EFFICACY OF ADDITIVE COMPOSITE LEAF MIX FROM SELECTED TROPICAL PLANTS ON THE PERFORMANCE OF BROILER CHICKENS

AYENI, Oluwafemi, ADEGBENRO, Muyiwa, OBADARE, Israel Gem, OLOJUGBA, Lincoln, OLADAYO, Taiwo Olarotimi and AGBEDE, Johnson Oluwasola
Department of Animal Production and Health, School of Agriculture and Agricultural Technology, Federal University of Technology, Akure, Ondo State, Nigeria.

Corresponding Author: Obadare, I. G. Department of Animal Production and Health, Federal University of Technology Akure, Ondo State, Nigeria. **Email**: israelobadare2@gmail.com **Phone**: +234 9030353891

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ABSTRACT

The study involved a six-week feeding trial conducted to investigate the efficacy of selected leaves added as composite leaf mix (CLM) on the carcass, relative organ weight, muscle development and performance of broiler chickens. Fresh Vernonia amygdalina, Moringa oleifera, Ocimum gratissimum, Azadirachta indica leaves were harvested, air-dried, milled and mixed with Allium sativum powder in ratio 4:3:1:1:1 to form the CLM. The CLM was tested for phyto-chemicals and added to a basal diet, as additive at 0, 5, 10, 15 and 20 g/kg. 150 day-old Ross 308 chicks were used in the experiment. The chicks were allotted to treatments, replicated three times with 10 chicks per replicate. At the end of the feeding trial, evaluation of three randomly-selected birds from each replicate showed that the treatments had significant (p<0.05) effect on growth parameters measured with the exception of feed conversion ratio. Weight gain record was highest in birds fed 20.00 g/kg. The carcass characteristics showed that the highest thigh (117.83 g/kg), drumstick (100.48 g/kg) and live weights (2.25 kg) values were observed in birds fed **Diet II, Control and IV respectively**. *Significantly highest values for the heart weight (6.10g/kg) and pancreas (2.51g/kg) were recorded for birds fed Diet IV and the control diet respectively. Birds fed with Diet IV had significantly higher pectoralis thoracicus weights (182.10 g/kg) and musculu supracoracoideus length (14.07 cm). From the results obtained, Diet IV could be recommended in broiler chickens diet to promote superior muscle development and all level of supplementations, for growth promotion.*

Keywords: Composite leaf meal, Feed conversion ratio, Feed intake, Broiler chicken

INTRODUCTION

Nigeria, like many other developing countries, is faced with the difficulty of effectively feeding its rapidly growing population with nutritious foods capable of meeting their individual dietary protein needs. Animal nutritionists in Nigeria have generally agreed that poultry products have significant potential to close the animal protein intake gap (Maidala and Istifanus, 2012). Poultry birds, especially broiler chicken, have relatively short production cycle, as they grow faster, mature earlier, and are more affordable. They are also easier to raise and have fewer production and marketing taboos unlike other species of livestock. According to De Vries-Ten Have *et al.* (2020), animal protein deficit among Nigerians, particularly among low-income earners, has resulted in hidden malnutrition. Poultry meat is an important source of nutrients as it contains all the essential amino acid, fatty acids, vitamins, minerals especially selenium, iodine, phosphorus, potassium, iron and zinc needed for maintaining health and wholesome wellbeing (Marangoni *et al.*, 2015). The quality and quantity of each feed ingredient in a diet determines the performance of the birds. Some poultry farmers feed whatever is available to their chickens without regard for the animals' health or physiological needs. The use of leafs in poultry farming is now becoming popular. Some medicinal plants used by humans have overtime, through studies and use, been utilized to offer alternative therapy in combating poultry diseases. Such plants are said to contain numerous nutrients that contributes in the protection of farm animals against microbial infections (Holetz *et al.,* 2003). They are touted to contain phytobiotic compounds such as aldehydes, alkaloids, phytates, and other compounds that are significantly therapeutic against bacteria, fungi and pathogens (Tipu *et al.,* 2002). These materials are inexpensive, readily available, safe, economical, and biodegradable (Chiejina, 2006). They are good additive sustainable for use by famers as they would reduce the cost of production. Prior to now, antibiotic growth promoters (AGPs) have been utilized at sub-therapeutic doses in animal feeds to maintain the production of poultry products such as eggs and meat (NOAH, 2022). Although birds reared with these AGPs as feed additives had better performances in meat and egg qualities, however, their possible adverse effects are serious public health concern globally (Donoghue, 2003). This concern prompted the European Union to ban AGP use in January 2006 (Castanon, 2007). The ban has led to an increase in the research for the potential use of natural alternative such as neem leaf (*Azadirachta indica* A. Juss., 1830, Sapindales: Meliaceae) (Nayaka *et al.,* 2013), *Moringa oleifera* Lam. (Brassicales: Moringaceae) (Mahfuz and Piao, 2019), ginger (*Allium sativum* Linn, Asparagales: Amaryllidaceae) (El-Hack *et al.,* 2020), and other leaves in livestock feed (Sari *et al.*, 2020). This research was therefore carried out to evaluate how a mix of *A. indica*, *Vernonia amygdalina* Delile (Asterales: Asteraceae), *Ocimum gratissimum* Linn. (Lamiales: Lamiaceae), *M. oleifera* and *A. sativum* at different additive levels in diets affects carcass quality, relative organ weight and muscle development of broiler chickens.

