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Screening Locally Grown Pulses for Proximate, Anti-nutritive and Mineral Compositions: Indices for Conservation and Improvement

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ABSTRACT
This study investigated the nutritive value of locally grown pulses' landraces (White "Fiofio", Brown "Fiofio", [*Cajanus cajan* (L.) Millsp] "Olaudi" "Akidi" and IT88D-867-11) [*Vigna unguiculata* (L) Walp] as indices for conservation and improvement. Proximate, anti-nutritional and mineral elements were evaluated. Data analyses were done using analysis of variance. Results showed that there were significant differences ($p<0.05$) in the proximate compositions of the screened pulses, except in the ash content which shows no significance among the pulses ($p>0.05$). The moisture content did not differ among the brown and white "Fiofio", "Olaudi" and IT88D-867-11 but differed significantly from "Akidi". Results obtained also revealed that there was no significant difference ($p>0.05$) in the protein contents of brown "Fiofio", "Akidi" and IT88D-867-11 but differed slightly from white "Fiofio" and "Olaudi". Additionally, "Olaudi" had the highest protein content in its seeds. There was no significant difference in the carbohydrate content among brown "Fiofio", "Olaudi" and "Akidi" but differed from white "Fiofio" and IT88D-867-11. Present results on the anti-nutritive contents also showed that there were significant differences ($p<0.05$) among the five sampled pulses. "Akidi" had the highest phytic acid level which was followed by IT88D-867-11. There was no significant difference in the hydrocyanide content of "Akidi", "Olaudi" and IT 888D-867-11. This component was highest in brown "Fiofio" and least in white "Fiofio". The oxalate content was highest in "Akidi". Comparing other pulses with IT88D-867-11, the landraces contained higher mineral elements. For the vitamins, IT88D-867-11 contained the highest level of Vitamin A but had the least Vitamin C. Coupled with their high adaptability in adverse climatic conditions, it is explicitly obvious that these landraces should be selected for conservation and improvement.

Key words: Pulses, proximate, mineral, anti-nutritive composition, conservation, improvement

INTRODUCTION
The world population is growing geometrically and it is projected to be over 7 billion by 2020 (Obembe, 2009). It is however, pathetic to note that the developing world which is under pressure with the challenge of food insecurity, is contributing most to this increase (Pardey and Wright, 2002). This scenario obviously paints a bleak picture of the future's food security, especially in the developing countries, with Nigeria as a case study. Nigeria, a country with a population of 140 million people (NPC, 2006) with an annual budget running in excess of several trillions has several of her citizenry struggling with malnutrition. It becomes, therefore, imperative to source for cheaper but quality food crops laden with nutritive and mineral elements.

Legumes belong to the plant family Leguminosae. The legumes and grains families are by far the world's most important sources of food. Grains supply starch while legumes which include bean, peas and alfalfa supply protein and fats (John, 2005). Nutritionally, legumes supply significant amount of energy, vitamins and minerals in addition to protein. They are 2-3 times richer in protein than cereal grain even some of these legumes are very rich in oil and they are mostly called oil seeds.

Pigeon pea [*Cajanus cajan* (L.) Millsp] is chiefly grown in India where it is probably originated and extensively cultivated in Africa and other warm climate areas and which is usually grown for its seeds which is a popular food. Pigeon pea is a useful fallow and fodder plant with edible seeds doing best on medium good soils (Philip, 2002). Cowpea [*Vigna unguiculata* (L.) Walp] on the other hand, is a good source of dietary protein for human consumption and of animal feed in the tropics, especially in Africa, Brazil and India. It thrives well in hotter more arid climates and more infertile soils than other food legume crops due to its symbiotic nitrogen fixing abilities which helps in maintaining soil fertility in peasant cropping systems. Over 65% of the cowpea crop is produced in Africa; Nigeria and Niger producing 50% of the world supply. The United States is the only developed country producing large amount of cowpea (Henshaw, 2008).

The landraces of these crops are increasingly threatened by extinction (Kiu *et al*., 2001) and urgent measures needed to be taken to conserve them. The nutritive advantage of these crops fundamentally is the area of much interest since the poorer sections of Sub-Saharan Africans are suffering from mal-nutrition. However, besides being high in protein, high adaptability and drought-tolerant, pigeon pea and cowpeas provide many benefits to resource poor farmers including fuel, fodder, improved soil fertility and control of soil erosion (Okaka *et al*., 2002). Despite this, pigeon peas and cowpeas landraces are neglected crops in terms of research.

