Proximate and functional Properties of *Mucuna* Bean Species as affected by Moisture Variation

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Abstract
This study looked at the functional qualities and nutritional benefits of Mucuna (Pruriens and Veracruz) seeds. While quality indices such as the amount of crude protein, lipids, and ash examined all indicate an improvement, the moisture content decreases from 15.82 to 6.04%. Crude protein levels for both species range from 29.91 to 37.01% and 29.10 to 39.21%, respectively. Lipid contents for both species range from 4.20 to 5.90% and 3.80 to 4.80%, respectively. Ash concentrations for both species were from 3.41 to 4.61% and 5.22 to 5.62%, respectively. The crude fibre content of both species ranged from 1.69 to 1.87 percent and 1.71 to 1.96%, respectively. It is in line with earlier assessments carried out by other scholars, including [6]. The carbohydrate content for each species ranged from 42.84 to 47.78% and 42.98 to 43.69%, respectively. As the moisture content decreased, it showed an upward trend. This is in line with the finding in [8] that a reduced moisture content enhances the quality of biomaterials by delaying the materials' biochemical and microbiological degradation. Mucuna Pruriens' bulk density and water absorption capacity dropped from 0.75 to 0.43 (g/ml) and 142.30 to 124.06, respectively. In contrast, the solubility and swelling power rose from 21.69 to 37.10 and 4.96 to 4.96, respectively. Additionally, the water absorption capacity and bulk density of Mucuna Veracruz dropped from 141.27 to 124.82 and 0.73 to 0.45 (g/ml), respectively, whereas the swelling power and solubility rose from 2.21 to 5.84 and 22.03 to 37.21, respectively. It is in line with earlier assessments carried out by other experts, including [13]. It is suggested that more studies be conducted with a larger range of moisture to further ascertain its impact on the characteristics under investigation.

Keywords: *Mucuna Prureins, Mucuna Veracruz, Moisture Content, Nutritional Properties and Functional properties*

Introduction

The biggest problem facing nutritionists and researchers has been to supply safe and nourishing meals to the underprivileged and impoverished. There have been a lot of attempts made to find underutilised legumes as a cheaper source of protein than traditional plant-based (such soy and peanut) and animal-based nutritional supplements. Numerous studies have been conducted on the nutritional value of underutilised legumes [1].

A popular annual climbing legume among the Igbo people of Eastern Nigeria is Mucuna (Pruriens and Veracruz) Agbara, which belongs to the Fabaceae family, a subfamily of the papilionaceous. It is sometimes referred to as cowage, cowitch, or velvet bean. It is one of the most often used medicinal herbs in Asia and Africa, to be found in more than 200 locally created medication combinations. [2] It is located on the Indian plains. Mucuna seeds contain the medication L3, 4-Dihydroxyl Phenyl Alamine (L-DOPA), which is used to treat Parkinson's disease (PD), which is the only reason why demand for Mucuna has skyrocketed in India and on global medical markets [3].

The Leguminosae family includes the genus Mucuna, which has over 100 species of climbing vines and shrubs. Tropical forests, particularly those in the Caribbean, tropical Africa, and tropical India, are home to the genus, which is named for the plant Mucuna. The annual twining crop Mucuna may grow up to 15 meters in length. The plant's fuzzy hair, which formerly covered it almost completely, almost completely falls off as it ages. The petioles are large and smooth, ranging in length from 6.3 to 11.3 cm, and the leaves are trifoliate, alternate, or spiralling. Membranous terminal leaflets are smaller than lateral leaflets, which vary widely in size.

The flowers droop in racemes and might be lavender, white, or dark purple. The petals are noticeably curled, and the blooms are bigger than peas. The glossy, oval-shaped, brown or black seeds measure 12 mm [4]. It has also been demonstrated to function as a male reproductive agent and to have neuroprotective, analgesic, and anti-inflammatory properties. Because of their high protein content and ease of digestion, Mucuna bean seeds are regarded as a potential source of dietary proteins. Its protein content ranges from 23 to 35%, and its nutritional characteristics are comparable to those of other pulses.