MATERIALS AND METHODS

Description of the Site: The six weeks experiment was carried out between May 7 – June 18 2021 at the Poultry Unit of the Teaching and Research Farm, Federal University of Technology, Akure (FUTA), Ondo State, Nigeria. Akure falls within the rainfall zone of the humid tropics which is characterized by the hot and humid climate. The annual rainfall is 1500 mm and the rain period is bimodal with a short break in August. The altitude is about 350.52 m above sea level, the annual humidity is 75 % and that of temperature is 27ºC (Wikipedia, 2021).

Collection and Air Drying of Leaf Samples for Milling: Fresh leaves of *V. amygdalina* (bitter leaf), *M. oleifera* (moringa), *O. gratissimum* (scent leaf), *A. indica* (neem leaf), *A. sativum* (garlic) was collected from different location in FUTA environment. The leafs were separately air-dried, milled into powder with grinding machine and stored in bags before use. The powdered leaf meals were mixed in a ratio of 4 kg (*V. amygdalina*), 3 kg (*M. oleifera*), 1 kg (*O. gratissimum*), 1 kg (*A. indica*) and 1 kg (*A. sativum*) to form the composite leaf mix (CLM). All collected plants were identified (Llamas, 2003) and authenticated by a plant taxonomist with the Department of Biology, Federal University of Technology, Akure. Voucher specimens (Table 1) were deposited in the Herbarium Centre, Federal University of Technology, Akure, for referral purposes.

Table 1: Plant materials of used in the formulation of the composite leaf mix fed to broiler chicken and their voucher numbers

Plant materials	FUTA herbarium number
Bitter leaf (*Vernonia amygdalina*)	0328
Garlic (*Allium sativum*) powder	0330
Moringa (*Moringa oleifera*)	0324
Neem leaf (*Azadirachta indica*)	0322
Scent leaf (*Ocimum gratissimum*)	0323

All other feed ingredients were purchased from a reputable feed mill in Akure, Ondo State, Nigeria.

Phytochemicals Composition of the Composite Leaf Mix: Phytochemical analysis was conducted to determine the presence of alkaloids, tannins, oxalate and phytate using standard methods as described by Sofowara (1993).

Experimental Design and Feeding Trials: One hundred and fifty (150) day-old Ross 308 chicks were procured from a reputable hatchery in Ibadan, Oyo State, Nigeria. The broiler chicks were then randomly assigned to five dietary treatments of three replicate and 10 chicks per replicate. The design of the experiment was Completely Randomized Design. The right to conduct the experiment was granted by the Research Committee of the Department of Animal Production and Health, Federal University of Technology, Akure, Nigeria. Among the routine management practices are, daily observation of the birds and general cleaning of the environment. The dietary treatments were as follows: Diet I (1 kg of diet + 0 g of CLM, control), Diet II (1 kg of diet + 5 g of CLM), Diet III (1 kg of diet + 10 g of CLM), Diet IV (1 kg of diet + 15 g of CLM) and Diet V (1 kg of diet + 20 g of CLM).

