BIOCHEMICAL EVALUATION OF SEEDS OF AN UNDER UTILIZED LEGUME (*Mucuna utilis*)

IYAYI E.A. AND EGHAREVBA J.I.

Department of Animal Science, University of Ibadan, Ibadan, Nigeria

Received 16 August 1997; Accepted 22 July 1998

ABSTRACT

The effect of heat treatment and germination on the proximate and mineral composition, HCN, tannins, phytic acid and the in-vitro protein digestibility of *Mucuna utilis* seeds were studied. The raw seeds had a protein content of 35.4%, 7.7% crude fibre, 3.2% ether extract, 5.8% ash and 47.9% carbohydrates on a dry matter basis. The germinated and dehulled seeds had 40.5% crude protein 2.2% crude fibre, 3.4% ether extract, 7.0% ash and 47.0% carbohydrates, while the heat treated seeds had 34.4% crude protein, 11.9% crude fibre, 3.3% ether extract, 9.4% ash and 41.1% carbohydrates.

Potassium and iron were the most abundant minerals while the least were sodium and copper. Germination caused a reduction in the levels of all minerals while heat treatment also caused a reduction in the levels of the minerals but with the exception of Ca, Mg and Zn. Processing caused a reduction in all the levels of anti-nutritional factors assayed. The in-vitro protein digestibility of the raw seeds was 89.4%; 91.7% for the heat treated seeds and 76.0% for the germinated seeds.

Key Words: *Mucuna utilis* seeds, chemical composition.

INTRODUCTION

There exist some legume seeds which are currently underutilized but have the potentials of being developed as livestock feed. One of such crops is the *Mucuna* which is a tropical legume (Aletor and Aladetimi, 1989; Ravindran and Ravindran, 1988).

Mucuna seeds are consumed in some parts of the tropics. In Sri Lanka, the seeds are soaked overnight, subjected to long cooking until they are soft, and used in various local food preparations (Ravindran and Ravindran,

1988). In some parts of India, it is eaten after repeated boiling (Janardhanan and Lakshanan, 1985). It is also consumed in some parts of Nigeria (Eyo and Abel, 1979; Afolabi *et al*, 1985).

There are many reports in the literature on the chemical composition of raw matured seeds of *Mucuna* (Kayisu *et al*, 1984; Afolabi *et al*, 1985; Ravindran and Ravindran, 1988). However, there are few reports on the effects of various processing treatments on its chemical composition and the endogenous anti-nutritional factors which limit its utilization by man and animals.

This study was designed to find a simple and cost effective detoxification method for *Mucuna* seeds that can make the seed adaptable for practical animal feeding.

The effect of soaking the seeds overnight and then heating for one hour; and that of germinating for four days, on the proximate composition, mineral composition, in-vitro protein digestibility and some anti-nutritional factors in the *Mucuna* seeds were studied.

MATERIALS AND METHODS

Mucuna utilis seeds were obtained from the International Institute for Tropical Agriculture (IITA), Ibadan, Nigeria. Sample A was the raw seed sample (RSM). Sample B was germinated seed sample (GSM) and sample C (HSM) was prepared from seeds soaked overnight and then heated for one hour. The raw seed samples were ground with a laboratory mill and passed through a 0.50mm screen and then stored in air tight plastic containers at room temperature. The samples were withdrawn as required for chemical analysis. For the germinated samples (GSM), the seed were soaked overnight in a flat plastic dish with the water just covering the surface of the seeds. The water level was periodically replenished to keep it constant until the seeds

TABLE 1: EFFECT OF HEAT TREATMENT AND GERMINATION ON THE PROXIMATE COMPOSITION OF *MUCUNA UTILIS* SEEDS (g/100gm DM)

Treatment	Moisture	DM	CP	CF	EE	Ash	NFE
RSM	9.75	90.25	35.39	7.73	3.16	3.62	47.88
GSM	7.00	93.00	40.46	2.22	3.38	6.99	46.96
HSM	8.50	91.50	34.42	11.85	3.26	9.40	41.07

