The African Yam Bean (*Sphenostylis stenocarpa*): A Neglected Crop in Ghana.

H. M. Amoatey[1*], G.Y.P Klu[1], D. Bansa[1], F. K. Kumaga[2], L. M. Aboagye[3], S. O., Benett-Lartey[3] and D. K. Gamedoagbao[3]

[1]Biotechnology and Nuclear Agriculture Research Institute, P.O. Box LG80, Legon, Ghana. [2]Department of Crop Science, University of Ghana, Legon, Ghana; [3]Plant Genetic Resources Centre P. O. Box 7, Bunso, Ghana.

** Corresponding author*

Abstract

The African yam bean (*Sphenostylis stenocarpa* Hochst ex A. Rich) is a small-holder's crop in Ghana. There is danger of this legume disappearing from the hands of traditional farmers due to the popularity of the major legumes. This paper highlights the potential of African yam bean in contributing to food security in Ghana, steps initiated to assemble and conserve available germplasm in order to prevent extinction and research efforts required to facilitate its improvement and development as a viable commercial crop. Information gathered during germplasm collection trips on cultivation and uses are also presented.

Key words: African yam bean, food security, germplasm, Ghana, legume, neglected crop

Introduction

African yam bean (*Sphenostylis stenocarpa* Hochst ex A. Rich) is a herbaceous leguminous plant occurring throughout tropical Africa (Porter, 1992). It is often cited among the lesser-known and underploited species (Rachie & Roberts, 1974; Anonymous 1979; Edem *et al.*, 1990; Ene-Obong & Okoye, 1992; Bennett-Lartey *et al.*, 1993; Amoatey *et al.*, 1997).

In Ghana, the African yam bean typifies a neglected traditional crop. There is no record indicating when it entered into cultivation. However, for several decades it has been cultivated and maintained by traditional farmers but has not received any attention from researchers. In areas of cultivation it serves as the security crop prior to the new season's harvest of main staples such as maize, sorghum, yam and cassava.

Locally, very little is known about the economic and nutritional value of the crop, unlike in neighbouring Nigeria where results of some research work have already been documented (Ezueh, 1977, 1984; Edem *et al.*, 1990; Nwachukwu & Umechuruba, 1991; Ofuya & Bamigbola, 1991; Ene-Obong & Okoye, 1992; Obizoba & Nnam, 1992; Oshodi *et al.*, 1994; Umechuruba & Nwachukwu, 1994; Okpara & Omaliko, 1995; Onyeike *et al.*, (1995). Available information is limited to the activities of the Plant Genetic Resources Centre at Bunso, which has collected a total of 10 accessions from Volta Region (Adansi & Holloway, 1978; Holloway, 1983; Bennett-Lartey *et al.*, 1997) for conservation.

Currently, there is no research activity on this crop as all efforts are focused on major legumes such as cowpea (*Vigna unguiculata* (L.) Walp), groundnut (*Arachis hypogea* L.) and soybean (*Glycine max* L.). The bean, thus, faces the danger of becoming extinct. There is, therefore, the need to collect all available accessions of the crop from regions where it occurs throughout

Ghana for characterisation, evaluation and conservation. Material thus assembled would serve as a source of variability for improving *S. stenocarpa* towards its development as a major leguminous crop in Ghana.

The objective of this paper is to highlight the following: i) potential of the African yam bean in contributing to food security in Ghana, (ii) steps initiated to assemble and conserve available germplasm in order to prevent its total extinction, and (iii) efforts required by researches towards its improvement and development.

Further studies are in progress to characterise the entire collection using morphological, agronomic and seed protein attributes as well as to evaluate them based on features such as yield, quality and resistance to both biotic and abiotic factors in the environment. Results of these studies shall form the substance for discussion in subsequent publications.

Phenology

The African yam bean is described as a prostrate or climbing vine reaching up to 3 m or more in height (Duke *et al.*, 1977; Anonymous, 1979) (Plate 1). The stems are often reddish, glaborous or sparsely puberous (Duke *et al.*, 1977). The leaves are trifoliate and alternate; leaflets are ovate, acuminate or lanceolate. The inflorescence has 4-9 flowers which may be purple, pink, cream or white with a twisted standard petal. It forms slightly woody pods which are linear and measure up to 30 cm long (Plate 2), containing 20-30 seeds (Duke *et al.*, 1977; Anonymous, 1979; Edem *et al.*, 1990).

