

SUSTAINABILITY OF BLACK NERA LAYING BIRDS ON PIG DUNG MEAL BASED DIETS.

SUSTENTABILIDAD DE GALLINAS PONEDORAS ALIMENTADAS CON HARINA A BASE DE ALIMENTO DE CERDO.

Ahaotu, E.O^{1*}, Onuoha, W¹ and Uwaleke, G¹ and Agiang, E.A²

¹Department of Animal Production and Health Technology, Imo State Polytechnic Umuagwo, Nigeria.

²Department of Animal Science, University of Calabar, Cross River State, Nigeria.

Corresponding author: emmaocy@yahoo.com. +234-803-8520-777

ABSTRACT

The study was undertaken on the utilization of farm animal organic waste as feeds for livestock and poultry. Increasing feed costs and international concern for the conservation of resources have focused attention on the nutrients in animal wastes that have in the past been used largely as fertilizer or as a major source of fuel for villagers in a number of countries. Animal wastes represent a vast reservoir of cheap nutrients, particularly for ruminants. The limitation in using animal waste as feed is that it needs processing. Dehydration, ensiling, chemical and physical treatments can be used to maintain the nutrient composition and increase the palatability and feeding values of the waste. Animal waste can potentially be used not only to maintain animals in the dry time but also to encourage performance quite satisfactorily. Feeding cattle manure in poultry and pigs promotes meat and egg productivity respectively. Pig waste, when processed and properly balanced with other ingredients, may become a potential feed substitute for cattle at levels up to 30%. No differences in the quality of meat from animals fed waste have been detected, nor has there been a problem of consumer acceptance in animal products.

Keywords: Black Nera Laying Birds, Pig Dung Meal, Diets, Feed Cost, Organic Waste.

RESUMEN

El estudio se realizó sobre la utilización de desechos orgánicos de animales de granja como alimento para ganado y aves de corral. El aumento de los costos de los piensos y la preocupación internacional por la conservación de los recursos han centrado la atención en los nutrientes en los desechos animales que en el pasado se utilizaron principalmente como fertilizantes o como una importante fuente de combustible para los aldeanos en varios países. Los desechos animales representan una gran reserva de nutrientes baratos, especialmente para los rumiantes. La limitación en el uso de desechos animales como alimento es que necesita procesamiento. Los tratamientos de deshidratación, ensilado, químicos y físicos se pueden utilizar para mantener la composición de nutrientes y aumentar la palatabilidad y los valores de alimentación de los desechos. El desperdicio de animales puede ser utilizado no solo para mantener a los animales en el tiempo seco sino también para alentar el rendimiento de manera bastante satisfactoria. Alimentar el estiércol del ganado en las aves de corral y los cerdos promueve la productividad de la carne y el huevo, respectivamente. Los desperdicios de cerdo, cuando se procesan y equilibran adecuadamente con otros ingredientes, pueden convertirse en un posible sustituto de la alimentación del ganado en niveles de hasta el 30%. No se han detectado diferencias en la calidad de la carne de animales alimentados con desechos, ni ha habido un problema de aceptación del consumidor en productos de origen animal.

Palabras clave: gallinas ponedoras de huevos, comida de cerdo estiércol, dietas, costo de alimentación, residuos orgánicos.

INTRODUCTION

Increasing feed costs have focused attention on the nutrients in animal wastes that have in the past been used largely as fertilizer or as a major source of fuel for villagers in several countries. Feed represents the major cost in animal production. Even with sheep which typically consume more forage than other domestic species, the feed may represent 55 percent or higher of the total production costs (Ahaotu *et al.*, 2013). This has been identified as the biggest factor militate against the industry in Nigeria. Ahaotu *et al.*, (2018a) observed that poultry production in Nigeria was not economically profitable due to the prevailing high cost of imported feed. In countries where cereal production is not a problem, the cereal component is always cheaper than protein ingredients (Ahaotu *et al.*, 2018b). The increasing cost of feed ingredients demands concerted research efforts directed towards alternative sources of feed ingredients to reduce the dependence on the expensive conventional ingredients.

Recycling of animal wastes has always existed in nature between the same or among diverse species. Rabbits, rats, poultry and pigs are the most typical examples because in specific nutritional situations they consume their own excreta in substantial quantities to meet their requirements of nutrients missing from their diets. Animal wastes can be used as source of feed nutrients for livestock, pig and poultry.