Though there is paucity of information regarding so many of these landraces, some researchers had reported the nutritive value of some grain legumes (Chinma *et al*., 2008; Ene-Obong, 2005; Siddhraju *et al*., 2001). Therefore, to achieve sufficient food production in Nigeria, effort have to be intensified towards diversifying the economic base which in implication means partly, selecting, conserving and domesticating these under-exploited extinction threatened crops.

This study was, therefore, designed to evaluate the nutritional and anti-nutritional composition of these selected pulses as indices for conservation and improvement.

MATERIALS AND METHODS

Collection and preparation of samples: This study was conducted in October, 2010. Seeds of "Olaudi", "Akidi", "Brown Fiofio"and "White Fiofio" were purchased from local farmers in Kogi State, while IT88D-867-11 (standard) was obtained from International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. Extraneous matter such as unhealthy seed, infected seed, sand and chaff were removed from the samples. The seeds were dehulled with water at room temperature (27°C). The dehulled samples were sundried for 2 days and then dried at 70-80°C for 2 h in an oven (Astell Hearson type). Finally, the dried dehulled samples were pulverized using an electric blender (Model 4250 Braun, Germany) and sieved to a particle size of 1 mm and stored in dissector for analysis.

Determination of proximate composition: The protein content was determined using micro kjeldhal method (N×6.25) and the carbohydrate content was determined by the difference obtained after subtracting the total organic nitrogen, protein, lipid, ash, fibre, from the total dry matter and expressing as percentage AOAC (2005). The gross food energy (caloric value) was estimated by multiplying the crude protein, crude fat and total carbohydrate by at water factors 4, 9 (Okwu, 2006).

Toxicant analysis: Hydrocyanic acid (HCN) was estimated by the alkaline titration method. For HCN determination, alkaline sample solution was titrated with standard 0.02 N $AgNO_3$ to a permanent turbid KI indicator end point (1 mL of 0.02 N $AgNO_3$ = 1.08 mg HCN) (AOAC, 2000) Phytic acid was determined as iron precipitate with the assumption that, Iron: Phosphorus molecular ratio is 4:6 according to McCance and Widdowson (1953) (The molecular formula of Phytic acid is C6H18O24P6 with molecular mass of 660 g mol^{-1}) while oxalate was determined according to Dye (1956). Oxalate determination involved three steps-digestion, oxalate precipitation and permanganate titration.

Determination of mineral composition: The ash of each sample was digested with 5 mL of 2 M HNO_3 and heated to dryness on a heating mantle. The 5 mL of 2 M HNO_3 was added again, heated to boil and filtered through a Whatman No. 1 filter paper into a 100 mL volumetric flask. The filtrate was made up with distilled water. Calcium, was determined using Jenway Digital Flame Photometer (PFP7 model) while other minerals apart from phosphorus were determined using Buck Scientific Atomic Absorption Spectrophotometer (BUCK 210VGP model). The Phosphorus in the sample filtrate was determined by using Vanadomolybdate reagent at 400 nm using colorimetric method (Colorimeter SP 20, Bausch and Lamb). Vitamin A and C were also estimated (AOAC, 2005).

Statistical analysis: Data obtained from the analyses were subjected to the Analysis of Variance (ANOVA) while significant means were separated using Least Significant Difference (LSD) test (Obi, 2002).

RESULTS

Generally, there were significant differences ($p<0.05$) in the proximate compositions of the screened pulses, except in the ash content which shows no significance among the pulses ($p>0.05$). The moisture content did not differ among the brown and white “Fiofio”, “Olaudi” and IT88D-867-11 but differed significantly from “Akidi”. Present results also revealed that there was no significant difference ($p>0.05$) in the protein contents of brown “Fiofio”, “Akidi” and IT88D-867-11 but differed slightly from white “fiofio” and “Olaudi”. Additionally, “Olaudi” had the highest protein content in its seeds. There was no significantly difference in the carbohydrate conent among brown “Fiofio”, “Olaudi” and “Akidi” but differed from white “Fiofio” and IT88D-867-11 (Table 1).

