Assessing the Anti-Nutritional Composition of Four Varieties of African Yam Bean in Afikpo Town of Ebonyi State Nigeria

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ABSTRACT: *The anti-nutritional composition of white, brown, spotted and black coat coloured African yam bean varieties that are cultivated in the Afikpo town of Ebonyi State in Nigeria was determined in this study. The oxalate, trypsin, inhibitor phytate, and tannin contents were determined. The results of the oxalate composition showed that the white variety was lowest with the value of 0.949 mg/100, while the brown variety was highest with the value of 5.973 mg/100. The trypsin, phytate and tannin contents ranged from 0.689 mg/l to 0.981 mg/l, 0.002 mg/100 to 0.003 mg/100 and 0.005 % to 0.008 %. There were no significant differences in the compositions of inhibitor phytate and tannin in the four varieties of the African yam bean. The findings suggest that the intake of the brown African yam bean should be minimized to avoid hindrance to calcium and magnesium metabolism because of the high oxalate content.*

KEYWORDS – *Anti-nutritional composition, African yam bean, Yam bean analysis, Yam bean varieties*

I. INTRODUCTION

African yam bean belongs to the family of the leguminous sub-papilcionacease family of flowering plants. It is native to East Africa precisely Ethiopia, but now it is widely cultivated in tropical Africa, especially in West Africa like Cameroon, Ghana, and Nigeria [1]. The yam bean is grown for the use of the seed and tuber as food since it tolerates an annual rainfall of less than 1000 mm. African yam bean is rich in potassium, phosphorous, magnesium, calcium, iron and zinc, but low in sodium and copper [2]. Uguru and Madukaife [3] opined that the amino acid content in African yam bean is higher than in pigeon pea, cowpea and bambara groundnut, which makes it an essential food commodity. This quality has attracted many researchers [4-16] towards the study of African yam bean.

Fasoyiro *et al.* [17] studied the proximate, minerals and anti-nutritional factors of two collections of African yam bean, lima beans and pigeon pea, and one collection of bambara groundnut seeds grown in southwestern Nigeria. The results showed that the crude protein in the legumes was in the range of 22–37 %, crude fat 1.47–4.96 %, crude fibre 1.92–7.21% and ash 3.33–5.61 %. The potassium, calcium and phosphorus contents were in the range of 0.15–0.52 %, with low Iron content. The tannin, phytic acid and trypsin inhibitor were very high when compared to those of cowpea, groundnut and soybean. The findings suggested that African yam bean needs to be processed before consumption to reduce their anti-nutritional factors.

Ajibade *et al.* [18] evaluated nutritive and anti-nutritive contents of twenty African yam bean seeds. The results showed that the anti-nutrients were negatively correlated with protein and carbohydrate contents. The findings indicated that the seeds with high anti-nutrient contents had darker seed colour.

Abioye *et al.* [19] studied the effect of variety on proximate, mineral, vitamin and anti-nutritional composition of African yam bean seed. Nine variants of African yam bean were used in the study. The results showed that the seeds have moisture content 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 calcium content of the seed was 48-33-85 mg/100g, potassium 10.83-14.56 mg/100g, iron 4.77-8.03 mg/100g, and phosphorus 108-135 mg/100g. The findings indicated that there were veritable differences in the nutritional and anti-nutritional compositions of African yam bean seeds.

Ajibola and Olapade [20] conducted research to unveil the nutritional importance of African yam bean for the enhancement of its production and utilisation. The seed size, length to diameter ratio, seed weight, percentage of seed coat, bulk density and loose density were the

physical properties considered in the study. The results indicated that there were significant differences in the physical properties of the African yam bean varieties. In addition, there existed a significant difference in the oxalate, phytate, alkaloids, tannin, trypsin inhibitor and hydrogen cyanide contents of the samples studied.

Although many researchers have carried out investigations on properties of African yam bean in the past, yet there is little literature on the composition of the African yam bean that is grown in Afikpo town in Ebonyi state of Nigeria. Therefore, the present study seeks to determine the anti-nutritional composition of four varieties of African yam bean that are cultivated in the Afikpo region of Ebonyi state, Nigeria.

II. MATERIALS AND METHODS

The white, brown, spotted and black varieties of African yam bean were bought from a farmer in Afikpo North local government area of Ebonyi State in Nigeria. They were prepared in line with the method described by Eneche [21]. 2 g of African yam bean seed that was free from foreign particles was weighed and milled with a locally fabricated attrition mill to obtain fine flour. The flour was packaged in sealed polyethylene bags ready for analysis. The dried samples were transferred into a crucible and ashed in a muffle furnace at 500 ℃ for 3 hours. The crucibles were removed after the ashing was completed. After cooling, 10 ml of 2M hydrochloric acid was added and heated directly to boiling. The contents of each crucible were thereafter transferred into 50 ml volumetric flask and then diluted to 50 ml.

