Nutritive Potentials of *Pterocarpus mildbraedii* in Livestock Production

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Abstract

Pterocarpus mildbraedii leaf is a common vegetable in the Southern part of Nigeria. It is available all year round hence the need to evaluate its potential in livestock nutrition. Leaves of *Pterocarpus mildbraedii* were air-dried at 25ºC for 14 days and milled. The phytochemical analyses, proximate composition, vitamin and mineral concentrations were determined using standard procedures. Proximate analysis indicated that the leaves contained dry matter (74.20%), ash (6.30%), crude fibre (4.60%), crude protein (1.05%), crude fat (4.60%), ash (7.33%) and nitrogen-free extract (81.83%). The phytochemical evaluation revealed that *Pterocarpus mildbraedii* leaf contained saponin (23.24mg/100g), an alkaloid (12.58mg/100g), hydrogen cyanide (0.36mg/100g) and tannin (95.79mg/100g). Mineral and vitamin analysis showed that *Pterocarpus mildbraedii* leaves contained macro minerals such as calcium (0.33%), magnesium (0.22%), potassium (0.15%), sodium (0.04%), micro minerals (mg/Kg) such as manganese (55.29) and iron (749.22) and high content of vitamins A (3528IU/Kg), B1 (2.03mg/100g), B2 (0.93mg/100g), B3 (4.62mg/100g), B6 (2.23mg/100g), B12 (1.77mg/100g) and C (12.58mg/100g). The results showed that *Pterocarpus mildbraedii* leaves are of high nutritional quality especially in carbohydrates, minerals (as indicated in the ash content), micro and macro minerals, as well as vitamins but low in crude protein. There should however be some levels of caution in its inclusion in monogastric nutrition considering its high level of tannin thus it is recommended that it should be included in minute quantities and basically for therapeutic purposes.

Keywords: Minerals, Nutrition, Phytochemicals, Proximate, Vitamins.

Introduction

Pterocarpus mildbraedii Harms, also known as "Oha" in Eastern Nigeria and African Rosewood in English, is one of the most commonly consumed vegetables in the country (Usunomena and Chinwe, 2016;). Cameroon, Equatorial Guinea, Ghana, Liberia, Nigeria, Sierra Leone, and Tanzania are home to *Pterocarpus mildbraedii*. *Pterocarpus mildbreadii* Harms is a large green leafy vegetable that grows to a height of 2 meters (6.6 feet) and a diameter of 20 meters (0.79 inch). The smooth, gray or pale brown bark of *Pterocarpus mildbraedii* Harms exudes red gum when cut. *Pterocarpus mildbraedii* Harms (Oha) and *Ptercurpus*

santalinoides are two species found locally (Ujowundu *et al.,* 2010).

Vegetables are the raw or cooked parts of herbaceous plants that are fresh and edible (Konsam *et al.,* 2016). Vegetables are essential for preserving the body's alkaline reserve; they are primarily valued for their high carbohydrate, vitamin, and mineral content (Nnamani *et al.,* 2009; Onwordi *et al*., 2009). Carotene, ascorbic acid, riboflavin, folic acid, and minerals like calcium, iron, and phosphorus are abundant in vegetables (Fasuyi, 2007) which make vegetables a potential replacement for the imported and expensive commercial vitamin-mineral premix, which further contributes to the high cost of feedstuffs in livestock production. They also contain phytochemicals or anti-nutrients including phytic acid, tannic acid, and oxalate, all of which minimize bioavailability (Akindahunsi and Salawu, 2005).

Pterocarpus mildbraedii leaf extracts are used by certain tribes in Eastern and Southern Nigeria to treat headaches, pains, fever, convulsions, and respiratory disorders, as well as antimicrobial agents (Assanta and Robert, 2011), and this suggests that the leaves or the extracts could be a possible replacement for antibiotics as there is surge globally at the moment for organic agriculture cum organic livestock production. Aside from humans eating the leaves as vegetables, livestock often grazes on them. Other applications include the processing of wood, gum or resin, and dyes (Dike, 2010), as well as analgesia from the bark (Oteng-Gang and Mbachu, 1990).

Some anti-nutritional compounds, according to Aletor and Adeogun (1995), have protective properties, allowing them to serve a dual function of decreasing some vital nutrients while also shielding the body from a variety of biochemical, physiological, and metabolic disorders.

