Mineral Composition and Anti-Nutritional Factors of *Moringa oleifera* leaves as correlates of adequate Layer Diets

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ABSTRACT

In many countries around the world, Moringa oleifera leaves are eaten by some people in the regions where this plant grows. The study sought to examine mineral composition and Anti-nutritional factors of Moringa oleifera leaves as correlates of adequate Layer Diets. The study was carried out at the Poultry Unit of the Teaching and Research Farm, Department of Animal Sciance, Faculty of Agriculture, Forestry and Wildlife Resource Management, University of Calabar, Calaber, Cross River State – Nigeria. Fresh Moringa oleifera leaves were harvested from Moringa trees and collected at Ugbo Village in Awgu Local Government Area, Enugu State and transported to Calabar. The test material (Moringa oleifera) leaves were dried under shade at room temperature of 32°C by spreading them on concrete slabs and allowed drying for two (2) weeks after which they were milled with a grinder to produce the meal of 0.35mm sieve size. The processed test material (the mealed sample of Moringa oleifera leaf) was bottled in an air tight container for chemical analysis to ascertain its mineral and anti-nutritional factors. The methods of Association of Official Analytical Chemists (AOAC), 2010 were used in determining the nutrient compositions of MOLM and experimental diets. The study concluded that Moringa oleifera leaf meal (MOLM) has high nutritional potential and could be used as an alternative plant protein feedstuff in broiler and layer diets up to 10.00 percent supplementation levels without deleterious effects on growth performance, nutrient digestibility, carcass and blood characteristics of broilers as well as egg quality parameters of layers. One of the recommendations was that there is need to create public awareness of Moringa oleifera leaf meal in the production of poultry birds to farmers for effective commercial production of poultry meat.

KEYWORDS: ***Moringa oleifera*** **leaf meal (MOLM), Mineral composition, Anti-nutritional factors, Poultry birds**

Introduction

The need to develop cheap and readily available alternative feeding material to support animal growth has become imperative. All parts of herbaceous plants as food by humans and animals, whole or in parts are generally considered as vegetables. Vegetables include leaves, stems, roots, flowers, bulbs, seeds and fruits. Vegetables contain water soluble vitamins like vitamin B and vitamin C, fat soluble vitamins including vitamin A and D and also contain a great variety of phytochemical constituents which have being claimed to have antioxidant, antibacterial, antifungal, antiviral and ant carcinogenic properties (Aja *et al.*, 2013).

Moringa oleifera is a fast growing, drought – resistant tree and there are widely cultivated species of the *Moringaceae* family in tropical and subtropical countries around the world. It is grown in India, Africa, South and Central America, Mexico, Hawaii, and throughout Asia and Southeast Asia. It has high biomass production of up to 2-4 ton/year/acre and height that ranges from 5 to 10 m (Fahey, 2005). It can survive in harsh climatic condition including destitute soil without being much affected by drought. It can tolerate wide range of rainfall requirements estimated at 250 mm and maximum at over 3000 mm and a pH of 5.0 to 9.0. *Moringa oleifera* is referred to as the 'drum stick tree' or the 'horse radish tree', whereas in others, it is known as the kelor, marango, mlonge, moonga, mulangay, saijhan, sajna or Ben oil tree (Anwar and Bhanger, 2003). Every part of the *Moringa oleifera* tree, from the roots to the leaves has beneficial properties. It is a multipurpose tree, various parts of which are used as fodder, herbal medicines, spices, food, natural coagulant, necter forbees, fuel and fertilizer. It possesses important medicinal properties which include antibacterial and antifungal activities (Nickon *et al.*, 2003) hepato protective (Pari and Kumar, 2002) and anti-oxidant, anti-inflammatory, anti-ulcer, anti-tumor, hypocholesterimic activity. The leaves, flowers and pods are used as good sources of vitamins A, B, C, and minerals Ca, K, Mg, Fe, Zn, Mn, P, Zn, Na, Cu, and Fe. The leaves are rich in carotene, iron and ascorbic acid. *Moringa oleifera* leaves have wide range of medicinal value including growth promotion and antimicrobial effect (Mbikay, 2012 and Moyo *et al.*, 2011).