The body weight of the birds in each replicate was taken; and recorded every week. Feed and water were supplied during 6 weeks. The birds were vaccinated against Newcastle Diseases and Infectious Bursal Diseases, other medications were administered as the need arose during the 6 week period.

A basal diet was formulated to contain 21 % crude protein and 3000 kcal/kg ME and used as straight diet. The diets were thoroughly mixed and thereafter, the proximate composition of each diet was done. The gross composition of the basal diet is presented in Table 2.

Data Collection

Growth Performance: The birds were weighed collectively at the start of the experiment and thereafter individually on a weekly basis. Live weight gains were calculated as final weight minus initial live weight, feed intake was determined by the difference between quantity offered and quantity not consumed, while the feed conversion ratio was determined as the ratio of feed consumed (g) to live weight gain (g).

Table 2: Gross composition of the experimental diet (%)

Ingredients	Quantity
Maize	60.00
Soybean meal	15.00
Groundnut cake	18.25
Fish meal	3.00
Di-calcium phosphate	2.00
Limestone	1.00
Premix	0.25
Methionine	0.10
Lysine	0.10
Salt	0.30
Total	100
Calculated Analysis	
Crude protein (%)	21.96
Metabolizable energy (Kcal/kg)	2995.60
Calcium (%)	1.05
Available phosphorus (%)	0.64
Lysine	1.09
Methionine (%)	0.44

Slaughtering, Carcass and Organs Measurement: Three birds selected at random from each replicate were sacrificed for evaluation of carcass and organs record at the end of the six (6) weeks feeding period. Performance record were taken weekly from week 1 – 6. Prior to slaughtering, the birds were kept off feed overnight; fresh drinking water was however given *ad libitum*. The birds were slaughtered and allowed to bleed completely. The slaughtered birds were de-feathered manually to leave the skin intact. The shanks were removed at hock joints and the dressed weight was recorded. The percentage dressed weight was calculated on the basis of live weight.

Evisceration was done by removing crop, gullet, trachea and preens glands. A horizontal cut was made at the rear of the keel bone; thereby the breast was a little upturned and pushed forward, exposing the viscera along with the visceral organs which were then removed completely by pulling. The lungs were scrapped off and heart, liver and gizzard constituting giblet removed carefully from the viscera. The gizzard was then opened, the contents washed out and inner epithelial lining removed. The heart was made free from blood and adhering vessels. The eviscerated weight was recorded as the weight of carcass together with giblets.

Muscle Measurements: The breast muscles of the remaining eviscerated chickens per replicate were dissected out. The inner breast muscle (musculu supracoracoideus) and outer breast muscle (pectoralis thoracicus) were carefully dissected out from the points of origin and insertion. The fresh weight, length and breadth of the muscles were taken and their weights were expressed in g/kg body weight, while length and breadth were expressed in cm body weight.

Statistical Analysis: Data collected were subjected to one-way analysis of variance (ANOVA) using SPSS version 22 package and significant means were separated using Duncan Multiple Range Test of the same package.

RESULTS AND DISCUSSION

The phytochemical/anti-nutrient composition of the composites is as presented in Table 3. Phytate present was 30.49 mg/g, while the oxalate, tannin and alkaloids present were 8.19 mg/g, 0.37 mg/100g and 1.84 % respectively.

