Tropical Science
**45(4)**: 144–148 (2005)
DOI: 10.1002/ts.14

# Genetic variation in nutritive and anti-nutritive contents of African yam bean (*Sphenostylis stenocarpa)*

*SR Ajibade, MO Balogun, OO Afolabi, KO Ajomale and SB Fasoyiro*
Institute of Agricultural Research and Training,Obafemi Awolowo, University, Moor Plantation, PMB 5029, Ibadan, Nigeria. (remiajibade2002@yahoo.com)

**Abstract** *Seeds of 20 African yam bean collections were evaluated for nutritive and anti-nutritive contents. Anti-nutrients were negatively correlated with protein and carbohydrate contents. Principal component analysis and the Fastclus procedure showed that collections with high anti-nutrient contents had darker seed colour. Copyright © 2005 John Wiley & Sons, Ltd.*

**Keywords:** African yam bean, nutrients, anti-nutrients, seed colour.

## Introduction

In Nigeria, animal protein is expensive, and to provide a good alternative source of protein to supplement the whole carbohydrate diet of the people, grain legumes like cowpea and soyabeans are widely used. African yam bean is a good source of protein, carbohydrate, vitamins and minerals, but it also contains anti-nutritive factors (ANFs) such as trypsin inhibitors, phytate, tannin, oxalate and alkaloids. The constituents of African yam bean have been studied by, for example, Oshodi et al. (1995), Adeyeye et al. (1994) and Adeparusi (2001), but the variations in the available collections have received little attention. This study concerns the variation in nutritive and anti-nutritive constituents in 20 collections of African yam bean seeds from southwestern Nigeria.

## Materials and methods

The 20 collections of African yam bean used consisted of ten from Ondo, nine from Oyo and one from Ekiti States. The seeds were collected from farmers and local markets, sorted to remove extraneous materials, dried at 105ºC for 24 h, milled and stored in polythene bags at 4ºC.

Nitrogen content was determined by the microKjedahl method using the conversion factor of 6.25. The other methods were crude fats, crude fibre and ash (AOAC 1990); tannins (Price et al. 1978); trypsin inhibitor (Kakade et al. 1969); phytate (Davies and Reid 1979); and oxalate (Fasset 1966). All the analyses were in triplicate. Data were subjected to analysis of variance, Duncan's multiple range test and correlation analysis. The resultant correlation matrix was used for principal component analysis (SAS 1997) and then the Fastclus procedure also of SAS.

*Accepted 25 January 2005*

## Results and discussion

There were significant differences among the nutritive and anti-nutritive contents. The protein, fat and fibre contents were 21.65–24.51, 3.81–5.20 and 4.79–8.02% respectively (Table 1). These results compared well with those of Nwokolo (1987), Edem et al. (1990), Adeyeye et al. (1994) and Adeparusi (2001), and those reported for other grain legumes such as *Vigna trilobata* and *V. radiata* (Siddhuraju et al. 1992). The carbohydrate and protein contents are similar to those of cowpea (Fashakin and Ojo 1988). For the anti-nutrient contents (Table 2), the trypsin inhibitor content was 17.11–33.56 Tiu/mg, phytate 3.30–4.20 g/100 g, tannin 3.95–7.83 g/100 g and oxalate 2.12–3.54 g/100 g. The trypsin inhibitor content is high, as reported by Adeparusi (2001), considerably higher than in soyabean and cowpea (Fasoyiro 2005), but lower than in jackbean and lima bean (Ologhobo et al. 2003).

The four anti-nutrients were all positively and significantly correlated with one another and with fat, fibre and ash contents, but negatively correlated with protein and carbohydrate contents (Table 3). The positive correlations among the ANFs indicate that all of them could be simultaneously selected in a breeding programme, while the negative correlation between ANF, protein and carbohydrate contents mean that in selecting for high protein or carbohydrate, the ANFs are automatically being selected against.