The plant produces spindle-shaped, starchy tubers smaller in size than those of sweet potato. These take between 5 and 8 months to mature (Anonymous, 1979) and serve as organs of perennation as the above-ground parts usually wither and die in dry weather (Porter, 1992).

African yam bean is distributed throughout most of tropical Africa (Anonymous, 1979; Porter, 1992). It is found in forests, open and wooded grasslands, rocky fields as well as marshy grounds, occurring both as a weed and a cultivated crop (Duke *et al.*, 1977; Porter, 1992). It grows on a wide range of soils including acid and highly leached sandy soils at altitudes from sea level to 1,950 m (Duke *et al.*, 1977; Anonymous, 1979).

Data collection

The study consisted of visits to farmers' fields and discussions with them on methods of cultivation and uses of the African yam bean. Seeds were collected and characterised, with the results presented below.

Three collection trips were made to the Nkwanta District in the Volta Region in September 1998, December 1998 and March 1999. The first trip coincided with the flowering and fruiting season of the crop as was observed in all the farmers' fields visited. The latter trips were made to coincide with periods when the crop is normally harvested and processed for marketing.

Results and discussion

Collection and characterization of seeds

In all, nineteen accessions were collected from 10 towns and villages visited in the district (Table 1). Farmers who donated seeds belong to the Adele, Atwode, Chala, Ntumuru, and Kokomba ethnic groups. Within these ethnic groups the crop is variously known as 'Akuturuku', 'Kuturuku', 'Kutreku', 'Tuwursoruku', 'Twusoruku' or 'Tusurukor'. The topography of the land in the Nkwanta District is undulating and the area experiences high diurnal temperatures (35-40 °C) throughout the year. The vegetation is pre-