Like certain other legumes, the seeds of the Mucuna plant contain both anti-nutritional and helpful substances. Finding the most economical methods to lessen or eradicate Mucuna seeds' anti-nutritional qualities while maintaining their nutritional value is one of the obstacles in marketing them for use by humans and animals. "Levo-Dopa," a dopamine neurotransmitter that is useful in the therapy and management of Parkinson's disease, is the most significant of these anti-nutritional qualities. Mucuna is marketed as a source of Levo-Dopa (2–7%) due to its high content [5]. Mucuna beans are roasted and ground into flour in many tropical nations to manufacture coffee replacements; in Enugu state, they are used to thicken soups and its leaves are cooked and consumed as a blood tonic.

Because of their high crude protein content (23–35%), which is equivalent to that of soy beans, Mucuna Pruriens and Veracruz are regarded as acceptable sources of dietary protein [6]. In Central American nations like Honduras [7] and African nations like Nigeria, Benin, Malawi, and Guinea [6, 8], dietary Mucuna has been crucial in avoiding malnutrition. Mucuna plants were grown extensively as green vegetables in many tropical nations, and both the immature seeds and green pods were cooked and consumed. The seeds are ground into flour and used as a vegetable or as a thickening for soups in South Eastern Nigeria. In many parts of the world, its leaves are also cooked and consumed as a blood tonic to cure pregnant women and children who are malnourished.

One crucial component of biomaterials that affects their stability, safety, and quality is their moisture content. Products that have just been harvested typically include a lot of water, which accelerates the pace of degradation. Even though their nutritional value may have been diminished after drying, baked or dried agricultural goods are more stable than fresh products while having a lower water content [6]. The impact of roasting on cashew nuts' size and moisture content, which caused the nuts to shrink, was documented by [7]. This resulted from the cashew nuts losing moisture when roasting; as a result, the nut's size drops as its moisture level does. This favours market for the product as buyers prefer nut with considerably low moisture content.

A biomaterial's functional attributes are the characteristics that dictate its final usage and applications. The quality of the processed food item and its eventual acceptability are often impacted by the direct or indirect interactions between the biomaterials under investigation and other food components [8]. The solubility water absorption index, swelling power, and bulk density are among the functional characteristics that were examined.

Mucuna seeds are a substantial source of protein for food and animal feed, and their nutritional value has been shown [6]. These pulses may now be used commercially for both medical and nutritional purposes because of earlier research and conclusions. The nutritional and physiological differences between the two varieties of Mucuna based on moisture content are not well understood. Designing and constructing equipment for harvesting, post-harvest handling, and processing may benefit from knowledge of how moisture variations affect the nutritional and functional qualities of Mucuna Pruriens and Veracruz. Therefore, knowing these characteristics will be beneficial for people who develop processing, storage, and general handling equipment.

Materials and Method

Sample Collection: The matured seeds of ***Mucuna Pruriens*** were harvested directly from a farm at Orba in Udenu Local Government Area of Enugu State, Nigeria. Its geographical coordinates are $6^{0}59^{'}0^{''}$ North and $7^{0}27^{'}0^{''}$ East. While ***Mucuna Veracruz*** seeds were harvested from a farm in Enugu Ezike, Igboeze North Local Government Area of Enugu State, Nigeria. Its geographical coordinates are North and $7^{0}27^{'}0^{''}$ East. The samples were manually cleaned to remove all foreign materials like pieces of stone, immature seeds, and chaff.

