Nutritional Potential of *Moringa oleifera* Leaf Meal (MOLM) for Broilers and Layer Diets

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ABSTRACT

The study sought to evaluate the Nutritional Potential of Moringa oleifera Leaf Meal for Broilers and Layer Diets. Two research objectives were employed for the study. 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. 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 proximate and vitamins, composition. 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 for aggressive agronomic studies of Moringa oleifera for commercial production of the leaves.

KEYWORDS: ***Moringa oleifera*** **leave meal (MOLM), Proximate composition, Vitamin composition, Broiler and Layer**

Introduction

The production of sufficient meat and milk to commensurate with the protein demand of the teeming population has become a serious challenge to the livestock industry. Therefore, there is a need to harness under – utilized crops of economic importance to the livestock industry to achieve a balance between population growth and agricultural productivity, particularly in developing countries such as Nigeria. In Nigeria, conventional feedstuffs such as maize, wheat, millet, guinea, corn, soybean, groundnut cake, fish meal, cotton seed cake and sunflower meal are becoming increasingly costly and scarce due to high demand among humans and livestock for the ingredients (www.laktobase.at). This problem has initiated the search for alternative feedstuffs for use in animal production especially for poultry species, which are the major source of animal protein in Nigeria. Such alternative feed ingredients should of necessity be available all the year round, less expensive and easy to process into usable forms. Such feedstuffs must be of good quality and should be formulated to provide maximum nutrient concentration obtainable at reasonable cost for maximum growth, production efficiency and utilization at appropriate levels of nutrition for the class of birds to which it could be fed. It must be compounded from ingredients that are known to be safe and acceptable; its physical form must also be appreciated and manageable in terms of handling (Bramadela, 1990). One of the most crucial consequences of intensive poultry keeping is vigorous and careful nutrition for the chicken (Ojebiyi *et al*, 2002). An important part of raising chicken is feeding which makes up the major part of production cost. Good nutrition is reflected in the birds' performance and its products (Cheeke *et al*, 1987; Emiola and Ologhobo; 2006).

Moringa Oleifera is commonly known in English as drumstick. Horseradish or miracle tree. The leaves have good protein that could be used to substitute conventional plant or animal protein sources in monogastric diet such as poultry birds. The Moringa tree can be easily be cultivated in the field because of its unique cropping potential. The tree is also used for forage production. Favourable soil climate conditions enhances its growth hence, forage production does not require expensive inputs. *Moringa oleifera* leaves are potentially less expensive plant protein sources for livestock feed Sarwatt at al. (2004). Moringa have several purposes such as fertilizer production, animal forages, domestic cleaning agent, gum and medicine Fugile (1999). Makkar and Becker (1997) reported that *Moringa oleifera* was first discovered in India and belongs to the *Moringacceae* family. The trees are commonly found in most tropical regions (Fahey *et al*, 2001). The essence of this research therefore was to access the effect of *Moringa oleifera* leaf meal (MOLM) as supplement for soybean meal in broiler and layer diets.

Statement of the Problem

The need to develop cheap and readily available alternative feeding material to support animal growth has become imperative. No research has been done on chemical and the elemental composition of the leaves in the country. Although there exists non or limited knowledge about the utilization of *Moringa oleifera* leaf meal by humans, this paper will go a long by creating awareness to the public most especially the poultry farmers.

Research Objectives

The specific objective of this study was to determine:

1. The Proximate composition of *Moringa oleifera* plant
2. The Vitamin composition of *Moringa oleifera* plant

Literature Review

Origin and distribution of *Maringa olrifera* plant

Maringa oleifera is a browse non-leguminous plant adds nitrogen to the soil through leaf. Fahey *et al*. (2001) documented that Maringa tree can adapt to wide range of soil in the tropics. It is commonly found within the tropical region. *Maringa oleifera* was introduced to the tropics and sub-tropics and it is a native of Northern India and Pakistan (Bosch, 2004). This plant has numerous uses in food, energy and herbal medicine (Fahey *et al*., 2001).

