Graded Levels of *Moringa Oleifera* Leaf Meal as a Determinant of Egg Production Performance of Layers/Egg Quality Parameters and Haematological/Serum Biochemical Characteristics of Broilers and Layers

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ABSTRACT

This study sought to examine the graded levels of moringa oleifera leaf meal as a determinant of egg production performance of layers/egg quality parameters and haematological/serum biochemical characteristics of broilers and layers. To carry out the study, two research objectives were employed. 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 the effect of graded levels of Moringa oleifera leaf meal on egg production performance of layers and egg quality parameters and the effect of graded levels of Moringa oleifera leaf meal on the haematological and serum biochemical characteristics of broilers and layers. The methods of Association of Official Analytical Chemists (AOAC), 2010 were used in determining the nutritional compositions of MOLM and experimental diets. The study concluded that Feeding of MOLM in the present study improves the shelf life of an egg by minimizing the rapid increasing of the yolk. During storage of eggs, the albumen increases and this is thought to be related to the deterioration of albumen quality. One of the recommendations made was that Moringa oleifera leaf meal could be used up to 10.00 percent in both broiler and layer diets.

KEYWORDS: *Moringa oleifera* leaf meal (MOLM), Broiler and layers, Egg production, Haematological and Serum biochemical characteristics

Introduction

The poultry industry is one of the fastest growing animal industries globally, but is hampered by a heavy shortage of feed ingredients especially in developing countries (Al-Harthi *et al*. 2009). Thus, it is essential to explore the non-traditional feed resources which could be used in poultry feed formulations (El-Deek *et al*. 2010). *Moringa oleifera* Lam., or known as drumstick tree, is a multipurpose tree that thrives in both tropical and sub-tropical conditions (Worku 2016). *Moringa oleifera* leaf (MOL) is reported to contain 25–27% crude protein (Gadzirayi *et al*. 2012) and high levels of minerals as well as vitamins (Yang *et al*. 2006). The protein quality of MOLM has been reported to be comparable to that of milk and eggs (Fahey 2005). Kakengi *et al*. (2005) compared the nutritive values of different morphological components of MOL with Leucaena leucocephala leaf meal in Tanzania and they observed a high level of pepsin and total soluble protein in MOL. Previous study also showed that MOL contains high level of antioxidants such as flavonoids (Vongsak *et al*. 2013). Several studies showed that animal performance could be improved by dietary supplementation of MOL. An improvement in egg production, yolk colour and feed conversion ratio were observed in Rhode Island Red hens supplemented with MOL (Mohammed *et al*. 2012). The addition of MOL powder to the diets was associated with increased weight in broilers (Donkor *et al*. 2013). In a recent study, Kholif *et al*. (2015) observed an increased feed intake, nutrient digestibility and milk yield in goats fed diets including MOL. The effect of MOL was proven to be dosage related and a higher supplementation level could lower animal performance due to the increased concentration of anti-nutrient factors (such as saponins and phenols) (Worku 2016). Several studies showed that animal performance could be improved by dietary supplementation of MOLM. An improvement in egg production, yolk colour and feed conversion ratio were observed in Rhode Island Red hens supplemented with MOL (Mohammed *et al*. 2012). Similarly, Davtyan *et al*. (2006), Petrosyan *et al*. (2006), Hanafy *et al*. (2009) and Agate et. al., (2000) reported that organic selenium supplementation of laying hens diets improved the environment of the sperm storage tubules in the hen’s oviduct, allowing the sperms to live longer, increasing the length of time the sperms can be stored and increasing the number of sperm holes in the yolk layer. Supplementation of plant leaves containing selenium increased fertility and hatchability % (Osman *et al*. (2010). Liao *et al*. (2013) also concluded that eggshell thickness affected hatchability. The physical characteristics of the egg like weight, shell thickness, length and width and shape index play an important role in the embryo development and successful hatching (Narushin and Romanov, 2002).

