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Effects of dried horse radish (*Moringa oleifera*) pod meal as feed additive on egg laying and performance of shaver brown birds

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ABSTRACT

Aim: Main purpose of the study was to explore the effect of *Moringa oleifera* pods meal (MOPM) as feed additive on performance, carcass and egg laying of shaver brown birds.

Method and materials: Sixty shaver brown laying birds having average weight of 1.58±3.02 Kg were assigned to four treatments with three replicates and five birds per replicate in a completely randomized design. Layer diets were added with four levels (0, 5.00, 10.0 and 20.0% of MOPM).

Results: Results revealed that performance was improved as feed conversion ratio (FCR) and feed intake (FI) were decreased with the increase in inclusion levels of MOPM ($P \leq 0.05$).

Conclusion: It was concluded that *Moringa oleifera* pod meal may positively improve performance and egg laying percentage of layers.

Keywords: *Moringa oleifera* Pod Meal, Shaver Brown Laying Birds, Performance, Carcass, Additive.

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Introduction

A well formulated diet adequate in all nutrients including protein is essential for normal growth and physiological function of poultry (Onu, 2011). This is done by carefully balancing the nutrients involved and taking into account the physiological state of the bird (Abbas, 2013).

Soyabean meal and fish meal have been widely and successfully used as conventional protein sources for livestock production (Aniebo, 2013). However, the prices of these protein sources have been escalating continuously in recent times, whilst availability is often erratic. The problem has been worsened by the increasing competition between humans (demands for soybean) and livestock for these protein ingredients (Aniebo, 2013). Conventional synthetic feed additives such as antibiotic growth promoters, antioxidants, anti-parasitic agents and anti-fungal agents have been used in poultry feed for decades (Uduji *et al*., 2020).

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However, they created multiple complications, such as traceability in animal products and resistance to antibiotics in the consumer, which became public health issues (Embuscado, 2015). On these grounds, the use of all kinds of antibiotic growth promoters was banned in animal feed in Europe (Nkukwana *et al.*, 2014). Revolutions in animal feed production gave rise to the idea of phytogenic feed additives (Grashorn, 2010 and Odoemelam *et al*., 2020). The recommended policy is to identify and use locally available feed resources to formulate diets that are as balanced as possible (Kakengi *et al*., 2007). There is the need, therefore, to explore the use of non-conventional feed sources that have the capacity to yield the same output as conventional feeds and perhaps at cheaper cost. Hence, any similar high protein ingredient which could partially or completely be used as a substitute for soyabean meal or fishmeal is desirable (Gadzirayi, 2012).

Plants and their metabolites, known as bioactive compounds, play a key role because of their feed additive attributes (Uduji *et al.*, 2020). These bioactive compounds, such as carotenoids, flavonoids and essential oils help to maintain animal's health and productivity, and to produce safe and healthy chicken eggs (Ao *et al*., 2011 and Ahaotu *et al*., 2019c). The primary mode of action of these active ingredients is inhibition of pathogenic microbes (Osuagwu *et al*., 2020) and endotoxins in the gut and enhanced pancreatic activity, resulting in better nutrient metabolism and utilization (Embuscado, 2015; Naazieand Akoto, 2011).

Moringa oleifera belongs to the family *Moringaceae* is widespread throughout the tropics. It is a small tree with sparse foliage, white flowers and long pods, often planted in farms and compounds or used as fence, especially in northern Nigeria (Ahaotu *et al.,* 2018a). It is known as Horse – radish tree, Oil of Ben tree and zogallagandi (in Hausa), ewe – igba (Yoruba) and okwe oyibo (Igbo). Its usual habitat is in farms and compounds.

In Nigeria, *Moringa* trees are distributed both in the south and north where it features as a multipurpose tree providing items of food, medicine, household, water treatment, farming system among other uses such as revenue generation through products formulation (Ahaotu *et al.,* 2018b). The tree is regarded as a miracle and life-saving resource with enormous nutritional and medicinal benefits readily providing the needs of local populace.

Reports indicated that synthetic growth enhancers and supplements in poultry nutrition are expensive, usually unavailable and may as well possess adverse effects in birds and humans (Ghazalah and Ali2008; Lee *et al*., 2008). Probiotics for example are viable single or mixed cultures of microorganisms that when administered to animalswould exert beneficially affects by improving nutrient utilization and enhance the beneficial properties of the gastro-intestinal microflora (Kyriakis *et al.,* 1999; Lee *et al*., 2008), however, improper storage and administration, indiscriminate use of antibiotics may affect the desired effects of probiotics. It has therefore become imperative to carefully source stable, cheap, locally available and highly nutritive feed ingredients needed for poultry feed formulations.