Pig dung is high in crude fiber and available energy than some other animal wastes (Onuoha and Uwaleke, 2017, Ezeafulukwe *et al.*, 2013, Smith and Wheeler, 2011). All the wastes are good sources of ash. It was stated by Blair and Knight (2003) that the high fiber and non-protein nitrogen contents of the waste will not affect the production of monogastric animals. Improvement of livestock production in many developing countries is militated against by a myriad of factors. Of the major constraints limiting the increased livestock is the inadequacy of animal feed resources (Ahaotu *et al.*, 2013). The utilization of unconventional feed stuffs especially when it encourages a shift to other ingredients that are not edible to man will reduce the cost of feed and maximize the returns from poultry farming.

The chemical composition and quantity of pig waste depends upon several factors: age, live weight, breed, feed and water intake, digestibility of the ration, housing, environment and waste management. The production of solid pig waste ranges from 0.6 to 1.0% of dry matter per day calculated on body weight. Low-digestibility rations yield relatively more manure. With the increase body weight, the quantity of pig waste decreases significantly (Agle *et al.*, 2010). Feces represent about 46% and urine 54% of wastes on fresh basis, but on dry basis, feces represent 77% and urine 23%. The pH of pig manure is in the range 7.2–8.3. The chemical composition of manure also changes rapidly with time after excretion (Almeida and Stein, 2012). The biochemical routes of bacterial decomposition of manure can be divided into the aerobic process (resulting in carbon dioxide, nitrites, and nitrates, dissolved nitrogen and soluble sulphate) and anaerobic action (yielding gases such as methane, ammonia, hydrogen sulphate and carbon dioxide). Pig waste, when processed and properly balanced with other ingredients, may become a potential feed substitute for cattle at levels up to 30%. No differences in the quality of meat from animals fed waste have been detected, nor has there been a problem of consumer acceptance in animal products.

Enzymes are natural proteins found in all living things. They facilitate the breakdown of large feed particles or molecules into smaller ones. This makes nutrients in the feed more readily available for digestion. Thus, enzymes increase the digestibility of feedstuff, and consequently, less feed may be used per unit gain. For example, Porzyme SF is a recommended enzyme for barley based grower diets.

Animal wastes represent a vast reservoir of cheap nutrients, particularly for ruminants. In most countries, waste, particularly from poultry, is easily collected, as it is concentrated in small areas, and its cost, as a raw material for feed, is generally the cost of transport alone. The only expensive item may be processing, but this cost is relatively small and is recoverable from the profit arising out of the low original cost. Feed costs for dairy or beef cattle usually represent 50–80% of the total production costs; this can be reduced to 20–40% by utilizing these new feed resources as donors of protein, minerals and other nutrients (Angel *et al.*, 2006).

Rabbits, rats, poultry, and pigs are the most typical examples because in specific nutritional situations they consume their own excreta in substantial quantities to meet their requirements of nutrients missing from their diets. Animal wastes can be used as a source of feed nutrients for livestock, pig and poultry.

Pig waste is a biomass that changes rapidly from the time of excretion. It creates a serious pollution problem. Pig waste amounts to about 1% of the weight of the pig, and from the nutrition standpoint, it is much poorer than poultry waste. Much however depends upon the plane of nutrition and other factors. The magnitude of the feeding potential has been evaluated in several studies. Carter *et al.* (2008) fed dried pig manure collected from concrete floors to pigs; the results indicate that incorporating the waste at the 30% level depressed growth and feed efficiency. Creech *et al.*, (2004) tests the feeding value of pig waste to bulls. The performance in all groups was quite satisfactory, although, the diet containing 50% pig manure, exhibited somewhat lower gain. Nevertheless, these experiments clearly demonstrated that pig waste, when processed and properly balanced with other ingredients, may become a potential feed substitute for cattle at levels up to 30%.

Recycling of pig waste to cattle, sheep and pigs is possible at 10–30% DM level in the ration providing the waste is properly balanced and processed, and the content of critical nutrients (cell walls, ash, copper, drugs and other undesired constituents) does not exceed the tolerance level beyond which the performance of livestock would be adversely affected (Henry and Dourmad, 1993).