Table 3: Phytochemical composition of composite leaf meal (CLM)

Parameters	Values
Phytate (mg/g)	30.49
Oxalate (mg/g)	8.19
Tannin (mg/100 g)	0.37
Alkaloids (%)	1.84

The phytate content of CLM under this study was lower than 66.15 mg/g reported by Gautam *et al.* (2011). The low phytate content suggests that supplementation of the CLM in monogastric diets may not necessitate the addition of phytase, an enzyme that could help in deactivating the effect of the phytate. Oxalate in poultry feed acts as a toxicologic antagonist to divalent cations which helps to improve the eggshell in poultry (Qureshi *et al.,* 2011). Oxalate binds with calcium to form calcium-oxalate crystals which are deposited as urinary calcium (stones) that are associated with blockage of renal tubules (Khan, 2013; Fulton, 2013). Soaking of plant materials or boiling in water is said to reduce toxic effects and improves utilization in terms of feed intake and protein digestibility (Ogbe and Affiku, 2012). Tannins on the other hand have a high affinity for proteins, with which they interact by hydrogen bonding, hydrophobic association or covalent bonding (Watrelot and Norton, 2020). In addition to protein binding, tannins are also thought to form complex with other compounds such as polysaccharides, amino acids, fatty acids and nucleic acids (Hassanpour *et al.*, 2011). Proper food processing would reduce this phytochemical (Akinyeye *et al.*, 2010). Alkaloids in livestock feed enhance intestinal health and absorption of nutrients (Yakhkeshi *et al.*, 2011). The phytochemicals present in the composite leaf meal used in this study are at tolerable level which therefore suggests that CLM could promote broiler production without adversely affecting their physiological activities.

The performance of broiler chickens fed CLM at age 1 – 42 days, revealed that there were significant differences ($p<0.05$) in the final weight (FWT), total weight gain (TWG), daily weight gain (DWG), feed conversion ratio (FCR) and daily feed intake (DFI) (Table 4). The highest FWT 2399.33 ± 67.00 and 2404.00 ± 146.00 g were recorded in birds fed Diet IV (containing 15 g/kg CLM) and Diet V (containing 20 g/kg feed CLM) respectively. Though not significantly different ($p>0.05$) from Diets II and III which was significantly higher than bird fed Diet I. The same trend was observed for TWG and DWG. However, birds fed Diet IV had the highest FI record, though not significantly different ($p>0.05$) from that of birds fed Diets III and V compared to the lowest recorded in Diets I and II. The same trend was observed for DFC. The best FCR (1.75 ± 0.11) was recorded in birds fed Diet V though not significantly different ($p>0.05$) from birds fed Diets I and II (1.87 ± 0.11 respectively), but better than those fed Diets III (2.01 ± 0.12) and IV (1.95 ± 0.07).

Table 4: Performance of broiler chickens fed composite leaf mix additives in diets for six weeks

Parameters	Diet I	Diet II	Diet III	Diet IV	Diet V
IWT (g)	39.80 ± 0.76	39.83 ± 0.38	39.73 ± 0.93	39.83 ± 0.52	39.77 ± 0.28
FWT (g)	1992.00 ± 93.85^{a}	2096.00 ± 19.10^{ab}	2096.00 ± 62.24^{ab}	2399.33 ± 67.0^{b}	2404.00 ± 146.00^{b}
TWG (g)	1952.20 ± 93.14^{a}	2056.20 ± 18.76^{ab}	2056.27 ± 61.64^{ab}	2359.50 ± 66.6^{b}	2364.23 ± 145.71^{b}
FC (g)	3647.33 ± 173.07^{a}	3755.00 ± 60.75^{a}	4137.00 ± 382.55^{ab}	4537.67 ± 283.1^{b}	4150.33 ± 65.25^{ab}
DWG (g)	46.48 ± 2.21^{a}	48.96 ± 0.45^{ab}	48.96 ± 1.47^{ab}	56.18 ± 1.58^{b}	56.29 ± 3.47^{b}
DFC (g)	86.84 ± 4.12^{a}	89.40 ± 1.45^{a}	98.50 ± 9.11^{ab}	108.03 ± 6.74^{b}	98.82 ± 1.55^{ab}
FCR	1.87 ± 0.11^{ab}	1.82 ± 0.03^{ab}	2.01 ± 0.12^{c}	1.95 ± 0.07^{b}	1.75 ± 0.11^{a}

Means on the same row with different letter superscripts are significantly different ($p<0.05$). IWT = Initial Weight, FWT = Final Weight, TWG = Total Weight Gain, FC = Feed Consumed, DWG = Daily Weight Gain, DFC = Daily Feed Consumed, FCR = Feed Conversion Ratio

