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Nutrient Composition and Growth Performance of Broiler Chickens Fed Diets Supplemented with Neem leaf meal (NLM), Pawpaw leaf meal (PLM), Scent leaf meal (SLM) and Bitter leaf meal (BLM)

By

Osuagwu, F. M[1]., Anigbogu, N. M[2]., Ugwuene, M. C.[3], Fadipe, T. W[4] and Onunkwo, D. N[5]

[1,2,3,4,5]Department of Animal Nutrition and Forage Science, College of Animal Science and Animal Production, Michael Okpara University of Agriculture, Umudike

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Abstract

Two experiments were conducted to determine the effect of some medicinal plant leaves on broiler production. The medicinal plant leaves used for the experiment were Neem leaf meal (NLM), Pawpaw leaf meal (PLM), Scent leaf meal (SLM) and Bitter leaf meal (BLM). The birds were assigned to 6 treatment diets supplemented with the leaf meals and prepared as follows; T1 (0g/kg NLM+PLM+SLM+BLM), T2 (2.50g/kg NLM+PLM+SLM+BLM), T3 (5.00g/kg NLM+PLM+SLM+BLM), T4 (7.50g/kg NLM+PLM+SLM+BLM), T5 (10.00g/kg NLM+PLM+SLM+BLM) and T6 (12.50g/kg NLM+PLM+SLM+BLM) in a completely Randomized Design. Data collected were subjected to Analysis of Variance. Results of proximate, energy and phytochemical composition of experimental diet containing medicinal plant composite leaf meals revealed that the DM content of the treatments ranged from 91.23% - 91.37%, ash, 4.27% - 4.29%; CP, 21.60% - 22.25%; EE, 3.40% - 3.49%; CF, 4.13% - 4.96%; NFE, 57.03% - 57.95% and ME, 2880.07kcal/kg – 2903.82kcal/kg. Ash content also decreases with increase in inclusion levels. With T1 having the highest ash content (4.29%) and T6, the lowest (4.25). The result of proximate and energy composition of experimental diets fed broiler chickens with medicinal plant leaf extracts revealed the DM content of the diet ranged from 91.28% in T6 – 91.40% in T1 and T3, respectively. The ash content of the diets ranged from 4.22% in T6 – 4.30% in T1, T2 and T5, respectively. The CP of the diets was 21.60% and the EE ranged from 3.39% in T4 – 3.41% in T1 and T3. The CF was between 4.13% – 4.15%. The NFE ranged from 57.93% in T2 - 57.96% in T1 while the ME was between 2897.59kcal/kg – 2899.52kcal/kg. The proximate and energy composition of test ingredients revealed that the crude protein content of neem leaf (11.20%) was higher when compared to the protein contents of other test ingredients. The crude fibre of the four investigated leaves ranged from 8.26% in neem leaf – 8.98% in bitter leaf. The ether extract ranged from 0.09% in scent leaf-0.15% in pawpaw leaf, NFE ranged from 53.89% in bitter leaf-56.70% in pawpaw leaf and scent leaf, respectively. The ME ranged from 2101.81kcal/kg in bitter leaf-2319.65% in neem leaf. Bitter leaf contained higher ash content (15.11%), followed by neem leaf (12.31%) when compared to pawpaw leaf (10.65%) and scent leaf (9.81%). The growth performance did not show any significant difference (P>0.05) in the body weights of the birds. Birds fed 10.00g/kg composite leaf meal (T5) ate the least feed. Medicinal plant leaves extracts did not have any significant effect (P>0.05) on the growth performance of the birds.

Keywords: *Nutrient composition, Growth performance, Broiler Chickens, Fed Diets, Medicinal Composite Plant Leaves*

INTRODUCTION

Poultry production remains the most widespread of all livestock enterprises and plays a pivotal role in food security, socio-cultural, and economic development globally (Hernandez et al., 2014). Broiler chickens, in particular, serve as a fast and efficient source of animal protein and income, providing quick returns on investment (Hernandez et al., 2014). In Nigeria, the poultry population stands at an estimated 137.6 million birds, comprising 84% backyard and 16% exotic poultry (Oyisha et al., 2014).

To enhance growth and feed efficiency, broiler diets have historically included antibiotics and synthetic growth promoters. However, concerns over antibiotic resistance and health hazards from residual effects have prompted a shift toward safer, natural alternatives. According to Nweze (2020),

*Corresponding Author: **Osuagwu, F. M.**

herbal feed additives present a viable alternative due to their lower toxicity, reduced health risks, affordability, and widespread availability. Phytogenic feed additives (plant-based) are thus gaining ground for their roles in boosting immunity and enhancing performance in poultry (Mbata & Asaikia, 2015). Generally, feed additives are dietary supplements added to improve growth, production efficiency, and disease resistance in poultry (Baker & Silverton, 2015).

The incorporation of leaf meals as dietary components for broilers has a long-standing history (Wyllie & Chamanga, 1979). These leaf meals are obtained from dried, ground plant leaves rich in nutrients and bioactive compounds. However, challenges such as the high cost of conventional feed ingredients and poor feed-to-gain ratios persist (Abbas, 2013). Phytogenic additives are advocated as a sustainable solution, capable of improving feed conversion ratio, weight gain, and digestibility in broilers (Akande et al., 2017; Benjamin et al., 2016).