Statement of the Problem

Poultry industry is one of the fastest growing animal industries, which has greated massive employment to millions of people globally. Despite the role poultry production plays in the economy it is hampered by a heavy shortage of feed ingredients especially in developing countries. Due to this decrease/shortage of feed ingredients, it effects proximately reduces the egg production/quality of broilers and layers. Recently, *Moringa oleifera* leaf (MOL) has been reportedly seen to enrich our birds with the required crude protein, minerals as well as vitamins. But it is not properly maintained or grown and it seems that farmers are not aware of this beneficial leaf in most developing countries, and this has posited a lot of deficiency to our birds. Thus, it is on this ground that this study is conducted to examined the graded levels of *moringa oleifera* leaf meal on egg production performance of layers/egg quality parameters and haematological/serum biochemical characteristics of broilers and layers.

Research Objectives

The following objectives were formulated to examine the:

1. Effect of graded levels of *Moringa oleifera* leaf meal on egg production performance of layers and egg quality parameters
2. Effect of graded levels of *Moringa oleifera* leaf meal on the haematological and serum biochemical characteristics of broilers and layers.

Literature Review

Inter-relationship of Poultry Production and Nutrition

There is no doubt that a well-nourished bird is healthier and able to produce and cope or withstand diseases challenges than those on poor quality feeds. Church (1993) stated that inadequate nutrients in feeds would lead to reduction of weight, infertility, stunted growth and less immunity to diseases. Also, birds that perform optimally in terms of meat or egg production mist be given good quality feed containing feed ingredients that will meet the animals' nutrient and physical needs when consumed inadequate quantities (Orr and Hunt, 1984). Also, Butcher (2006) emphasized that the nutrients requirement of animals should be met for optimum growth and other productive performances to be achieved. Broilers production is one of the cheapest ways of producing high quality animal protein at a reduced cost (Awesu *et al.* 2000). Broiler keeping has improved tremendously in the country in recent times due to a better understanding of management practices among poultry farmers. Broiler production does not appear profitable when conventional rations utilized by other livestock are used for its production. In cockerel diets, the bulk of protein supplied by either soybean or groundnut cake is seriously being competed for by man and livestock since the use of soybean or cottonseed in ration formulation has become expensive because of their scarcity. This was also reported by Awesu *et al.* (2000) that acute shortage and high prices of feed ingredients are responsible for the present rise in prices of poultry and other livestock feed in Nigeria such as meat and eggs. It is also noted that industrial by-products such as feather meal could serve as major ingredients in the poultry feed industry. Therefore, intensive research estimate of nutritive values and positive checks should be done on the limitation arising from their scarcity. (1997) reported that nutritional, physiological and metabolic effects of fibre consistently vary with fibre type. Onifade and Babatunde (1998) observed that agro-industrial by-products though potentially valuable as feedstuffs, nevertheless, have the problem of lignifications and associated barrier to microbial digestion to contend with (Awesu *et al.* 2000).

Alternative Leaf Meals

Conventional feed resources become imperative costly and scarce, therefore alternative feedstuffs such as bitter leaf, neem leaf; sunflower leaf, cassava leaf and *Moringa oleifera* leaf which are rapidly available have been extensively used in poultry production. Esonu*et al.* (2008) reported higher values of crude protein when neem leaf was fed to broiler birds as compared to the reference diet. However, Sokumbi *et al.* (2003) reported a lower crude protein value in the same broiler birds but the argument was that it was due to the age of the leaf which was also applicable to other parameters such as feed convention ratio, weight gain and feed intake. Some changes were also noticed when bitter leaf (*Venoniaamygdalina*) leaf meal was fed. There was also a better performance in the birds haematological components and feed efficiency (Dibner and Buttin, 2002; Pangasa*et al.,* 2007; Singla*et al.,* 2007).

Prospect of Non-Conventional Feed Sources

The use of non-conventional feed sources in poultry diets has a lot of advantages; it serves as scarce foreign exchange earnings by stopping the importation of costly feed items like cereals, milk powder, fish meal, soybean which are scarce due to competition between humans and livestock. There is a strong competition for conventional feed resources between human and animal (Ojebiyi*et al.,* 2002). The use of less competitive feeds for monogastrics will ensure more availability of conventional feed for human consumption. Another issue is the generation of more employment opportunities through processing of non-conventional feedstuffs to feed industries. Most of the conventional feedstuffs are generally scarce during off season thereby causing scarcity of such feedstuff but leaf meals like *Moringa oleifera* are always available in the field all year round. Consequently, their prices may remain stable and will be available as feed source for livestock (Eteshola and Oraedu, 1996).

