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Original Research Article

Effect of Varieties on the Proximate, Nutritional and Anti-nutritional Composition of Nine Variants of African Yam Bean Seeds (*Sphenostylis Stenocarpa*)

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The effect of variety on proximate, mineral and vitamin and anti-nutritional composition of African Yam bean (AYB) (*Sphenostylis sternocarpa*) seed, an underutilized legume was investigated. The nine variants of African yam bean used were AYB 13, AYB 34, AYB 95^{N}, AYB 95, AYB 45, AYB 91, AYB 93, AYB50, AYB 61. The proximate analysis reflected the moisture content of the AYB seeds to be between 8.73 and 9.37%; protein (28.63-30.43%); fat (2.40-3.33%); Ash (3.23-3.70%); crude fibre (2.40-3.03%) and carbohydrate (50.80-53.57%). The mineral contents evaluated, reflected the calcium content of the seed (48-33-85 mg/100 g); potassium (10.83-14.56 mg/100 g); iron (4.77-8.03 mg/100 g); and phosphorus (108-135 mg/100 g). Vitamin C content ranged between 4.37-5.67 mg and Beta-carotene ranged between 56.67-93.33 µg. The anti-nutritional components were tannin (6.67-23.33 mg); haemagglutinin (0.13-0.57 mg); oxalate (6.6.7-15 mg); trypsin inhibitor (0-0.47 mg) and phytate (16.66-33.33 mg). The results indicate that there are varietal differences in the nutritional and anti-nutritional composition of African yam bean seed. AYB 34 recorded the highest protein content and AYB 95 had a minimal content of tannin. These varieties with high protein content and the one with less anti-nutritional value could be further propagated to maximize the potential of these seeds.

Keywords: African yam bean, Variety, Nutritional, Tannin, Anti-nutritional.

INTRODUCTION

Protein-energy malnutrition is one of the most serious problems common in the developing countries (FAO, 2000). This can be attributed mainly to the ever-increasing population as well as to the enhanced dependence on a cereal-based diet, scarcity of fertile land, and degradation of natural resources (Balogun and Olatidoye, 2012). Legumes are important ingredients of a balanced human diet in many parts of the world due to their high protein and starch contents (Adebowale *et al.,* 2009). It is a good source of protein, carbohydrate, vitamins and minerals. It also contains high concentrations of anti- nutritional factors, such as trypsin inhibitor, phytate, tannin, oxalate and alkaloids (Nwokolo, 1987; Ajibade *et al*., 2005; Fasoyiro *et al.,* 2006).

African yam bean (*Sphenostylis stenocarpa*) is an important legume in Africa usually classified as a lesser-known legume of the tropical regions of the world because it is not as popular as other major food legumes (Moyib *et al.,* 2008). In Nigeria, it is mostly grown in the Northern parts of the country where it is grown in mixed association with yam and cassava mainly for its edible seeds and tubers. The African yam bean provides two consumable products, the tuber which grows as the root source and the actual yam bean seeds which develop in pods above ground (Olasoji *et al*. 2011). It has many seed types, which vary in seed size, shape and seed coat colour. The colour of the seed coat varies from white to various shades of cream, brown and grey. The beans contain considerable amounts of essential proteins comparable to levels found in soybeans and are easily preserved through drying or stored in earthenware. It ranks well among neglected crops and can contribute to food security if its genetic resources are saved for utilization in breeding and improvement (Adewale *et al*., 2012).

In Western Africa they are often preferred over other grain legumes (Obizoba and Nnam, 1992; Okpara and Omaliko, 1995). African yam bean (AYB) has been reported to be of importance in the management of chronic diseases like

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diabetes, hypertension and cardiovascular diseases because of its high dietary fibre. AYB though deficient in sulphur containing amino acids methionine and cysteine but high in lysine can be utilized as a complementary protein in carbohydrate-based foods to improve their nutritional quality and attributes. It has high metabolizable energy, low true protein digestibility, moderate mineral content that compares favourably with most pulses.

The primary challenge to the wide consumption of African yam bean (AYB) includes hardness of the seed and the feature of anti-nutritional factors in the grains. These have adverse effects on the wide utilization of the crop. African yam bean seeds have been reported to have high nutritional value and are recommended for people suffering from malnutrition especially protein energy malnutrition. Different varieties of African Yam bean seeds have been developed and grown in some research institutes in Nigeria such as IITA (International Institute of Tropical Agriculture), IAR&T (Institute of Tropical Agricultural Research and Training) and NACGRAB (National Centre for Genetic Resources and Biotechnology).