(A)

(B)

Figure 1: Mucuna seeds varieties (a = Pruriens and b = Veracruz)

Orba in Udenu LGA

Fig .2a: Map of Orba GPS

Enugu Ezike in Igboeze LGA

Fig. 2b: Map of Enugu- Ezike

Sample Preparation

The Mucuna seed samples were hand-picked, cleaned, and evaluated to separate the good from the bad. To maintain the seed samples' initial moisture content, they were separated and put in sealed polythene bags. The moisture content of Mucuna seeds was measured using the oven method described in [8, 9]. Seed samples with the required moisture levels were produced by conditioning the samples in accordance with the process outlined in [8, 9]. Each sample has to be soaked in clean water for one to four hours. The samples were soaked, then thinly spread out and left to dry for around eight hours outside. After that, the samples were stored in polyethylene bags for a further twenty-four hours. This enabled the samples to have a consistent and consistent moisture content. After that, the samples were taken to the laboratory for nutritional value analysis.

Experimental Procedure

Using the method recommended by [8, 9], samples of Mucuna (Pruriens and Veracruz) flour were prepared. Before being manually dehulled, 1 kg of clean Mucuna Pruriens seeds were steeped in clean water for 10 hours at 250°C + 20°C. The cotyledons were dried at 105 °C for ten hours. The dried seeds were pulverised in a hammer mill and sieved through a 0.50mm screen before being kept in an airtight container at 4°C until they were needed.

Proximate Analysis

Proximate analysis describes the basic nutritional makeup of biomaterials in terms of crude protein, moisture content, fat, ash, fibre, and carbs. The moisture content, crude protein, crude fibre, fat, ash, and carbohydrate content of the flour samples were analysed using Approved Methods [9]. For every drug, analytical concentrations were employed.

Determination of Moisture Content of The Samples.

The moisture content, which quantifies the amount of water in a food sample, usually influences the kind of food, age or maturity, diversity, and geographic location. The food's ability to be kept can be inferred from its moisture content during harvest. The moisture content of the samples was determined using the procedure described by [9]. The moisture content was determined by weighing 5g of the flour sample in an aluminium container. After then, the sample was dried until its weight remained constant at 105°C.

The Moisture Content = (Weight of empty Can Sample) - $\frac{Weight\ of\ empty\ Can}{Weight\ of\ Sample}$ ×100% (1)

Determination of Crude fiber

The "crude fibre" fraction of a nutrient is made up of the parts of food that are hard to digest. The crude fibre was identified using the [9] Method. To do this, 2g of the sample must be added to a 1-liter conical flask. The conical flask with the samples was filled with 100ml of boiling water. After that, the mixture boiled for a further half hour. After boiling for 30 minutes, the mixture was filtered through a Muslin cloth in a funnel. The remaining substance was thoroughly cleaned until its alkali concentration was eliminated. After that, the leftover substance was put in a dry crucible and heated to 600 degrees. Crude fibre was evaluated using Equation 2.

The Crude fiber = $\frac{Weight\ of\ the\ Crucible}{Weight\ of\ Sample}$×100% (2)

Determination of the Ash Content

The amount of ash in a biomaterial indicates its mineral or organic residue. It gives a broad idea of the total amount of minerals present in the food. [3, 8] was used to compute the quantity of ash.

Ash Content (%) = $\frac{Weight\ of\ Ash}{Weight\ of\ Sample}$×100% (3)

Determination of Crude Fat Content

The term "fat" is frequently used to describe substances that dissolve in organic solvents like ether, hexane, etc. The crude fat content was calculated using the technique proposed by [8] using a Soxhlet extractor and hexane. Hexane was added, and a thimble extractor was placed in an extraction chamber to remove the fat from 1g of the samples. The fat was evaluated using Equation 4.

% Lipid content = $\frac{W_2 - W_3}{W_2 - W_1}$ **x 100%** (4)

Where W1 = Weight of empty extraction thimble

W2 = Weight of extraction thimble plus sample extraction

W3 = Weight of extraction thimble plus sample residue after extraction.

Determination of Crude Protein

Amino acids are joined by peptides to form protein. Carbon, hydrogen, oxygen, nitrogen, and other essential elements are present in them. [9, 10] method was employed to evaluate the crude protein using KJECTEC2200 Distillation apparatus, Protein Digester, and Foss Desiccators.