Phytogenic feed additives (PFAs) are plant based components that are of nutritive and medical values and which seem efficient in meeting up the current challenges of livestock feeds (van der Klis, 2015). For a long time, plant proteins are identified as cheap and are most naturally available in the tropics (Esonu *et al* 2006; Iheukwumere *et al*., 2008; Gadziriya *et al*., 2012). Leaf meals obtained from many tropical plants such as *Moringa* are affordable sources of protein and micronutrients in human diets, and have therefore stimulated a lot of interest in poultry nutrition research (Abou-Elezz *et al*., 2011; Olugbemi *et al*., 2012).

However, most studies conducted on moringa plant seems to have been on the leaves (Du *et al*., 2007; Kasolo *et al*., 2010; Nuhu, 2010; Olugbemi *et al*., 2010; Moyo *et al*., 2011; Gadzirayi *et al*., 2012; Mukumbo *et al.,* 2014) with little or no research on moringa pods that is often allowed to mature into seeds for propagation or sometimes thrown away together with uneatable branches.

The plant possesses many valuable properties which make it of great scientific interest. These include the high protein content of the leaves twigs and stems, the high protein and oil contents of the seeds, the large number of unique polypeptides in seeds that can bind to many moieties, the presence of growth factors in the leaves (Moreki and Gabanakgosi, 2014). The study however viewed the following objectives to investigate the effects of including *Moringa oleifera* pod mealon egg quality and performance of Shaver brown layer birds, determine the levels of inclusion of *Moringa oleifera* pod meal in diets of Shaver brown layer birds and assess the effects of essential nutrients and antioxidant-enriched Moringa pods on production performance.

In Nigeria, the very high cost of poultry feed has limited the expansion of the poultry industry as this has forced many poultry producers to folding. This has further drawn the already low intake of animal protein by Nigerians.

Layers premix is however expensive as a feed ingredients and this therefore increased the cost of poultry production. In order to arrest this trend, efforts are being directed towards the use of some unconventional and cheaper feed ingredients as additives with locally available, cheaper and quality feed ingredients. The use of *Moringa oleifera* pod meal to replace layers premix in layer diets is a possible way of reducing feed cost and producing cheaper eggs and meat for the populace.

Using *Moringa oleifera* pod meal as a feed additive in layer diets will go a long way in reducing the cost of production in poultry enterprise thereby making animal protein more available to the populace and also improving the profitability of the poultry farmers. Also findings from this research would represent a significant contribution to science and knowledge.

Materials and Methods

Moringa oleifera pods were collected from the botanic garden of forestry department, Imo State Polytechnic Umuagwo and stored in polythene bags after shade drying and grinding for further analysis and addition to feed (Banjo, 2012). The pods were stripped off, washed, allowed to drain and spread in a well-ventilated room to dry for five days. Shade- dried moringa pods were milled into powder using a blender (National Mx-795N), sieved with a muslin cloth and stored for used.

The pod meal was analysed for chemical composition in the Department of Science Laboratory Technology, Imo State Polytechnic Umuagwo, according to standard procedures (Mehta *et al*., 2003 and AOAC, 2005) (Table 1).

Table 1: Chemical Composition of Moringa oleifera Pod Meal

Chemical Composition	**Proportion**	**Unit**
Moisture	8.05	g/100 g
Crude Protein	18.98	g/100 g
Ether Extract	2.34	g/100 g
Ash	7.88	g/100 g
Crude Fibre	48.00	g/100 g
Minerals		
Sodium	805	mg/100 g
Potassium	2815	mg/100 g
Calcium	291	mg/100 g
Magnesium	251	mg/100 g
Phosphorus	9456	mg/100 g
Iron	53	mg/100 g
Sulphur	137	mg/100 g
Copper	3.1	mg/100 g
Oxalic acid	10	mg/100 g
Selenium	25.71	mg/100 g
Bioactive Compounds		
Quercetin	114	mg/100 g
Vitamins		
Vitamin A-B carotene (mg)	0.11	mg/100 g
Vitamin B-choline (mg)	423	mg/100 g
Vitamin B1-thiamin (mg)	0.05	mg/100 g
Vitamin B2-riboflavin (mg)	0.07	mg/100 g
Vitamin C-ascorbic acid (mg)	120	mg/100 g
Β-carotene	2.76	mg/100 g
Vitamin E-tocopherol acetate (mg)	-	
Arginine (mg)	90	mg/100 g
Histidine (mg)	27.5	mg/100 g
Lysine (mg)	37.5	mg/100 g
Tryptophan (mg)	20	mg/100 g

Experimental Animals

Sixty (24 weeks old) Shaver brown layer birds were assigned to four treatments and three replicates with five birds each in a completely randomized design. Four levels substitution levels (0, 5.00, 10.0, and 02.0g MOPM/kg) were added to the four diets.