There have been several studies on alternatives to antibiotic as growth promoters. Medicinal plants like garlic, ginger, neem, bitter leaf and moringa etc. are the most popular option as growth promoters (Elangovan *et al.,* 2000; Hanuš *et al.,* 2005; Esonu *et al.,* 2006; Garba *et al*., 2010) as they serve to alter gut microbial interactions to the benefit of the animals. The data from the present study showed that the performance of broiler chickens was affected by the supplementation of the CLM. From day 1 – day 42, the birds fed with Diet I (containing 5 g/kg CLM) had a 5.0 % increase in TWG than the birds fed with the control diet. It was observed at various stages, that there was improved performance on the broiler chickens at all levels of inclusion of the CLM when compared to the control diet. These was in agreement with the report of Gheisar *et al.* (2015) that feeding broiler chickens with diet containing phytogenic blend led to an improvement in weight gain. This may be due to the presence of proteins, amino acids, minerals and vitamins, in diets and phytochemicals, and secretion and activities of digestive enzymes in the intestine and pancreas stimulated by essential oils from spices and herbs that increase antimicrobial activity, improve palatability and flavour of feed as reported by Jang *et al.* (2004), Czech *et al.* (2009), Owolabi *et al.* (2010) and Ahmadi *et al.* (2015), thus increasing feed intake and weight gain of broiler chickens. According to Manan *et al.* (2012) herbs are valuable alternatives antibiotics beneficial for improved health and nutrition in poultry industry. They can stimulate feed intake, the endogenous secretion of enzymes, and may exhibit antibacterial or anticoccidial activities.

At the end of the experiment (42 days), the birds fed with the CLM showed results for the final weight ranging between 15 - 30 % than that of the control diets and have the best FCR of 1.75. The individual phytogenic properties of the CLM improved the birds' performance. Tollba and Hassan (2003) reported that *A. sativa* can improve FCR in poultry due to the increase in the villus height of the small intestine which in turn activate absorption process thereby increasing growth of the birds. Different plant species can support both health and performance of broiler either individually or as a combined mixture (Khan *et al.,* 2012; Stoev *et al.,* 2019; Khoobani *et al.,* 2020). Phytogenics have been reported to replace antibiotics as feed additives in broiler chickens proc 4408 (Raza *et al.,* 2016; Saeed *et al*., 2020)

Carcass Indices of Birds Fed Composite Mix Supplemented Diets: It was observed that the live weight of birds fed 15 g/kg CLM additive in diets (2.25 ± 0.12 kg) though statistically similar ($p>0.05$) to those fed 5, 10, 15 and 20 g/kg CLM additive in diets was significantly ($p<0.05$) higher than those fed the control diet (1.84 ± 0.10 kg) (Table 5). However, the dressed-out percentage was highest (91.59 ± 0.67 %) in birds fed Diet IV (15 g/kg CLM) and lowest (90.00 ± 0.73 %) in those fed Diet V (20 g/kg CLM) additive in diet. On the other hand, the eviscerated weight (79.34 ± 0.87 %) of birds fed Diet III (10 g/kg CLM) was the highest, and the lowest (75.52 ± 1.06 %), in those fed Diet V. The weights (32.41 ± 2.70 and 100.48 ± 0.33 g/kg) of the head and drumstick of the birds fed the control diet was adjudged to be highest compared to

Table 5: Carcass performance of broiler chickens fed composite leaf mix additives in diets for six weeks