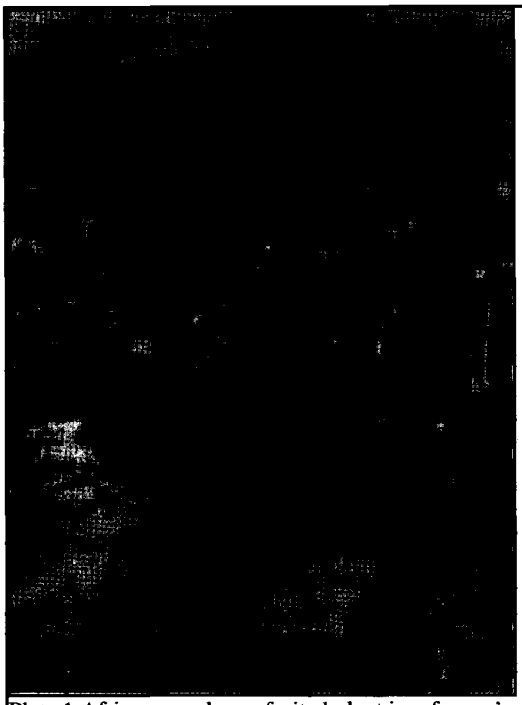

Plate 1 African yam bean: fruited plant in a farmer's field

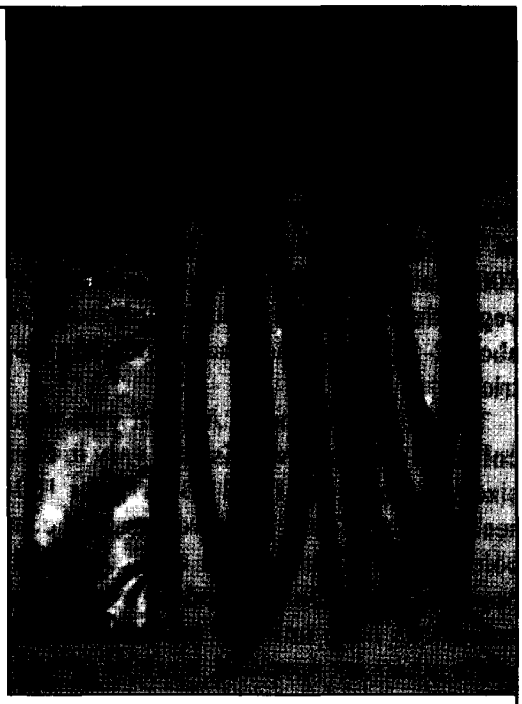

Plate 2 Pods of the African yam bean

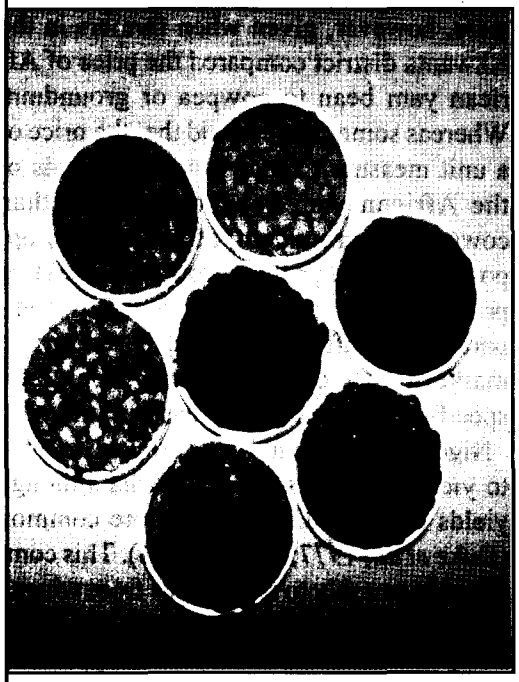

Plate 3 Variation in seed coat colour in the African yam bean

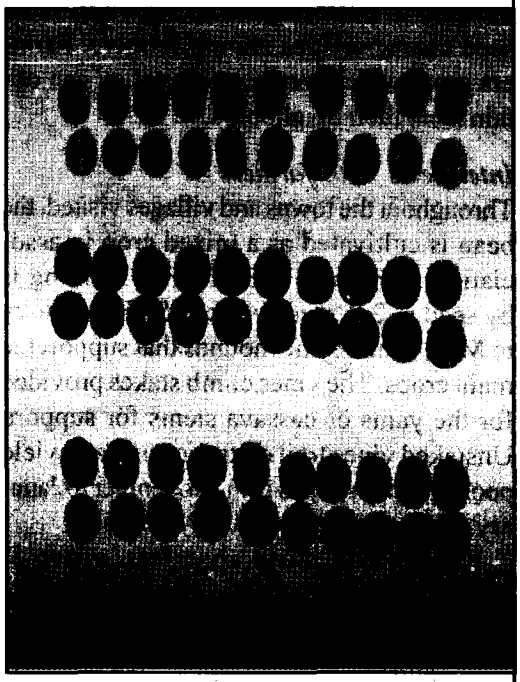

Plate 4 Variation in hilum colour in the African yam bean

dominantly wooded grassland (transitional). Further collections were made in Gbadzeme in the Ho-West District of the Volta Region between October 1998 and March 1999. Three accessions were collected from this area (Table 1) where the crop is referred to as 'Kulege'. This area is mountainous (over 500 m above sea level), has tropical forest vegetation and experiences temperatures of about 2-5°C lower than the surrounding districts.

The 22 accessions of African yam bean collected from the two districts vary in seed size, ranging from 19.12 - 35.11g for 100-seed weight (Table 1) as well as seed coat colour, which varies from cream, through brown to black (Table 1 and Plate 3). Some accessions have uniform seed coat colour while others are speckled, marbled or spotted with or without a black or brown eye around the hilum (Plate 4). There was no indication of preference with regard to these seed characteristics among farmers. Farmers grow whichever accession they can obtain from their neighbours.

Interviews with farmers

Throughout the towns and villages visited, the bean is cultivated as a mixed crop in association with yams and cassava. Planting is by seed at 2-3 seeds per hill from February to May, on the same mounds that support the main crops. The vines climb stakes provided for the yams or cassava stems for support. Unstaked vines trail on the ground and yield poorly. Harvesting is from November to January, or later, based on family needs.

Farmers in both districts grow *S. stenocarpa* for its dry seeds which are boiled and prepared into sauces or soups and eaten with yam, cassava, sorghum, rice or "gari" (grated, fermented and roasted cassava). They may also be roasted and mixed with maize for the preparation of a protein-supplemented food "Tom Brown". The seeds have very hard testa and require boiling for several hours. Two to three changes of water are required during cooking to remove an unpleasant smell, which comes off during the process.

Potential

Sphenostylis stenocarpa exhibits great potential for development into a major cash crop and thereby contributing to food security in the country. It fits quite well into the traditional practices of farmers in the middle and northern parts of the Volta Region where it is grown in mixed association with yams, cassava, maize and sorghum.

The crop is harvested, stored and processed for marketing as any of cowpea, groundnut and soybean crops. Several farmers already market surplus seed after meeting domestic requirements. Conflicting reports were, however, given when farmers in the Nkwanta district compared the price of African yam bean to cowpea or groundnut. Whereas some farmers said that the price of a unit measure, "mudu", of dried seeds of the African yam bean was higher than cowpea and groundnut, others said the opposite. However, a third group indicated that prices of these pulses were generally comparable but often fluctuated based on the market forces of demand and supply at a specific locality or on the season of the year.