Constraints to the use of Non-Conventional Feed Resources

Agwunobi (1990) noted that most of these non-conventional feed resources could be utilized by pigs and poultry, but their incorporation in feed/ diet is constrained by a number of factors which may be nutritional factors (fibre content and chemicals compounds) and socio-economic factors. Their opportunity value for human food, transport, processing cost and limited shelf life because of high moisture content become a limitation. The high demand for some conventional food resources as staple food (cassava, soybean, cowpea, sweet potato) for man makes them unattractive feedstuffs for animals. The need for processing may be another limitation. Many non-conventional feeds have high moisture content such as root/tuber crops which include cassava, yam, and cocoyam etc, fruits like plantain, banana and sugarcane (North and Bell, 1990). It is therefore not convenient to incorporate high moisture feeds in large scale to livestock-feed installations which usually are designated to use dry feeds because of the moisture content which can pose problem to the animal. It is not also economical to dehydrate such feeds either. Another constraint the use of non-conventional feedstuffs in a large scale is their relative high fibre content. The truth about modern breeds of poultry that have been selected to perform in an environment where all factors especially nutrition is optimized. Nutrition bring about high productivity and their productivity fall due to susceptibility to diseases and when they are fed with ration of low protein content (Agwunobi, 1990).

Conventional Protein Feedstuffs in Poultry Nutrition

Much of the cost of poultry production is attributable to protein source, especially that of animal origin, protein feed source is made up of plant and animal protein. Plant protein comprises of groundnut cake, sunflower meal etc., while animal protein includes fish meal, blood meal, feather meal etc. Feedstuffs are broadly grouped into conventional and non-conventional (Igene, et al., 2002). The conventional feedstuffs (cowpea, soybean, cotton seed cake, fish meal and blood meal) are of high quality, containing most of the nutrients and higher amino-acid profiles. They are highly competitive and most of them are staples which are mostly available in the processed form (Agwunobi, 1992). However, most of the conventional feeds experience frequent shortages, high cost and unavailability at some season thereby raising production cost, causing meat products to be unavailable to Nigerians (Ojebiyi, et al., 2002). It therefore becomes imperative that cheaper alternative feedstuffs locally available be used in place of scarce and costly conventional feedstuffs in feed formulation for poultry birds (Ani and Okorie, 2002).

Non-conventional Protein Sources

Non-conventional feedstuffs such as bitter leaf meal, paw-paw meal and mango are currently under – utilized in feed formulation. The feedstuffs are not readily used in livestock feeding trials and are used in minute's quantities for animal feeds, due to their deficiencies in fermentable energy; some have low organic matter and mineral contents. They also have storage problem that makes processing methods difficult (Agqunobi, 1990). The amino-acid profiles of some of the non-conventional feedstuffs are consequently low compared to most of the conventional feedstuffs as earlier mentioned.

Empirical Review

Nutrition as it affects Egg Quality

Nutrients primarily involved in the formation of a strong shell are calcium, phosphorus, magnesium, zinc, manganese, chlorine, potassium and vitamin A and D (Wooldfords, 1985). Laying hens basically exhibit two peak feed consumption periods – one at the time of lay and the other, late in the afternoon (Williamson and Payne, 1978). Further report indicated that high energy diets (12.00 – 12.5 MJ/Kg), clean fresh water (about 500 ml) and fresh green feeds (3 kg/100 birds per day) should be given daily to laying birds to improve egg production while oyster shell should also be included in the diets to prevent production of broken and cracked eggs.

Ousterhout (2001) stated that the size of the egg is directly related to protein level in the feed of the bird. A decrease in dietary protein from 16 – 11.5 percent significantly reduced egg weight within eight (8) weeks of lay. Increase the dietary protein level from 16-20 percent does not significantly increase egg weight either but the optimum dietary protein level should be 16 percent (Williamson and Payne, 1978). Egg shell thickness is directly related to the deposition of calcium levels in the diet. Researchers have shown that plateau of shell deposition of 2.5 percent and 4.0 percent, constitutes lower end of the range for bird laying at the range of 60 – 70 percent and higher end of the range for hen laying at 70 – 80 percent respectively (Summers and Leeson, 1993; Brown, et al., 2000; Ousterhout, 2001). A level of 0.4 percent of total phosphorus is required for the correct maintenance of egg production and shell quality (Wooldfords, 1985).