Parameters	Diet I	Diet II	Diet III	Diet IV	Diet V
Live weight (kg)	1.84 ± 0.10[a]	2.05 ± 0.08[ab]	1.97 ± 0.04[ab]	2.25 ± 0.12[b]	2.07 ± 0.15[ab]
Dressed weight (%)	91.43 ± 0.71[ab]	91.17 ± 0.33[ab]	91.26 ± 0.29[ab]	91.59 ± 0.67[b]	90.00 ± 0.73[a]
Eviscerated Weight (%)	77.51 ± 1.72[ab]	78.81 ± 0.49[ab]	79.34 ± 0.87[b]	79.07 ± 1.13[ab]	75.52 ± 1.06[a]
Head (g/kg body weight)	32.41 ± 2.70[b]	22.89 ± 1.65[ab]	26.17 ± 2.31[ab]	18.62 ± 2.32[a]	26.29 ± 3.11[ab]
Neck (g/kg body weight)	42.82 ± 1.73	49.88 ± 2.49	42.55 ± 2.81	45.55 ± 5.82	35.52 ± 2.47
Thigh (g/kg body weight)	109.47 ± 12.55[ab]	117.83 ± 9.24[b]	108.98 ± 5.60[ab]	108.29 ± 17.20[ab]	101.55 ± 9.56[a]
Drumstick (g/kg body weight)	100.48 ± 0.33[b]	98.07 ± 1.64[ab]	99.02 ± 3.25[ab]	92.13 ± 6.69[a]	95.42 ± 3.14[ab]
Wings (g/kg body weight)	80.65 ± 0.80	80.11 ± 1.17	83.32 ± 8.83	76.70 ± 4.93	79.41 ± 2.25
Breast (g/kg body weight)	207.26 ± 4.15	221.71 ± 1.38	228.39 ± 1.37	235.38 ± 2.17	209.68 ± 3.24
Shank (g/kg body weight)	45.39 ± 3.82	35.79 ± 3.20	41.10 ± 3.24	39.64 ± 2.94	37.12 ± 1.79
Back (g/kg body weight)	146.29 ± 7.43	152.69 ± 5.94	152.52 ± 8.33	157.35 ± 10.90	152.57 ± 4.95
Belly Fat (g/kg body weight)	11.56 ± 3.50	13.61 ± 1.45	14.81 ± 0.54	12.29 ± 5.40	17.97 ± 1.55

Means within a row having different superscripts are significantly different (p<0.05)

the lowest values recorded for head (18.62 ± 2.32 g/kg) and drumstick (92.13 ± 6.69 g/kg) in birds fed Diet IV. The highest weight (117.83 ± 9.24 g/kg) for the thigh was recorded in chickens fed Diet II, while the lowest was in chickens fed Diet V. All other carcass parameters measured were not significantly ($p>0.05$) affected by the CLM inclusion. The highest value for breast (235.38 ± 4.83 g/kg) and back (157.35 ± 2.07 g/kg) was recorded in bird fed Diet IV (15 g/kg CLM), while birds fed the control diet ranked lowest for breast (207.26 ± 4.15 g/kg) and back (146.29 ± 7.43 g/kg). Shank varies between 45.39 ± 1.49 g/kg in birds fed the control diet to 35.79 ± 3.20 g/kg in birds fed Diet II. Carcass is an important parameter for determining the relationship for the whole sale or further process bases of birds (Groen *et al*., 1998). The output quality of the system is fixed by a predetermined amount of kilogram carcass of final product of broiler (Greon *et al*., 1998). Results from the live weight of the birds fed the CLM test diets were more improved than that of the control diet, this implies the bird fed the CLM diet gained more weight as a result of the CLM inclusion although results from dressed weight and eviscerated weight didn't show improved values for the birds fed with CLM test diets when compared with the control diet. This observation therefore implied that the dressed weight and eviscerated weight of chickens may not necessarily be directly proportional to the performance traits (Adegbenro *et al*., 2017). A high weight gain value in birds does not imply a resultant increase in dressed weight as a percent of live weight (Adegbenro *et al.,* 2017). The values for eviscerated weight in this study ranged from 75.52 – 79.34 % which surpassed the normal range of 65 – 70 % reported for broiler chicken by Oluyemi and Roberts (1979). Results from the thigh weights of the birds fed Diet II showed improved performances as compared to those fed the control diet, while variations exist between the weights of the drumstick of birds fed the CLM diets and those fed the control diet was not significant. This result was in agreement with a study conducted by Adegbenro *et al.* (2017) who found no significant difference between the weight of drumstick of birds fed with diet containing CLM as premix and those fed the control diet. Thus the result indicated that the CLM diets promoted the development of identical thigh and drumstick weights.