Data Collection

A daily feed allowance of 100g per bird was offered (Table 2). Feed offered, feed refused, feed intake and mortality were recorded daily and tabulated cumulatively for FCR every week. The total number of eggs laid by each replicate group of birds was determined on daily basis at 1200 hours and 1800 hours. Also daily egg production was recorded from each experimental unit separately to calculate various parameters, including egg weight, feed per dozen.

Table 2. The Performance Characteristics of Shaver Brown Pullet Birds Fed *Moringa oleifera* Pod Meal as Feed Additive.

Parameters	T_1	T_2	T_3	T_4	SEM
Mean live weight at 19 weeks (Kg)	1.615^a	1.555^b	1.575^b	1.570^b	0.04*
Mean live weight 24 weeks old (Kg)	2.115^a	1.975^b	1.970^b	1.960^b	0.06*
Mean daily weight Gain (g)	55.3^c	54.2^c	53.8^c	50.6^b	0.55*
Mean daily feed intake (g)	165.73^a	166.14^b	166.32^b	169.82^b	0.45*
Feed conversion ratio	4.43	5.01	5.34	5.46	0.08^{ns}
Feed cost/Kg weight gain (N)	179.24	177.84	176.44	175.04	0.10^{ns}
Mortality	1	1	1	4.0	0.08^{ns}

abc: Means with same row having different superscripts were significantly different ($P<0.05$).

Data Analysis

Data collected was analysed through one-way ANOVA (Steel *et al*., 1997) using PROC GLM in SAS software (SAS Inc. 9.4). Significant means was separated through Duncan's multiple range tests (Gordon and Gordon, 2004).

Results and Discussion

Results of feed consumption and weight gain of shaver brown layer birds fed with *Moringa oleifera* pod meal as feed additive, Probiotic and Vitamin E and Selenium were followed by carcass parts measurements of shaver brown pullet birds fed *moringa oleifera* pod meal as feed additive (Table 3).

Table 3. Carcass Parts Measurements of Shaver Brown Pullet Birds Fed *Moringa oleifera* Pod Meal as Feed Additive.

Parameters	T_1	T_2	T_3	T_4	SEM
Shank length (cm)	16.1^c	15.4^b	15.3^b	14.3^a	0.12*
Wing length (cm)	28.5	28.4	28.3	27.8	0.05^{ns}
Body length (cm)	49.4^c	49.3^c	49.2^c	45.4^a	0.03*
Body height (cm)	44.1^c	43.5^c	43.1^c	41.5^a	0.17*
Thigh length (cm)	13.9^b	13.7^b	13.3^b	12.9^a	0.07*
Leg length (cm)	11.6^a	10.9^b	10.8^b	10.6^b	0.07*
Heart girth (cm)	37.9	37.5	37.5	38.3	0.15^{ns}
Head Circum-ference(cm)	12.6^a	12.7^a	12.9^a	13.8^b	0.09*
Live weight at 24 weeks(gm)	2115^d	1980^c	1975^c	1860^a	0.09*
Dressed carcass Weight (gm)	1715^d	1580^c	1500^b	1480^a	0.08*
Eviscerated weight (gm)	1300^c	1280^a	1280^a	1250^b	0.02*

abc: Means within same row, having different superscripts are significantly different (P<0.05)

The significantly (P<0.05) lower live weight, fully dressed carcass weight and eviscerated weight of birds on diet T_4 could be attributed to high level of 20% MOPM in the diet. This has led to the reduction in live weight gain and carcass weight of the tested animals as reported by (Zanu *et al*., 2012 and Ziggers, 1997). The author observed that there was a general depression in eviscerated weight by birds fed higher levels of MOPM diet. The average live weight at 24th week reported in this study are higher than those reported by Hayse and Marion (1973) who observed that mean live weights at 24 weeks pullet layer birds were below 1800gms. The lower values recorded in shank lengths, body lengths body heights and thigh lengths in treatments T_3 and T_4 was as a result of higher inclusion levels of MOPM in the diets.

It was noticed that chickens in T_1 had significantly higher (P≤0.05) body weight gain than those in the other 3 treatment groups. However, chickens in T_2 had higher (P≤0.05) body weight gain than those in treatment groups T_3 and T_4respectively. There was no significant difference in weight gain of chickens in T_3 compared with chickens in group T_4 respectively.