Statement of the problem

Leaves of the *Moringa* tree are the preferred part for use in animal diets as leaf meal. Although there exists non or limited knowledge about the nutritional value of *Moringa* leaves that would help to prepare data for feed supplements and alternative non-conventional feed ingredients for animals this paper will go a long way by creating awareness to the public as regards mineral composition of *Moringa oleifera* leaves and anti-nutritional factors of *Moringa oleifera* leaves due to the importance.

Objective of the study

The specific objective of the study is therefore to determine the:

1. Mineral composition of *Moringa oleifera* leaves

2. Anti-nutritional factors of *Moringa oleifera* leaves

Literature Review

***Moringa oleifera* Plant**

Moringa is a perennial non-leguminous browse plant; it grows to the height of 10 to 14cm. it can be reproduced by seed and cutting which form strong branches above the ground when trimmed. It is the plants that grows well in marginal and non-marginal lands and requires modest inputs for cultivation. Traditionally, it is grown as a source of vegetable and aids in the purification of water. Anti-nutritional factors (ANF) otherwise called secondary metabolites found in the plant (Soetan and Oyewole, 2009). These anti-nutritional factors are used as pharmacologically-actives agent in nutrition (Soetan and Oyewole, 2009). This plant is rich in vitamins, minerals, fatty acids and fibre (Olugbemi *et al.,* 2010a: Gafar and Itodo, 2011). *Moringa* seed and leave oil has high medicinal value. Maker and Becker (1996) reported that the green pods and leaves have some substantial amount of vitamin A, C and well balanced of protein profile. This plant has both anti-bacterial and anti-oxidant properties (Patel, 2011).

Nutrition

Generally, nutrition refers to the interrelated steps by which living organisms assimilate food and use it for growth, tissue repairs and replacement of worn-out tissues. Therefore, nutrition of an animal influences substantially the pattern of growth and development of its parts, organs and tissues in an orderly way (Janick., 1976). Variation in growth rate of chickens is due to the imposed variation in feed intake. It is seen that high feed intake encourage faster growth rate relating to body development and conformation. Smith (1990) stated that broiler diets must contain material (nutrients) which are essential for maintenance and growth. Hill (1969) noted that adequate nutrition will provide for various physiological and anatomical features depending on the feeding behavior of the animal and the qualitative distribution of the essential nutrients in the feeding materials. Hill (1969) further observed that the feed consumption of growing birds is in relation to their body size and that there is an increase in feed intake as the birds grow larger in size and older in age. The feed efficiency decline greatly as the birds grow older indicating a progressively higher maintenance requirement of older birds as indicated by the gain in weight per unit feed intake.

Empirical Review

Minerals

Minerals are inorganic elements require for bone formation and well-being of poultry (Holick, 1990). Mineral elements have a great diversity of uses within the animal body. Minerals play a key role in the maintenance of osmotic pressure, and thus regulate the exchange of water and solutes within the animal body. They also help in transmission of nerve impulses and muscle contraction. However, minerals play a vital role in acid-base equilibrium of the body, and thus regulate the pH of the blood and other fluids. Chickens vary greatly according to the purpose for which they have been developed. The major minerals needed in poultry diets are calcium, phosphorus, sodium and chlorine. Trace minerals may be added if feeds grown on soil deficient in them. Sources of calcium in poultry diets are oyster shell, limestone, bone meal, dicalcium phosphate. Inorganic phosphorus supplied by bone meal, dicalcium phosphate, rock phosphate. The calcium requirement of laying hens is very high and increases with the rate of egg production and age of the hen.

Some Vitamins, Minerals and their Deficiency Symptoms (table 1)

Vitamin A	Decrease egg production, weakness and lack of growth.
Vitamin D	Thin shelled eggs, reduce egg production, retarded growth, rickets
Vitamin E	Enlarged hocks, encephalomalacia (crazy chick disease)
Vitamin K	Prolonged blood clothing, intramuscular bleeding.
Thiamine (B_1)	Loss of appetite and death
Riboflavin (B_2)	Curve-toe paralysis, poor growth and poor egg production.
Pantothenic acid	Dermatitis and lesions on mouth and feet.
Niacin	Bowed legs, inflammation of tongue and mouth cavity
Choline	Poor growth, fatty liver, decreased egg production
Vitamin B_{12}	Anaemia, poor growth, embryonic mortality
Folic acid	Poor growth, Anemia, poor feathering and egg production
Biotin	Dermatitis on feet and around eyes and beaks
Calcium	Poor egg shell quality and poor hatchability, rickets
Phosphorus	Rickets, poor egg shell quality and hatchability
Manganese	Poor hatchability and perosis
Iron	Anaemia
Copper	Anaemia
Iodine	Goiter
Zinc	Poor feathering, short bones
Cobalt	Slow growth, mortality, reduced hatchability

