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Studies on seed characteristics and chemical composition of three morphotypes of *Mucuna urens* (L.) Medikus – Fabaceae

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Abstract

Seed characteristics and nutrient composition of three morphotypes of big-grained *Mucuna urens* (L.) Medikus were studied. Results showed that 100-seed weight ranged from 3200.2 to 4700.9 g, cotyledon weight per seed (23.2–26.6 g) and testa weight per seed (9.0–21.2 g). The testa constituted 43.7%, 28.1% and 44.7% of the average seed weight for morphotypes 1, 2 and 3, respectively. The cotyledon also constituted 56.3%, 71.9% and 55.3% of the average seed weight for morphotypes 1, 2 and 3, respectively. Nutrient composition analyses showed that the three morphotypes of *M. urens* are good sources of crude protein (19.97–20.57 g 100 g^{-1}), carbohydrate (72.39–75.49 g 100 g^{-1}) and fat (1.84–5.05 g 100 g^{-1}). Other nutritional components, including ascorbic acid, calcium and phosphorus are present in the three morphotypes in moderate amounts. The iron content of the *M. urens* is low. The three morphotypes contain appreciable amounts of essential amino acid. The oxalate content is low. The variations observed in the seed characteristics and nutrient compositions are suspected to be due to genotype. Genetic improvement of this plant is recommended to remove the itching hair trait so as to encourage its cultivation.
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Keywords: *Mucuna urens*; Morphotypes; Seed characteristics; Nutrient composition

1. Introduction

Increasing population, high prices of available food staples and policy constraints on food importation are the major factors worsening the food situation in developing countries (Weaver, 1994). The Food and Agricultural Organisation of the United Nations (FAO) (1994) recognized protein deficiency as the commonest form of malnutrition in developing countries, particularly in regions where diets are mainly starch-based. Therefore providing sufficient protein should be given the highest priority in every effort to increase national food supplies (Ezeagu et al., 2002). Several authors including Grivetti, Frentzel, Ginsberg, Howell, and Ogle (1987), Vietmeyer (1990), Adebooye (1996), Ezeagu et al. (2002), and El-Adaway and Taha (2001) among others stated that attention should now be focused on inexpensive and lesser known traditional useful plants as food for man and feed for animals.

An under-exploited, neglected and lesser-known plant used for food by the Igbos of southwest Nigeria is *Mucuna urens* (L) Medikus, also known as Horse Eye Bean; occurs in Nigeria, Ghana and Sierra Leone. The plant has not been given any research attention in Nigeria because it is regarded as a weed and more important because the fruits (pods) have stinging hairs. The stinging hairs make farmers avoid this plant even during land clearing. The stinging hairs that have long-lasting itching characteristic, is a major factor that prevents farmers from cultivating this plant.

The Igbo community in South-Eastern Nigeria uses the seed of the *M. urens* as a soup thickener and source

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of vegetable oil (Afolabi et al., 1985; Ukachukwu, Ezeagu, Tarawali, & Ikeorgu, 2002). *Mucuna* seeds generally are a relatively good source of crude protein and fats (Ajiwe, Okeke, Nnabuike, Ounleye, & Emeka, 1997; Ezeagu et al., 2002; Mohan & Janardhanan, 1995; Prakash & Misra, 1987; Rajaram & Janardhanan, 1991), have a relatively favorable amino acid composition (though certain amino acids are deficient), and contain high amounts of certain minerals, including Ca, Mg, and Fe (Badifu & Okeke, 1992; Ezeagu, Maziya-Dixon, & Tarawali, 2003; Prakash & Misra, 1987; Rajaram & Janardhanan, 1991).

Recent observation has shown that some of the indigenous African plants are disappearing because they are not domesticated and research and development process have not given them attention for several years (Adebooye, Ogbe, & Bamidele, 2003). Consumers are still gathering *M. urens* from the wild and evidence has shown that the gathering is becoming increasingly difficult. Some of the factors that have led to the reducing population of this plant are bush clearing and uncontrolled bush burning which are rampant in the dry season in Nigeria and other parts of Africa where this plant is endemic. Perhaps a more important factor is the fact that only a few seeds germinate in the field after many months of dormancy (Esenowo, 1990).