Animal wastes may cause water, soil, and air pollution, but if managed judiciously they are valuable resources. The main uses of animal wastes are as sources of plant nutrients (fertilizer) and animal nutrients (feedstuffs). The wastes are more valuable when used as feedstuffs than as fertilizer. Due to the unusually high fiber content and frequently high levels of non-protein N, wastes are more valuable for feeding ruminants than non-ruminants. Poultry wastes, especially poultry litter, have the potential for increased use as animal feed. If processed properly, the wastes do not contain harmful

pathogens, and with appropriate management and withdrawal periods, there is no serious residue problem.

Poultry wastes have been used in practical feeding for different classes of beef cattle, and the potential exists for increased utilization of these by-products. With the renewed emphasis on environmental quality, the livestock industry could capitalize on these valuable resources. Use of the wastes as animal feed could serve to enhance environmental quality and potentially increase profits for the industry.

The objectives of this study are to determine the utilization of pig dung meal as feeds for feeding black Nera laying birds, examine the effects of feeding pig dung meal supplemented with Grandizyme® enzyme at the expense of maize to black Nera layers on performance and cost of production and also to determine the levels of inclusion of pig dung meal in diets for black near laying birds on carcass characteristics and organ weight evaluations.

MATERIALS AND METHODS

Location of Study Area: The study will be conducted at the Poultry Unit of Imo State Polytechnic Umuagwo. Imo State Polytechnic Umuagwo is located at the site is situated between longitudes $7^{\circ} 01' 06''$ E and $7^{\circ} 03' 00''$ and latitudes $5^{\circ} 28' 00''$ N and $5^{\circ} 30' 00''$ N in the humid tropical West Africa (IMLS, 2009). The climate is marked by two seasons.

Sampling and Sample Preparation: Pig dung will be collected from the piggery unit of Imo State Polytechnic Umuagwo, Nigeria. Stones and other large particles will be removed from the pig dung and then sun dried before the removal of extraneous matter.

Processing Methods of Manure; Dehydration: Dehydration is widely applied for commercial purposes because dried waste can be used either as feed or as urban fertilizer (Ahaotu and Adeyeye, 2014). Drying reduces the bulk of animal wastes to 20-30% of the original volume (Burkholder *et al.*, 2004) nevertheless. it is usually a costly process, involving substantial investment and operational costs. Animal wastes must be processed immediately to prevent the rapid decomposition of organic matter and to conserve its nutritive properties. Losses of the most valuable substances in poultry litter — crude protein — vary considerably according to the drying method and nature of the processing; ensiling completely preserves the nutritive value. The following energy and nitrogen losses as result of various drying techniques were reported by Burkholder *et al.*, (2004).

Chemical Treatments: the prime objectives of chemical treatments of animal wastes are to eliminate pathogenic bacteria, preserve nutrients, improve the nutritive value and increase the feed intake of the waste. Kim (2012) compared several processes for pasteurizing wastes: dry heat (150°C for 20 minutes), autoclaving (10 minutes or longer), para-formaldehyde fumigation and treatment with ethylene oxide. All treatments totally eliminated coliforms present in unprocessed litter. Dry heat treatment was less effective in reducing total bacterial count than autoclaving, which yielded the best results at 121°C and 1.05 kg/cm² steam pressure for 30 minutes. Fumigation with ethylene dioxide (EO) at 22°C for 120 minutes at depth of litter 76 mm gave results comparable to those for PFA at the 4% level.

Mechanical Treatments: various mechanical processes, mainly involving cattle and pig wastes, are aimed at reducing volume and separating liquid and solid fractions.

A. Grinding and Separation: the effect of grinding and pelleting dry cattle manure was studied by Ahaotu *et al.*, (2015). Grinding had little or no effect on the digestibility of individual constituents. In fact, ground manure showed a substantial decrease in cell-wall and cellulose digestibility and in nitrogen retention, possibly due to a by-pass of rumen digestion because of the reduction in particle size. Hernandez *et al.*, (2012) attempted to improve the nutritive value of the solid fraction separated from manure by a vibrating screen (8 mesh/cm). The solid fraction was fed to cattle fresh, ensiled or alkaline treated (7% NaOH). The results are shown in Table 3. The highest voluntary intake of dry matter was recorded with NaOH-treated screened manure solids (SMS) incorporated into rations at the 30% level (on DM).