About thirteen species of moringa tree have been identified. Of all the species, only *moringa oleifera* from the family Moringaceae is extensively cultivated (Kristin 2000). All parts of *moringa oleifera* have long been consumed by humans. Grubben and Denton (2004) reported that *Moringa oleifera* leaves contain per 100 g consumable portion: protein 9.4 g, Fat 1.4 g, carbohydrates 8.2 g, total dietary fibre 2.09 g, Water 78.79 g, Energy 26.8 g, Ca 185 mg, Mg 147 mg, P 112 mg, Fe 4.0 mg, Zn 0.6 mg, Vitamin A7564 1U, Thiamine 0.3 mg, Riboflavin 0.7 mg, Niacin 2.2 mg and Folate 40ug. Bosch (2004) reported that the raw fruits of the plant contain per 100g consumable portion: Protein 2.1 g, Fat 0.29 g, Carbohydrates 8.5 g, total dietary fibre 3.2g, Water 88.2g, Energy 15.5kg (37kcal), Ca 30g, Mg 45mg, P 50mg, Fe 0.4mg, Zn 0.4mg, Niacin 0.6mg, Vitamin A 74 1U , Thiamine 0.05mg, Riboflavin 0.07mg, Folate 44ug and Ascorbic acid 141.0mg. Subadra and Monica (1997) reported that sundried leaves retain about 20-40 percent of vitamin A while 50-70 Vitamin A is retained in air dried leaves. According to CSIR 1962, the leaves have substantial amount of ascorbic acid, carotene, protein, and iron.

Agronomy of *Moringa* plant:

Generally, agronomic practices of Moringa plant begins with land preparation and as with other tree crops, harrowing and planting which are the usual practices before planting is done, with accompanying practices of fertilizing, spraying against pest and diseases, planting can be done in ridges or on flat land. For planting on ridges, spacing of 1 metre by 1 metre can be used or 2 metres by 2 metres. In both of these cases, they can be inter-planted with other corps e.g (Bean, Ginger and Yam) as reported by Makkar and Beckar (1997). Its propagation is by direct sowing, cuttings. Makkar and Beckar (1997) observed that the spacing and the population density of moringa plant influences yield.

Uses of *moringa oleifera* in humans, livestock and poultry

In Nigeria, some diseases of poultry set in due to contamination of drinking water by litter materials and faeces. In human, millions of children died yearly because of infectious diseases due to dirty water (Jose *et al.,* 2010). The seeds of *Moringa oleifera* are reported as an ideal water cleanser agent as the conventional cleanser (alum) may be detrimental to health (Ayotunde *et al.,* 2011). Ngaski (2006) reported that about 25 percent substances derived from *moringa oleifera* plants are found in most medicines.

Moringa oleifera leaf has been recently used as one of the antibiotic agents for therapeutic use that treat diseases, prophylactic to improve feed efficiency and performance of livestock animals as there are risks associated with the use of antibiotics. Available literature had shown that some forages leaves have some limitation, due to anti-nutritional factors that might affect production (D'Mello *et al.*,1987). The cytokine – types hormones extract of *moringa* which is 80 percent ethanol enhances plants growth. *Moringa* has also been reported increase the flow of milk let down in the mammary gland (Estrella *et al., 2000*). *Moringa* leaves are consumed by humans to increase milk flow (Fuglie, 2001). Recently, studies have proof that moringa leaves have anti-oxidant properties. It increases natural body defense and stimulates metabolism. It also creates even distribution of cholesterol levels, enhances healthy kidney and liver, aids digestion and regulates blood pressure.

Uses of *Moringa oleifera on* livestock:

Nuhu (2010) reported that offspring of rabbits on *moringa oleifera* leaf meal diet had insignificant effect in total weight gain and crude protein. It was reported that the ether extract values of meat from *Moringa oleifera* diets were reduced when compared to the reference diet. It was also noticed that *Moringa oleifera* leaf meal based-diet had significant depression on parameters such as crude fibre and feed intake, feed efficiency, carcass composition, haematology, cholesterol reduction, total protein, albumin. On the other hand, it was noted that *Moringa olleifera* could partially replace animal protein sources such as fish meal thereby reducing the cost of feed production which will in turn increase the farmer's income (Nuhu, 2010). Adeniji and lawal (2010) also observed the significance of substituting MOLM with groundnut cake in growing rabbits in the cost of production.