Nigerian accessions of the crop are reputed to yield as much seed as 3.0 t/ha although yields of 0.3 – 0.5 t/ha are more common (Duke *et al.*, 1977; Ezueh, 1984). This compares favourably to seed yields from winged bean (2.5 t/ha) (Anonymous, 1975) or cowpea (0.2 – 2.0 t/ha) (Amoatey, 1987). The seeds are rich in minerals such as potassium, phosphorus, magnesium, calcium,

TABLE 1.

Seed characteristics of accessions of African yam bean collected from various ecological sites in two districts.

No.	*Collecting No.*	*District*	*Town/Village*	*Site description*	*Seed characteristics*	
					Seed colour	*100 seed-wt(g)*
1	BC/AYB/98/01	Nkwanta	Nkwanta	1b, 2b, 3a	Creamish-white	31.31
2	BC/AYB/98/02	"	Abrewankor	1c, 2b, 3a	Cream	29.68
3	BC/AYB/98/03	"	Abrewankor	1c, 2b, 3a	Cream	25.00
4	BC/AYB/98/04	"	Abrewankor	1c, 2b, 3a	Yellowish-cream	26.55
5	BC/AYB/98/05	"	Abrewankor	1c, 2b, 3a	Yellowish-cream	29.29
6	BC/AYB/98/06	"	Me-hwe-me-Nyame	1b, 2b, 3a	Brown/black streaks	35.11
7	BC/AYB/98/07	Ho-West	Gbadzeme	1d, 2a, 3b	Yellowish-cream	22.33
8	BC/AYB/98/08	Nkwanta	Bonakye	1b, 2b, 3a	Cream	26.94
9	BC/AYB/98/09	"	Kebukuu	1b, 2b, 3a	Cream	27.04
10	BC/AYB/98/10	"	Bonto	1b, 2b, 3a	Yellowish-cream	19.19
11	BC/AYB/98/11	"	Nkwanta	1b, 2b, 3a	Yellowish-cream	19.12
12	BC/AYB/98/12	"	Nana Yaw	1b, 2b, 3a	Whitish-cream	26.68
13	BC/AYB/98/13	"	Chali	1b, 2b, 3a	Cream	23.53
14	BC/AYB/98/14	"	Galiba	1b, 2b, 3a	Whitish-cream	27.24
15	BC/AYB/98/15	"	Nkwanta	1b, 2b, 3a	Brown/black streaks	28.94
16	BC/AYB/98/16	"	Abodome	1b, 2b, 3a	Creamish-white	33.64
17	BC/AYB/98/17	"	Abrewankor	1c, 2b, 3a	Cream	25.94
18	BC/AYB/98/18	Ho-West	Gbadzeme	1d, 2a, 3b	Cream	30.92
19	BC/AYB/98/19	Ho-West	Gbadzeme	1d, 2a, 3b	Ivory	31.76
20	BC/AYB/98/20	Nkwanta	Nkwanta	1b, 2b, 3a	Black	24.76
21	BC/AYB/98/21	"	Bonakye	1b, 2b, 3a	Creamish-yellow	27.41
22	BC/AYB/98/22	"	Bonakye	1b, 2b, 3a	Ivory	24.70

Key

1. Relief: (a) Flood plain; (b) Lowland; (c) Highland; (d) Mountains
2. Vegetation: (a) Forest; (b) Transitional zone; (c) Savanna grassland
3. Temperature: (a) Hot; (b) Cool

TABLE 2

Nutritional composition of the African yam bean compared to some tropical legumes. (After Klu, 1996 modified from Watson, 1971, 1977).

	Percent composition				
Crop	*Protein*	*Fat*	*Carbohydrates*	*Fibre*	*Ash*
African yam bean	19.1	0.5	61.6	5.2	2.4
Baambara groundnut	19.2	5.6	54.5	5.3	3.5
Cowpea	19.0	1.1	60.6	5.0	3.0
Mung bean	23.0	1.3	53.5	3.8	3.4
Pigeon pea	19.8	1.2	55.0	7.8	3.2
Winged bean	32.2	16.5	3.2	6.0	3.4
Soybean	32.5	19.2	29.2	4.6	4.8
Groundnuts	20.5	48.5	20.0	2.6	2.4

iron, and zinc but low in sodium and copper (Edem *et al.*, 1990). Their protein, carbohydrate, crude fibre and ash contents compare adequately with those of other common tropical legumes (Table 2). An average tuber yield of 1.8 t/ha (Edem *et al.*, 1990) is low compared to 5. 0 t/ha for sweet potato, 7.1 t/ha for cassava and 9.8 t/ha for white yam in sub-Saharan Africa (Ewell & Mutuura, 1991). However, this is more than adequately compensated for by the high protein content which is twice that of sweet potato or white yam but more than ten times that of cassava (Anonymous, 1979).