Animals, Diets and Experimental Design: a total of sixty (60) points of lay Nera Black layer birds will be used for this study. The birds will be randomly allotted to five experimental treatments in a completely randomized design. The birds will be replicated three times per treatment. The experimental diets and water will be provided *ad libitum* throughout the experimental period that will last for six weeks. Prior to the beginning of the experiment, birds will be weighed to obtain their initial body weight and subsequently on a weekly basis. The performance parameters measured will be feed intake, body weight gain, feed conversion ratio and egg laying performance. Carcass characteristics and organ weights will also be evaluated.

Data Analysis: data analysis was done using analysis of variance technique of (Steel and Torrie, 1980) while significant differences in means were separated using the method of Duncan's Multiple Range Test as outlined by (Gordon and Gordon, 2004).

Layer Vitamin/mineral premix containing the following per kg. Vitamin A 10,000,000IU; Vitamin D3 2,000,000IU; Vitamin E 10,000IU; Vitamin K 2,000mg; Thiamine 1,500mg; Riboflavin B 4,000mg; Pyridoxine B6 1,500mg; Anti-oxidant 125g; Niacin 15,000mg; Vitamin B12, 10mg; Pantothenic acids 5,000mg; Biotin 50mg; Choline

chloride 400g, manganese 80g; Zinc, 20g; Iron, 50g; copper, 20g; Iodine 1.5g; Selenium 200mg; Cobalt 200mgr; Folic acid 500mg; Vitamin C 100mg.

Six chickens were randomly selected from each replicate, leg – banded in three separate groups of two birds and weighed on a spring balance. The initial body weights were between 347 and 352g. The birds were fed the experimental diets for 39 weeks, excluding 2 weeks collection period and had free access to feed and water throughout the experimental period.

Blood sample collection: the determination of the haematological values of the experimental chickens was done at week eight for the initial values. These were carried out soon after allocating them into their respective treatment cages, prior to dietary treatment to establish the status of the blood parameters of interest. At the sampling period, three birds were randomly selected from each replicate totaling forty-eight chickens. Two millimeters of blood sample was collected from each of the three chickens via the wing web veins of each chicken with the use of 23-gauge needle being fixed to a 3ml syringe (Ahaotu *et al.*, 2015). Soon after the blood samples were taken, 1ml from each sample was immediately transferred to a glass tube containing ethylene diamine tetraacetic acid – EDTA and then thoroughly shaking to mix both blood sample and EDTA together (Jain,1993), to prevent coagulation. The sample glass tubes were carried in ice container filled with ice block to prevent the deterioration of the blood samples and taken to the Department of Science Laboratory Technology, Imo State Polytechnic Umuagwo, Nigeria, for the blood and haematological analysis by the use of automatic analyzer (SYSMEX – KX -2IN). The blood samples after mixing with relevant reagent were fed in turn into the analyzer. The sample was then siphoned and the results are shown on the screen of the analyzer.

RESULTS AND DISCUSSION

Table 1 shows the mean initial and final levels of haemoglobin (Hb), haematocrit (HCT), red blood cells counts (RBC), white blood cell counts (WBC), mean cell volume (MCV), mean cell haemoglobin (MCH), and mean cell haemoglobin concentration (MCHC).

Table 1. The composition of the Experimental Diets (Layers 22 – 34 Weeks).

Ingredients	% Level of Dried Pig Waste Meal (DPWM)			
	0	5	15	20
Maize	51.0	46.0	40.6	37.5
Dried Pig Waste Meal	0.0	5.0	10.0	15.0
Porzyme SF	0.10	0.10	0.10	0.10
Wheat Bran	16.0	16.0	16.0	16.0
Fish Meal	9.0	7.5	6.5	4.0
Vegetable Oil	2.5	4.0	5.4	6.0
Soya bean Meal	11.0	11.0	11.0	11.0
Bone Meal	9.5	9.5	9.5	9.5
Lysine	0.25	0.25	0.25	0.25
Methionine	0.15	0.15	0.15	0.15
Common Salt	0.25	0.25	0.25	0.25
Layers Premix	0.25	0.25	0.25	0.25
Total (Kg)	100	100	100	100
Crude Protein (%)	17.9	18.3	18.2	17.9
Crude Fiber (%)	2.45	2.47	3.01	3.70
Ether Extract (%)	4.00	4.50	5.00	5.45
Ash Content (%)	11.0	12.0	12.0	12.50
Moisture Content (%)	13.00	13.00	12.50	13.00
ME (Kcal/Kg)	2665.0	2676.2	2677.9	2647.3
Calcium	3.7	3.7	3.7	3.6
Phosphorus	0.7	0.9	0.7	0.7