Note: RSM = Raw seed meal, GSM = Germinated seed meal, HSM = Heated seed meal

TABLE 2: MINERAL COMPOSITION ON RAW, HEAT-TREATED AND GERMINATED *MUCUNA UTILIS* SEEDS

TREATMENT	MAJOR MINERALS (g/Kg DM)					TRACE MINERALS (mg/Kg DM)			
	K	Ca	Mg	P	Na	Zn	Mn	Fe	Cu
RSM	14.29	1.04	1.92	0.83	0.16	12.75	26.49	128.96	25.13
GSM	10.33	1.03	1.45	0.63	0.09	41.55	16.92	94.06	15.96
HSM	11.81	1.66	1.86	0.75	0.21	49.37	20.37	129.79	22.24
SD	2.00	0.25	0.27	0.10	0.06	4.21	6.14	18.25	4.69
CV (%)	16.48	20.82	14.69	13.70	39.22	9.45	25.66	15.93	4.93

RSM = Raw seed meal, GSM = Germinated seed meal, HSM = Heated seed meal, SD = Standard deviation.

germinated after about 4 days. The seeds were then dehulled and sundried before milling. The third sample (HSM) was prepared from seeds which were first soaked overnight. The next morning, they were heated for one hour over an electric stove in already boiling water. At the end of the heating, the boiling water was poured away while the seeds were sundried, milled with a laboratory mill, sieved and then stored as was done for samples A and B.

Proximate analysis

Standard methods according to AOAC (1980) were used for estimating moisture, ash, crude protein, crude fibre and ether extract. The nitrogen free extracts, estimated as carbohydrates, was calculated by difference.

Mineral and antinutritional factor analyses

The samples were digested in a mixture of perchloric and nitric acids. Sodium and potassium were analysed by using a Corning 400 flame photometer. Phosphorus was analysed using Technicon auto analyser based on the reaction of phosphorus with molybdovanadate to form a

phosphomolybdovanadate complex which was measured colorimetrically at 420nm. Calcium, magnesium, iron, manganese, zinc and copper were estimated by a Perkin Elmer Model 403 atomic absorption spectrophotometer.

Tannic acid content of the samples was measured by the modified vanilin-hydrochloric acid method of Price *et al* (1978). HCN was determined according to the method of International Standard Organization (ISO, 1975). Phytic acid content was determined by the method of Young (1936).

In-vitro protein digestibility.

The in-vitro protein digestibility was carried out according to the method of AOAC (1980). Protein digestibility was calculated by using the formula:

$$\text{Protein digestibility (\%)} = \frac{\text{Digested protein}}{\text{Total protein}} \times \frac{100}{1}$$

RESULTS

The effect of processing on the proximate composition of *Mucuna utilis* seeds is shown in Table 1. There was a 3.3% and 1.4% increase in dry matter content between the RSM, the GSM and HSM samples respectively. The

NUTRITIVE VALUE OF MUCUNA UTILIS SEEDS

TABLE 3: ANTI-NUTRITIONAL FACTORS (g/kg DM) AND IN VITRO PROTEIN DIGESTIBILITY (%) OF RAW, HEAT-TREATED AND GERMINATED MUCUNA UTILIS SEEDS

Treatment	HCN	Tannins	Phytic Acid	Digestibility	% change in Digestibility
RSM	82.27	2.05	2.05	89.40	
GSM	32.56	1.16	1.29	75.98	15.01(-)
HSM	25.79	1.16	1.64	91.68	2.55(+)
SD	0.84	0.51	0.38	8.48	
CV (%)	65.78	35.28	22.89	9.90	

crude protein values were 35.4%, 40.5%, 34.4% on dry matter basis respectively. Soaking and heating caused a 2.7% decrease in the crude protein content of the seeds while germinating and dehulling caused a 14.3% increase in the crude protein. Germination caused a 71.3% reduction in the crude fibre content compared to the raw seeds while the soaked and heat treated seeds increased in crude fibre content relative to the raw seeds by 34.8%.

There was a 5.3% increase in ether extract in the germinated and dehulled seeds and 2.5% increase in the soaked and heated samples. Processing caused a reduction in the nitrogen free extracts. The soaked and heat treated samples had the higher loss of 14.2% while the germinated seeds had a loss of 1.3% relative to the raw samples.

The results of mineral composition of the samples are shown in Table 2: There was a decrease in the levels of all the major minerals as a result of processing with the exception of calcium in the soaked and heat treated samples. Germination and dehulling caused a greater loss in all the minerals than soaking and heating. From the results obtained, the minerals most affected by processing were Sodium, Calcium, Potassium, Magnesium and Phosphorus in that order. On the other hand, soaking caused far less reduction in the levels of the major minerals.