The significantly (P<0.05) depressed weight gain and feed conversion ratios of birds on diet T_4 was attributed to higher crude fiber in the diet (Ali and Ali 2002; Apple *et al*. 2005). These authors further reported that high crude fibers in the diet affect growth rate. The improved performance of birds on 5%, 10% and up to 20% MOPM in this phase agreed with literature findings that MOPM improves the nutritive value of diets. Obi and Sonaiya (1995); FLD, (1981); Robert (2005); Sonaiya (1995) and Roland *et al.* (2004) stated that an essential practical consideration in evaluating a ration for animals is the cost of the feed in terms of returns obtained for the products. The 4.4% mortality rate at diet T_4 observed between 19th and 24th week (Table 4) was lower than the results of Ali and Ali (2002), Leeson and Caston (1999) who reported mortality rate of 6% for layer pullets with live weight up to 1.5kg.

Table 4. Egg Laying Performance of Shaver Brown Layer Birds Fed Moringa oleifera Pod Meal as Feed AdditiveFrom Point of Lay.

Parameter	T_1	T_2	T_3	T_4	SEM
Egg circumference (gm)	19.99^a	18.45^b	13.45^b	13.24^b	0.60*
Hen day production (%)	87.96^d	79.80^c	71.63^c	58.0^b	2.21*
Egg weight (gm)	62.66^a	60^b	59.4^b	57.4^b	1.84*
Mean Egg Production /Number	58^c	54^b	50^b	42^b	1.99*

abcd: Means within same row, having different superscripts are significantly different (P<0.05)

The results showed that the average egg circumferences determined were 19.99, 18.45, 13.45 and 13.24 cms for birds on diet T_1, T_2, T_3 and T_4 respectively. T_1 (P<0.05) had significantly the highest value and differed significantly from all the treatments. T_4 had (P<0.05) significantly the lowest value while T_2 and T_3 were similar.

Egg production of the birds differed (P<0.05) significantly between T_1 and T_4. However, the highest average egg numbers of 58 was recorded for birds on T_1 and the least number 42 was for T_4. Highest percentage hen – day egg production were significantly (P<0.05) higher for birds on T_1, T_2, T_3 and T_4 in that order. Birds on T_4 had the least hen – day egg production. Hen – day productions were 87.96, 79.80, 71.63 and 58.00% for birds on T_1, T_2, T_3 and T_4 respectively, while mean number of eggs laid were 58, 54, 50 and 42 for the four treatments (T_1, T_2, T_3 and T_4).

Low digestibility of diet, T_4 (20% MOLM) could have resulted in its relative higher rate of consumption over the other diets. The high dietary fiber in the diet made its component nutrients less digestible and available to the birds (Van Soest and Robertson, 1976). Therefore, the birds ate more to satisfy their nutrient requirements. The relatively higher egg production of birds on treatment T_2, T_3 and T_4 could be attributed to the effect of mineral components in *Moringa oleifera* pod meal which improved the nutritional value of those diets (Akomaegbe, 2020). The average percentage hen – day egg production in this experiment is higher than the range of 49.56 and 55% reported by Ali and Ali (2002); Chandrasiri *et al*., (2004); Akhtar – uz – Zaman (2006); Roland, (1998) and Merat *et al*. (1992) for exotic hybrid layers. Hen – day egg production of birds on the control diet T_1 and on diets T_2, T_3 and T_4 agreed with the minimum of 65% recommended by Henken *et al.* (2002); Chineke (2001) and Oladunjoye *et al.* (2002).

The sizes of eggs obtained in this study were above the standard egg weights of 58 gm reported in the literature (Ali 2002; Austic and Nesheim 2003; Demeke 2006 and Doran *et al*. 1990) for exotic breeds of layers. The relatively low values of eggs obtained from birds on diet T_4 is in agreement with Austic (2005); Banerjee (2002); Merat *et al.* (1992); Parsons *et al*. (1998) and Roland (1998) who reported that higher crude fibre rations decrease egg production just like water deprivation. The superior egg circumference qualities obtained from treatment diets T_2 and T_3 support the findings of Reid *et al*. (2004) and Singh*et al*., (2002) that MOPM positively influences nutrient utilization, thereby impacting on egg production.

Herb extracts have been reported to significantly improve body weight gain, feed conversion ratio as well as layer carcass dressing percentages (Omar *et al*., 2016). Photogenic feed additives containing essential oils, spices and saponins have been reported to significantly influence nutrient digestibility in layer birds. Plant derived feeds are believed to possess antioxidant properties that improve nutrient absorption by cells, strengthen cellular defense and minimize damages by oxidative stress which consequently leads to improvement in health status of animals (van der Klis, 2015).