Haematological responses of the experimental chickens fed with dietary treatments: the average Hb Ranged from 9.60 – 10.68g/dl. The mean HCT levels ranged from 31.20 – 35.62%., the average RBC counts ranged from 2.375 – 2.47 ($\times 10^{12}/l$). The mean WBC counts ranged from 251.35 – 262.60 ($\times 10^9/l$). The MCV had rand between 135.00 – 137.50FL. The MCH ranged between 38.00 – 42.17Pg, whilst the average MCHC values ranged between 29.52 – 30.63g/dl. The results shown that haemoglobin concentration (Hb), haematocrit (HCT), red blood cells count (RBC) and mean cell values

(MCV) of chickens recorded no significant differences ($P > 0.05$) for both initial and final values. However, the final values observed for these parameters were lower than the initials. Again, no significant ($P > 0.05$) effects of the experimental diets were observed on initial and final white blood cell (WBC) counts, however, final mean cell haemoglobin (MCH) and both initial and final values of mean cell haemoglobin concentration (MCHC) recorded significant ($p < 0.05$) differences among treatments. It could be observed from the study that with exception of final mean cell haemoglobin (MCH), the initial and final mean cell haemoglobin concentration (MCHC) which was significantly ($p < 0.05$) affected all the other haematological parameters were not significantly influenced by the dietary treatments. However, the final values for all the mentioned indices were consistently lower than before the experiment (Table 2). Ahaotu *et al.*, (2016) suggested that age, gender and altitude could be some of the possible causes of different haematological levels.

The trend shown in these values could be related to neither gender nor altitude in this present study, since all the experimental chickens were layers of the same strain reared under the same altitude and environmental conditions. One of the possible causes for this difference in the haematological indices could be the age difference. Blood samples for the analysis were taken at different stage of growth, with the initial sample taken at 8 weeks of age before the commencement of the feed trials. The final was collected at 47 weeks which were two weeks prior to the termination of the experiment.

The haematological parameters that registered significant difference (Table 2), similarly recorded significantly ($P < 0.05$) lowered values in all cases. This finding is in agreement with the previously reported data Adua *et al.* (2012). It could also be observed that the final HB, HCT and RBC were lower than the initial values. This could mean that there is an inherent positive correlation among these parameters, implying that these are affected by the same factors in the same way and that their levels indicate the nutritional and health status of the chickens as indicated by Chineke *et al.* (2002). One significant observation about the results is that, though the final haematological values were lower as indicated earlier, the values fell within the normal range for chicken as reported by Mitruka and Rawnsley (1997). This could mean that the experimental birds were neither anemic nor suffering from any physiological disorders before and throughout the experimental period and that the alkali treatment might have elicited just a minimal dietary effect on blood profile of the experimental chickens.

Table 2. Haematological responses of the experimental chickens fed with dietary treatments

Parameters	T ₁	T ₂	T ₃	T ₄	SEM	LOS
Initial Hb (g/dl)	10.68	10.47	10.60	10.68	0.30	ns
Final Hb (g/dl)	9.62	9.25	9.80	9.55	0.66	ns
Initial HCT (%)	34.60	34.58	34.34	35.62	0.66	ns
Final HTC (%)	32.52	31.25	32.55	35.08	1.04	ns
Initial RBC(x 10 ¹² /l)	2.53	2.50	2.48	2.53	0.04	ns
Final RBC(x 10 ¹² /l)	2.38	2.40	2.38	2.40	0.09	ns
Initial WBC(x10 ⁹ /l)	252.93	252.35	251.35	251.35	0.80	ns
Final WBC(x10 ⁹ /l)	252.80	257.60	262.60	262.10	10.62	ns
Initial MCV (Fl)	135.43	135.75	136.00	135.00	0.82	ns
Final MCV (Fl)	136.60	137.90	137.50	135.32	1.55	ns
Initial MCH (Pg)	41.20	41.15	42.50	42.17	0.43	ns
Final MCH (Pg)	38.00 ^c	39.98 ^a	41.00 ^b	40.20 ^b	1.28	*
Initial MCHC (g/dl)	30.63 ^a	30.48 ^a	30.13 ^b	30.41 ^b	0.17	*
Final MCHC (g/dl)	30.43 ^a	30.32 ^a	29.75 ^b	29.52 ^b	0.51	*

