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Proximate Composition, Nutritionally Valuable Minerals, Protein Functional Properties and Anti-Nutrient Contents of Mucuna Preta, Mucuna Ghana and Mucuna Veracruz Mottle

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Abstract: Results of the proximate composition, functional properties and physico chemical properties of mucuna ghana, mucuna preta and mucuna Veracruz mottle is reported. The ranges are; ash (3.17-4.33), moisture (8.50-8.85), crude protein (30.92-33.25) and crude fat (46.20-49.34). Mineral contents showed phosphorus to be most abundant while manganese and copper were least. Lead was not detected. Functional properties of the protein showed a good Water Absorption Capacity (WAC) ranges (145-160) and Oil Absorption Capacity (OAC) ranges (130.10-138.23). The foaming capacity (17.00-25.00), mucuna preta was least and mcuna ghana highest. The Oil Absorption Capacity (OAC) (130.10-138.23) with mucuna ghana highest and mucuna veracruz mottle least. The Least Gelation Concentration (LGC) and emulsion capacity (ES) are relatively good. The Foaming Capacity (FC) after 2 h showed appreciable and acceptable values (17.00-25.00) in which mucuna preta was least and mucuna ghana was highest. The Foaming Stability (FS) values were also within acceptable ranges (9.0-12.50). Emulsion stability (59.00-66.00) has mucuna ghana least and mucuna veracruz mottle highest. Plots of the protein solubility against pH showed protein to be soluble at both acidic and alkaline regions. Anti-nutrients in the samples showed tannic acid range (8.54-10.30), Oxalate mg/g (6.78-8.31) and phytate mg/g (55.11-85.47). The ranges were however within acceptable values.

Key words: Protein content, moisture content, crude fiber, oxalate, emulsion capacity.

INTRODUCTION

Food, either from plants or animals is the basic feeding materials that provide animal with necessary nutrients for healthy life and growth. With the global food scarcity and current encouragement into agriculture, there is need to investigate some seeds that are not popularly known or consumed globally. Most seeds are yet unknown and how can the world go hungry in the midst of plenty. In our first paper, we reported the physico chemical, properties mineral composition and nutritional functions of some unpopular leguminous seeds (mucuna veracruz white, mucuna pruniens utilis and mucuna rajada) The results of the investigations was quite impressive and informed curiosity into further analysis of other leguminous seeds of the same family (mucuna ghana, mucuna preta and mucuna veracruz mottle).

Leguminous seeds/crops supply both the protein and energy not only to people in the tropical area but still meets the need of livestock population in the region (Norman *et al*., 1995). Proteins in legumes are regarded as dietically inferior to animal protein because of their low sulphur amino acid concentration. Paul and Southgate (1978) reported that grain legume seeds have large protein contents, which may account for as much as 40% of their dry matter. They also reported that pulse legumes are also rich in digestible carbohydrate mainly starch and concentration of 50% or greater are common, they also contain appreciable amounts of dietary fiber. Generally, legume seeds are rich in carbohydrate, contain relatively small amount of lipids (1-2%) mainly as phospholipid (Paul and Southgate, 1978). The legume seed or pulse sometimes termed “grain legumes” are second to cereal as a source of human and animal food and provide the much needed protein to food vegetarian population (Kochlar, 1978). Though legumes have potential for livestock fed, they are known for toxic effects on poultry diets. Several studies have shown the toxic effect of some raw legume seeds when ingested by poultry (Aletor and Aladetimi, 1984, Ologhobo and Apata (1990) and Ologhobo, 1992).

MATERIALS AND METHODS

The leguminous seeds (mucuna ghana, mucuna preta and mucuna veracruz mottle) were obtained from the crop protection department, Federal University of Technology Akure. The raw dry seeds were mechanically dehulled, ground into powder using Kenwood blender (mini processor model A 902 D) Thom. Emi Kenwood small appliance Ltd. Hamsphire, UK), stored in an air tight plastic container and kept in a refrigerator at 4°C for analysis.

All reagents are of analytical grade and products of British Drug House (BDH) Limited England and Eagle scientific Limited England.

The AOAC (1990) method was applied in the determination of the moisture content, ash content, fat, crude, fiber and carbohydrate by difference.

The crude protein was determined using micro Kjeldahl digestion flask on an electro thermal heater inside a fume cupboard as described by (Pearson, 1976).

The least Gelation concentration and foaming capacity were determined using the modified procedure of Coffman and Garcia (1977).

The water and oil absorption capacity were determined by the method of Beuchat (1977) while the emulsion capacity and stability were determined by centrifuging using (Gallenkamp instruments, U.K at 3,500 rmp by the method described by Yasumatsu *et al.* (1972).