As a leguminous crop, the African yam bean probably has the ability to fix atmospheric nitrogen into the soil, although there is no mention of this in the literature. Proof of this potential should emphasize its importance in the traditional mixed farming system where fertilisers are not used.

A number of farmers interviewed cultivate this crop because it is free from pests and diseases commonly encountered with cowpea or groundnut. Besides, the pods do not shatter easily, giving them the flexibility to make harvests as the need arises. Finally, it suffers less damage in storage compared to cowpea. Their main problem is the long hours required for cooking.

Conclusion

Sphenostylis stenocarpa is a neglected crop in Ghana as there is no record on its production, consumption and utilisation throughout the country. Access to genetic materials is limited to 10 accessions collected by the Plant Genetic Resources Centre, Bunso, a decade-and-a-half to over two decades ago. There are no improved cultivars as available materials are in the hands of traditional farmers as landraces. Existing knowledge on agronomic practices currently resides with these farmers. Concentration of research efforts on major legumes, as is currently being done, will lead to the extinction of the crop in Ghana. There is need for concerted effort

at collecting, characterisation and conservation of available germplasm.

The African yam bean is already adapted to cultivation in the middle belt of the Volta Region of Ghana. It is cultivated and used in the diets of several ethnic groups with limited amounts traded in at local markets. Farmers are, therefore, already familiar with methods of cultivation, harvesting and processing into diets for immediate consumption or for storage. Both seeds and tubers are edible. There is evidence that the crop produces as much seed per unit area as cowpea (the most popular tropical legume) or winged bean (a promising tropical legume), which also bears both seeds and tubers. Nutritional as well as mineral element composition of the seeds compare adequately with those of other common tropical legumes while protein content of the tuber far exceeds those of sweet potato, white yam and cassava. It suffers less damage from both field and storage pests. These are favourable attributes that should compel the development of the crop and expansion of its cultivation throughout yam and cassava growing areas in the country.

Indeed the African yam bean has a potential role in contributing to national food security when developed to such an extent that it becomes accepted nation-wide as a component of some popular meals. To achieve this status, the crop must receive attention from researchers who would not only evaluate agronomic characteristics but also remove barriers to increased yield and wider utilisation. Highest priority should be given to reduction of cooking time, which was cited as the main problem by the farmers. The requirement for trellises or stakes to support plants limits large-scale cultivation. The possibility exists for modifying architecture through mutation breeding and other methods to obtain semi-erect or erect types that will be easier to grow.

Acknowledgement

The authors are grateful to Messrs A. M. Akrofi and G. Akude (agricultural extension officers in the Nkwanta District) for their technical assistance.

References

Adansi, M. A. & Holloway, H. Q. (1978). Exploration for Plant Genetic Resources in Ghana. Paper presented at a symposium on Crop Improvement at the University of Ghana, Legon, 15th December, 1978.

Amoatey, H. M. (1987). Genetic studies in some cowpea (Vigna unguiculata (L) Walp varieties in Ghana. Thesis presented in partial fulfilment for MSc/PhD degree of the Department of Crop Science, University of Ghana, Legon. 1987, 95 pp.

Anonymous (1975). Under-exploited Tropical Plants with Promising Economic Value. Washington, D.C. National Academy of Sciences, 189 pp.

Anonymous (1979). Tropical Legumes: Resource for the Future. Washington, D.C. National Academy of Sciences.1979, 331 pp.

Amoatey, H. M., S. O., Bennett-Lartey, S. O. & Gamedoagbao, D. K. (1997). Conservation and Improvement of Neglected Traditional Food Crops in Ghana using Induced Mutation Techniques. Paper presented at AFRA Planning Workshop on Improvement and Rehabilitation of Traditional and neglected Food Crops through Mutation Techniques, Pretoria, 24th-28th Novemb1997, 9 pp.

Bennett-Lartey, S. O., Ayensu, F. K., Mohma, S. & Ito, K. (1997). Vegetable germplasm Collection in Ghana. Plant Genetic Resources, *Newsletter* **111**: 69-71.