The crude protein = (Titre Value of the Sample- Blank) x $\frac{0.01 \times 14.007 \times 6.25 \times 100}{1000 \times Weight\ of\ Sample}$ **(5)**

Determination of Carbohydrate

The percentages of ash, moisture content, crude fibre, crude fat, and crude protein are added together, and the proportion is subtracted from 100% to determine the amount of carbs, which are the nitrogen-free extract.

Determination of the functional Properties of *Mucuna* samples

The functional properties investigated include Bulk density, swelling power, solubility and water absorption index.

Determination of Bulk densities

The method suggested by [10] was used to assess the bulk densities of the Veracruz and Mucuna pruriens samples. Each sample weighed 5g, which was then measured into a measuring cylinder with 50 graduations. Ten light taps of the cylinder on the benchtop from a height of five centimetres were used to condense the Mucuna samples. The samples' volume was measured and noted. The following equation 6 is used to calculate the bulk density.

$$\text{Bulk density } \left(\frac{g}{cm^3}\right) = \frac{Weight\ of\ the\ sample}{Volume\ of\ the\ sample\ after\ tapping} \qquad (6)$$

Determination of the swelling power of the samples

The technique suggested by [12] was used to assess the samples' swelling power. This entails weighing out 1g of the Mucuna flour samples, adding 10 ml of distilled water, and gently mixing in a 5 ml centrifugal tube. For fifteen minutes, the mixture was heated to 100 °C in a water bath. For ten minutes, the tube with the paste is centrifuged at 3000 rpm. After that, the sediment's weight was measured and noted. The dry matter content of the sediment gel was determined using its moisture content. The following equation was used to calculate the swelling power.

$$Swelling\ power = \frac{weight\ of\ the\ wet\ sediment}{weight\ of\ dry\ matter\ in\ gel} \qquad (7)$$

Determination of Solubility

The procedure [10] was used to evaluate them. 10g of the Mucuna flour samples are weighed into a 100 ml measuring cylinder. Water is then added to each 100 ml volume, stirred violently, and left to stand for three hours. The settled particles' volume was measured and deducted from 100%. The variation expressed as a solubility percentage

% Solubility* = 100 – *Volume of settled particle **(8)**

Determination of water absorption index

A technique suggested by [10] was used to accomplish this. Crucibles and centrifuge tubes were dried in an oven set to 105°C for 20 minutes. After cooling in desiccators, the crucible and the centrifuge tubes were weighed jointly. After measuring 1g of the sample into the tube, 10ml of distilled water was added, and the mixture was swirled for half an hour. After centrifuging the tube holding the paste for 15 minutes at 4000 rpm, the supernatants are dried in an oven set at 105 °C until the supernatant is removed.

Water absorption Index was calculated as:

$$(\textit{Weight of tube +residue after centrifuge}) - \frac{\textit{Weight of empty tube}}{\textit{Weight of sample}} \times 100\% \qquad (9)$$

The functional properties of the ***Mucuna (pruriens and Veracruz)*** are presented in Tables 3 and 4 respectively.

Table.1: Results of Nutritional Qualities of *Mucuna Prureins*

Moisture Content (%)	Crude Protein (%)	Fat Content (%)	Ash Content (%)	Crude Fiber (%)	Carbohyd rate (%)
15.82	29.10	3.80	5.22	1.71	42.84
10.06	33.14	4.19	5.53	1.85	45.44
6.04	39.21	4.30	5.62	1.96	47.78

Table.2: Results of Nutritional Qualities of *Mucuna Veracruz*

Moisture Content (%)	Crude Protein (%)	Fat Content (%)	Ash Content (%)	Crude Fiber (%)	Carbohyd rate (%)
15.82	29.91	4.20	3.41	1.69	42.98
10.06	33.05	5.22	4.33	1.74	43.12
6.04	37.01	5.90	4.61	1.87	43.69