This work is therefore aimed at determining the effects of variety on some quality attributes of AYB.

MATERIALS AND METHODS

Materials

African yam bean seeds used for this research work were obtained from IAR&T and NACGRAB, Ibadan, Oyo State, Nigeria. The chemicals used were of analytical grade, which were obtained from the Department of Food Science and Engineering, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria.

Methods

Sample preparation

The AYB seeds used were cleaned and sorted to remove extraneous materials and damaged seeds.

Determination of Proximate Composition

The seeds were analyzed for moisture, ash, crude fibre, protein (N*6.25), crude fat and the carbohydrate determined by difference according to the method described by AOAC (2005).

Determination of Minerals

Selected minerals, including calcium, phosphorus, potassium, and iron were extracted from dry ashed samples and determined by atomic absorption spectrophotometer (AOAC, 2005).

Determination of the Vitamin content

Vitamin A in form of β - Carotene was determined using the method of AOAC (2005), which involved extraction of the samples with acetone and hexane. Concentrations were determined by comparison with a standard curve. The total vitamin C was determined by titration with 0.02% 2,6-dichloro-indophenol (DFI) as method by Strohecker and Henning (1967). One gram of ground seed was diluted to 100 mL of 0.5% oxalic acid and homogenized. Then, 5 mL of this solution was diluted to 50 mL with distilled water and titrated and results were expressed as mg/100 g FW (fresh weight).

Determination of anti-nutritional factors

The condensed tannins were determined by the method of Morrison *et al*. (1995) which was a modification of the vanillin method of Burns (1971) using 1.0 mg mL^{-1} of catechin in 1% HCl-MeOH as standard, the coloured substituted product was measured at 500 nm. Phytate was determined by the anion exchange method which is the modified Holts Method using HN_4CNS as standard. Trypsin inhibitor and haemagglutinin activity were determined according to the methods described by Arntfield *et al*. (1985). The oxalate content of the samples was determined using titration method.

RESULTS AND DISCUSSIONS

The proximate composition of the nine different variants of African Yam Bean seeds is as shown in Table 1. The moisture content ranged between 8.73 and 9.17%. AYB 13 had the least and AYB 34 had the highest. The moisture contents of some of the variants were significantly (p< 0.05) different. The moisture content is an indicator of grain storability. Grains with high moisture content (over 14.5%) attracts mold, bacteria and insects all of which cause deterioration during storage while those with low moisture content is more stable during storage. Indicating that the nine variants of AYB seeds have better potentials of storage.

The percentage moisture content of African yam bean seed was higher than that of peanut but lower than those of soybean, cowpea and chickpea (Ekpenyong and Borchers, 1978). The protein contents of the nine variants of African yam seeds were between the values of 28.63 and 30.43% and some were significantly (p< 0.05) different. AYB 34 had the highest protein content while AYB 13 had the least. The protein contents of the nine variants were higher that the protein value reported by previous researchers; Kay (1987) reported 24-28%; Adeyeye *et al*. (1999) reported 20-25%; Apata and Ologhobo (1990) 22.6 to 23.8%.

The protein contents were higher than most of the legumes such as lima beans, lentils, chick pea and peanuts except for the soybean which has higher values according to Eromosele *et al.* (2008). The fat content ranged between 2.67 and 3.33%. These values indicate that AYB seeds are low in fat content and this could be an advantage in storage. The ash and the crude fibre contents were between 3.23 and 3.57% and 2.60 and 2.77%. The carbohydrate contents were between 51.90 and 53.57%. The crude fibre contents of the seed in the nine varieties of African yam bean seeds were more than that of other legumes (Apata and Ologhobo, 1994). This could mean that the seed could serve as functional food with health benefits associated with both soluble and insoluble fibre.

The result of the mineral composition of the African yam bean seed is as shown in Table 2. The result revealed an appreciable amount of potassium, phosphorus, calcium and iron in African yam bean seeds. The values obtained are in line with previous researchers (Arogundade *et al*., 2009). Values obtained for the calcium content ranged from 48.33 to 85.00 mg/100 g. It could still be referred to as a good source of calcium. The calcium content of African yam bean seed was higher than all the legumes except that of soybeans that was higher. The potassium content ranged between 11.17 and 14.50 mg/100 g. AYB 91 had the least and AYB 34 had the highest value. The potassium contents of legumes are generally high, African yam bean compares favourably with other legumes in calcium content, though some are higher.