The most abundant of the trace minerals was Iron while Copper was least abundant. Germination and dehulling caused a reduction in levels of all trace minerals assayed with copper being the most affected.

Table 3 shows the effect of processing on the levels of some anti-nutritional factors. Heating and germination caused a reduction in the levels of all the anti-nutritional factors. The most affected was hydrocyanic acid (HCN). The HCN levels were 82.7, 32.7 and 30.8mg/Kg DM for the RSM, GSM and HSM respectively. Germination caused a 60.4% reduction in the level of HCN and heating caused a 68.60% reduction. The tannic acid values were 2.1, 1.2 and 1.2g/Kg DM respectively for the RSM, GSM and HSM. The phytic acid levels were 2.1, 1.3, 1.6g/Kg DM for the RSM, GSM and HSM respectively. Germination was more effective in reducing the phytic acid causing a loss of 37.0% while heating caused a reduction of 20.0%. Table 3 also shows the effect of processing on the in-vitro digestibility of Mucuna seeds. The raw seeds had a value of 89.4% compared to the germinated with 76.0% and heated 91.7%. Thus there was a 15.0% reduction in digestibility as a result of germination while heating caused an improvement of 2.5% in digestibility.

DISCUSSION

Processing brought about an increase in the DM content of the seeds. There was a 3.3% increase in DM content as a result of germination and heating respectively. The DM value for the raw seed is similar to the value of 90.1% reported by Aletor and Aladetimi (1989). Generally, processing resulted in an improvement in the crude protein content of the seed. The crude protein of the raw seed was high. The value of

35.4% for the raw seed is higher than reported by Janardhanan and Lakshanan (1985) and Ravindran and Ravindran (1988). But the values are similar to recently reported values by Siddhuraju *et al* (1996). The high crude protein of the seed indicates its high nutritional value. The higher protein value (40.5%) of the germinated sample agrees with the results of other workers. Ranhontra *et al* (1977) reported a substantial increase in protein of germinating wheat. They attributed the increase in protein to the loss in dry weight through respiration during germination. Similarly, Lee and Karunanithy (1990) reported an increase in the protein content of *Phaseolus* seeds during a five day germination period. They attribute part of the gain as being due to the loss of water soluble components during soaking. Buckle and Samdudi (1990), also reported an increase in the protein content of the winged bean as a result of peeling and re-soaking from 370/kg for the raw bean to 499g/kg DM. The 2.7% decrease in the crude protein content of the seeds as a result of heating can be attributed to the loss of soluble or proteinous parts of the seeds into the cooking water (Mbajunwa, 1995, Nestares *et al*, 1996). There was a considerable change in the crude fibre content of the seeds as a consequence of processing. The crude fibre value for the raw seed sample is comparable to values obtained by Ravindran and Ravindran (1988) and Aleto and Aladetimi (1989). Germination and dehulling caused a 71.3% reduction in the crude fibre content with respect to the raw seed. The very low crude fibre level for the germinated and dehulled sample is according to Wang and Fields (1978) due to the removal of the testa which is high in fibrous material. This result is also in consonance with the report of Aleto and Ojo (1989) who reported that cooking, roasting and autoclaving treatments generally reduced the crude fibre levels in legumes.

There was a decrease in the levels of all the major minerals as a result of processing with the exception of calcium in the heat treated samples. Similar report by Ologhobo (1980) showed a decrease in the level of P, Ca, Mg

and Na in Ife brown, Aduki and Farv-13 varieties of cowpeas with cooking, soaking autoclaving and sprouting treatments. Aleto and Ojo (1989) noted a decrease in the K, Mg, Na and P levels of samples of cooked soya and lima beans. The occurrence of potassium as the most abundant of the major elements agrees with many reports in the literature Afolabi *et al* (1985) and Siddhuraju *et al* (1996) have reported the abundance of potassium with processing. The least abundant mineral was sodium. This is in line with the results of Ravindran and Ravindran (1988) and Siddhuraju *et al* (1996). Germination produced a greater loss in all the minerals than heating. The reduction in the levels of Na, K, Mg and Ca indicated that there was a considerable loss in the level of minerals as a result of germination. Most of the losses may have been through leaching into water while others were used probably for metabolic processes during germination.