The anti-nutrients (phytin phosphorus) was carried out using the method of Young and Greaves (1940) while the Markkar and Goodchild (1996) method was employed for the determination of tannin and the oxalate was determined as described by Day and Underwood (1986).

Colorimetric determination of phosphorus using vanadomolybdate (yellow) method: Phosphate salt (KH_2PO_4) was used to prepare the standard by dissolving 4.3 g of the anhydrous KH_2PO_4 in 1 litre of distilled water. 5 ml of the sample solution was pipetted into a 50 ml volumetric flask and 10 ml of the vanadomolybdate reagent was added with few ml of distilled water then diluted further with distilled water and allowed to stand for 10 min.

Vanadomolybdate reagent: 20 g of ammonium molybdate $(NH_4)_6$ MO_7O_{24}. $4H_2O$ was dissolved in hot, 200 ml of distilled water was cooled. 1 g of ammonium metavanadate $(NH_4VO_3)_3$ was also dissolved separately in 120 cm^3 of hot distilled water and cooled. 140 cm^3 concentrated nitric acid (HNO_3) was gradually added to the vanadate solution and diluted to 1 litre. 5 ml of the sample solution was pipetted into 50 ml volumetric flask and 10 ml of vanadomohybdate reagent with few drops of distilled water, mixed, diluted to the volume with distilled water and allowed to stand for 10 min. The absorbance was determined at 470 nm using the colorimeter. Phosphorus was determined from the calibration curve obtained by taking 0, 2, 4, 6, 8 and 10 cm^3 of the 50 ppm stock solution of phosphorus diluted to 50 cm^3 in a volumetric flask (Pearson, 1976).

RESULTS AND DISCUSSION

Proximate composition (%) of the dry weight of (dehulled) seeds) mucuna ghana, mucuna preta and mucuna veracruz mottle is shown in Table 1. The ash content ranged from 3.17-4.33, with mcuna ghana least and mucana Veracruz mottle highest. These values are however lower than 5.20±0.09 reported for Bahulunia racemosa seed by Amoo and Moza (1999).

The moisture content are almost the same values for the three species investigated. These values are however higher than 5.60±0.07% reported for haemtostaphis bacteria fruit by Amoo and Lajide (1999). The crude protein content ranged from 30.92 for mcuuna veracuz mottle and 33.25 for the other two species. The value of the crude protein is of acceptable standard requirement nutritionally for healthy living. These values are comparable with those reported for pisum vicia faba, cajanus cajan, monihot glaziomy cowpea and some leaf vegetable. Ravidran and Ravidran (1988), Aletor and Aladetimi (1989) and Oke *et al.* (1975). Based on the values of the crude protein, these samples can play vital role as supplementary nutrient source to cereal and other low nitrogen farm products currently used in feed formulation.

The crude fiber has values from 0.17-0.40 with mucuna ghana least and mucuna preta highest. This however is again lower than 4.51 reported for Adenophis breviflorus benth whole seed Flour by Oshodi (1992). The crude fat content values are from 6.89 for mucuna ghana and 7.62 for mucuna preta. Carbohydrate by difference was calculated and the values were 47.68 for mcuna ghana, 46-20 for mucuna preta and 49.34 for mucuna veracruz mottle.

Table 2 shows the mineral composition of the three leguminous seeds under investigation. The values obtained are fairly high when compared with other Nigerian edible plants as reported by Achinewhu (1983). The samples are rich in Sodium (18.73-30.66), potassium (23.75-41.84), Calcium (11.23-14.12), magnesium (15.32-298.32), Zinc (22.98-40.21) and phosphorus (556.25-768.80). The value for iron is however low (3.41-6.16), copper (0.65-1.73) and manganese (0.59-1.20). Phosphorus is found to be very abundance in all the samples copper and manganese were present in lower concentration in all the samples with the least values of 0.666±0.01 and 0.75±0.01 in mucuna veracruz mottle. Lead was not detected in all the samples. All the samples have good and nutritional valuable minerals whose importance had already been emphasized (Bowen, 1966 and Bender, 1992).

In this investigation, the functional properties of the samples are shown in Table 3. The Water Absorption Capacities (WAC) values are from 145.0-160.0 which are higher than 138.00± 0.06% reported for pigeon pea flour by Oshodi and Ekperigin (1989). Since the capacity to retain moisture during cooking is required in meat (Altchul and Whileke, 1985). These classes of species may be useful in production of meat products.

The oil absorption capacity values for the samples ranged from 130.10-138.23. These values are higher than that of pigeon and pea flour (89.7-0.41) but lower than that of unripe raw plantain flour (225±2.1%) reported by Oshodi and Ekperigin (1989). These samples, may be applicable in food processing involving fat absorption such as bakery products.

