Heavy Metal Composition of *Moringa oleifera* Leaves and Graded Levels of *Moringa oleifera* Leaf Meal as Determinants of the Growth Performance Characteristics of Broiler Chicken

BY

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ABSTRACT

The study sought to determine the Nutritional Potential of Moringa oleifera Leaf Meal for Broiler and Layer Diets. Two research objectives were posed and addressed in the study. The area of the study was 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 it's metal composition. The methods of Association of Official Analytical Chemists (AOAC), 2010 were used in determining the effect of graded level of MOLM on growth performance of broiler chickens. The study concluded that Moringa oleifera has the potential of reducing the feeding cost of broilers. *The study also recommended that accurate information and or relevance instructional materials should be provided to poultry famers to enhance Moringa oleifera leaf meal feeding on birds.*

KEYWORDS: *Moringa oleifera* leaf meal (MOLM), Metal composition, Broiler chicken, Growth performance, and Nutrition

Introduction

Moringa oleifera Lam. (family of *Moringaceae* and genus, *Moringa*) is a useful plant for commercial meat production. In a study conducted by (Ghasi, Nwobodo, Ofili 2000) the leaf extracts have hypocholesterolemic and hypolipidemic effects. According to (Vongsak et al., 2013), the leaves have been reported to have antioxidant, hypoglycemic and antiatherosclerotic activities. The seed extracts showed antispasmodic, anti-inflammatory and diuretic activities. Furthermore, the seed extract has been shown to have ameliorative effect on liver fibrosis in rats (Hamza 2010). A recent study of the nutritional value of *Moringa oleifera* leaves found that the dried leaves are composed of amino acids such as alanine, threonine, tyrosine, methionine, valine, phenylalanine, isoleucine, leucine, histadine, lysine, tryptophan, and cystine, fatty acids such as α-linolenic acid, heneicosanoic acid, γ-linolenic acid, palmitic acid, and capric acid, and several minerals such as calcium, phoshorus, magnesium, potassium, sodium, sulphur, zinc, copper, manganese, iron and selenium. Moreover, the leaves also reported to consist, vitamin A, vitamin E, β-carotene, fiber, condensed tannins, and polyphenols (Moyo, Masika, Hugo, and Muchenje 2011). The phytochemical investigation for bioactive compounds of Moringa oleifera seeds showed the presence of glycosides such as 4-alpha-L-rhamnosyloxy-benzylglucosinolate, niazimicin and niazirin, beta-sitosterol and moringa oil (Hamza 2010). In summary, the nutritional characterization of leaves and seeds from *Moringa oleifera* indicated that they are rich in nutrients and possess some medicinal properties. Therefore, leaves and seeds of *Moringa oleifera* were prepared for herbal medicines, dietary supplements, and functional drinks.

Statement of Problem

The increase in the cost of poultry products is influenced by the increase of feed cost. The successful investigation of *Moringa oleifera* plant will add to the feed resource available to the livestock industry in Nigeria. With its inherent high yield, high protein content, tolerance to wide variety of soil, resistance to most common pests, easily accessible and locally available, successful utilization of MOLM in this study will contribute to solving the crucial problem of scarcity and increased feed ingredient prices in the livestock industry.

Research Objectives

The objective of the study was to determine the:

1. Heavy metal composition of *Moringa oleifera* leaves.
2. Effect of graded levels of *Moringa oleifera* leaf meal on growth performance characteristics of broiler chicken.

Literature Review

Poultry nutrition

Poultry refers to all birds kept or reared for economic value e.g. chicken, turkey and ducks (Oluyemi and Roberts, 2000). Most poultry birds are domesticated for the major reasons of supplying meat, egg and money (Obioha, 1992). Poultry keeping was done at subsistence level under the extensive system but with commercialization, resulting from increased demand caused by rising human population, large number of birds running into millions are now reared indoors intensively (North and Bell, 1990). This nutrition is only balanced when the six classes of nutrients are presented in the right proportions.

Poultry production is more than day to day feeding of birds; it involves giving a balanced diet for proper functioning. To achieve market weight of poultry-broilers and turkeys on time, good management and proper nutrition is required. Also, the nutrients requirement of the laying flocks must be met for a productivity to be realized. In humans, well balanced diets is needed by the body on a daily basis for maintenance and physiological processes. Similarly, poultry require balanced diet for optimum growth, maintenance and production (myimsservice.com) therefore, livestock farmers should know the nutrient requirements of birds for growth, eggs, breeding and maintenance. It is also important for poultry farmers to know the limiting factors of feed ingredients which could limit its usage in monogastric diets (Cheeke *et al*., 1985; Emiola and Ologhobo; 2006). Poultry are efficient converter of feed into useful products such as meat and eggs. They have high metabolic rate which require high nutrient feeds. Poultry require about 38 dietary nutrients in the right proportion (NRC, 1994).