a,b,c means within the same row bearing different superscripts are significantly different. (* p<0.05). NS= Not significant. SME = Standard error

Table 3. Laying Performance and egg Quality Evaluation of Pullets fed Diets Containing Dried Pig Waste Meal.

Parameters	Replacement levels (%)				SEM
	T ₁	T ₂	T ₃	T ₄	
Hen day production (%)	64.67 ^b	83.33 ^a	69.25 ^b	72.34 ^b	± 2.09
Feed efficiency (kg feed/kg egg)	3.33	2.91	2.65	3.32	± 0.21
Average weekly egg weight (g)	54.99 ^b	57.07 ^{ab}	57.53 ^a	58.42 ^a	± 0.50
Shell weight (g)	6.71	7.07	6.52	6.58	± 0.08
Shell thickness (mm)	0.34	0.35	0.34	0.33	± 0.02
Yolk weight (g)	12.31	12.49	12.73	12.91	± 0.09
Albumen weight (g)	23.00	25.39	25.44	25.64	± 0.45
Haugh unit	84.04	81.52	76.94	75.12	± 1.35
Yolk index	0.34	0.34	0.33	0.34	± 0.07
Mortality	0.00	0.00	0.00	0.00	0.00

Means with different superscripts within the same row are significantly ($p < 0.05$) different SEM- standard error of mean.

Laying Performance and egg Quality Evaluation of Pullets fed Diets Containing Dried Pig Waste Meal. Percentage hen Day Production: comparatively, birds on T₂ DPWM diet recorded a significant ($p < 0.05$) higher percentage hen day production of 83.33. Values between birds fed control diet and those on diets with T₃ and T₄ DPWM were however not significant ($p > 0.05$). The lower values observed among pullets on the control diet and those eating higher levels of DPWM could be attributed to the reduced feed intake, resulting in the relatively lower nutrient intake. This translates to lower nutrient availability for egg production (Togun *et al.*, 2006). The birds thus reduced egg production because the only available nutrients would also be required for other physiological needs of the birds. Togun *et al.* (2006), Fafiolu *et al.* (2006) and Eniolorunda *et al.* (2007) reported an average percentage hen day production of 94.34, 76.38 and 55.32, respectively whereas, Ahaotu *et al.* (2017) and Madubuike and Obidimma (2009), reported 55.32 and 35 – 82.1 as the percentages hen day production. Values reported by these authors were comparable with those obtained in this experiment.

Feed Efficiency: the result of the feed efficiency (kg feed/kg egg) revealed that birds on T₃ DPWM diet were more efficient in converting their feed to unit weight of egg followed by group fed T₂ DPWM. The least feed efficiency was recorded by birds fed the control diet. The variation in feed efficiency was however not significant ($p > 0.05$) among the groups. Yasmeen *et al.* (2008) reported feed conversion ratio/kg egg mass of 2.33 and 2.61 for pullets and spent layers, respectively; while Fafiolu *et al.* (2006) gave a range of 1.90 to 2.06 as feed efficiency (kg feed kg⁻¹ egg) for laying hens fed diet containing sprouted malted sorghum. Values reported by these authors were lower than those observed in this experiment.

Average Egg Weight: the effect of treatment on average egg weight was significant ($p < 0.05$). Egg weight increased as the inclusion level of DPWM in the diets increased. Bird eating T₄ DPWM diet had the highest average egg weight of 58.42g, while the least egg weight of 54.99g was observed in birds fed the control diet. Egg weight is a function of so many factors, notably; quality and quantity of feed, the strain of the birds, stage of lay and management system. In the instant case, it seems there is a factor that increases egg weight as level of DPWM in the diets increased. It appears that the level of lysine increased with increasing level of DPWM in the diets. There is evidence (Onyimonyi and Ugwu, 2007), that each 0.1 unit of extra lysine increased egg weight by 1.16g.