Table 1: Proximate composition of the nine variants of African Yam bean seeds (%)

Samples	Moisture	Protein	Fat	Ash	Crude	CHO
AYB 13	8.73b	28.63c	2.80b	3.57a	2.77a	53.57a
AYB 34	9.17a	30.43a	2.67b	3.23a	2.60a	51.90c
AYB 95	8.97ab	29.97b	3.33a	3.43a	2.63a	53.37b
AYB 45	9.13ab	29.57c	2.77a	3.37b	2.93a	52.23b
AYB 91	9.37a	30.13a	3.17b	3.50ab	3.03a	50.80c
AYB 95^N	9.03b	28.70c	2.53a	3.70a	2.83a	53.10a
AYB 93	8.93a	29.33b	2.93a	3.53a	3.03a	52.23b
AYB 50	9.14a	30.13a	2.40c	3.26b	2.40b	52.66b
AYB 61	8.83b	28.93c	2.60b	3.63a	2.56b	53.43a

Mean values with the same alphabets within the same column are not significantly (p< 0.05) different from each other

Table 2: Bioactive compounds of the nine variants of African Yam bean seed

Sample	Ascorbic Acid (mg/100g)	β-Carotene (µg/100g)
AYB 93	5.27bc	73.33bc
AYB 50	4.67d	93.33a
AYB 61	5.47ab	65.00cd
AYB 45	5.13c	56.67d
AYB 91	4.37e	81.67ab
AYB 34	4.70d	61.67cd
AYB 13	5.17c	76.67bc
AYB 95	5.67a	56.67d
AYB 95^N	4.47de	66.67bcd

Mean values with the same alphabets within the same column are not significantly (p< 0.05) different from each other

Table 3: Mineral composition of the nine variants of African yam bean seed (mg/100g)

Sample	Ca	K	Fe	P
AYB 93	50.00c	13.00bc	6.37c	130.00abc
AYB 50	48.33c	12.33cd	5.47d	128.33abc
AYB 61	48.33c	12.33cd	7.13b	133.33ab
AYB 45	51.67c	10.83e	4.77e	135.00a
AYB 91	51.67c	14.50a	5.57d	126.67bc
AYB 34	80.00a	11.17e	7.23b	118.33d
AYB 13	71.67b	13.50b	8.03a	125.00c
AYB 95	66.67b	12.83bcd	6.40c	108.33e
AYB 95^N	85.00a	12.17d	5.63d	130.00abc

Mean values with the same alphabets within the same column are not significantly (p< 0.05) different from each other

Table 4: Anti-nutritional components of nine variants of African yam bean seeds (mg/100g)

Sample	Tannins	Haemagglutinins	Oxalates	Trypsin (Protease) Inhibitors	Phytates
AYB 93	15.00bc	0.17c	11.67ab	0.40ab	33.33b
AYB 50	11.67cde	0.57a	8.33bc	0.17c	25.00c
AYB 61	10.00def	0.43b	5.00c	0.43ab	16.67d
AYB 45	8.33ef	0.57a	8.33bc	0.33b	41.67a
AYB 91	11.67cde	0.23c	6.67c	0.20c	21.67cd
AYB 34	23.33a	0.47ab	8.33bc	NDe	21.67cd
AYB 13	18.33b	0.37b	11.67ab	0.33b	21.67cd
AYB 95	6.67f	0.23c	11.67ab	0.20c	33.33b
AYB (NACGRAB)	13.33cd	0.13c	15.00a	0.47a	18.33d

Mean values with the same alphabets within the same column are not significantly ($p< 0.05$) different from each other

When compared with other seed legumes, soybean and lima beans have the highest concentration of potassium with lower values in chickpea and lentils.

The iron content ranged between 4.77 to 8.03 mg/100 g. AYB 95 had the least and AYB 45 had the highest value. Iron was high in all the varieties which agree to findings with Poulter and Caygill (2006). Legumes are generally low in iron contents but higher values are recorded in African bean seed. This probably means that the high content of iron will have beneficial effects on blood formation in the body. The phosphorus content ranged between 108.33 and 135.00 mg/100 g. AYB 45 had the highest value while AYB 95 had the least value. This reflects that African yam bean seed is a good source of phosphorus.