Table 1: Mean and standard error of proximate composition of five pulses varieties (%)

Proximate composition	Brown fiofio	White fiofio	Olaudi	Akidi	IT88D-867-11 (standard)
Moisture	51.30 ± 0.50^{b}	51.80 ± 0.58^{b}	52.23 ± 0.24^{b}	44.60 ± 0.98^{a}	52.6 ± 0.75^{b}
Protein	22.20 ± 0.35^{a}	24.25 ± 0.40^{ab}	27.52 ± 0.54^{c}	21.60 ± 0.69^{a}	23.0 ± 0.58^{a}
Fat	5.50 ± 0.35^{b}	4.60 ± 0.23^{a}	3.92 ± 0.89^{a}	3.70 ± 0.40^{a}	4.1 ± 0.03^{a}
Ash	6.60 ± 0.35^{a}	5.90 ± 0.40^{a}	6.45 ± 0.65^{a}	7.70 ± 0.58^{a}	6.2 ± 0.06^{a}
Crude fibre	1.28 ± 0.03^{a}	1.90 ± 0.06^{b}	1.89 ± 0.62^{b}	1.90 ± 0.17^{b}	1.5 ± 0.17^{b}
Carbohydrate	14.15 ± 0.35^{b}	13.11 ± 0.46^{a}	17.56 ± 0.45^{b}	18.71 ± 0.75^{b}	12.5 ± 1.56^{a}
Caloric value (kcal/100 g)	195.33 ± 1.62^{b}	172.50 ± 2.85^{a}	209.74 ± 0.34^{c}	213.50 ± 4.08^{c}	179.2 ± 3.88^{a}

Means followed by the same superscript along a horizontal array indicates no significant difference $p<0.05$

Table 2: Means and standard errors of the anti-nutritive content of five pulses' landraces (mg/100 g DW)

Samples	Phytic acid	Hydrocyanide	Oxalate
Brown Fiofio	1.15± 0.02^{b}	5.20±0.12^{c}	7.50±0.14^{b}
White Fiofio	0.61±0.002^{a}	3.43±0.12^{a}	6.10±0.06^{a}
Olaudi	1.18±0.01^{b}	4.38±0.03^{b}	6.09±0.04^{a}
Akidi	1.54±0.03^{d}	4.41±0.12^{b}	8.00±0.10^{bc}
IT88D-867-11	1.31±0.10^{c}	4.40±0.15^{b}	7.30±0.10^{b}

Means followed by the same superscript along a vertical array indicates no significant difference p<0.05

Table 3: Mineral elemental composition and Vitamin (A and C) content of five pulses' landraces (mg/100 g DM)

Mineral component	Brown fiofio	White fiofio	Olaudi	Akidi	IT88D-867-11(standard)
Calcium	22.60±0.61^{b}	14.40±0.73^{a}	27.34±0.21^{c}	27.40±0.76^{c}	12.60±0.58^{a}
Magnesium	18.20±0.14^{c}	19.20±0.25^{d}	10.47±0.03^{b}	9.60±0.35^{b}	8.60±0.12^{a}
Phosphorus	0.52±0.02^{b}	0.40±0.02^{b}	1.04±0.20^{c}	1.31±0.01^{d}	0.12±0.01^{a}
Iron	0.05±0.01^{b}	0.05±0.002^{b}	0.12±0.02^{c}	0.11±0.01^{c}	0.02±0.002^{a}
Vitamin A	48.96±0.15^{b}	25.12±0.27^{a}	47.75±0.23^{b}	59.99±0.33^{c}	93.03±1.77^{d}
Vitamin C	48.85±0.61^{b}	59.20±0.36^{c}	41.51±0.56^{a}	78.87±0.47^{d}	41.53±0.77^{a}

Means followed by the same superscript along a vertical array indicates no significant difference p<0.05

Results on the anti-nutritive contents show that there were significant differences (p<0.05) among the five sampled pulses. "Akidi" had the highest phytic acid level which was followed by IT88D-867-11. However, there was no significant difference (p>0.05) between white "fiofio" and "olaudi". Brown "fiofio" had the least phytic content. There was no significant difference in the hydrocyanide content of "akidi", "olaudi" and IT 888D-867-11. This component was highest in brown "fiofio" and least in white "fiofio". The oxalate content was highest in "Akidi" (Table 2).

The mineral composition also differed remarkably in the screened pulses. However, comparing with IT88D-867-11, the landraces contained higher mineral elements. For the vitamins, IT88D-867-11 contained the highest level of Vitamin A but had the least Vitamin C (Table 3).