Cock, J. H. (1985). Cassava: New potential for a neglected crop. Boulderland, London. Wetview Press, 191 pp.

Duke, J. A., Okigbo, B. N., & Reed, C. F. (1977). African Yam bean, *Sphenostylis stenocarpia* (Hochst ex A. Rich). *Tropical Grain Legume Bulletin,* **10:** 4 - 5.

Edem, D. O., Amugo, C. I. & Eka, O. U. (1990). Chemical composition of yam bean (Sphenostylis stenocarpa). *Tropical Science,* **30:** 59 - 63.

Ene-Obong, E. & Okoye, F. I. (1992). Interrelationships between yield and field components in

the African yam bean, *Sphenostylis stenocarpa* (Hochst ex A. Rich.) Harms. *Beitrage zur tropischen Land Wirtschaft und Veterinarmedizin* **30** (3): 283 - 290.

Ewell, P. T. & Mutuura, J. (1991). Sweet potato in the food systems of Eastern and Southern Africa. In Tropical Root Crops in a Developing Economy. Proceedings of the Ninth Symposium of the International Society for Tropical Root Crops, 20-26 October 1991, Accra, Ghana.

Ezueh, M. I. (1977). The cultivation and utilisation of minor food legumes in Nigeria. *Tropical Grain Legume Bulletin,* **10:** 28 - 32.

Ezueh, M. .I. (1984). The African yam bean as a crop in Nigeria *World Crops,* **36** (6): 199 - 200.

Holloway, H. L. O. (1983). Germplasm collection in Ghana. Nov. 1982- Feb. 1983. AGIBPGR/83/10

Klu, G. Y. P. (1996). Efforts to accelerate domestication of winged bean (Psophocarpus tetragonolobus (L.) DC) by means of induced mutations and tissue culture. Ph.D. Thesis. Wageningen Agricultural Unversity, Wageningen, The Netherlands. 110 pp.

Nwachukwu, E. O. & Umechuruba, C. I. (1991). Seed-borne fungi associated with African yam bean seeds in four eastern states of Nigeria. *Seed Research,* **19:** 13 - 20.

Obizoba, I. C. & Nnam, N. (1992). The effects of Sprouting times on nutritive value of two varieties of African yam bean (*Sphenostylis stenocarpa*). *Plant-foods-for-Human-Nutrition,* **42** (4): 319- 327.

Ofuya, T. I. & Bamigbola, K. A. (1991). Damage potential, growth and development of the seed beetle, Callosobruchus maculatus on some tropical legumes. *Tropical Agriculture,* **68** (1): 33 - 36.

Okpar, D. A. & Omaliko, C. P. E (1995). Productivity of yam bean (*Sphenostylis stenocarpa*), yellow yam (*Dioscorea cayenensis*) intercropping. *Indian Journal of Agricultural Sciences,* **65** (12): 880 - 882.

Onyeike, E. N., Ayalogue, E. O. & Uzogara, S. G. (1995). The influence of heat processing of African yam bean seed (*Sphenostylis stenocarpa*) flour on the growth and organ weights of rats. *Plant-Foods-for-Human-Nutrition,* **48** (2): 85 - 93.

Oshodi, A. A., Adeyeye, E. I. & Ipinmoroti, K. O. (1994). Functional properties of some varieties of African yam bean *(Sphenostylis stenocarpa)* flour. International *Journal of Food Science and Nutrition,* **45** (2): 115 - 126.

Otoo, J. A. (1998). Second inspection of sweet potato for varietal release. Technical Report. CRI (CSIR), November 1998.

Porter, D. (1992). Economic botany of *Sphenostylis* (Leguminosae). *Economic Botany,* **46** (3): 262- 275.

Rachie, K. O. & Roberts, L. M. (1974). Grain legumes of the lowland tropics. *Advances in Agronomy,* **26:** 1 - 132.

Umechuruba, C. I. & Nwachukwu, E. O. (1994). The efficacy of certain fungicides against seed-borne fungi of African yam bean (Sphenostylis stenocarpa (Hochst ex A. Rich) Harms) seeds. *International Journal of Pest Management,* **40** (2): 126 - 131.

Watson, J. D. (1971). Investigations on the nutritive value of some Ghanaian foodstuffs. *Ghana Journal of Agricultural Science* **4** (1): 95 – 110.

Watson, J. D. (1977). Chemical composition of some less commonly used legumes in Ghana. *Food Chemistry* **2:** 267 – 271.