Leaf meals from tropical legumes, browse trees, and shrubs (in which *Pterocarpus mildbraedii* fits in more appropriately) are some of the feed ingredients that can be used to make rations for poultry and other monogastric animals (Ogungbesan *et al.,* 2013). Leaf meal is a healthy and important source of protein, vitamins, and minerals (Esonu *et al.,* 2003).

The aim of this study is to determine the composition of *Pterocarpus mildbraedii* leaves in terms of proximate, phytochemicals, minerals, and vitamins to assess its potential for use in livestock feeds considering the clamour for organic agriculture.

Materials and Methods

Experimental site

The study was conducted at the Animal Laboratory of the Department of Agriculture and Industrial Technology, Babcock University, Ilishan-Remo, Ogun State, Nigeria situated in the South-Western rainforest belt with an annual rainfall of 1500mm and mean daily temperature of 280C within Latitude 60 52'N and Longitude 30 43'E.

Fresh leaves of *Pterocarpus mildbraedii* were purchased from the market around Ilishan-Remo, Ogun State, Nigeria.

Samples preparation

The leaves were washed and air-dried for fourteen (14) days at 25^{o}C. After air drying, they were ground into a fine powder and placed in a cool, dry container until they were used for examination.

Proximate analysis

The Association of Official Analytical Chemists (AOAC) methods were used to determine the moisture, crude fiber, crude protein, fat, ash, and cyanide content of the samples (AOAC, 1990). All analyses were carried out in duplicates. The proximate

values were reported using percentages. The moisture content of *Pterocarpus mildbraedii* leaf (PML) samples (5 grams each) was determined by weighing them in a crucible and drying them at 105°C until they reached a constant weight. The ash content was determined by ashing at 550ºC for around 3 hours. The Kjeldah method (AOAC, 1990) was used to measure the protein content, which involved multiplying the nitrogen value by a conversion factor (6.25). The digestion method was used to determine the crude fiber content of the samples, and the Soxhlet extraction method was used to determine the lipid content (AOAC, 1990). Complete soluble carbohydrate was calculated using the difference between the amount of all proximate composition and 100 percent. Akinyeye *et al.* (2010) methods were used to measure the calorific (energy) value. The Atwater factors of 17, 17, and 37 are compounded by the value of starch, protein, and crude fat, respectively (Akinyeye *et al.*, 2011; Kilgour, 1987). Crude fat was converted to a fatty acid by multiplying with a conversion factor of 0.80, as described by Akinyeye *et al.* (2010).

Mineral analysis

The mineral contents (elements) of *Pterocarpus mildbraedii* leaves were determined using an atomic absorption spectrophotometer (AAS-Buck 205), as described by the AOAC (1990) for calcium (Ca), magnesium (Mg), potassium (K), sodium (Na), iron (Fe), zinc (Zn), manganese (Mn), and copper (Cu). The colorimetric method was used to determine phosphorus levels (AOAC, 1990). Both of the analyses were repeated twice. Calcium, magnesium, and potassium were measured in percentages, while sodium, iron, zinc, phosphorus, manganese, and copper were measured in parts per million (ppm).

Phytochemical analysis and anti-nutrients

To evaluate quantitative phytochemical analyses of anti-nutrients, Sofowora (1993) methods were used. All determinations were carried out twice.

Statistical analysis

All data were analyzed using descriptive statistics and t-tests in SPSS Version 22. As statistical values, the mean and standard deviation were calculated.

Results and discussion

The result of the proximate composition of *Pterocarpus mildbraedii* leaf samples is presented in Table 1.

Table 1. Proximate composition of *Pterocarpus mildbraedii* leaf

Item	Concentration (%)
Dry matter	74.20±1.07
Ash	6.30±0.28
Crude fat	6.23±0.11
Crude fibre	4.60±0.14
Crude protein	1.05±0
Nitrogen Free Extract	81.83±0.25

The moisture content of PML was 10.80%, which was lower than 13.33%% and 17.2% reported by Akinyeye *et al.* (2010) and Okerulu *et al.* (2017) and 24.77% reported by Ayo-Enwerem *et al.* (2017) for *Pterocarpus santalinoides* leaf meal. The result was however in agreement with the findings of Oyibo *et al.* (2020), who reported 9.35% and 9.19% of moisture for samples collected from Samaru and Sabo areas in Zaria, Kaduna State, Nigeria.