The result of the Vitamin content of the nine varieties of African yam bean seed is as shown in Table 3. The ascorbic acid value ranged between 4.37 to 5.67 %. AYB 91 had the least value and AYB 95 had the highest value. Ascorbic acid functions as a preservative which aids endosperm maturity after harvesting e.g. gas retention, increases fermentation stability and improves volume yield. The beta carotene value ranged between 56.67 to 93.33 %. AYB 95 had the least value and AYB 50 had the highest value. The beta-carotene which is a precursor of vitamin A will be an advantage in solving the vitamin A Deficiency (VAD) problems common in developing countries like Nigeria

The result of the anti-nutritional composition of the nine varieties of African Yam Bean seeds is as shown in Table 4. The tannins content obtained ranged between 6.67 to 23.33 mg/100g which is within the range of values reported by Ndidi *et al.* (2014) for African yam bean seed. AYB 95 had the lowest value of tannins and AYB 34 had the highest. Tannin affect the digestive tract and their metabolites are toxic (Ene-obong and Okoye, 1992). Other negative effects are reduced palatability, reduced weight gain and feed efficiency (Ahmed 1991, Mariscal-Landin 1992 and Emiola *et al*., 2007). The variety with lower contents of tannin will be a better variety for propagation for reduced effect of tannins, which has been one of the major drawbacks in the use of African yam bean despite the nutritional potentials.

The haemaglutinin content ranged between 0.23 to 0.57 mg/100g. AYB 95 had the least value and AYB 45 had the highest value. Haemagglutinins are known to exert deleterious effects via structural and functional disruptions of the intestinal microvilli resulting in reduced nutrient absorption. The seeds of many edible legumes have long been known to contain proteins with agglutinate erythrocytes (Boyd, 1963). Some of these haemagglutinins have been suggested to contribute to the poor nutritive quality of raw beans (Jaffe, 1969).

The oxalates content ranged from 6.67 to 11.67mg/100g. AYB 91 had the lowest value and AYB 13 and AYB 95 both had the highest, the values are within the range of values reported by Ndidi *et al*. (2014). Oxalate has a significant effect on mineral level and it forms complexes with minerals (Adegunwa *et al*., 2012). The trypsin inhibitor content ranged from 0.20 to 0.47 mg/100g. AYB 95 had the least value and AYB 95 (NACRAB) had the highest value. Trypsin is an enzyme involved in digestion. There is evidence that the ingestion of trypsin inhibitors from legumes result in the hypertrophy and hyperplasia of the pancreas (Liener, 1989; Ologhobo *et al*., 2003).

The phytate content values ranged from 16.66 to 41.67%. AYB 61 and AYB 45 had the highest value. Phytate, a chelator of cations causes reduction in protein availability (Macrae and Joslyn 1993). It decreases calcium bioavailability and forms calcium phytate complexes that inhibit the absorption of iron. The level of phytate were generally high and the seeds had over 50% of their total phosphorous linked to phytate.

CONCLUSION

Poor awareness of the full potential of African yam bean has been one of the major constraints in its consumption. This research work has been able to establish that there are differences in the nutritional and anti-nutritional value of African yam bean seeds with varieties. The protein content was very high and compares well with other legumes, making it a good substitute for protein. The variety AYB 34, which recorded the highest value of protein had about 30%, which is very close to that of soybean (32 %) indicating that it could be substituted into various food formulations where soybean have been used.

This will relieve the heavy demand on soybean and enhance the optimum utilization of African yam bean seeds. Higher values of crude fibre contents were obtained in the variety AYB 91 and AYB 93 and the crude fibre contents of the seeds were higher than that of most other legumes which indicates that the seeds could serve as functional food with health benefits associated with both soluble and insoluble fibre.

The variety AYB 95 had a very low content of tannin (6 mg/100 g) against about 18 mg/100 g of tannin content reported for African yam bean seeds. This could mean that this variety has been improved with a much reduced amount of anti-nutritional components and could solve the anti-nutritional factor constraints in the utilization of African yam bean seed and hence lead to maximization of the potentials of the seeds. The high protein, carbohydrate and crude fibre contents of African yam bean could be of great importance. This could be incorporated into various traditional dishes for both children and adults to alleviate protein energy malnutrition in the developing countries.

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