Results showed that *Moringa oleifera* pod meal inclusion in layer diets had decreased feed intake but improve live weight gains in layer chickens. The least feed intake as well as the highest weight gain was noticed in *moringa* pod treated group as compared to other treatment groups and the control thus suggesting *moringa* pods to be of economic value especially in terms of its probable feed conversion efficiency. Lannaon (2007) reported high improvement in daily weight gain, final weight gain and profit on the performance of Shaver brown layers given *Moringa oleifera* pod meal.

Worthy of noting also was work of Du *et al*., (2007) who evaluated the effect of dietary supplementation of *Moringa oleifera* on growth performance, blood characteristics and immune response of Abore acre strain of broilers. It was found that increasing supplementation of *Moringa oleifera* decreases the contents of uric acids, triglycerides and albumin ratio in the serum of broilers. Hence, immune response of broilers increased significantly. Also Ahaotu *et al.,* (2019 a) and Yang *et al*., (2007) evaluated the effect of *Moringa oleifera* on growth performance, immune function and ileum microflora in broilers.

However, *Moringa* seed pod has also been reported to be a source of activated carbon used to treat poisons in addition to its rich source of vitamins A, B and C, protein, sulphur containing amino acids, calcium, phosphorus and iron (Ahaotu *et al.,* 2019 b and Mohammed, 2013) which most likely could account for its nutritive value that led to higher weight gain observed in this study. It is also noted that the improvement in body weight gain in moringa treated group could be due to improved feed conversion or reduced amount of feed required to produce one unit of meat.

Probiotics on the other hand are live nonpathogenic and non-toxic microorganisms, which when administered through the digestive route favour the host's health (Guillot, 1998). The addition of probiotics especially Bactofort® and Anthox® to livestock feed were reported to improve the nutritive quality of feed and performance of animals by (Martin *et al.,* 1989).

Non-antibiotic growth promoters such as organic acids and probiotics are increasingly being produced and used for animal nutrition worldwide (Windisch *et al.,* 2008). The cost may hinder many backyard poultry farmers in especially developing nations and therefore moringa pods may be an excellent alternative.

One of the major reasons for increased interest in the use of probiotics in livestock in recent years is because they are natural alternatives to antibiotics and for their growth promotion effects in especially poultry (Bajpai*et al*., 2005). Rajmane and Ranade (1994) found that the inclusion of vitamin E and C at 150 mg/kg and 200 mg/kg in poultry diet respectively improved growth rate as well as immune response of vaccinated chickens. Furthermore, Bharali *et al*. (2003) reported that inclusion of selenium in poultry diet markedly reduced feed conversion ratio due to the fact that it significantly lowered feed intake but found it to have improved eviscerated carcass weight.

Contrary, Bhattacharya *et al*. (1982) reported that selenium yeast improved body weight and feed conversion ratio in layers. In this study however, it was found out that layers treated with vitamin E and Selenium had a high feed consumption with a concomitant least body weight gain agreeing closely to the findings of Atuahene *et al*. (2008). Vitamin E and selenium may therefore be of little or no value in enhancing body weight gain in layers.

The decrease in the feed intake was due to high density feed on account of essential amino acids, vitamins and minerals present in MOPM which meet the body requirement even with smaller intake (Abbas and Ahmed, 2012). During the experimental period best FCR and BWG was recorded in the T_3 with 10% MOPM. This might be due to rich availability of essential nutrients like amino acids, vitamins and antioxidant compounds present in *Moringa oleifera* pods (Abou-Elezz *et al*., 2011) which affect the overall health, production and FCR in experimental layers. The increase in relative giblet weights can be attributed to the bioactive compounds (carotenoids, flavonoids) of Moringa pods meal, which interact with the metabolism and enhance the productive performance by improving digestibility. Some other studies also reported that *Moringa oleifera* supplementation affect the giblet relative weight (Glade and Sist, 1998). Similarly it has been reported in other studies that Moringa supplementation showed positive impact on FCR of broiler birds (Ahaotu *et al*., 2019).

Conclusion

It was concluded that MOPM at 10% inclusion in layers feed improved egg production and body weight. It is recommended that more extensive work with larger number of birds from point of lay to the end of lay and higher levels of MOPM be carried out for more authentic conclusion and recommendation. The pod meal also had relative economic efficiency and could serve as an excellent alternative to commercially available growth promoters.

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