The organ performance of broiler chicken fed CLM diets indicated that the relative weight of the lungs (6.94 ± 0.47 g/kg) of birds fed Diet V was the highest and significantly higher ($p<0.05$) than those fed the control diet and Diet II (Table 6). The highest weight of pancreas (2.51 ± 0.22 g/kg) was recorded in birds fed the control diet and it's significantly higher ($p<0.05$) than birds fed other diets. The lowest weight (1.79 ± 0.20 g/kg) was recorded in birds fed Diet IV. Furthermore, birds fed Diet IV (15 g/kg CLM) had the highest weight of heart (6.10 ± 0.38 g/kg), while the lowest weight of heart (4.39 ± 0.05 g/kg) was recorded in birds fed Diet II. All other organ parameters measured were not significantly ($p>0.05$) influenced by the dietary treatment. The highest value for liver (21.31 ± 1.71 g/kg) and proventriculus (4.62 ± 0.16 g/kg) were recorded in bird fed Diet V, while birds fed Diet IV ranked lowest for liver (16.20 ± 1.38 g/kg) and proventriculus (4.32 ± 0.32 g/kg). Gizzard value varies between 17.25 ± 1.27 – 14.78 ± 0.86 g/kg, with birds fed the control diet ranking highest, while the lowest value was recorded in birds fed Diet V (Table 6). Organs are visceral parts of the animal, composed of several types of tissues capable of carrying out specialized function (Britannica, 2019). The weight of organs in broilers according to Adegbenro *et al.* (2017) reflects the anatomical response of birds to the type of diet intake. The relative organ weights measured in this study were comparable in all dietary treatments except for that of the lungs, pancreas and heart. Lower pancreas weights are considered to reflect relief from pancreatic hypertrophy induced specifically by dietary presence of trypsin inhibitors (Clarke and Wiseman, 2007). Results from the pancreas weight indicated a lower weight in birds fed the CLM diets compared with the control diet which had the highest pancreas weight; this implied a reduced risk of pancreatic hypertrophy in birds fed the CLM diets. The weight of the heart in the birds fed Diet IV (15 g/kg CLM) and Diet V (20 g/kg CLM) was higher than those fed the control diet. This may be advantageous to the circulatory system through the pumping of larger volume of blood (Stephenson *et al.*, 2017). However, there was no observed particular trend in the differences due to the lower weights recorded in birds fed Diet II and III containing 5 g/kg and 10 g/kg inclusion levels of CLM respectively. The spleen is an important immune organ in poultry, and its relative weight was not affected by the test diets. The gizzard which often has been reported to increase in size when birds were fed fibrous feed materials (Fasina *et al.*, 2004) was observed in the present study but not to a significant extent. This indicated that the level of fibre in the diets was moderately high for the birds' gizzard to deal with without much stress. The non-significant differences observed in most of the carcass and organ development signify that the experimental treatments produced similar influence on the organ traits. This was an indication that supplementing the CLM in the feed of birds did not pose serious danger to the functions and development of organs.

The muscle indices of birds fed CLM diets indicated that birds fed Diet IV (15 g/kg) ranks highest for pectoralis thoracicus weight (182.10 ± 14.96 g/kg), pectoralis thoracicus length (18.63 ± 0.24 cm) and musculu supracoracoideus length (14.07 ± 0.56 cm), while the lowest pectoralis thoracicus weight (121.03 ± 17.27 g/kg), pectoralis thoracicus length (16.00 ± 0.58 cm) and musculu supracoracoideus length (12.27 cm) were recorded in birds fed the control diet, Diet IV and V (Table 7). All other muscle parameters measured were not significantly influenced ($p>0.05$) by the dietary treatment. The control diet had the lowest value for musculu supracoracoideus breath (3.67 ± 0.10 cm) and musculu supracoracoideus weight (30.07 ± 1.55 g/kg). Pectoralis thoracicus breath varies between 8.20 – 7.60 cm. Rosochacki *et al.* (1986) and Schreurs (2000) demonstrated that nutrition has significant influences on muscular growth and that malnutrition causes an increase in protein degradation in chicken. Birds fed Diet IV (15 g/kg CLM) had the highest values for pectoralis thoracicus weight, pectoralis thoracicus length and musculu supracoracoideus length showing 33.54, 8.21 and 6.68 % increase on the control diet for pectoralis thoracicus weight,