However, excessive quantities of dietary phosphorus results in reduced shell thickness (Taylor, 1965; Shen et al., 1980; Wooldfords, 1985).

Vitamin A is responsible for the coloration of the yolk, while Vitamin D_3 is needed for normal egg production and adequate quality of calcium and phosphorus utilization is for egg shell and bone formation (Taylor, 1965; Wooldfords, 1985). Water is perhaps the most important substance that influences egg size, while inadequate water intake during plumping of albumen and after oviposition has an effect on egg size (Karunajeewa, 1980).

Physical Characteristics of Poultry Egg

Physical characteristics of poultry egg stands out as a primary trait of interest to egg procedures, such as egg size, shell color and thickness, egg weight are all of importance in determining acceptability by consumers. In commercial egg business, the farmer's interest lies in the following economic parameters; egg number, egg size, egg weight as well as body weight and egg conversion efficiency of poultry species. Poultry egg is unique in human diet, it appears to be the most eaten and relished in the world and also the most perfect, naturally occurring protein for man. Egg serves as a yardstick of perfection against which other protein foods are measured (Panda, 2000). The physical characteristics of eggs are affected by breed as well as environment (Essien, 1989).

Egg quality is the sum total of both the external and internal characteristics which affect the visual appeal of the egg to the consumer to meet the nutritional standard (Oluyemi and Robert, 1988). Quality traits commonly used in the assessment of poultry eggs include, egg shell thickness, percentage weight and laugh unit (Hu) is a product of albumen height and the weight of the egg. Most commonly employed to measure the internal egg quality. Doyon *et al*. (1980) reported that mean haugh unit decreases with age of poultry species. Hill *et al.* (1980) and Klain and Jaeger (1990) demonstrated that variability of haugh unit increases with age of poultry species.

Egg size is another important characteristic which affect the economy of the poultry enterprise; small sized eggs may be caused by usually small ova which did not attain proper size before ovulation (Obioha, 1992). Egg laid at the point of lay is generally smaller than those at the tail end of production (Williamson and Payne, 1996). It is of note that nutritional imbalance such lack of proper diet can also affect egg size. Singer (1976) observed that an exotic chicken weighs 55.58g and regarded this as standard. Ofobruketa (1991) and Odunsi *et al.* (2002) reported a yolk weight of 13.52g for local chicken but a higher value of 17.60g was obtained by Ayerinde (1987). Albumen weights of 33.81g, 34.70g and 33.68g were reported by Ofobruketa (1991). Ayorinde (1999) and Olayemi *et al.* (2007), respectively.

The thickness of shell is a good indicator of shell strength which helps in preventing loss of content and minimizing spoilage by contaminating from microbes. Patil *et al.* (1980) reported egg shell thickness of 0.34mm for chicken egg while 0.33mm is a minimum thickness to be able to move through normal market handling. Card and Nesheim (1972), Jull (2004) and Fletcher *et al.* (2007) observed that the egg white weight is highly correlated with the weight of the egg. Albumen weight itself is enough index to measure the quality of an egg at the weight of 49.61g. An egg is at its highest quality at the time of lay. If eggs are broken out after one hour after lay, there is significantly more thin albumen than in eggs broken out after 24 hours of storage period

(Essien, 1989). Essien (1989) further attributed this to osmotic pressure differences between the albumen and yolk height which are directly related to egg quality. Egg shell thickness determines the degree of resistance of the egg to breakage. Improvement in shell strength can be achieved by ensuring that layer rations contain the right amount of calcium (Oluyemi and Roberts, 2000). Egg laid prematurely is usually covered with a membrane or with soft shell, as the amount of shell deposition is an index of time in the uterus (shell gland). It appears that hard shelled eggs have minimal stay of 20 hours (Cole and Garret, 1974). According to acceptable level and is also an indication of freshness of egg.