There is no information in the literature on the seed characteristics and chemical composition of the three Nigerian big-grained morphotypes of *M. urens* that are reported in this paper. This study was therefore conducted to document the fruit characteristics and nutrient composition of three big-grained morphotypes of *M. urens* found in the southern region of Nigeria.

2. Materials and methods

Seeds of *M. urens* used in this study were collected from the farmers in local villages in *M. urens* endemic areas in Southwest and Southeast Nigeria. For the purpose of collection, four zones were selected. In each of the zones, two local government areas (LGA) were chosen and in each LGA, four villages were selected for survey and collection of *M. urens* seed. In each village, local farmers served as guide for the researchers in the collection of the samples. All the samples were collected from forests where there was no cultivation and no application of agrochemical, at least in the last 15 years. Table 1 shows the summary of the selected zones, LGAs and villages in the survey area. Samples collected from each tree were bagged separately and taken to the laboratory for sorting and analyses. After sorting on the basis of collection site, observation showed that there were three identifiable morphological variants among the seeds collected. The three identifiable variants are:

(i) Morphotype 1 – dark brown testa type.
(ii) Morphotype 2 – black testa type.
(iii) Morphotype 3 – light brown testa type.

The dark brown testa type (morphotype 1) was collected in Imo zone; black testa type was collected in Osun and Ogun zones while the light brown testa type was collected in Anambra zone. Because of the difficulty encountered in seed collection, a total of 400 seeds were collected per morphotype for physical and chemical analyses. The seeds of each morphotype were weighed in a batch of 100 seeds three times independently. The average of the three measurements gave 100-seed weight. A sub-sample of 50 seeds was randomly taken per morphotype and the seeds were split open carefully using sharp knife. The testa was separated from the cotyledon and each component was weighed separately using an electronic scale (Mettler Toledo P153). Thereafter, the average fruit whole weight, average testa weight and average cotyledon weight were calculated.

The cotyledons (1 kg) of each morphotype were dried at 80 °C for 24 h. Dried samples were ground into powder using a Wiley microhammer stainless mill and samples were packed in screw-capped bottles and stored at −4 °C in a refrigerator until required for analyses. All the chemical analyses described below were carried out in triplicate. For the determination of essentials amino acids, 0.1 g digested sample was suspended in 5 ml 6 N

Table 1
Summary of the sites in Nigeria from where samples of *M. urens* seeds were collected

Zone	Local Government Area(LGA)	Village from where samples were collected	Morphotype collected
Imo	Isu	Agbobu, Alulu, Ugwuoba, Amafor	Dark brown testa type
	Nkwere	Awlu, Obiogo, Obizi, Naze	Dark brown testa type
Osun	Ayedaade	Akiriboto, Ogbaaga, Animu, Onimu	Black testa type
	Irewole	Odeyinka, Elekiri, Arinkinkin, Majeroku	Black testa type
Ogun	Shagamu	Makun, Ogijo, Ogunsolu, Orija	Black testa type
	Obafemi-Owode	Owode-Egba, Ofada, Papa, Ibafo	Black testa type
Anambra	Ihiala	Amichi, Neni, Ndiowu, Okija	Light brown testa type
	Njikoka	Nsugbe, Nkpor, Ojoto, Ogboji	Light brown testa type