The crude protein content was 1.05% which was lower than the reports of 26.5% and 29.5% reported by Akinyeye *et al.* (2010) and Okerulu *et al.* (2017) and 21.00% and 21.27% crude protein values obtained for the dried

leaves of *P. mildbraedii* in different areas of Zaria, Kaduna State, Nigeria.

The ash value of 6.3% obtained from this study was also in agreement with the report of Okerulu *et al.* (2017) who reported a value of 5.70% but in contrast with the values of 10.94% and 10.81% reported by Oyibo *et al.* (2020) and 20.86% reported by Akinyeye *et al.* (2010) and 7.83% reported by Ayo-Enwerem *et al.* (2017) for *Pterocarpus santalinoides* Leaf Meal.

The crude fibre content of 4.6% of PML was lower than the 8.15%, 9.46%, 12.3% and 17.5% reported by Oyibo *et al.* (2020), Ayo-Enwerem *et al.* (2017), Akinyeye *et al.* (2010) and Okerulu *et al.* (2017) respectively. To ensure proper physiological activity in the digestive tract, pig diets should have a minimal amount of fiber (Wenk, 2001). According to Mateos *et al.* (2006), young pigs may have a minimum requirement for a fibre level of 6%. Diets or ingredients heavy in fiber, on the other hand, may have a negative impact on voluntary feed intake and nutritional digestion in young pigs (Wilfart *et al.,* 2007). It has also been observed that including moderate amounts of diverse fiber sources in the diet has positive effects on chickens. Diets high in fiber, particularly insoluble fiber, may help to lower the occurrence of cannibalism. As a result, in some production systems, it could be utilized instead of beak trimming (Hartini *et al.,* 2002). It can also improve the development of poultry digestive organs, particularly gizzard activity, as well as stimulate bile acid and enzyme secretion and alter intestinal bacteria. Improved nutrition consumption, growth performance, and, finally, satiety and animal wellbeing are the results of these modifications (Mateos *et al.,* 2012). Furthermore, fibers in poultry diets may improve gut health by inhibiting pathogen bacterial populations from adhering to the epithelial mucosa (Jha *et al.,* 2019). The values of crude fiber in PML as observed in this study were lesser than the required minimum of 6% hence making it a great source of nutritional fibre for livestock.

The crude fat content of 6.23% of MFL suggested that the leaves contain low quantities of lipid biomolecules (Harbone, 1998) and cannot serve as the main source of these biomolecules which are important for body metabolism. This was in agreement with the values of 5.91% and 6.0% found in leaves of *Pterocarpus mildbraedii* in Samaru and Sabo areas of Zaria, Kaduna State, Nigeria as reported by Oyibo *et al.* (2020). However, the value was higher than 4.15% and 4.25% reported by Okerulu *et al.* (2017) and Ayo-Enwerem et al. (2017) but lower than 8.66% reported by Akinyeye *et al.* (2010).

The carbohydrate content of 81.83% was higher when compared with 13.40%, 18.6%, 35.95% and 45.65% obtained by Ayo-Enwerem *et al.* (2017), Akinyeye *et al.* (2010), Okerulu *et al.* (2017) and Oyibo *et al.* (2020). These results do not agree with the suggestion that most vegetables are generally not good sources of carbohydrates (Ihenacho and Udebuani, 2009).

Phytochemicals are natural bioactive compounds found in plants that work with nutrients and dietary fiber for disease protection (Dike, 2010).

The quantitative analysis of the phytochemicals showed that the composition of the alkaloids in PML was 12.58mg/100g, which was lower than 2.66%, 4.65% and 1.12mg/100g reported by Okerulu *et al.* (2017), Akinyeye *et al.* (2010) and Ayo-Enwerem *et al.* (2017) respectively. The values of alkaloids observed in this study were also lower (Table 2) than the analysis earlier reported on the same species by Dike (2010) who reported composition of 1.32%. Leeson and Summer (2008) stated that chickens receiving 1 to 2% of ergot in their diet can show symptoms ranging from depressed growth to necrosis of the extremities, staggers, ataxia, tremors and convulsions. They further

stated that consumption of very low level of alkaloids (less than 0.02%) are well tolerated by poultry. However, the level of alkaloids in PML as observed in this study was 0.0126% (12.58mg/100g) thus making it safe for consumption by monogastric animals. Thus, the antimicrobial action of the alkaloid (Sofowora, 1982; Ekong, 1989; Ebana *et al.*, 1991) could be leveraged with PML due to the tolerable level of the alkaloid.