**Table 1.** Nutritional profile of African yam bean collections (% DM)

| Collection | Protein | Fat | Fibre | Ash | Carbohydrate |
|---|---|---|---|---|---|
| 1 | 22.03k | 4.97b | 7.40d | 4.79i | 48.82hi |
| 2 | 22.38j | 4.72d | 8.02a | 4.60j | 48.27ij |
| 3 | 22.99g | 2.91jkl | 6.58f | 3.80n | 50.62de |
| 4 | 23.84e | 3.79n | 6.51g | 3.71o | 49.18gh |
| 5 | 22.87gh | 3.88kl | 5.31m | 4.02m | 53.74a |
| 6 | 21.79l | 4.02hj | 6.29i | 7.05a | 48.76hi |
| 7 | 24.28bc | 5.14a | 6.81e | 5.71g | 46.33k |
| 8 | 22.30j | 4.82c | 7.59c | 6.89b | 46.83k |
| 9 | 22.97g | 4.40e | 6.40h | 5.78f | 49.56fg |
| 10 | 24.07d | 5.20a | 6.04k | 6.30d | 47.79j |
| 11 | 24.41a | 5.18a | 6.22j | 6.03e | 47.68j |
| 12 | 23.79e | 4.06gh | 5.21n | 4.05m | 51.45bc |
| 13 | 22.75hi | 4.02hi | 5.02o | 4.21l | 51.70b |
| 14 | 21.73l | 3.93jk | 7.58b | 7.02a | 47.55j |
| 15 | 24.13cd | 4.15f | 6.10k | 5.27h | 49.58j |
| 16 | 21.65l | 3.86ml | 5.29m | 6.74c | 50.32de |
| 17 | 22.80gh | 3.95ij | 4.92p | 4.31k | 50.85cd |
| 18 | 22.65i | 3.81mn | 4.79q | 4.60j | 50.91cd |
| 19 | 23.30f | 4.00hi | 4.95p | 6.01e | 49.91ef |
| 20 | 24.51a | 4.11fg | 5.60l | 6.30d | 46.74k |
| Mean | 23.06 | 4.29 | 6.12 | 5.36 | 49.33 |
| SE | 0.12 | 0.06 | 0.12 | 0.15 | 0.25 |

Means in the same column with the same letter are not significantly different at $P = 0.05\%$.



 

**Table 2.** Anti-nutritive factors in African yam bean collections

| Collection | Anti-nutrients mean values | | | |
|---|---|---|---|---|
| | Trypsin inhibitor (Tiu/mg) | Phytate (g/100 g) | Tannin (g/100 g) | Oxalate (g/100 g) |
| 1 | 30.27bc | 3.98c | 7.23cd | 3.23ab |
| 2 | 28.95cd | 4.08b | 7.83a | 3.28ab |
| 3 | 23.03hi | 3.52f | 4.38k | 2.12c |
| 4 | 21.05ij | 3.44g | 4.82j | 2.19c |
| 5 | 21.06ij | 3.42g | 4.82j | 2.19c |
| 6 | 32.90a | 4.20a | 7.67ab | 3.42a |
| 7 | 26.32ef | 3.60e | 6.47fg | 2.25c |
| 18 | 31.58ab | 3.87d | 7.45bc | 3.21ab |
| 29 | 26.32ef | 3.98c | 6.90de | 3.14ab |
| 10 | 28.29cde | 3.91d | 6.79ef | 2.98b |
| 11 | 25.66fe | 4.04b | 5.92hi | 3.33ab |
| 12 | 17.11k | 3.54f | 4.17kl | 2.34c |
| 13 | 19.74j | 3.54f | 3.95l | 2.97b |
| 14 | 31.58ab | 3.99c | 7.78ab | 3.54a |
| 15 | 25.66fg | 4.04b | 6.25gh | 3.54a |
| 16 | 33.56a | 4.07b | 7.01de | 2.94b |
| 17 | 23.69gh | 3.46g | 5.70i | 2.16c |
| 18 | 21.71hij | 3.36h | 4.82j | 2.21c |
| 19 | 27.64def | 3.30i | 4.38k | 2.19c |
| 20 | 26.16f | 3.45g | 4.49jk | 2.24c |
| Mean | 26.11 | 3.74 | 5.944 | 2.77 |
| SE | 0.6 | 0.038 | 0.17 | 0.07 |

Means in the same column with the same letter are not significantly different at $P = 0.05\%$.