HCl in a test tube. The suspended sample was hydrolyzed in a controlled water bath at 110 °C for 20 h. The hydrolysed sample was centrifuged at 6000 rpm for 10 min. The HCl was evaporated through a rotary evaporator while the residue was dissolved in 5 ml methanol. The essential amino acids were read directly using the Beckman 126AA amino acid analyzer (Spitz, 1973; Moore, 1963). The essential amino acids determined were those that cannot be synthesized by the body and must be supplied in feed and these are: arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine. The ether extract content was determined by Soxhlet extraction method (Association of Official Agricultural Chemists (AOAC, 1995). Two grams of the ground sample was put into a fat free extraction thimble and plugged lightly with cotton wool, petroleum ether was added up to 300 ml mark and the content was boiled for 2 h ensuring that the ether siphon until the siphoning was no longer noticed. After draining, the extraction thimble was removed and dried. The thimble was weighed and ether extract content determined by difference. Nitrogen content was determined by the Kjedhal method. Five grams of the ground sample was weighed into Kjedhal flask and 1:2 mixture of perchloric acid/tetra-oxo-sulphate (VI) acid was added. The mixture was left for 20 min and then transferred to a digester for one hour till the sample turned colourless. The sample was left to cool under fume cupboard. The digest was distilled in a 500 ml flask using 100 ml distilled water, 50 ml NaOH and selenium tablet. The flask was immediately covered and placed in a condenser. The final solution was titrated against standardized tetra-oxo-sulphate (VI) acid using phenolphthalein indicator and the titre value was used to determine the nitrogen content. The crude protein content was determined by multiplying the nitrogen value by factor 6.25. The moisture content was determined by drying 10.0 g of the ground cotyledon samples in the oven at 80 °C for 48 h. The proportional difference in weight converted to percentage was expressed as percent moisture content. The ash contents of the samples were obtained by digesting 5 g ground cotyledon sample in a muffle furnace at 550 °C for 1 h. The proportional difference in weight converted to percentage is expressed as percent ash content. The crude fibre was determined by digesting 5.0 g of the ground cotyledon sample in 1.25% H_2SO_4 and 1.25%NaOH. The carbohydrate content was determined by the difference method. The routine chemical analytical methods of Association of Official Agricultural Chemists (AOAC) (1995) were used for the proximate determination described above. For the determination of iron (Fe), calcium (Ca) and phosphorus (P), 10 g of ground cotyledon sample were digested in 2:1 mixture of H_2SO_4 and perchloric acid. The Fe, Ca and P contents of the digests were read directly using atomic absorption spectrophotometer model BUCK Scientific 200 A. Potassium (K) contents of the digests were determined colourimetrically using Flame photometer model Corning 400. The oxalate content was determined by using the HPLC method as described by Wilson, Shaw, & Knight, 1982).

Data collected were subjected to analyses of variance (ANOVA) using the standard method for completely random design according to Steele and Torrie (1995). Means, where significantly different were separated using the least significant difference at 5% level of probability.

3. Results and discussion

The fruit characteristics of the three morphotypes of *Mucuna urens* are shown in Table 2. Results showed that morphotypes 1 and 3 had about the same average whole seed weight, while morphotype 2 was only 67.9% of the average whole seed weight of morphotypes 1 and 3. The 100-seed weight (3200.2–4700.9 g) obtained in this study was far higher than 1000-seed weight (573.18–958.33 g) obtained for twelve accessions of *Mucuna* species reported by Ezeagu et al. (2003). This result therefore shows that the three morphotypes of *Mucuna* reported in this paper are large-grained species. A large proportion of the whole seed weight was made up of the testa in morphotype 1 (43.7%) and morphotype 3 (44.7%) while the testa component was only 28.1% in morphotypes 2. The cotyledon constituted 71.9% of the whole seed weight in morphotype 2, while the cotyledon constituted 56.3% and 55.3% in morphotypes 1 and 3, respectively. The first implication of these results is that whole seed weight is not a determinant of cotyledon weight for *M. urens*. Similar observation had been made on 15 accessions of *Irvingia gabonensis* var *dulcis* by Adebooye and Bello (1998). The second implication of these results

Table 2
Fruit characteristics of three morphotypes of *Mucuna urens* (L.) Medikus

Morphotype	100- seed weight (g)*	Testa weight g seed^{-1}	Cotyledon weight g seed^{-1}	% Testa	% cotyledon
1	4700.9	21.2	26.6	43.7	56.3
2	3200.2	9.0	23.2	28.1	71.9
3	4600.8	20.5	26.3	44.7	55.3
Lsd(5%)	300.4	6.4	1.4	–	–

* Values are means of three independent measurements for each morphotype.

is that morphotypes 1 and 3 with high testa weight are hard because of the testa thickness. Indeed, during cracking of the seeds, it was more difficult to crack morphotypes 1 and 3 than morphotype 2. This information is useful in designing a machine that can be used for cracking the seeds of *M. urens* during processing. The third implication of this result is on the cost of cracking the seeds because hard seeds may cost more to crack. This high cost of cracking will add to the cost of processing and subsequently increase the cost of finished or processed products of *M. urens*.