Egg Composition

Jones (1995) reported that avian egg is made up of small reproductive cell quite similar to that of mammals. Whereas chicken egg consists of cell surrounded by yolk, albumen, shell membrane, shell cuticle. The ovary is responsible for the formation of the yolk. The remaining portion of the egg originates in the oviduct (Jones, 1995). Water makes up of about 65 percent of the shelled egg. The albumen is high in water content; the solid portion is almost protein with a small amount of carbohydrate. The yolk is composed of about half water; the solid portion is made up of high amount of fats, vitamins, proteins, minerals (Oluyemi and Roberts, 2000). Abdelsamie *et al.* (2006) observed that the age of hen affects egg composition. It was also observed that as laying flocks is ageing there is an increase in egg weight, dry weight and the percentage of yolk, while the percentage of shell, albumen solid decreases.

Adegbola and Olatoke (1998); Durunna *et al.* (1999) and Ezieshie *et al.* (2001) noted further that altering of diet brings about slight changes in energy content, amount of certain vitamins and trace minerals. Likewise, through genetic makeup, certain vitamins and trace minerals. Likewise, through genetic makeup certain portions of egg content may be altered. On an equal weight basis, a typical Araucona egg has 23 percent more yolk, 9 percent less shell membrane, 10 percent more whole egg dry matter and 0.6 percent less moisture than white is largely (Oluyemi and Roberts, 2000). Egg shell is high in inorganic content which is largely calcium and phosphorus (Oluyemi and Roberts, 2000). Egg albumen in raw egg is opalescent and does not appear white until it is beaten or cooked (www.ncegg.org). It contains 10.9 percent protein mostly ovalbumin (Ayorinde, 1987). Egg yolk is easily identified by its bright yellow colour both cooked raw. It is surrounded by a thin transparent membrane. It is spherical, although when cooked raw is needed to flatten out (Oluyemi and Roberts, 2000). Yolk colour varies with the type of feed, eggs from layers fed green plants or yellow maize based-diets has higher yolk colour. According to Olayemi and Robert (2000) xanthophylls suitable for egg yolk pigmentation are usually found in two common poultry feeds; alfalfa and yellow maize. Other factors that cause variation in yolk colour include: strain differences, individual bird variation, morbidity, cage stress, fat in the diet, oxidation of xanthophylls, certain ingredients and egg/feed ratio. The edible part of an egg is made up of 12 percent protein, 11 percent fat, 1 percent vitamins (Gamman and Sherrington, 1989). Minerals such as calcium, phosphorus, zinc, iodine and sodium, apart from iron, sulphur and copper are also contained in egg (Gamman and Sherrington, 1989). Infact egg can be used as a standard for comparing protein in the egg has a high biological value and a good profile of essential (indispensable) amino-acids (Oluyemi and Roberts, 1988).

Egg size (weight)

Egg size is the consumer's preference. According to Onyimonyi and Ugwu (2007) egg consumers are much interested in the external features than internal composition. Large eggs size is highly demanded than small sizes (Iposu *et al.*, 2000). The size of egg is a function of several factors such as management system, age at sexual maturity, quality and quantity lay, and (Oluyemi and Roberts, 2000; Onyimonyi and Ugwu, 2007; Yisa *et al.*2009). Oluyemi and Roberts (2000) reported an average egg weight of 58g, indicating that this or less may be true in the tropics as against 62g for temperate regions. Fafiolu *et al.* (2006), Togan *et al.* (2006) and Onyimonyi and Ugwu (2007) all reported an average egg size of 58.75, 60.00 and 61.39g, respectively, while Ukachukwu and Akpan (2007), Yesmeen *et al.* (2008) and Madubuike and Obidimma (2009) reported average egg size of 47.85, 51.36 and 68.13g, respectively, Omeje and Okafor (2009) also reported an average egg weight of 61.13g.

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. 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

Egg quality parameters/cholesterol content:

Table 1 shows the internal qualities and cholesterol content of eggs of the laying hens on different inclusion levels of MOLM. No statistical effect was observed in all the indices expect cholesterol content. The cholesterol content was high in eggs obtained from the control diet and low in eggs from MOLM based diets. This finding suggests that MOLM reduces the cholesterol content of eggs. The egg shell thickness was significantly ($p > 0.05$) influenced by the treatment groups. It is a good indicator of shell strength and is important in the handling and marketing of eggs to minimize breakage. Haugh unit is the measure of egg white or albumen quality. The Haugh unit values from MOLM treatments were higher than the value of 40 which depicts inferior quality eggs (Brant et al., 1951; Ayorinde et al., 1999), implying that eggs obtained in this study with very high values of Haugh unit were of good quality. The egg yolk index ranges from 1.00 – 1.24 while the egg yolk weight ranged from 24.17 – 25.80. the egg yolk height and weight as well as albumin height and diameter recorded insignificant differences among dietary groups.