**Table 3.** Correlation coefficients of nutritive and anti-nutritive seed constituents

| Seed content | Trypsin inhibitor | Phytate | Tannin | Oxalate | Protein | Fat | Fibre | Ash | Carbohydrate |
|---|---|---|---|---|---|---|---|---|---|
| Trypsin inhibitor | – | | | | | | | | |
| Phytate | 0.70** | – | | | | | | | |
| Tannin | 0.83** | 0.85** | – | | | | | | |
| Oxalate | 0.61** | 0.91** | 0.75** | – | | | | | |
| Protein | –0.49** | –0.34* | –0.47** | –0.34* | – | | | | |
| Fat | 0.31 | 0.43** | 0.47** | 0.37* | 0.29 | – | | | |
| Fibre | 0.51** | 0.58** | 0.71** | 0.54** | –0.22 | 0.51** | – | | |
| Ash | 0.81** | 0.55** | 0.60** | 0.53** | –0.18** | 0.29 | 0.23 | – | |
| Carbohydrate | –0.59** | –0.41** | –0.54** | –0.37* | –0.21 | –0.63** | –0.63** | –0.64** | |

Significant at *0.05 and **0.01%.

The principal component analysis is in Table 4. The first two PCs accounted for 75% of the total variation among the collections. Most of the variation was accounted for by the first PC (57%), which gave higher loadings to the four anti-nutrients, ash, fibre and fat. In the second PC (18%), protein, fat and carbohydrate had the highest weights (Table 4). The

**Table 4.** Contributions of the factors to PC1 and PC2

| | PC1 | PC2 |
|---|---|---|
| Trypsin inhibitor | 0.39 | –0.15 |
| Phytate | 0.39 | –0.12 |
| Tannin | 0.41 | –0.12 |
| Oxalate | 0.36 | –0.14 |
| Protein | –0.15 | 0.67 |
| Fats | 0.25 | 0.51 |
| Fibre | 0.32 | 0.13 |
| Ash | 0.33 | 0.01 |
| Carbohydrate | –0.31 | –0.45 |
| Eigen value | 5.14 | 1.65 |
| Variance (%) | 57.08 | 18.35 |

higher eigen values for the ANFs by PC1, indicate their importance in differentiating among the collections.

None of the variables was redundant. A specific grouping by the Fastclus procedure gave three groups with 7, 7 and 6 collections (Table 5). Groups 1and 2 had significantly higher protein contents than group 3, while group 3 had significantly higher anti-nutrient contents. Group 1 seeds were whitish to grey, group 2 brown and group 3 dark brown seeds with black speckles. Nehad (1990) found higher tannin contents in the coloured varieties of faba beans than in white. Thus the light-skinned collections had low anti-nutritive, high protein and carbohydrate contents, so in breeding for animal and human nutrition, selections should be made from group 1.