Table 3 shows that Nitrogen, crude protein, ash and moisture content of the three morphotypes are not significantly different with nitrogen ranging from 3.09–3.29 g 100 g^{-1}, crude protein (19.36–20.57 g 100 g^{-1}), moisture content (11.21–12.6 g 100 g^{-1}) and ash ranged from 2.61–3.24 g 100 g^{-1}. The results correspond with earlier work done by Prakash and Misra (1987), Mary and Janardhanan (1992) and Ezeagu et al. (2003) on some *Mucuna* species. The moisture content was also within the range (10.20–11.40) reported by Janardhanan and Lakshmanan (1985) for some *Mucuna* species. The crude protein contents of the three morphotypes reported in this paper are however lower than those reported for *M. veracruz* (24.30 g 100 g^{-1}) and *M. cochinchinensis* (29.79 g 100 g^{-1}) by Ezeagu et al. (2003). However, the crude protein values are comparable to those reported for some *Mucuna* species(20.13–31.44 g 100 g^{-1}) by Arulmozhi and Janardhanan (1992), Siddhuraju, Vijayakumari, and Janardhanan (1996) and Ukachukwu et al. (2002). The crude fibre content for the three morphotypes is very low (0.66–1.53 g 100 g^{-1}). These morphotypes of *M. urens* are therefore of great advantage for inclusion in feeds for monogastric animals. Earlier reports by Ezeagu et al. (2003) gave the average crude fibre content of 12 accessions of small-grained *Mucuna* as 4.05 g 100 g^{-1}. The total carbohydrate contents ranged between 72.39 and 75.49 g 100 g^{-1} for the three morphotypes studied. This suggested that the three morphotypes are good sources of carbohydrate for man and animals. These values are higher than those reported by Ezeagu et al. (2003) for 12 *Mucuna* accessions. morphotype 2 (black testa type) had significantly highest ether extract content (5.05 g 100 g^{-1}) compared to morphotype 1 (dark brown testa type) and morphotype 3 (light brown testa type) that had 1.90 and 1.84 g 100 g^{-1} ether extract contents, respectively. These values are low compared to 7.28 g 100 g^{-1} obtained by Ezeagu et al. (2003) on *M. veracruz*. The calcium contents of morphotypes 1 and 3 were 0.33 and 0.31 g 100 g^{-1}, respectively while that of morphotype 2 was 0.07 g 100 g^{-1}. The implication of this result is that morphotypes 1 and 3 had five times more calcium than morphotype 2. Result also showed that there was no Iron (Fe) in morphotype 1 while morphotypes 2 and 3 had iron contents of 2.20 and 13.80 mg

Table 3
Proximate and nutrient composition of three morphotypes of *M. urens*

Morphotype	Total nitrogen g 100 g^{-1}	Crude protein g 100 g^{-1}	Crude fibre g 100 g^{-1}	Ether extract g 100 g^{-1}	Moisture content g 100 g^{-1}	Ash g 100 g^{-1}	Carbo- hydrate g100 g^{-1}	Ca g 100 g^{-1}	Fe mg 100 g^{-1}	P g 100 g^{-1}	K g 100 g^{-1}	Ascorbic acid mg 100 g^{-1}	Oxalate mg 100 g^{-1}
1	3.29	20.57	0.79	1.90	11.90	2.60	74.30	0.34	0.00	0.89	4.30	17.10	2.25
2	3.09	19.36	1.53	5.05	11.14	3.20	72.39	0.17	2.20	0.94	3.00	11.24	2.14
3	3.19	19.97	0.66	1.84	12.70	2.70	75.49	0.35	13.8	0.78	8.74	14.05	2.05
Lsd(5%)	0.25	1.70	0.40	1.91	1.56	0.91	2.50	0.10	4.30	0.21	2.45	2.15	0.10

Values are means of triplicate analyses expressed on dry matter basis.