Table 2. Phytochemical constituent, minerals and vitamins composition of *Pterocarpus mildbraedii* leaf

Items	Amount
Phytochemical	
Saponin (mg/100g)	23.24±0.11
Alkaloid (mg/100g)	12.58±0.02
Hydrogen Cyanide (mg/100g)	0.36±0.03
Tannin (mg/100g)	95.79±0.04

The amount of saponins in PML was 23.24mg/100g which was in contrast with the value of 1.02%, 1.2%, 5.49% and 6.46mg/100g reported by Dike (2010) and Okerulu et al. (2017), Akinyeye *et al.* (2010) and Ayo-Enwerem *et al.* (2017) respectively. However, in a study by Bera *et al.* (2019), the results revealed that dietary saponin supplementation of 150 mg saponin/kg diet of broiler chicken significantly and progressively decreased the cholesterol, fat content, and peroxide values (after 30 days of 0°C storage) of breast and thigh meat. In another study by Pasaribu *et al.* (2014), saponin was administered within the ranges of 0.125% to 0.25% to broiler chickens that were challenged with *Eimeria tenella*, it was reported that body weight gain was not significantly different from the control. The level of saponin in PML observed in this study was 0.0232% (23.24mg/100g) thus making its utilization safe in poultry nutrition.

The amount of tannins in the leaves was 95.79mg/100g, which was in contrast with the values of 0.28%, 0.47% and 4.15% reported by Dike (2010), Akinyeye *et al.* (2010) and Okerulu *et al.* (2017) respectively. Tannins are a group of polyphenolic compounds commonly found in the plant kingdom (Huang *et al.*, 2018). Because they are antimicrobial, antiparasitic, antiviral, antioxidant, and anti-inflammatory and they can replace antibiotics in chicken feeds (Huang *et al.*, 2018). Tannins alter the digestive processes in ruminants not only by binding food protein (rumen bypass) but also by modulating the rumen microbiota and enhancing the growth of specific bacterial populations (Min and Rhee, 2015). Tannins can also help to reduce the spread of zoonotic pathogens and livestock diseases. Bilic-Sobot *et al.* (2016) found that when swine were given a 1 - 3% concentration of chestnut tannin, the liver was unaffected, but the gut showed alterations such as increased villus height, mucosal thickness, and villus perimeter, as well as reduced large intestinal apoptosis and mitosis. In a similar study, Ebrahim *et al.* (2015) found that applying tannic acid at 1% improved the fatty acid profile of broiler breast muscle, however, there was a decrease in body weight gain and feed consumption. However, the level of tannin in PML as observed in this study was lesser than 1% (0.096%) thus making the utilization safe and could serve therapeutic purposes in monogastric animal production.

The composition of hydrogen cyanide was 0.36mg/100g, which was in contrast with the value of 0.05mg/100g reported by Ayo-Enwerem *et al.* (2017). This value is lower than the recommended cyanide level for animal rations; less than 100mg/kg (Wood, 1992). Cassava meals containing up to 50 mg total cyanide/kg have been fed successfully up to 50% inclusion in broiler diets without any deleterious effect (Leeson and Summers, 2008). This makes the utilization of PML safe for consumption by livestock.

Generally, minerals from plant sources are less bio-available than those from animal

sources (O'Dell, 1983). *Pterocarpus mildbraedii* contained Calcium, Manganese, Sodium, Phosphorus, Potassium, Magnesium, and Iron contents (mg/kg) in a relatively high amount and the leaf is particularly rich in Phosphorus, Iron and Manganese (Table 3). Elements like Magnesium, Potassium, Calcium and Sodium are very low with values of 0.22mg/kg, 0.15mg/kg, 0.33mg/kg, and 0.04mg/kg respectively while heavy metals like Cu, Cr, and Cd were not detected in the leaves.