The foaming capacity and stability after 2 h of the samples ranged between 17.00-25.00 and 9.00-12.50.

Table 1: Proximate composition (%) dry weight of (dehulled seeds) mucuna ghana, mucuna preta and mucuna veracruz mottle

	Ash	Moisture Content	Crude protein	Crude Fat	Crude Fibre	CHO
A	3.17 ± 0.13^{a}	8.85 ± 0.01^{d}	33.25 ± 1.01^{b}	6.89 ± 0.10^{a}	0.17 ± 0.03^{a}	47.68 ± 0.05^{ab}
B	4.03 ± 0.20^{bc}	8.50 ± 0.01^{b}	33.25 ± 1.01^{b}	7.62 ± 0.20^{bc}	0.40 ± 0.12^{bc}	46.20 ± 0.99^{a}
C	4.33 ± 0.17^{cd}	8.53 ± 0.01^{b}	30.92 ± 0.53^{ab}	7.24 ± 0.14^{ab}	0.23 ± 0.03^{ab}	49.34 ± 0.41^{ab}

Means with differing superscripts along the same column are significantly different ($p>0.05$). A = Mucuna Ghana, B = Mucuna preta
C = Mucuna veracruz mottle.

Table 2: Mineral composition (%) dry weight of mucuna ghana, mucuna preta and mucuna veracruz mottle

	Na	K	Ca	Mg	Zn	Fe	Cu	P	Mn	Pb
A	23.44 ± 0.02^{b}	27.55 ± 0.05^{b}	12.33 ± 0.01^{e}	28.32 ± 0.01^{b}	40.21 ± 0.01^{a}	5.24 ± 0.1^{e}	1.05±0.01	556.25±150	0.59±0.0	ND
B	18.73 ± 0.01^{a}	23.75 ± 0.01^{a}	11.23 ± 0.02^{d}	19.49 ± 0.01^{ab}	22.98 ± 0.04^{a}	6.16 ± 0.05^{f}	1.73±0.01	738.50±0.1	1.20±0.0	ND
C	30.66 ± 0.01^{v}	41.84 ± 0.16^{f}	14.12 ± 0.01^{f}	15.32 ± 0.01^{a}	33.44 ± 0.01^{a}	3.51±0.01	0.65±0.01	768.80±0.40	0.75±0.01	ND

Mean with differing superscripts along the same column are significantly different ($p>0.05$).

Table 3: Functional parameters

	%WAC	%OAC	%FC	%FS	%EC	%ES	%w/v LG
A	160.0 ± 0.00^{ab}	138.23 ± 0.13^{b}	25.00 ± 1.00^{d}	12.00 ± 2.00^{b}	42.5 ± 2.50^{cd}	59.00 ± 1.00^{b}	2.00±0.0
B	145.0 ± 5.00^{a}	130.86 ± 0.00^{b}	17.00 ± 1.00^{b}	12.50±1.50	35.71 ± 0.00^{ab}	62.00 ± 1.00^{b}	2.00±0.00
C	150.0 ± 10.00^{a}	130.10 ± 0.00^{b}	20.50±0.50	9.00 ± 1.00^{ab}	36.67 ± 2.04^{ab}	66.00 ± 2.00^{d}	2.00±0.00

Means with differing superscripts along the same column are significantly different.

These values are lower than the foaming capacity and stability of soy flour (66%) and 14.6% as reported by Lin *et al*. (1974).

The emulsion capacity of the samples are mucuna preta (35.71±0.00), mucuna veracruz mottle 36.67±2.04 and mucuna ghana (42.50±2.50). The emulsion stability of these samples are mcuna ghana (59.00±01.00) Mucuna preta (62.00±1.00) and mucuna veracruz mottle (66.00± 2.00). These results are higher than that reported for African oil beam seed flour by Akubor and Chukwo (1999). Since the capacity of protein to aid the formation and stabilization of emulsion is important application in cake baking, coffee whiteners, milk mayonnaise, Salad dressing, comminuted meat and frozen deserts, the good emulsion capacity and stability suggest that the sample will be useful as preservatives in these food products. The result showed the least gelation concentration of these leguminous seeds to be 2% w/v. This value however is very low compared to that reported by Oshodi (1992) on Adenopus Breviflorus bent whole seed flour. This value may favour the application of these samples in some food such as snacks that required gelling and thickening.

Table 4 showed the values of the solubility protein as a function of pH. The protein solubility plot/curves are shown in Fig. 1. The plots of these graphs showed that the concentrations of the protein are almost soluble in both acidic and alkaline medium.

