respective crude protein (7.82 ± 0.23, 6.53 ± 0.11%DM), ash (1.84 ± 0.02, 3.83 ± 0.02%DM), crude fat (0.84± 0.03, 1.00± 0.03%DM) and caloric energy (316.87± 0.16 and 309.63± 0.09 kcal/100g) contents obtained respectively for RY and BY.

Also, the hydrocyanic acid (0.19±0.02, 0.17±0.01, 0.17±0.02, 0.19±0.01and 0.13±0.00 mg/100g) and total oxalate (0.54±0.01, 0.74±0.03, 0.83±0.02, 0.77±0.04 and 0.83±0.01 mg/100g) composition recorded respectively for BY, PYSS, BYS, FYS and BYPo, though not significantly different, were insignificantly lower (P>0.05) compared to the hydrocyanic acid (0.23±0.01 mg/100g) and total oxalate (1.07±0.01 mg/100g) composition recorded for RY. However, the phytate compositions (4.37± 0.10, 1.91± 0.03, 2.25± 0.03, 2.37± 0.01 and 2.17± 0.01 mg/100g) recorded respectively for BY, PYSS, BYS, FYS and BYPo were significantly lower (P<0.05) compared respectively to the composition (7.85± 0.03 mg/100g) recorded for RY. The results of this study gave a clear indication that while the different processing methods increased the proximate composition of yam diets, the anti-nutrients contents were significantly decreased, compared to the diets made from raw yam.

Table 3: Proximate composition of raw yam, boiled yam and yam diets (%dry matter)

Parameters	RY	BY	PYSS	BYS	FYS	BYPO
Crude protein	7.82 ± 0.23	6.53 ± 0.11	17.13 ± 0.05*	15.14 ± 0.08*	14.63 ± 0.05*	5.65 ± 0.06
Ash	1.84 ± 0.02	3.83 ± 0.02*	6.02 ± 0.01*	5.13 ± 0.02*	4.84 ± 0.03*	4.48 ± 0.04*
Crude Fibre	0.42 ± 0.01	0.39 ± 0.01	1.01 ± 0.01*	0.98 ± 0.01*	0.82 ± 0.02*	0.83 ± 0.01*
Moisture	19.58 ± 0.06	19.63 ± 0.01	22.77 ± 0.22*	18.79 ± 0.30*	11.34 ± 0.02*	10.20 ± 0.03*
Crude Fat	0.84 ± 0.03	1.00 ± 0.03	11.22 ± 0.21*	10.79 ± 0.03*	12.72 ± 0.10*	18.32 ± 0.09*
Carbohydrate	69.50 ± 0.33	68.57 ± 0.06	41.86 ± 0.15*	49.18 ± 0.30*	55.65 ± 0.13*	60.52 ± 0.15*
Caloric energy (kcal/100g)	316.87 ± 0.16	309.63±0.09*	336.88± 1.72*	354.38± 1.12*	395.24± 0.79*	429.56± 0.37*

*Values are expressed as mean of three determinations ±SEM, *P<0.05 compared to RY.*

Table 4 : Antinutrient contents of raw, boiled yam and various yam diets (mg/100g)

Parameters	RY	BY	PYSS	BYS	FYS	BYPO
Hydrocyanate	0.23±0.01	0.19±0.02*	0.17±0.01*	0.17±0.02*	0.19±0.01*	0.13±0.00*
Phytate	7.85±0.03	4.37±0.10*	1.91±0.03*	2.25±0.03*	2.37±0.01*	2.31±0.01*
Total oxalate	1.07±0.01	0.54±0.01*	0.74±0.03*	0.83±0.02*	0.77±0.04*	0.83±0.01*
Soluble oxalate	0.88±0.02	0.46±0.01*	0.64±0.03*	0.58±0.02*	0.64±0.02*	0.76±0.02*

*Values are expressed as mean of three determinations ±SEM, *P<0.05 compared to RY.*

DISCUSSION

Nutrients and other chemical compositions of food stuffs, including yams, are lost or preserved by various processing methods, including cooking in boiling water with the peel and frying, among others [11]. According to [17], heat-moisture treated samples of yam had significantly different densities, shrinkage, drying rate and diffusion coefficient from the untreated samples. The observed effects were found to be dependent on the mode and temperature of the heat treatment. Heat treated yam pieces have greater densities than untreated samples. Shrinkage was more when the yam was pre-heated in a sealed container (conduction heating) than samples heated in contact with water. In this study, the proximate composition and energy values in white Guinea yams were increased significantly, while the anti-nutrient contents were significantly reduced by the different processing methods adopted.

Studies on the proximate composition and energy values of selected Nigerian staple foods from Niger Delta showed that in raw samples of Dioscorea rotundata, moisture was highest in Ogoni at 63.77 ± 0.25% while Nembe had 63.50 ± 0.10%. The control sample from Abakaliki in the South-eastern region was given at 61.96 + 0.02%. However, crude protein was reported to be low for yams from all the study areas. The high protein level of 1.71 ± 0.06% was obtained from the control sample, with the lowest in Okrika 1.39 ± 0.13%. Crude fat level was low and ranged from

0.10 ± 0.00% from Okrika to 0.17 ± 0.01% from Nembe. The total carbohydrate content reported for yams in this study was observed to be significantly higher than the results reported by [18]for yams from Ogoni (33.32 ± 0.42%) and those from Abakaliki (35.21 ± 0.13%). The highest caloric value of 149.08kcal/100g was obtained from Abakaliki with the lower value of 140.09kcal/100g in Ogoni [18]. The values reported by these authors are however lower than the values reported in this study. The results of this study therefore indicated that the different processing methods adopted here increased the proximate composition of the various yam diets, particularly protein, ash, fat and caloric energy and reduced the carbohydrate content.

In a study by [19] on the effect of food processing on glycemic response to white yam meals, it was reported that food processing affected the rate of starch digestion in white yam. Pounded yam had the highest glycemic response index at about 82% compared to amala 37% and boiled yam at 53%. Amala had the least of the indices although it underwent more processing than the others. [20] reported that cooking had considerable reducing effect on phytate levels in tubers including yams. Phytate levels in unprocessed yam were reported as 6.7 ± 0.32mg/g. It was also reported that 72hrs of fermentation substantially reduced the phytate levels in yams by up to 65%. Lowering of phytate levels was most rapid within the first 48hrs of fermentation. This report agrees with the results reported in this study for anti-nutrients in the processed yam diets. Protein are body building foods and must contain essential amino acids the needs for optimal development. Cells divide when protein mass rich maximum and minerals play vital roles in maintaining cellular, tissue, organ and whole body functions.

CONCLUSION

The result of the study showed that white guinea yam *(Dioscorea rotundata)*from Ibarapa local government area of Oyo State in Nigeria in its raw state contains phytochemicals and antinutrients, most of which were significantly reduced by the various processing methods. The study also revealed that the various processing methods adapted, enhanced the proximate composition of *D. rotundata* and the anti-nutrients in all the diets were considerably reduced. PYSS recorded the highest protein contents and had low carbohydrate and phytate levels.

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