Uses of *Moringa oleifera* in poultry:

The use of MOLM based – diets on pullets had been reported by Melesse *et al.* (2011). Results shows that feed intake had significant increase and was comparable to the control diet. The same researcher was also reported that monogastric animals fed MOLM meal based – diets could have higher balanced of amino acid profile than soybean meal. Replacement of moringa leaves with sunflower for laying bird's diets revealed significant increase in daily feed and dry matter intake (Kakengi *et al*., 2007). It was also observed that egg production percentage reduced as MOLM increased in the diet of laying birds. It was reported that 20 percent of MOLM in laying birds diets recorded the best conversion ratio. Olugbemi *et al.* (2010a) documented that 10 percent MOLM to cassava-based broiler at 30 and 40 percent, respectively showed no significant influence on final body weight. The inclusion levels of 5,6 and 10 percent of MOLM in the diets of growing layer chicks, laying hens and broilers respectively had no deleterious effects on performance. MOLM is also fed to ruminants.

Empirical review

Proximate composition of *Moringa oleifera* plant: *Moringa* samples contain total protein average 31.5%. There is no significant difference of protein content of the 3 samples. These results are the same with those of some researchers but vary slightly from those of others. Moyo *et al*. (2011), in their nutritional characterization of *Moringa* leaves from Limpopo province of South Africa, found that samples contain 30% of protein. Oduro *et al*. (2008) found *Moringa* leaves from Kumasi (Ghana) contain average 27.5% of **crude protein** while Ayssiwede *et al*. (2011) found a **crude protein** content of 28.5 for *Moringa* leaves from Senegal. Joshi and Metha (2010) obtain less **crude protein** value of 23.32% for sun dried leaves of *Moringa* from Jaipur, India. Campaore *et al*. (2011) found a greatest protein content of 35.56% of *Moringa* leaves from **Burkina Faso**. In the same country, Yameogo *et al*. (2011) found smaller value of 27% of protein from samples at Ouagadougou. Suchada *et al*. (2010) found the **crude protein** content ranging from 19 to 27% from dried leaves of *Moringa* of eleven regions of Thailand. Mensah *et al*. (2012) in the study of **nutritional value** of Moringa leaves from central Nigeria found only 6.8% of total protein content.

Crude protein: The relative amount of crude protein that *Moringa oleifera* contain when they are grown under optimal conditions is similar for different species. However, the cell composition for a single species may vary significantly depending on the growth conditions. However, under unfavorable conditions these species can accumulate up to 80% fatty acids, 80% hydrocarbons and 40% glycerol, respectively. Environmental conditions (e.g. light, temperature, etc.), nutrients concentration and salinity are among the main factors influencing cellular metabolism and thus dynamic cell composition. Furthermore, during times of crisis (e.g., Second World War) the high crude protein content of green forage crops stimulated interest in the use of leaf protein concentrate for human nutrition (Pirie, 1971). The removal of surplus protein prior to feeding green forage crops to ruminants was proposed as a mechanism to alleviate food-supply shortages in Europe. In this case the primary product of economic value was the green juice fraction. More recently, novel protein foods from plants have been proposed as a protein-rich replacement for meat in human diets so as to reduce the strain that intensive animal husbandry practices pose to the environment. Corn steep water contains substantially more crude protein, ash, phosphorus and lactic acid than CDS, but the low oil levels leave it with low energy content.