**Table 5.** Cluster means based on PC1 and Fastclus groupings

| Clusters | 1 | 2 | 3 |
|---|---|---|---|
| Collections | 3, 4, 5, 12, 13, 17, 18 | 7, 9, 10, 11, 15, 19, 20 | 1, 2, 6, 8, 14, 16 |
| Range of eigen value | –3.11 to –2.14 | –1.80 to 1.57 | 1.47 to 3.13 |
| Seed colour | Whitish to grey | Brown | Dark brown speckled |
| Cluster means | | | |
| Trypsin inhibitor (Tiu/mg) | 21.05 | 26.58 | 31.47 |
| Phytate (g/100 g) | 3.47 | 3.76 | 4.03 |
| Tannin (g/100 g) | 4.66 | 5.87 | 7.51 |
| Oxalate (g/100 g) | 2.31 | 2.80 | 3.27 |
| Protein (%) | 23.1 | 23.95 | 21.98 |
| Fat (%) | 3.92 | 4.59 | 4.38 |
| Fibre (%) | 5.47 | 6.01 | 7.01 |
| Ash (%) | 4.10 | 5.91 | 6.18 |
| Carbohydrate (%) | 51.20 | 48.22 | 48.42 |



 

## References

Adeparusi EO (2001) Effect of processing on some minerals, anti-nutrients and nutritional composition of African yam bean. Journal of Sustainable Agriculture and Environment 3: 101–108.

Adeyeye EI, Oshodi AA and Ipinmoroti KO (1994) Functional properties of some varieties of African yam bean (*Sphenostylis stenocarpa*) flour II. International Journal of Food Science and Nutrition 45: 115–126.

AOAC (1990) Official Methods of Analysis. Washington, DC: Association of Official Analytical Chemists.

Davies WT and Reid H (1979) An evaluation of phytate, zinc, copper, iron and manganese contents of soybean textured vegetable protein meat substitute or meat extenders. British Journal of Nutrition 41: 580–588.

Edem DO, Amugo CI and Eka OU (1990) Chemical composition of yam beans (*Sphenostylis stenocarpa*). Tropical Science 30: 59–63.

Fashakin SB and Ojo FA (1988) Chemical composition and nutritive changes of some improved varieties of cowpea (*Vigna unguiculata*) L. (Walp). Tropical Science 28: 191–199.

Fasoyiro SB, Ajibade SR, Omole AJ, Adeniyan ON and Farinde EO (2005) Proximate, mineral and anti-nutritional factors of some underutilized grain legumes in south-western Nigeria. Nutrition and Food Science (in press).

Fasset DW (1966) Oxalates. In: Oxalate – Toxicants Occurring Naturally in Foods. Washington, DC: National Academy of Sciences Research Council, pp. 99–107.

Kakade ML, Simon N and Leiner IE (1969) An evaluation of natural vs synthetic for measuring the antitryptic activity of soybean samples. Cereal Chemistry 46: 518–526.

Nehad NAM (1990) Effect of presoaking of faba bean enzyme inhibitors and polyphenol after cooking. Journal of Agricultural and Food Chemistry 38: 1479–1482.

Nwokolo E (1987) A nutritional assessment of African yam bean *Sphenostylis stenocarpa* (Hochst ex A. Rich) Harms and Bambara groundnut *Voandzeia subterranea* L. Journal of the Science of Food and Agriculture 41: 123–129.

Ologhobo A, Mosenthin R and Alaka OO (2003) Products from under-utilized plant seeds as poultry feed ingredients. Tropical Journal of Animal Science 6: 101–110.

Oshodi AA, Ipinmoroti KO, Adeyeye EI and Hall GM (1995) Amino and fatty acids composition of African yam bean (*Sphenostylis stenocarpa*) flour. Food Chemistry 53: 1–6.

Price ML, Van Scoyoc S and Butler LGA (1978) A critical evaluation of the vanillin reaction as an assay for tannin in sorghum grains. Journal of Agricultural and Food Chemistry 26: 1214

SAS (1997) Users' Guide. Basic version, 6th ed. Cary, NC: SAS Institute.

Siddhuraju P, Vijayakumari K and Janardhanan K (1992) Nutritional and chemical evaluation of raw seeds of the tribal pulse, *Vigna trilobata* (L.) Verdc. International Journal of Food Science and Nutrition 43, 97–103.



 