Source: Dan (2008)

Mineral composition of *Moringa oleifera* leaves:

The anti – nutritional factors were determined as follows:

Phytates: The method of Maga (1982) was used in determining the phytates content. 202ml of 0.2NHCI was used to soaked two gram (2gms) and thereafter filtered. 1ml of ferric ammonium sulphate solution was mixed with 0.5 ml filtrate and then heated for 30 minutes in a water bath. The sample was centrifuged at 3000rmp for 15 minutes. Phytate content was determined by extrapolation from a curve using standard phytic acid solution.

Tannin content: About 200 mg of sample was added to 10ml of 70 percent aqueous acetone in a properly sealed container. The sealed container was allowed to cool for 2 hours at about 30^{o}C and later centrifuged. 0.25ml of the solution was added to 0.8ml of distilled water through the pipette. 0.5ml of folin reagent was then added to the solution after which 2.5 ml of 20 percent Na_2CO_3 was added. The concentration of tannin was determined following the procedures of Maga (1982).

Saponins: Double solvent extractive gravimetric method (Harborne, 1980) was used to determine the saponin content of the sample was determined by the A measured weight of the processed sample was mixed with 20 percent aqueous ethanol solution in a ratio of 1:10 percent w/v (i.e 5g sample in 50 ml content). The pH was adjusted to 4.5 using dilute NaOH solutions in drops. The saponin content was determined by difference weight samples.

$$\text{Saponin} = \frac{W_2 - W_1}{\text{Weight of sample}} \times \frac{100}{1}$$

Methods

The study was carried out at the Poultry Unit of the Teaching and Research Farm, Department of Animal Science, Faculty of Agriculture, Forestry and Wildlife Resource Management, University of Calabar, Calaber, Cross River State – Nigeria. According to the GeoNames geographical database by Google Earth (2012), Calabar is located at 4.9517° Latitude and 8.322° Longitude (in decimal degrees) with the average elevation/ attitude of 42 meters. Akpan *et al.* (2006) reported that Calabar is located at Latitude 3°N and Longitude 7°E with a landmass of 233.2 sq. miles (604 Km^2) with rainfall of 3000-3500 mm per annum and average daily temperature of 25°C/77°F which increases to 30°C (86°F) in the month of August. The relative humidity ranges from 70-80 percent whereas wind speed direction is 8.10 km/h west and the cloud is broken at 1000 ft with little cumulonimbus 2200 ft. the time zone in Calabar is Africa/ Lagos.

Results and Discussion

Research Objective 1

The result of the mineral composition of *Moringa oleifera* leaf is presented in table 2

The mineral composition of air-dried MOLM is shown in Table 2. Results showed that the leaf contained minerals such as calcium (732.00), iron (184.33), zinc (493.67), copper (49.67), sodium (218.00), and manganese (241.00) in abundance including potassium (25.00) and phosphorus (4.90) mg/100g. the mineral content of MOLM when compared with that of processed water hyacinth leaves recorded higher values of calcium content (600, 620.00 and

67.00 mg/100g for fresh, wilted and sun-cured water hyacinth leaves, respectively) (Mako and Akinwande, 2014).

The content of other mineral elements were however lower in MOLM than in water hyacinth leaf meal. The mineral contents of *Ocimum gratissimum* (calcium, 0.52; iron, 713; zinc, 27.50 mg/100g; copper, 13.70 mg/100g; sodium, 0.76 mg/100g, manganese, 31.30; potassium, 1.34 and phosphorus, 0.34 mg/100g, respectively) as well as *Ocimum sanctum* (calcium, 0.44; iron, 689; zinc, 44.30; copper, 14.20; sodium, 0.69; manganese, 36.50, potassium, 1.41 and phosphorus, 0.25 mg/100g, respectively) reported by Alikwe *et al.* (2013) are far lower than the mineral content of MOLM obtained in this study. The differences in the mineral compositions among MOLM, water hyacinth leaf, *Ocimum gratissimum* and *Ocimum sanctum* in the different respective studies could be attributed to the ash content and processing methods of he different leaf meals. Arseme *et al.* (2005) observed that potassium is the common mineral with sufficient amount in Nigerian agricultural products, but the presence of other minerals showed that MOLM is rich in other minerals which are vital for livestock production, maintenance and survival.