Vitamin composition of *Moringa oleifera* plant: All three samples of Moringa exhibit the same levels of chlophyll A, chlorophyll B, total carotenoid and **vitamin C** content. No bibliographic data was found about pigments from ***Moringa oleifera***. Pigments (Chlorophyll A, Chlorophyll B and carotenoids) are pigments which permit plant to realize photosynthesis, the processus that cause light energy to turn into chemical energy in organic compounds. Dere *et al*. (1998) have used three solvents (Diethy ether, methanol and acetone) for the determination of chlorophyll A, B and total carotenoid from four algae species. They found the highest content of chlorophyll A in *Cladophora glomerata* species but they found no significant difference in the chlorophyll B content with the three others species (*Ulva rigita*, *Codium tomentosum* and *Cladosthephus verticilatus*). The β-carotene, a carotenoid, is also known as pro**vitamin A** because it is converted to form **vitamin A** which protect human eyes. There is also no significant difference of **vitamin C** content of the three location samples of *Moringa*. This mean value is average 250 mg/100 g of fresh matter. Vitamin C plays many functions in the human body including antioxidant agent, cofactor for enzymes. The daily requirement of **vitamin C** for adults range from 75 to 125 mg depending of activities.

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. As recorded by 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. Also, Akpan *et al.* (2006) had earlier 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.

Proximate analysis: The methods of Association of Official Analytical Chemists (AOAC), 2010 were used in determining the nutrient compositions of MOLM and experimental diets. The proximate analysis of each sample was carried Crude protein was determined by Micro-kjeldahl method as reported by Pearson (1976) An air oven (Gallenkamp) method at a temperature of 105^0C was used to determine the amount of moisture content. Muffle furnace at a temperature of 550^0 for 4 hours was used in determining the ash content of the samples.

Vitamin analysis: Water and fat soluble vitamins were determined using standard method (AOAC, 2010).

Results/Discussion

Research Objective 1

The result of the proximate composition of MOLM is presented in table 1.

TABLE1: Proximate composition of MOLM (DM basis)

FRACTION	COMPOSITION (%)
Dry Matter (DM)	91.03
Crude Protein (CP)	39.17
Ether Extract (EE)	2.47
Crude Fibre (CF)	5.93
Ash	5.50
Nitrogen Free Extract (NFE)	46.93

The proximate composition of MOLM showed that the crude protein of MOLM was 39.17 percent in this study, which is close to soybean meal that is between 42 and 48 percent but higher than values of African locust been seed with 28.82 percent and Jack bean 27.8 percent (Udedibie *et al.,* 2002). The CP was also higher than the values reported for bitter leaf (25.00 percent), paw – paw leaf (7.00 percent) and mango leaf (16.60 percent) by Domingueze de Maria, *et. al.* (2006) and Durunna, *et al.,* (2011), respectively. Bitter leaf value for crude protein is higher than the values for *Moringa oleifera* leaf meal (19.76, 20.40 and 25.10 percent) earlier reported by Abou-Elezz *et al.,* (2011) and Gadzirayi *et al.,* (2012) respectively in other ecological zones. Furthermore, the crude protein content of MOLM (39.17 percent) obtained in this study is higher than the value (23.61 percent) reported for *Leucaena leucocephala* seed (Abou – Elezz *et al.,* 2011). The Cp content of *Moringa oleifera* leaf meal (39.17 percent) is lower than most of the crude protein values of many conventional feedstuffs such as soybean meal (42-48 percent), groundnut cake (42-44 percent) and dehulled cotton seed cake (50 percent), but higher than that of pigeon pea (*Cajamus cajan*) (24 percent) but almost like that of winged bean (*Phoscarpus tetragonolobus*) (37 percent) (Agwunobi, 2002). This is an indication that MOLM is not a poor source of plant protein as it can meet the required range of protein necessary for poultry birds. The differences in amount of crude protein could be attributed to the variation in soil type, season, geographical location, plant variety and stage of maturity of the leaves.

Ether Extract:

The ether extract (EE) content of air – dried MOLM obtained in this study was 2.47 percent. This value is in range reported by Apata and Ologhobo (2004) for most legume seeds including Bambara nut (6.70 percent), kidney bean (1.40 percent), Lima bean (1.30 percent). Pigeon pea (2.80 percent) and Jack bean (2.50 percent). The value is low when compared with that of soybean (19.10 percent) as reported by Oyenuga (1968). Other observations by Ayssiwede (2011), Gadzirayi *et al.,* (2012) and Zanu (2012) have recorded higher values for ether extract in MOLM (4.82, 5.40 and 3.33 percent) respectively. The variation in ether extract values could be attributed to different plant variety and stage of maturity of the Moringa leaves. This reveals that MOLM is not rich in ether extract (fat). Though, ether extract is useful in diet as it aids the absorption of vitamins such as fat soluble vitamins (Bogert *et al.*, 1994). However, high fat diets should be supplemented with anti-oxidants like vitamin E or ethoxyquin, so as to reduce peroxidation/ rancidity of the feed which may pose adverse effects on animals.