Protein

Proteins are essential nutrients needed by the animals for growth and development. Proteins are the major constituents of all body cells and the most abundant kind of molecules in the body (Berthold, 1991). It enhances growth and repairs the tissues. Protein can be found in wide range of food such as grains, nuts, fish meal, meat meal, legumes and crayfish dust. They are polymer chains made of amino acids. (Aarnink and Verstegen, 2007) reported that amino acids are carried to all part of the body through the blood. Plant protein can come directly or indirectly as by-products such as soybean meal, cottonseed meal, peanut meal which high protein contents. Majority of these by-products have edible oil extracted from oil seeds. Proteins of animal sources are usually by-products of feed processing which includes fishmeal (Aarnink and Verstegen, 2007). Protein or amino acid digestibility varies with different sources of protein used in compounding feed. It has reported that animal proteins are more digestible than plant. NRC, 1980 reported that nutrient compositions of chicken are approximately 85 percent ingredient bioavailability.

Carbohydrates

Carbohydrates are composed of carbon, hydrogen and oxygen. They provide energy to all cells in the body and produce B complex vitamins made by beneficial bacteria in the body. They constitute about 75 percent of an animal's diet. Carbohydrates may be either simple or complex. Simple carbohydrates are easily digested and found in cereals. Most of the carbohydrates in poultry diet are provided by cereal grains (Parr *et al.*, 1998). Carbohydrates occur in various forms such as starch, cellulose, hemicelluloses, pentosans, oligosaccharide, stachyose of which starch can be easily digested by poultry.

Fats and Oils

Moringa seed contains mostly oils which are important source of energy in feeds but may effect upon other feed constituents as well as digestive processes (McDonald *et al.,* 1991). The fat present in the meat of monogastrics reflects the type of oil contained in the diet fed to the animals (Obioba, 1992) but that of moringa leaf contains unsaturated type which is desirable to livestock therefore acceptable for use in poultry feeding. Poultry can tolerate small quantity of fats and oils but may have an effect upon other feed constituents as well as digestive processes (McDonald *et al.,* 1991).

Empirical Review

Heavy metal composition of *Moringa oleifera* leaf meal

According to (NRC 1980), heavy metals are defined as any metallic chemical substance with relatively high density, atomic weights or atomic number. The heavy metals include lead, selenium and calcium. Chromium III is required as a micronutrient in human and animal nutrient (NRC, 1980). Poultry production and alleviate protein deficiencies in Nigeria, it is therefore necessary to check the new materials/ingredients used in compounding feeds for animals which are made of various origin since birds are exposed to various anthropogenic pollutants which could affect the food chain through feeds (NRC, 1980). Heavy metals have some trace amount of toxic substances through some of them have nutritional benefits (Henry and Miles, 2001).

Effect of graded levels of *Moringa oleifera* leaf meal on growth performance characteristics of broiler chicken.

Scarcity of conventional feed ingredients and rising cost of poultry feed have compelled researchers in developing countries to direct their attention to non-conventional feeds, with particular emphasis on protein substitute (Gadzirayi et al., 2012). *Moringa oleifera* is among plants that can be used as a cheap protein supplement to improve digestibility of other diets. *Moringa oleifera* is native to India, Red sea, and some parts of Africa including Madagascar (Onu and Aniebo, 2011). *Moringa oleifera* tree contains high crude protein (CP) in the leaves (125 kg DM) and negligible content of tannins and other anti-nutritive compounds. It offers an alternative source of protein to ruminants and non-ruminants. Half the protein content can be extracted from the leaves in the form of a concentrate that can be added to chicken feed (Onu and Aniebo, 2011). According to Fuglie (2013), the nutrient value of *Moringa oleifera* leaves can be increased for chickens through the addition of phytase to break down phytate leading to increased absorption of phosphorus. If uncontrolled, raw Moringas added to poultry diets can be dangerous because of high bio-availability of protein, therefore particular care must be taken to avoid excessive protein intake (Gadzirayi et al., 2012). The serum is the plasma content of the blood which lacks coagulating factors. It is similar to intestinal fluid in which the correct composition of key ions acting as electrolytes is essential for normal functioning of muscles and nerves. Other components in the serum include proteins which assist with maintaining pH and osmotic balance while giving viscosity to the blood; antibodies, or specialized proteins that are important for defense against viruses and bacteria; lipids, including cholesterol, which are transported in the serum; and various other substances including nutrients, hormones, metabolic waste, and external substances such as drugs, viruses and bacteria (Martin, 2007).

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, Calabar, 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. 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. Other feed ingredients were procured from the local markets in Calabar Metropolis. 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.

Results/Discussion

Research objective 1: The results of the heavy metal composition of *Moringa oleifera* leaves

Heavy metals composition

The heavy metal composition of air-dried MOLM is shown in Table 1. The result showed lead (0.00), mercury (0.00), chromium (0.00) and negligible values of cadmium (0.02) and arsenic (0.01); compared to the values for chromium (0.05), lead (1.70) and cadmium (0.05) mg/100g in *Ocimum gratissimum* reported by Alikwe *et al.* (2013). These elements are detrimental to animals and human health (Li *et al.*, 2005). Most of these heavy metals are ingested through food in diets and they vary from place to place (Louekakri and Salminen, 1986). Also the accumulation of these heavy metals in ovaries and uteri may have negative impact on reproduction (Smith, 1986; Costa, 2000). The absence of most of the heavy metals in MOLM makes it quite safe for animals.