TABLE 2: The mineral composition of air-dried *Moringa oleifera* leaf meal

Mineral element	Values (mg/100g)	SD
Iron (Fe) (mg)	184.33	9.29
Zinc (Zn) (μg)	493.67	4.73
Copper (Cu) (μg)	49.67	4.04
Sodium (Na) (mg)	218.00	2.65
Magnesium (Mg) (mg)	654.67	13.61
Potassium (K) (mg)	25.00	0.100
Phosphorus (P) (mg)	4.90	0.10
Selenium (Se) (mg)	0.24	0.02
Manganese (Mn) (mg)	241.00	8.19
Calcium (Ca) (mg)	732.00	8.19

Values are means of triplicate determinations
SD = Standard deviation

The result obtained from the study has confirm that MOLM is rich in both macro and micro minerals such as calcium, phosphorus, potassium, sodium, magnesium and iron, zinc, copper, manganese and selenium, respectively. Studies have shown that the iron content of MOLM is three times higher than that of spinach, while the potassium content is also thrice higher than that of banana (De Silva, 2010). According to Nuhu (2010) there will be excellent nutritional performance of the birds since deficiencies of these minerals will likely not occur and conditions such rickets in chicks, osteomalacia in adult birds, lowered egg production in hens and thin egg shelled will be adequately addressed. Furthermore, research has shown that leaf meals contain chlorophyll and other phytonutrients that enhance efficient digestion, absorption and use of nutrients from food and other herbs MOLM and other leaf meals also known to have medicinal properties (Alikwe *et al.*, 2013).

Research Objective 2

The result of anti-nutritional factors in air-dried MOLM is presented in Table 3

Oxalate:

Oxalate in MOLM showed a low value of 0.42 mg/100g as compared to 2.38 mg/100g reported by Gupta *et al.* (1989) and 1878.50 mg/1000g reported by Etong and Abbah (2014) in cassava leaf meal. Oxalate value of 0.42 mg/ed100 g is also far lower than the value of 308 mg/100 g in sweet potato leaf meal report by Akwaowo *et al.* (2000). The differences in oxalate value of content among the different leaf meals could be attributed to the processing method. This is similar with the findings of Dei *et al.* (2007) who stated that chemical compositions of most leaf meals may be affected by climate, season and processing methods.

TABLE 3: Anti-nutritional factors (mg/100g) in *Moringa oleifera* leaf meal

Anti-nutrients	Values (mg/100g)	SD
Oxalate	0.42	0.13
Tannins	0.54	0.09
Cyanogenic glycoside	0.06	0.01
Phytates	0.72	0.11
Saponins	4.00	0.36
Polyphenols	5.83	0.31
Alkaloid	1.20	0.08
Simple phenolics	2.93	0.25
Steroids	1.75	0.11
Triterpenoids	1.32	0.11

Values are means of triplicate determinations
SD = Standard deviation

Oxalates form chelates with calcium. Plants with high metabolic calcium deficiency will cause hypocalcaemia when consumed by livestock (Cheeke and Shull, 2003).

Tannins:

The value of tannin in MOLM was 0.54 mg/100g. this value was quite low compared to the tannin content of raw cowpea (3.30 mg/100g) and raw lima bean (2.12mg/100g) (Ologhobo *et al.,* 2004; Oke, 2006). This low value of tannin shows that it may not be harmful to birds. The value obtained was higher than that of *Mucuna pruriens* seed with 0.28 mg/100g (Vijayakumari *et al.,* 1996) and higher than that of soybean, brown millet and sweet potato with values of 0.15, 0.07 and 0.21 mg/100g (Odumodu, 1992; Anita *et al.,* 2006). However, the tannin content of cassava leaf meal (9.70 mg/100g) reported by Fasuyi (2005) is higher than that of MOLM obtained in this study, may be due to the differences in the feedstuffs. Tannis bind protein through hydrogen bonds and hydrophobic interactions thereby reducing the digestibility of protein, carbohydrate and fibre (Jeroch *et al.,* 1993). It also reduces the palatability of feeds due to its bitter and astringent taste, thereby reducing feed intake and performance (FAO, 1996).