Figure 1 is the solubility curve of the mucuna samples investigated in which the mucuna ghana is soluble at both acidic and alkaline medium, with the maximum solubility at pH 8 and minimum at pH 4.

For the mucuna preta, the protein concentration is also soluble at both acidic and alkaline medium. The solubility curve showed 2 points maximum at pH 4.0. The mucuna veracruz mottle solubility curve showed that

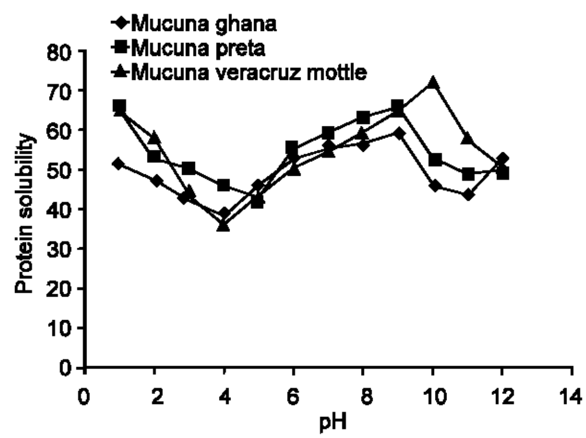

Fig. 1: Plot of protein solubility against pH

the protein concentration is also soluble at both acidic and alkaline medium. Its protein solubility curve is maximum at pH 10. and minimum at pH 5.0. These results are however in total agreement with the report of Kinsella (1979) that if protein seed flour is soluble at pH 4-8, such seed can be used in production of vegetable milk beverage.

We also report here the anti-nutrients observed in the samples investigated as showed in Table 5, the values of tannic acid, oxalate and phytate are shown. The percentage of tannic acid are; 8.54±0.35% for mucuna ghana, 9.72±0.57% for mucuna veracruz mottle and 10.30± 1.15% for mucuna preta. Tannins were characteristically present in the legumes grains having pigmented seed coat and decortications which results in removal of tannins. High values of tannins usually affect nutritive values of foods and in the digestibility of proteins, carbohydrate; fats and bioavailability of the minerals. The high values of tannic on the seeds

Table 4: Protein solubility of samples

pH	Mucuna ghana	Mucuna preta	Mucuna Veracruz mottle
1	51.31	65.79	64.91
2	47.37	52.63	57.70
3	42.11	50.00	43.37
4	38.16	46.05	36.06
5	46.05	42.63	43.27
6	52.63	55.26	50.49
7	55.26	59.21	54.81
8	56.58	63.16	59.14
9	59.21	65.79	64.91
10	46.05	52.63	72.24
11	43.42	48.68	57.70
12	52.63	50.00	50.49

Table 5: Anti-nutrients

	Phytate mg/g	0xalate mg/g	Tannic acid (%)
A	55.11±0.08[ab]	6.78±0.03[b]	8.54±0.35[a]
B	85.47±0.62[e]	8.31±0.03[c]	10.30±1.15[a]
C	68.17±0.62[b]	8.24±0.05[c]	9.72±0.57[a]

Means with differing superscripts along the same column are significantly different (p>0.05).

investigated will definitely affect the nutritive values of the food.

The oxalate values are 6.87, 8.31 and 8.24 mg/g for mucuna Ghana, mucuna preta and mucunna veracruz mottle respectively. They found to be significantly different ($p<0.05$) from each other.

The phytate value recorded were 55.11, 85.47 and 68.17 mg/g. The presence of toxic substances such as anti-nutritional factor is one of the main draw backs limiting the nutritional food qualities of some legumes. Legumes are particularly rich source of phytates, which could reduce significantly the overall availability of certain minerals found in them.

The anti nutritional nature of phytin lies in its ability to chelate certain minerals elements especially Ca, Mg, Fe and Zn thereby rendering them metabolically unavailable and leading to the subsequent development of Osteomalacia when certain legumes and cereals are fed to growing animals. The value of mucuna ghana is least and significantly different from other samples ($p>0.05$), the values of mucuna preta and mucuna veracruz mottle are not significantly different at ($p<0.05$).

Conclusion: The present study has shown that from the observed proximate, mineral composition functional properties and anti-nutritional factors, the seeds of the samples studied are good sources of protein, carbohydrate and essential minerals which can serve various food and economic purposes. However, the high level of tannins, oxalate and phytate in the seeds of the samples pose problem to the total availability of the minerals and protein.

Based on the foregoing, processing methods (soaking, boiling, fermentation) will form the basis for further investigation to see if it could help to reduce the anti nutrients within the seeds.

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