TABLE 1: Heavy metals composition of *Moringa oleifera* leaf meal

Mineral element	Values (mg/100g)	SD
Lead (Pb)	0.00	0.00
Mercury (Hg)	0.00	0.00
Arsenic (As)	0.01	0.00
Cadmium (Cd)	0.02	0.01
Chromium (Cr)	0.00	0.00

Values are means of triplicate determinations
SD = Standard deviation

Performance characteristics of the experimental broiler birds (starter phase):

The performance of the broiler birds at starter phase fed graded levels of *Moringa oleifera* leaf meal is presented in Table 2.

Feed intake

The average daily feed intake (22.03 – 30.40 g/bird) at starter phase showed significant ($P < 0.05$) effect among dietary treatments. The highest daily feed intake (30.40 g/bird) was recorded in birds T_2 with 2.50 percent MOLM compared with the value (22.03 g/bird) in the control (T_1). Birds in T_3, T_4 and T_5 with 5.00, 7.50 and 10.00 percent MOLM recorded daily feed intake of 26.52, 29.11 and 25.58 g/bird, respectively. The values for daily feed intake in this study are almost similar to the range (27.50 – 35.83 g/bird) documented by Ijaiya *et al.* (2011) who fed rubber seed meal as replacement for soybean meal to broiler starter chicks. These observed variation in feed intake of birds at the starter phase by others workers could

be attributed to dietary effect due to different feed ingredients and methods of processing the test materials.

Body weight gain

At starter phase, the total weight gain was significantly ($P < 0.05$) influenced between dietary treatments. Birds on T_2 with 2.50 percent MOLM recorded the highest total weight gain (455.60 g/bird) compared to birds on the references diet T_1 (405.00 g/bird). Birds on T_3, T_4 and T_5 fed diets containing 5.00, 7.50 and 10.00 percent MOLM recorded total weight gain values of 349.70, 437.60 and 409.40 g/bird respectively. However, the results from T_1 and T_5 were similar for average daily weight gain which followed a similar trend with the total weight gain.

Research Objective 2: Effect of graded levels of *Moringa oleifera* leaf meal on growth performance characteristics of broiler chicken. The result of the effect of graded levels of *Moringa oleifera* on growth performance of broiler chicken

TABLE2: Performance of broiler starter birds (0 – 4 weeks) fed graded levels of *Moringa oleifefra* leaf meal (MOLM)

Dietary Levels of MOLM						
Parameters	T_1 0%	T_2 2.50%	T_3 5.00%	T_4 7.50%	T_5 10.00%	SEM
Av. Initial body wt.(g)	43.50	43.50	43.50	43.50	43.50	0.00
Av. Final body wt. (g)	448.50^{ab}	499.10^{a}	392.30^{b}	481.10^{a}	452.90^{ab}	8.10
Total wt. gain (g)	405.00^{b}	455.60^{a}	349.70^{c}	437.60^{b}	409.40^{b}	7.98
Av. Daily wt. gain (g)	14.48	16.27	12.49	15.63	14.63	0.64
Av. Feed intake (g/day)	22.03^{b}	30.40^{a}	26.52^{ab}	29.11^{ab}	25.58^{ab}	2.75
Feed conversion ratio (g feed/g wt (g)	1.52	1.87	2.10	1.87	1.99	0.12

$^{a, ab}$Means within the same row with different superscripts are significantly different ($P<0.05$)
SEM = Standard Error of Mean

The highest daily weight gain (16.27 g/bird) was also recorded in birds on T_2 with 2.50 percent MOLM, while the least value (12.49 g/bird) was recorded in birds on T_3 with 5.00 percent MOLM. This growth pattern could be attributed to the rate of feed consumption as birds fed T_2 recorded the highest feed intake. The range of values for average daily weight gain (12.49 – 16.27 g/day) obtained in this study is lower than the range (26.52 – 27.31 g/bird) observed by Ijaiya et al. (2011) who fed rubber seed meal as replacement for soybean meal to 4 weeks old broilers birds. The differences in weight gain could be attributed to the effect of different test ingredients used in the separate studies. The presence of anti-nutritional factors some of the ingredients used in ration formulation may have been responsible for the reduced growth rate of broilers due to reduced protein and poor amino-acids utilization (Elkin et al., 2005). With the reduced availability of nutrients, animal consuming diets with some levels of anti-nutritional factors may not be able to meet their nutrient requirements for building up of tissues (Fanimo et al., 2007).

Conclusion

This paper has discussed among others the various nutritional potential of *Moringa oleifera* leaf meal. It was very clear from the result obtained that MOLM can be used in broiler ration up to 10.0% level without adverse effect on performance. It has the potential of reducing the feeding cost of broilers.

Recommendation

Based on the findings of this paper the following is recommended

1. Accurate information and or relevance instructional materials should be provided to poultry famers to enhance *Moringa oleifera* leaf meal feeding on birds.

2. Moringa oliefera leaf meal should be employed in the feeding of poultry birds so as to survive the increase in cost of feed.

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