The trace levels were reduced by germination with copper being most affected. These reductions could be attributed to leaching during course of germination (Lee and Karunanithy, 1990; Mbajunwa, 1995). But heating produced a variable effect on the levels of the trace minerals. There was a fall in Cu and Fe levels by 11.5% and 6.3% respectively and an increase in the levels of Zn and Mn by 15.5% and 7.1% respectively.

Processing caused a reduction in the levels of all the anti-nutritional factors. The most affected was HCN compared with values for the raw sample. Germination and heating respectively caused a 60.4% and 68.6% reduction in the levels of HCN of mucuna seeds. Siddhuraju *et al* (1996) have reported a 67% and 78% reduction in the levels of HCN in *Mucuna pruriens* when dry-heated and autoclaved respectively. There was a 43.4% reduction in the levels of tannic acid due to the processing treatments employed. This according to Griffiths (1991) will improve the digestibility of such samples since tannic acid is known to adversely affect protein digestibility. Verma and Mehta (1988) and Chang *et al* (1994) have also reported reduced

NUTRITIVE VALUE OF *MUCUNA UTILIS* SEEDS

tannis in rice, beans and cowpeas respectively following soaking/cooking and sprouting.

Phytic acid levels were more effectively reduced by germination than by heating. Lee and Karunanithy (1990) reported considerable losses of phytic acid due to soaking with further losses as germination progressed in phaseolus beans. The greater losses associated with germination is due to the fact that phytase activity during germination results in hydrolysis of phytate-phosphorus to inositol monophosphate which contributes to the loss of phytic acid. Verma and Mehta (1988) have found that on sprouting, the phytic-phosphorus values for rice, bean and mung bean decreased by 11.3% and 9.8% respectively as compared with the whole ungerminated bean. Reduction in the levels of phytic acid increased the availability of the minerals in the digestive tract of animals as the chelating capacity of phytic acid is reduced (Khan et al; 1991 and Sharma et al; 1996).

Germination caused 15.0% reduction in digestibility while heating improved it. This is consistent with the results of several workers (Ologhobo, 1980, Ravindran and Ravindran, 1988) since the nutritive value and protein digestibility of most legumes are poor unless subjected to some form of heat treatment. Wu et al (1994) also reported that cooking and autoclaving red kidney beans at 121°C for 10 to 20 minutes improved their protein digestibility.

The nutritional profile of *Mucuna utilis* seeds, an underutilized legume, indicates its potential as a feeding resource for livestock. The anti-nutritional factors present in mucuna as reported in the present study do not pose a problem as processing causes a substantial reduction in their levels with an improvement in the digestibility of the processed samples. Its use as a plant protein source after sprouting or heating in livestock feeding needs to be investigated.

REFERENCES

- AFOLABI, O.A., OSUNLOGUN, B.A.
ADEWUSI, S.R., FOPOWO, O.O.,
AYORINDE, F.O., GRISSON, F.E., O.L. (1985). Preliminary nutritional and chemical evaluation of raw seeds from *Mucuna solanei*: an underutilized food source. J. Agric. Food. Chem. 33:1, 122 - 124.
- ALETOR, V.A. and ALADETIMI, O.D. (1989). The compositional evaluation of some cowpea varieties and some underutilized edible legumes in Nigeria. Nahrung, 33: 10, 999 - 1007.
- ALETOR, V.A. and OJO, O.I. (1989). Changes in differently processed soya bean (*Glycine max*) and (*Phaseolus lunatus*) with particular reference to the chemical composition and their mineral and some inherent anti-nutritional constituents. Nahrung, 33: 10, 1009 - 1016.
- AOAC (1980). Official Methods of Analysis of the Association of Analytical Chemists. 12th Edition. Washington D.C.
- BUCKLE, K.A. and SAMDUDI, H. (1990). Effect of soaking and boiling treatments on the quality of Winged bean seed. J. Sci. Food Agric., 53: 379 - 388.
- CHANG., M.J., COLLINS, J.L., BAILEY, J.W. and COTTEY, D.L. (1994). Cowpea Tannins Related to Cultivator, Maturity, Dehulling and Heating. J. Fd. Sci, 59, 5: 1034 - 1036.
- EYO, E.S. and ABEL, H. (1979). Investigation of the fatty acid composition of the seeds of *Irvincia gabonesis*, *Cucumerosis manni* and *Mucuna solanei* from Nigeria. Tropenlandwirt, 80: 7 - 13.
- GRIFFITHS, D.W. (1991). Condensed Tannins: In Toxic Substances in Crop Plants. (D'Mello, J.P.F., Dufus, C.M. and Duffus, J.H., Eds.). Royal Society of Chemistry, Cambridge, pp. 1 - 20.
- JANARDHANAN, K. and LAKSHANAN, K.K. (1985). Studies on the pulse, *Mucuna utilis*: Chemical composition and anti-nutritional factors. J. Food. Sc. Tech. 22, 5: 369 - 371.