Table 6: Organs performance of broiler chickens fed composite leaf mix additives in diets for six weeks

Parameters	Diet I	Diet II	Diet III	Diet IV	Diet V
Live weight (g/kg)	1.84 ± 0.10[a]	2.05 ± 0.08[ab]	1.97 ± 0.04[ab]	2.25 ± 0.12[b]	2.07 ± 0.15[ab]
Lungs (g/kg)	6.01 ± 0.31[bc]	5.03 ± 0.38[b]	4.91 ± 0.43[a]	6.58 ± 0.67[c]	6.94 ± 0.47[d]
Pancreas (g/kg)	2.51 ± 0.22[b]	1.89 ± 0.08[ab]	2.01 ± 0.21[ab]	1.79 ± 0.20[a]	1.92 ± 0.16[ab]
Spleen (g/kg)	1.09 ± 0.07	0.99 ± 0.24	1.05 ± 0.10	1.65 ± 0.33	1.60 ± 0.74
Liver (g/kg)	18.55 ± 1.17	19.31 ± 1.25	16.52 ± 0.36	16.20 ± 1.38	21.31 ± 1.83
Proventriculus (g/kg)	4.56 ± 0.18	4.40 ± 0.62	4.43 ± 0.40	4.32 ± 0.32	4.62 ± 0.91
Heart (g/kg)	5.29 ± 0.33[c]	4.39 ± 0.05[a]	4.53 ± 0.27[b]	6.10 ± 0.38[d]	5.68 ± 0.16[cd]
Gizzard (g/kg)	17.15 ± 1.27	16.72 ± 1.64	16.81 ± 1.40	15.83 ± 0.16	14.78 ± 0.86

Means within a row having different superscripts are significantly different (p<0.05)

Table 7: Muscle performance of broiler chickens fed composite leaf mix additives in diets for six weeks

Parameters	Diet I	Diet II	Diet III	Diet IV	Diet V
Breath					
Musculu supracoracoideus (cm)	3.67 ± 0.28	3.97 ± 0.26	3.73 ± 0.10	3.43 ± 0.23	4.13 ± 0.20
Pectoralis thoracicus (cm)	8.13 ± 0.57	7.67 ± 0.47	8.20 ± 0.21	7.77 ± 0.27	7.60 ± 0.06
Weight					
Musculu supracoracoideus (g/kg body weight)	30.07 ± 1.55	35.87 ± 0.52	36.83 ± 1.27	39.27 ± 7.10	35.07 ± 2.91
Pectoralis thoracicus (g/kg body weight)	121.03±17.27[a]	166.83±1.58[c]	167.70±4.84[d]	182.10±14.96[e]	124.57±3.03[b]
Length					
Pectoralis thoracicus (cm)	17.10±0.46[bc]	16.07±0.17[b]	18.37±0.30[bc]	18.63±0.24[c]	16.00±0.58[a]
Musculu supracoracoideus (cm)	13.13±0.30[ab]	12.27±0.15[a]	13.73±0.15[ab]	14.07±0.56[b]	12.27±0.14[a]

Means within a row having different superscripts are significantly different (p<0.05)

pectoralis thoracicus length and musculu supracoracoideus length respectively. Earlier report by Robert (1977) showed that pectoralis thoracicus and musculu supracoracoideus are very important muscles in broiler. This result indicated that the CLM diets especially at 15 g/kg level of inclusion promoted superior pectoralis thoracicus weight, pectoralis thoracicus length and musculu supracoracoideus length development and hence the weight of the birds.

Conclusion: The addition of CLM in the diets of broiler chickens stimulated feed intake, that in turn promoted growth and performance of broiler chickens at all levels of inclusion. The CLM diets at 15 g/kg inclusion promoted superior muscle development and live weight in broiler chickens. From the results of this study, Diet IV (15 g/kg CLM) is an ideal functional diet for a desirable carcass and superior muscle performance and thus recommended.

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