TABLE 1: Effects of graded levels of *Moringa oleifera* leaf meal MOLM on egg quality parameters and cholesterol content

Parameters	Dietary Levels of MOLM					SEM
	T_1 0%	T_2 2.50%	T_3 5.00%	T_4 7.50%	T_5 10.00%	
Egg yolk length (mm)	3.90	3.70	4.00	3.77	3.27	0.50
Egg yolk weight (g)	24.80	24.17	24.27	25.17	24.63	0.78
Egg yolk height (mm)	1.87	2.03	1.83	1.80	1.33	0.47
Egg yolk index	1.24	1.05	1.10	1.04	1.00	0.03
Albumin height (mm)	0.93	1.10	0.67	1.67	0.67	1.00
Albumin diameter (mm)	7.47	7.47	7.50	6.73	7.47	0.74
Egg shell thickness (mm)	0.10	0.07	0.13	0.10	0.10	0.03
Haugh unit	94.12	94.98	94.51	96.01	95.89	1.54
Egg cholesterol (mg/1)	8.83^a	6.00^c	6.44^c	6.61^b	6.05^c	0.56

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

Research Objective 2

Serum biochemical indices of the layer birds

Table 2 shows the result of the effects of the effect of graded levels of MOLM on scrum biochemical indices of layer birds. Result did not follow any particular trend birds. Result did not follow any particular trend but it was observed that T_5 (5,11 percent) had high total protein which was close to that of T_1 (5.58 percent). Albumin content of T_1 (3.68 g/dl) decreases with MOLM when compared with the reference diet (T_1). However, it is not in the range (2.54 – 3.27g/dl that is considered normal for healthy laying hens (Mitruka and Rawnsley, 1997). Significant ($P < 0.05$) increases the creatinine content in T_3 was observed with the value (1.33 mg/1) compared to values from other treatments. There was a decrease in serum cholesterol level with birds fed MOLM and no particular trend was observed which was in line with the report of Ojako and Nwanjo (2009) that some plants have medicinal value and help in improving health condition of animals as they lower the cholesterol level and makes the meat healthy for consumption. This result suggest that MOLM help in reducing excess urea from the system of laying hens as uric acid which is in line with the report of (Ojako and Nwanjo, 2009).

TABLE 2: Effects of graded levels of *Moringa oleifera* leaf meal (MOLM) on the serum biochemical indices of layer birds

Parameters	Dietary Levels of MOLM					SEM
	T_1	T_2	T_3	T_4	T_5	

	0%	**2.50%**	**5.00%**	**7.50%**	**10.00%**	
Total protein (g/d1)	5.58^{a}	4.74^{b}	4.93^{b}	5.06^{ab}	5.11^{ab}	0.05
Albumin (g/d1)	3.68^{a}	3.13^{b}	3.25^{b}	3.34^{b}	3.50^{ab}	0.16
Globulin (g/d1)	1.88	1.62	1.68	1.81	1.81	0.13
Glucose (g/d1)	7.24^{ab}	7.54^{a}	6.86^{ab}	6.25^{ab}	5.76^{b}	0.57
Creatinine (mg/1)	0.30^{c}	0.50^{ab}	1.33^{a}	0.70^{b}	0.80^{b}	0.53
Cholesterol (mg/1)	4.64	4.76	4.26	4.26	4.51	0.69
Urea (g/d1)	32.05	31.10	30.52	31.22	29.75	0.50

^{a,b,c} Means within the same row with different superscripts are significantly different ($P < 0.05$)

SEM = Standard Error of Mean

Conclusion

Feeding of MOLM in the present study improves the shelf life of an egg by minimizing the rapid increasing of the yolk. During storage of eggs, the albumen increases and this is thought to be related to the deterioration of albumen quality. Similar, Benton and Brake (2000) noted that their Dietary supplementation with 5% or 10% MOLM could improve yolk colour, albumen height and Haugh unit of eggs during storage, and without adverse effects on laying performance and egg quality of layers. Thus, 5% MOLM could be added to the diets of laying hens.

Recommendations

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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