Table.3: The Functional Properties of *Mucuna Pruriens*

Moisture content (%)	Water Absorption Capacity	Swelling Power	% Solubility	Bulk density(g/ml)
6.04	142.30	2.41	21.69	0.75
10.37	137.24	3.89	29.96	0.68
15.82	124.06	4.96	37.10	0.43

Table 4.: The Functional Properties of *Mucuna Veracruz (white)*

Moisture content (%)	Water Absorption Capacity	Swelling Power	% Solubility	Bulk density(g/ml)
6.04	141.27	2.21	22.03	0.73
10.37	136.26	4.24	31.80	0.69
15.82	124.82	5.84	37.21	0.45

Discussion of Results

The nutritional properties of the ***Veracruz* and *Mucuna Prureins*** samples at different moisture content levels were shown in Tables 1 and 2. Legume seed moisture is crucial for preserving their overall quality and shelf life. The results of the investigation showed that moisture content affected the nutritional properties of the biomaterial (Tables 1 and 2). When the moisture level decreases from 15.82 to 6.04% wb, the measured quality indices, including the crude protein, fat, and ash content, typically increase for both species.

Crude Protein: For both species, the crude protein varies from 29.10 to 39.21% and 29.91 to 37.01%, respectively. It is in line with earlier assessments carried out by other scholars, including [8].

Lipid Content: For both species, the lipid concentrations vary from 3.80 to 4.80% and 4.20 to 5.90%, respectively. It is in line with earlier assessments carried out by other scholars, including [8]

Ash Content: For both species, the ash concentration varied between 5.22 and 5.62% and 3.41 and 4.61%, respectively. It is in line with earlier assessments carried out by other scholars, including [6]

Crude Fiber: For both species, the crude fiber content varied from 1.71 to 1.96% and 1.69 to 1.87 percent, respectively. It is consistent with previous analyses conducted by prior researchers, such as [8].

Carbohydrate: The carbohydrate content for each species ranged from 42.84 to 47.78% and 42.98 to 43.69%, respectively. As the moisture content decreased, it showed an upward trend. It confirms the conclusion of [8], according to which the carbohydrate content of dry grains decreases as the moisture content increases.

Tables 3 and 4 showed the functional characteristics of the (***Mucuna Pruriens and Veracruz)*** at different moisture content levels of 6.04%, 10.37%, and 15.82% (dry basis).

For both species, it was discovered that the functional characteristics, such as swelling power, solubility, and water absorption capacity, varied significantly when the moisture content rose. The water absorption capacity and bulk density of Mucuna Pruriens dropped from 142.30 to 124.06 and 0.75 to 0.43 (g/ml) correspondingly when the moisture content increased from 6.04% to 15.82%. However, the solubility and swelling power rose from 21.69 to 37.10 and 4.96 to 4.96, respectively.

Additionally, Mucuna Veracruz's water absorption capacity and bulk density dropped from 141.27 to 124.82 and 0.73 to 0.45 (g/ml), respectively, while its swelling power and solubility rose from 2.21 to 5.84 and 22.03 to 37.21, respectively. As previously observed by [13], the depolymerisation of starch into short chain dextrin with a strong affinity for water may be the cause of the increase in swelling power and solubility of both species. In order to preserve freshness and facilitate handling, flours with a high swelling power are useful for making foods like bread and sausages.

Conclusion

Research on the nutritional value of Mucuna pruriens and Veracruz species revealed that the biomaterial's nutritional value was significantly influenced by its moisture level. All of the nutritional qualities exhibit a positive correlation with a reduction in moisture content, indicating that the concentration of the nutritious qualities rises as the moisture content falls. Additionally, for both tested species, it was shown that when the moisture level rose, swelling power and solubility increased while water absorption capacity and bulk density dropped.

Recommendations

● Further work can be carried out with wider moisture content ranges to also identify its effects on the tested properties and further determine the electrical and electromagnetic properties of both species.

● To use the ***Mucuna pruriens and Veracruz*** species as substitutes for soybeans in animal feed formulation due to the high crude protein contents of both species.

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