- KAYISU, T.K., VANBELIKE, M., VERVACK, W. (1984). *Revue des fermentations et des Industries Alimentaires*. 39, 4: 87 - 94.
- KHAN N., ZAMAN, R. and ELAHI, M. (1991). Effect of heat treatment on the phytic acid content of maize plants. *J. Sci. Food Agric*. 54: 153 - 156.
- LEE, C.K. and KARUNANITHY, R. (1990). Effects of composition of glycine and *Phaseolus lunatus* beans, *J. Sci. Food Agric*. 50: 437 - 445.
- MBAJUNWA, K.C. (1995). Effect of processing on the nutritional composition of the African oil bean seed (*Pentaclethra macrophylla* Benth). *J. Sci. Food Agric*. 68, 2: 153 - 156.
- NESTARES, T., LOPEZ-FRIARS, M., BARRIONUEVO, M. and URBANO, G. (1996). Nutritional Assessment of raw and processed chickpea (*Cicer arietinum* L.) protein in growing rats. *J. Agric. Food Chem*. 44: 2760 - 2765.
- OLOGHOBO, A.D. (1980). Biochemical and nutritional studies of cowpea and lima bean with particular reference to some inherent anti-nutritional components Ph.D. Thesis, University of Ibadan, Ibadan.
- PRICE, M.L., VAN, S., BUTTLER, S.L.G. (1978). A critical evaluation of vanillin reaction as an assay for tannin in sorghum grains. *J. Agric. Food Chem*. 26: 1214 - 1216.
- RANHOTRA, G.S., LOEWE, R.J. and LEHMANN, T.A. (1977). Bread making quality and nutritive value of sprouted wheat. *J. Food Sci.*, 42, 5: 1269 - 1273.
- RAVINDRAN, V. and RAVINDRAN, G. (1988). Nutritional and anti-nutritional characteristics of *Mucuna utilis* bean seeds. *J. Sci. Food and Agric*. 46, 1: 71 - 79.
- SHARMA, A., JOOD, S. and SEGHAL, S. (1996). Anti-nutrients (Phytic acid, Polyphenols) and minerals (Ca, Fe) availability (in-vitro) of chickpea and lentil cultivars. *Nahrung* 40, 4: 182 - 184.
- SIDDJURAJU, P., VIJAYAKUMARI, K. and JANARDHANAN, K. (1996). Chemical composition and protein quality of the little known legume, Velvet bean (*Mucuna Pruriens* L.) *J. Agric. Food Chem.*, 44: 2636 - 2641.
- VERMA, P. and MEHTA, U. (1988). Study of physical characteristics, sensory evaluation and the effect of sprouting, cooking and dehulling on the anti-nutritional factors of Rice bean (*Vigna umbellata*). *J. Sci. Technol.*, 25, 4: 197 - 200.
- WANG, D.Y. and FIELDS, M.L. (1978). Germination of corn and sorghum in the home to improve value. *J. Fd. Sci*. 43: 1113 - 1115.
- WU, W., WILLIAMS, W.P., KUNKEL, M.E., ACTON, J.C., WARDLAW, F.B., HUANG, Y. and GRIMES, L.W. (1994). Thermal effects on in-vitro protein quality of red bean (*Phaseolus vulgaris*). *J. Food Sci*. 59, 6: 1187 - 1191.
- YOUNG, L. (1936). Determination of phytic acid. *Biochem. J.*, 30: 252 - 254.