Shell Weight: variation in the shell weight was not significantly ($p > 0.05$) influenced by increasing levels of DPWM in the diets. Values obtained in this experiment were similar to 6.27 – 6.54g reported by Onyimonyi and Ugwu (2006), but higher than the range (4.84 – 6.32g) and 5.8g reported by Fafiolu *et al.* (2006) and Karaman *et al.*, (2008), respectively. Differences in the shell weight may be attributed to the age of the birds and the weight of eggs. A number of studies have shown that egg shell weight increases as the bird grows older (Suk and Park, 2001; Roberts 2004; Yasmeen *et al.*, 2008).

Shell Thickness: egg shell thickness range from 0.32mm in birds fed T₄ DPWM diet to 0.35mm for birds on T₂ DPWM diet. The level of DPWM in the diets did not, however, affect this parameter significantly ($P > 0.05$). This implies that the test diets did not contain any material whose toxicity could impair this egg quality index. Lower value observed in group fed T₄ DPWM diet could be due to the larger egg size. Olayeni *et al.* (2007) maintained that the shell thickness declined as egg size increased, thereby causing a shell to be spread thinner, forcing shell quality to decline. The values obtained in this experiment were generally lower than the range 0.59 – 0.67mm (Onyimoyi and Ugwu, 2007) and 0.50 – 0.58mm (Iyayi and Taiwo, 2003), but similar to 0.34 - 0.37mm (Eniolorunda *et al.*, 2007), and 0.35mm (Olayeni *et al.*, 2007). It is estimated, that a shell thickness of 0.33mm is needed if the egg is to have a more than 50 percent chance of moving through normal market handling without breaking (Stadelman *et al.*, 1977).

Yolk Weight: yolk weight ranged from 12.31g in birds fed control diet to 12.49g in birds on T₂ DPWM diet. Yolk weight was not significantly ($p > 0.05$) influenced by the treatments.

Albumen Weight: value for the albumen weight was highest (25.64g) in the group fed T₄ DPWM and lowest (23.00g) in birds fed control diet. The treatments did not significantly ($p > 0.05$) influenced this parameter although the higher albumen weight observed among birds fed T₄ DPWM relative to the group fed control diet could be attributed to the higher egg weight. Albumen weight is known to increase the egg weight.

Haugh Unit: the Haugh unit (Hu) is an expression of the relationship between egg weight and height of thick albumen (Haugh, 1937) and it is the most widely used research measurement of albumen quality (Togun *et al.*, 2006). Its values had proved to be more significantly correlated to quality measurements than any other parameter (Onuoha and Uwaleke, 2017, Selle, and Ravindran, 2008). Birds fed control diet recorded the highest Hu value of 84.04% while those fed T₄ DPWM diet recorded the lowest Hu value corresponding to 75.12%. The levels of DPWM in diet did not, however, influence the Hu values significantly ($p > 0.05$). Haugh unit of 72% and above is regarded as an indicator of freshness in egg (Olayeni, 2007). None of the values obtained for different treatments showed value below 72, indicating that eggs from all the treatments were fresh.

Yolk Index: values for yolk index ranged from 0.34 in birds fed T₄ DPWM diet to 0.33 in birds fed T₃ DPWM diet. Birds fed control and those on T₂ and T₄ DPWM diets recorded similar yolk index values. Values were statistically similar ($p > 0.05$) in all the treatment groups. The absence of significant changes in the yolk index showed that DPWM diets did not contain any toxic material that could impair this egg quality index.

Mortality: no mortality incidences were observed in any of treatment group throughout the experimental period, indicating that the processed mucuna bean meal did not have any significant detrimental effect on the birds.

As conclusion, dried pig waste meal replacing wheat offals inclusion in layer diets resulted in decreased final HB, HCT, RBC, MCH and MCHC, but increased in final WBC (except in control), MCH. Values recorded for all these blood parameters fall within the normal range for healthy chickens, thus apparently indicating that the chickens were in healthy conditions pre and post-xperimental period. The use of exogenous enzymes like non-starch polysaccharides is being encouraged to enhance higher utilization of this novel feedstuff.

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