Crude Fibre:

In this study, the value of crude fibre in MOLM was 5.93 percent and was lower than the values reported for bitter leaf (8.50 percent), paw-paw leaf (9.00 percent) and mango leaf (11.53 percent) by Domingueze de Maria *et al.,* (2006) and Durunna *et al.,* (2011). The crude fibre of 5.95 percent is however higher than 4.05, 3.33 and 2.25 percent reported by Ayssiwede *et al.,* (2011), Zanu (2012) and Gadzirayi *et al.,* (2012) respectively for MOLM in different ecological locations. The differences in crude fibre content could be attributable to plant variety, processing method and the growth phase of the leaves during the period of usage. The low crude fibre content in MOLM suggest that it may not cause any deleterious effects on the birds, since poultry species need low fibre diets due to the nature of their digestive tract. The values of crude fibre in MOLM is in line with the nutritional importance of fibre in monogastric feeds. Fibre aids digestion and otherwise acts as diluents in animal feeds (Nsa *et l.,*).

Ash Content:

The ash content in the MOLM was 5.50 percent. This value is lower than that of bitter leaf (13.30 percent), Paw-paw leaf (17.00 percent) as reported by Domingueze de Maria *et al.* (2006) and also lower than 8.48, 9.61, 7.41, and 15.00 percent earlier reported by Ayssiwede (2010). Abou-Elezz *et. al.* (2011), Zanu (2011) and Gadzirayi *et al.* (2012) respectively for *moringa oleifera* leaf meal. The value of ash (5.50 percent) of MOLM is lower than that of *Leucaena luecocephala* (8.27 percent) reported by Abou-Elezz *et al.* (20011). It was relatively low as ash content of leaves is a reflection of their deposits of mineral elements (antia *et al*., 2006). However, the ash content of MOLM is not in the range of 1.50-3.00 percent recommended by pomeranz and Clifton (1981) for poultry feeds. This implied that the level of ash (mineral) content in the MOLM in this study was relatively low compared to others leaf meals but falls with the acceptable limit for poultry feeds, thus would not pose any adverse effect on the birds.

Nitrogen – free extracts (NFE):

The value of nitrogen free extract (NFE) in the MOLM was 46.93 percent. This valued is low compared with the values (71.30, 62.25 and 47.25 percent) in MOLM reported by Nuhu (2010), Ayssiwede (2011) and Zanu (2012) respectively. The valve obtained in this study is however close to the value earlier reported by Zanu *et al.*, (2012). The observed differences in NFE content in MOLM in the various studies could be as a result of agro-climatic conditions and the growth phase at the period of harvest.

Research Objective 2

The result of the vitamin composition of MOLM is presented in table 2.

TABLE2: Vitamin composition of air-dried MOLM

VITAMIN	VALUES (mg/100g)	SD
Vitamin A (iu)	597.00	122.31
Vitamin C (mg/100g)	48.33	6.66
Vitamin E (μg)	27.67	2.31
Vitamin B_1 (mg/100g)	7.73	0.41
Vitamin B_2 (mg/100g)	1.82	0.08
Vitamin B_6 (mg/100g)	1.72	0.03
Folic acid (mg/100g)	0.22	0.01
Vitamin B_{12} (mg/100g)	0.07	0.02
Vitamin D_3 (mg/100g)	0.17	0.04

Values are means of triplicate determinations
SD = Standard deviation

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 was therefore recommended that:

1. *Moringa oleifera* leaf meal could be used up to 10.00 percent in both broiler and layer diets.
2. There is need for aggressive agronomic studies of *Moringa oleifera* for commercial production of the leaves.

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