100 g^{-1}, respectively. The low Fe content in morphotypes 1 and 2 suggested that if any animal feed or human food is to be produced using these two morphotypes as raw materials, adequate arrangement must be made for more Fe supplementation than when morphotype 3 is used. The potassium content ranged from 3.00–8.74 g 100 g^{-1}. These values are within the 3.00 and 8.46 g 100 g^{-1} reported for *M. georgia* and *M. jaspeada* by Ezeagu et al. (2003). The results generally showed that appreciable amounts of essential mineral elements could be supplied by *M. urens*. The ascorbic acid content of morphotype 1(17.10 g 100 g^{-1}) was significantly higher than that of morphotype 2 (11.24 g 100 g^{-1}) and morphotype 3 (14.05 g 100 g^{-1}) while that of morphotype 3 was in turn significantly higher than that of morphotype 2. The oxalate content ranged from 2.14–2.25 mg 100 g^{-1}. These values are low oxalate considering the limit of 10 mg oxalate/serving considered as high-Oxalate foods (Horner, Cervantes-Martinez, Healy, Bailey, & Palmer, in press). Oxalate is one of the anti-nutritional factors known in plants and it has deleterious effect on nutrient absorption by the body. Oxalate, depending on its form can bind calcium (Ca) and/or magnesium (Mg) in food undergoing digestion and therefore can render Ca and Mg unavailable to the body (Oke, 1966; Badifu & Okeke, 1992; Adebooye, 1996; Ezeagu et al., 2003). These workers also reported that oxalates are leached out during the soaking, boiling and processing of the plant materials, therefore, the low oxalate content of *M. urens* can easily get leached out during processing.

Table 4 shows the essential amino acid composition of the three morphotypes of *Mucuna*. The results showed that they are high in essential amino acids when compared with those reported for *M. pruriens* by Afolabi et al. (1985), Achinewhu (1984) and Siddhuraju and Becker (2001). The implication of this is that *M. urens* can be a good source of essential amino acids for man and animals consumption. Amino acids are the ''building blocks'' of the body protein. Besides building cells and repairing tissue, they form antibodies to combat invading bacteria and viruses; they are part of the enzyme and hormonal system; they build nucleoproteins (RNA and DNA); they carry oxygen throughout the body and participate in muscle activity (Lehninger, 1990).

Table 4
Amino acid composition of three morphotypes of *Mucuna urens*

Amino acid	Morphotype 1 g 16 g^{-1} N	Morphotype 2 g 16 g^{-1} N	Morphotype 3	Lsd 5% g 16 g^{-1} N
Arginine	8.10	14.85	10.89	4.10
Histidine	1.92	2.05	1.84	0.08
Isoleucine	3.65	3.80	2.91	NS*
Leucine	7.90	8.60	9.05	0.05
Methionine	1.99	2.09	1.25	0.04
Tryptophan	0.95	0.96	0.86	NS
Valine	4.55	4.90	5.70	0.04

All values are means of triplicate analyses expressed on dry matter basis. NS*: Not significantly different at 5% level of probability.

4. Conclusions

A major characteristic of *M. urens* is the stinging hair. This is an undesirable agronomic character, which must be removed to encourage the domestication of this plant. Therefore, to bring this plant into cultivation serious research effort should be initiated to breed varieties without stinging hairs. The large grain size of this plant compared to several other *Mucuna* will be an advantage for farmers especially at harvesting and packaging. The results of this study showed that the protein, fat, vitamin and mineral composition of *M. urens* are high enough and compare favourably with the composition of other known legumes. The low and safe oxalate content also suggested that the availability of Ca and Mg in *M. urens* for man and animal use would not be threatened. Further studies on the improvement of this novel plant are a worthwhile effort to broaden the food base and widen the income base. Its improvement will provide alternative for farmers who are in constant need of additional protein especially in sub-Saharan Africa. Improving this plant will also help in its conservation and prevent it from the threat of extinction. It is globally acknowledged today that many plants are facing threat because, they have for long been neglected by research and development process.

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