Table 3. The minerals composition of *Pterocarpus mildbraedii* leaf

Items	Amount
Minerals	
Calcium (%)	0.33±0
Magnesium (%)	0.22±0
Potassium (%)	0.15±0
Sodium (%)	0.04±0
Phosphorus (mg/kg)	8.99±0.01
Manganese (mg/kg)	55.29±0.02
Iron (mg/kg)	749.22±0.03

The sample is a very good source of Calcium and Phosphorus, which are important for strong bones and teeth formation. The values obtained for Calcium, magnesium and potassium were in variance with the findings of Akinyeye *et al*. (2010) and Usunomena and Chinwe (2016) who reported lower values of 128.87mg/Kg (0.13%) and 1283mg/Kg (0.13%) for calcium, 84mg/100mg (0.084%) and 778mg/Kg (0.0778%) for magnesium and 91.64mg/100g (0.09164%) and 1048mg/Kg (0.1048) for magnesium. However, the values obtained for sodium were lower than the values reported by Akinyeye *et al.* (2010) and Usunomena and Chinwe (2016). The variations could be a result of different geographical locations of the sample collection and the nutrient content of the soil where the test samples were harvested. Also, the stages at which the leaves were harvested could account for the variation.

Also, the values obtained for manganese and iron in this study were higher than the values of 4mg/Kg and 146mg/kg respectively as reported by Usunomena and Chiwe (2016).

The high amount of potassium in the leaf suggests that it is a good source of potassium which helps in developing brain function as well as keeps alertness which is a vital function needed in feed seeking behavior of livestock. Zinc present in the leaf is a considerable amount needed in the body's defence (immune) system to properly work since it plays a vital role in cell division, cell growth, wound healing, and the breakdown of carbohydrates. The adequate amount of manganese in the leaf plays a role in fat and carbohydrate metabolism, calcium absorption and blood sugar regulation.

Calcium helps in bone formation and healthy teeth. It is also required for the metabolism of many enzymes and blood coagulation (Grosvenor and Smolm, 2002). Copper is involved in iron and lipid metabolism. It is also involved in connective tissue synthesis and maintenance of heart muscle. Deficiency of copper leads to impaired growth, degeneration of heart muscle, and decreases in immune responses and may lead to increased incidences of infections (Grosvenor and Smolm, 2002). Zinc forms zinc fingers (Zn^{2+} co- ordinate to four amino side chain) which provide structural stability to another 300 - 700 proteins and facilitates the binding of protein to DNA. It is used therapeutically to promote wound healing and in treating gastric ulcers (Delvin, 2006). Magnesium is indispensable as a supplement in the metabolism of calcium, vitamin C, phosphorus, sodium and potassium. It is essential for proper nerve and muscle function effectively helping against stress and depression. Potassium regulates the activity of muscles and nerves because its cations are important in neuron function. It

helps in the maintenance of the body's pH level (Bernadine *et al.,* 2002). Sodium helps to maintain the balance of water, acids and bases in the fluid outside the cell. Iron is a component of haemoglobin and myoglobin. It is required for oxygen and carbon dioxide transport and oxidative phosphorylation (Grosvenor and Smolm, 2002).

The average result of the vitamin composition in PML shows in Table 4.

Table 4. Vitamins composition of *Pterocarpus mildbraedii* leaf

Items	Amount
Vitamin composition	
Vitamin A (IU/kg)	3528.00±2.83
Vitamin B1 (mg/100g)	2.03±0.02
Vitamin B2 (mg/100g)	0.93±0.03
Vitamin B3 (mg/100g)	4.62±0.01
Vitamin B6 (mg/100g)	2.23±0.02
Vitamin B12 (mg/100g)	1.77±0.01
Vitamin C (mg/100g)	12.58±0.06

The presence of vitamin A in the leaves makes them good for the maintenance of the immune system, good vision and also serves as an antioxidant.

The presence of vitamin C in this vegetable shows that the leaves could be used to promote healthy living such as maintenance of tissues, bones and teeth, protection against scurvy and other ascorbic acid deficiency-related diseases

The leaves of *Pterocarpus mildbraedii* Harms were also observed to have adequate minerals and high amount of vitamins A, B1, B2, B5, B6 and C in line with the report of Ujowundu *et al*. (2010).

Conclusion

It can be concluded from this study that *Pterocarpus mildbraedii* leaves are of high nutritional quality especially in carbohydrates, minerals (as indicated in the ash content), micro and macro minerals as well as vitamins but low in crude protein.

However, there should be some levels of caution in its inclusion in monogastric nutrition considering its high level of tannin thus it is recommended that it should be included in minute quantities and basically for therapeutic purposes however, it is safe for ruminants animals as the inclusion of these leaves will help in the effective utilization of dietary protein.

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