DISCUSSION

Interestingly, pigeon peas and cowpeas landraces are well adapted to tropical climates and insufficient protein of good quality is a limiting factor in developing countries. Adequate information is needed, especially on their nutritive potentials which will enhance their utilization in human diet. The protein content of these crops is of immense importance, other constituents, notwithstanding. Result obtained revealed that the protein content was high. However, this was higher than the range 15.52-20.74% DM reported for its close relative such as, *Cassia hiruta* (Vadivel and Janardhanan, 2000) and other Nigerian legumes, *Afzelia Africana* (Obun and Ayanwale, 2008). The result obtained is also comparable to the reports of Ingweye *et al.* (2010) on *Senna obtusifolia*, *Parkia filicoidea* and *Mucuna utilis* (Bawa *et al.*, 2007; Tuleun and Patrick, 2007). However, differences observed in this result with their other legumes obviously, could be attributed to genetic differences. Interestingly, the carbohydrate content agrees with caloric value as it is a major contributor to the energy value of food. It will therefore be a misconception to assume that these landraces are for the poorer sections of the population.

Phytic acid is often considered as an anti-nutrient because it forms insoluble complexes with minerals such as zinc, calcium, magnesium and iron. In the human gut, it acts by reducing the absorption of valuable vitamins and minerals such as niacin, calcium, iron, magnesium and zinc. The phytic acid level was low compared to the reports of Osman (2007) on raw sweet Lablab bean, *Hisbiscus sabdraiffa* (Yagoub *et al.*, 2008), different varieties of Lablab beans (Abeke *et al.*, 2008), *M. obanensis* (Umoren *et al.*, 2005), raw mung bean seeds (Mubarak, 2005) and Ingweye *et al.* (2010) on *Senna obtusifolia*. According to Onomi *et al.* (2004), dietary intake of phytic acid at a level of 0.035 percent may protect against a fatty liver resulting from elevated hepatic lipogenesis. They observed that the effect of phytic acid on mineral absorption will only occur at 10 fold higher levels. The researchers even speculated that phytic acid may be considered more like a vitamin than an anti-nutrient. Present result showed that the phytic acid content in sampled pulses was higher than the figure reported by Onomi *et al.* (2004). However, this seeming high level reported may not pose health risk as it can be reduced through meticulous processing.

The oxalate value was lower when compared with the earlier reports of Umoren *et al.* (2005) in *M. obanensis*, Tuleun and Patrick (2007) in *M. utilis* seed meal and Ingweye *et al.* (2010) in *Senna obtusifolia*. The amount of oxalate ingested may be an important risk factor in the development of idiopathic calcium oxalate nephrolithiasis (Holmes and Kennedy, 2000). The physiological role of oxalate in plants is not precisely known, though it has been indicted to be involved in seed germination, calcium storage and regulation, ion balance, detoxification, structural strength and insect repulsion. The importance to the inherent plant notwithstanding, high content in seeds could be detrimental to health if not reduced during cooking. The ingestion of more moderate amounts of oxalate appears to play an important role in calcium oxalate kidney stone disease because of its absorption and excretion in urine.

The Hydrocyanide (HCN) content in the present study showed that there were significant differences ($p<0.05$) in sampled screened. Interestingly, it was higher than the reports of Abeke *et al.* (2008) in *L. purpureus* bean. The level of anti-nutritional factors in the legumes sampled will not be a barrier to their utilization as they will either be reduced.

The mineral contents Ca, Mg, K and Fe were lower than those of Mung bean (Mubarak, 2005), some Nigerian cowpeas (Chinma *et al.*, 2008) *M. obanensis* (Umoren *et al.*, 2005; Elleuch *et al.*, 2007), Soybean (Vasudevan and Sreekumari, 2007) but however, comparable with the report of Ene-Obong (2005).

IT88D-867-11 variety had the highest level of Vitamin A but with the lowest Vitamin C comparing with other pulses screened. It is probable that IT88D-867-11 was genetically fortified with Vitamin A. This deduction however, holds hope to the fact that these landraces also could be manipulated genetically, even the said hard-to-cook phenomenon. The problem associated with the landraces-"hard-to-cook" phenomenon should not be a reason for allowing them to go into extinction as they have more advantage over the improved lines-their high adaptability potential, wide genetic variability as well as their nutritive and mineral element compositions.

It is rather thrilling to observe that there were differences between brown and white "Fiofio" in their nutritive, anti-nutritive and vitamin compositions. Though the reason underlying these differences could not be ascertained in the present study, it is a clear indication that brown and white "Fiofios" are different local varieties of *Cajans cajan* (L.) Millsp.

CONCLUSION

The study evaluated the nutritional value of selected pulses seeds as indices for conservation and improvement. It showed that these landraces of pulses are rich in protein, carbohydrate, some mineral elements such as Calcium, Magnesium, Vitamin A and C. The anti-nutritional contents were quite low. The results are suggestive of the fact that these landraces threatened by extinction should be conserved and improved.

The under-utilization of these landraces is a source of concern.

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