The quantity of oxalate was determined using the method described in Obadoni and Ochuko [22]. 2 g of sample was weighed and extracted thrice at 50 ℃ for one hour with 20 ml of 0.3 M HCl. The combined extract was diluted to 100 ml with distilled weight. 5 ml of the extract was made alkaline, with 1 ml of 5 M ammonium hydroxide. About 3 drops of phenolphthalein were added to the extract and acetic acid was added in drops. Also, 1 ml of 5 % CaCl was added to the mixture and allowed to stand for 2 hours, after which it was centrifuged at 3000 rpm for 15 minutes. The supernatant was discarded and the precipitates dissolved in a 250 ml conical flask with 0.2 ml of H_2SO_4 warming in a water bath of 75 ℃ for 30 minutes. The content of the flask was titrated with freshly prepared 0.01 M $KMnO_4$ until the pink colour appears and persists.

The Phytate content was determined using the method described in Obadoni and Ochuko [22]. About 2g of the sample was soaked with 100 ml of 2 % HCl for 3 hours and then filter with Whatman number 1 filter paper. 50 ml of the filtrate and 10 ml of distilled water was added to give proper acidity. The millilitre of 0.3 % ammonium thiocyanate solution was added as indicators and titrated with a standard $FeCl_2$ solution. The endpoint was observed by yellow colouration which will persist for 5 minutes.

Tannin was determined by the Folin-Denis colourimetric method described by Kirk and Sawyer [23]. About 5 g of the sample was dispersed in 50 ml of distilled water and shaken. The mixture was allowed to stand for 30 minutes before it was filtered through a Whatman number 42 filter paper. 2 ml of the extract was poured into a 50 ml volumetric flask. Similarly, 2 ml of standard tannin solution and 2 ml of distilled water was added and allowed to incubate at room temperature for 90 minutes.

Trypsin inhibitor was determined using the spectrophotometric method described by Arntfield *et al*. [24]. 5 grams of the test sample was dispersed in 50 ml of 0.5 M NaCl solution and stirred for 3 minutes at room temperature. It was centrifuged and the supernatant was filtered through Whatman number 42 filter paper. The filtrate was used for the assay. Standard trypsin was prepared and used to treat the substrate solution. The extent of inhibition was used as a standard for measuring the trypsin. In the tube containing 2 ml of extract, 10 ml of the substrate was added. Also the second part of the standard trypsin solution was added in another test tube containing only 10 ml of the substrate. This serves as the blank. The content of the tube was allowed to stand for 30 minutes. And the absorbance of the solution was measured spectrophotometrically at 410 nm wavelength. One trypsin activity unit inhibited is given by an increase in 0.01 absorbance unit at 410 nm.

III. RESULTS AND DISCUSSION

The results of the anti-nutritional composition of the African Yam bean seed are presented in Table 1. The result obtained from the analysis of the oxalate composition showed that there were significant differences between the mean values of the four varieties of the African yam bean. The white variety was lowest with the value of 0.949

mg/100, while the brown variety was highest with the value of 5.973 mg/100. Oxalates affect calcium and magnesium metabolism and react with protein to form complexes which have an inhibitory effect on peptic digestion [25].

The trypsin inhibitor, on the other hand, showed significant differences between the mean values of the four varieties of the African yam bean. The trypsin inhibitor ranged from 0.689 mg/l to 0.981 mg/l in black and brown varieties respectively. This anti-nutrient inhibits the function of trypsin enzyme, causes pancreatic hypertrophy and dietary loss of cystine. Trypsin inhibitor is a protein that interferes with nutrient absorption by reducing the activity of proteolytic enzymes trypsin and chymotrypsin. The amount and activity of trypsin inhibitor in the diet have been shown to be inversely related to the availability of energy and protein [26].

The result of the phytate content of the four varieties of the African yam bean ranged from 0.002 mg/100 to 0.003 mg/100 in white and other varieties with no significant difference between their mean value. The tannin had a range value of 0.005 % to 0.008 % with no significant difference between the mean values of four varieties of the African yam bean. The spotted has the highest level of tannin while the black variety has the lowest. The variation in the anti-nutritional composition may be attributed to differences in the genetic makeup of the African yam bean, as well as the geographical location where the plant was cultivated.

IV. CONCLUSION

The assessment of the anti-nutritional composition of four varieties of the African yam bean that are cultivated in the Afikpo town of Ebonyi State in Nigeria was conducted. The results of the oxalate composition showed that the white variety was lowest with the value of 0.949 mg/100, while the brown variety was highest with the value of 5.973 mg/100, and there were no significant differences in the compositions of inhibitor phytate and tannin in the four varieties of the African yam bean examined. The findings suggest that the intake of the brown African yam bean should be minimized to avoid hindrance to calcium and magnesium metabolism because of the high oxalate content.

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Table 1: Anti-nutritional composition of four varieties of African yam bean

Sample	Oxalate (mg/100g)	Trypsin (mg/l)	Inhibitor phytate (mg/100g)	Tannin (%)
White variety	0.949 ± 0.001^{d}	0.707 ± 0.001^{b}	0.002 ± 0.000^{a}	0.008 ± 0.000^{a}
Brown variety	5.973 ± 0.001^{a}	0.981 ± 0.001^{a}	0.003 ± 0.000^{a}	0.006 ± 0.000^{a}
Spotted variety	3.818 ± 0.001^{b}	0.860 ± 0.030^{b}	0.003 ± 0.001^{a}	0.009 ± 0.000^{a}
Black variety	2.144 ± 0.001^{c}	0.689 ± 0.259^{b}	0.003 ± 0.001^{a}	0.005 ± 0.004^{a}

Values with the same superscript in the same column are not significantly different ($p<0.05$)