Cyanogenic glycosides:

The value of 0.0 mg/100g hydrogen cyanide (HCN) was obtained for MOLM in this study. This value was quite low when compared with the HCN content of cassava leaf meal (52.90 mg/100g) reported by Fasuyi (2005), 30.24mg/100g in sweet potato leaf meal reported by Anita *et al.* (2006) and 48.80 mg/100g in bitter leaf reported by Hill (1987) as well as 0.10 mg/100g *Ocimum gratissimum* reported by Alikwe *et al.* (2013). This suggest that MOLM may not pose a threat of HCN poisoning in birds under normal circumstances. The minimum lethal dose (LD_{50}) of HCN in poultry species is 0.9 mg/100g (Burns *et al*, 1970). The content of cyanide reported for various feedstuffs are 2.10, 2.10, 3.12, 2.30, 2.00 and 0,80 mg/100g for cowpea, lima bean, field peas, kidney bean and chicken peas respectively (Liener, 2006). These values are generally higher than that of MOLM. It is clear that cyanide in MOLM is low and the leaf meal could be a good substitute for plant protein source in broilers and layers.

Phytate:

The value of 0.72 mg/100g phytate in MOLM was obtained in this study. This value was negligible when compared with other feedstuffs as reported by Eka (1980) for white sesame seed (3.40 mg/100g) and black millet (1.57 mg/100g). Odumodu (1992) reported 2/16 mg/100g for locust bean while Anita *et al* (2006) reported 1.44 mg/100g for sweet potato while Fasuyi (2005) reported 102.00 mg/100g for cassava leaf meal. Phytate from chelates which cannot be completely broken down for easy assimilation or absorption in the digestive tract (Mega, 2002).

Saponins:

The value of saponin in MOLM was 4.00 mg.100g, which was within the range (1.74-4.73 mg/100g) reported by Mkpong *et al*, (1990) for cassava leaf meal and far lower than 756.67 mg/100g in cassava leaf meal reported by Etong and Abbah (2014). This wide disparity in saponin content suggested the differences in plant type between Moringa and Cassava leaves in terms of anti-nutrient content. Saponins have a bitter property which determines the palatability of feeds and affects feed intake of animals. The value reported for saponin in MOLM was low and could not have any effect in feed intake even at 10 percent supplementation level. Saponins are known substances that retard growth (Cheeke and Shull, 2003).

Alkaloids and polyphenols:

The alkaloids content of MOLM was 1.20mg/100g. This value is higher than that reported for pigeon pea and lower than cowpea with 0.26 and 9.61 mg/100g respectively (Onwuka, 2006). These differences are attributable to different plant types and associated alkaloid contents. The value of polyphenols was 5.83mg/100g. this value is higher than that of tigernut with 100mg/100g which is one of the unconventional feedstuffs for poultry birds. Iyayi *et al.* (2008) reported that polyphenols are labile to heat and reported up to 70 percent reduction in polyphenols of *Mucuna pruriens and Centrosema pubescence* when heated at $100^{o}C$ for an hour.

Conclusion

The results of this study have confirmed that *Moringa oleifera* leaf meal (MOLM) has high nutritional potential and could be used as an alternative plant protein feedstuff in broiler and layer diets up to 10.00 percent supplementation levels without deleterious effects on growth performance, nutrient digestibility, carcass and blood characteristics of broilers as well as egg quality parameters of layers. MOLM in the diets tend to reduce cholesterol content of the eggs which is beneficial to human health.

Recommendation

Based on the findings of this study, it is therefore recommended that:

1. *Moringa oleifera* leaf meal should be used in both broiler and layer diets as the nutrients would be beneficial to broiler and layer growth.

2. There is need to create public awareness of *Moringa oleifera* leaf meal in the production of poultry birds to farmers for effective commercial production of poultry meat.

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