Several medicinal plants have shown promise in this regard, including *Vernonia amygdalina* (bitter leaf), *Ocimum gratissimum* (scent leaf), *Azadirachta indica* (neem leaf), and *Carica papaya* (pawpaw leaf).

Bitter leaf (*Vernonia amygdalina*), widely consumed in Southeastern Nigeria, contains steroid glycosides and vernonioside B1, which offer antimicrobial, anti-parasitic, and anti-tumor properties (Ahmad, 2015). Durunna et al. (2011) reported its crude protein content as 15.67%, with significant levels of fibre and ether extract. It enhances feed efficiency in broilers without negatively affecting hematology (Aliero et al., 2018), and may also offer antioxidant benefits (Ani et al., 2012).

Scent leaf (*Ocimum gratissimum*), also known as African basil, is a common herb used both culinarily and medicinally. It thrives across tropical regions and is rich in alkaloids, tannins, flavonoids, thymol, saponins, and essential oils like eugenol, which possess potent antimicrobial activities (Abd El-Latif et al., 2012; Botsoglou et al., 2013). Its nutritional profile includes 4.7% crude protein, 10.8% fibre, and 12.24% ash (Benjamin et al., 2016), making it a safe and effective feed ingredient. Its low levels of anti-nutritional factors further ensure it poses minimal risk when consumed in large amounts (Ubua et al., 2019).

Neem leaf (*Azadirachta indica*) has long been studied for its broad-spectrum medicinal benefits. While it contains anti-nutritional compounds that may affect nutrient absorption in layers (Abd El-Latif et al., 2012), it also holds bactericidal, anti-inflammatory, and immune-modulatory bioactive compounds like margolon and cyclic trisulphides (Nweze, 2020). Its leaves contain approximately 15.5% crude protein and 12.7% fibre (Mbata & Asaikia, 2015). Neem is globally valued for its antibacterial, antiviral, antifungal, and hepatoprotective properties, making it a potential candidate for natural feed supplementation (Mahejabin et al., 2015).

Pawpaw (*Carica papaya*), native to tropical America but widely grown in Nigeria, is known for its economic value, adaptability, and fast growth (Akande et al., 2017). Its leaves are rich in vitamins A, B, B2, and C, as well as calcium, phosphorus, and iron. It also contains powerful proteolytic enzymes—papain and chymopapain—that aid in protein digestion and intestinal health (Baker & Silverton, 2015). These enzymes are also known to tenderize meat and are stable up to 80°C. Pawpaw leaf's low fat and sodium content, coupled with its medicinal and nutritional value, make it a favorable addition to broiler diets (Better Life Health Channel, 2019).

Given the negative effects associated with synthetic additives, attention is shifting toward phytogenic alternatives such as bitter leaf, scent leaf, neem, and pawpaw leaves. These plants have been widely used in traditional medicine and are known for their bioactive compounds, including antibacterial, anti-inflammatory, and immune-enhancing properties (Bhowmik, 2016; Esonu, 2016; Durani et al., 2018; Fanimmo et al., 2015; Doyle, 2017).

Therefore, this study aims to evaluate the effects of composite leaf meals or extracts from *Vernonia amygdalina*, *Ocimum gratissimum*, *Azadirachta indica*, and *Carica papaya* on the growth performance of broiler chickens. The goal is to determine their viability as natural growth promoters, with the potential to reduce reliance on synthetic additives while improving feed efficiency, growth rate, and overall poultry health.

MATERIALS AND METHODS

Study Area

The experiment was carried out at the poultry farm of Sumed livestock farms, Owaza, Ukwa west L.G. A of Abia State, Nigeria. The area falls within the tropical rain forest zone with an annual average rainfall of 2180mm, temperature of about 26^0C, with relative humidity of 71%, depending on season (www.manpower.com.ng, 2023).

Source of Test Ingredients and Feedstuff

Vernonia amygdalina (bitter leaf), *Ocimum gratissimum* (scent leaf), *Azadirachta indica* (Neem leaf), and *Carica papaya* (Pawpaw leaf) were purchased from Oyibo Market in Rivers State. These medicinal plants were washed separately to remove debris. They were subjected to drying at room temperature, after which it was grinded into meal using an attrition mill separately. The respective products were stored in an airtight container and used throughout the period of the experiment. The feedstuffs were purchased from Jocan Store, Umuahia.

Experiment 1: Preliminary

Experiment II: Effect of Medicinal Composite Leaf Meal on Growth Performance of Broiler Chickens Experiment III: Effects of Medicinal Plant Leaves Extract of *Vernonia amygdalina* (Bitter Leaf), *Ocimum gratissimum* (Scent Leaf), *Azadirachta indica* (Neem Leaf), and *Carica papaya* (Pawpaw Leaf) on Broiler Chicken

Experimental diets

Six experimental straight line broiler diets were formulated such that treatment 1 contained no medicinal plant leaf

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(control) while treatment 2, 3, 4, 5 and 6 contained step-wise addition of medicial plant leaves at the following inclusion order, 2.50 g, 5.0 g, 7.50 g, 10.0 g and 12.50 g respectively of each of the four (4) medicinal plant leaves (*Vernonia amygdalina* (bitter leaf), *Ocimum gratissimum* (scent leaf), *Azadirachta indica* (Neem leaf), and *Carica papaya* (Pawpaw leaf). The composition of the diets, medicinal plant additives and calculated chemical analyses are shown in Table 1.

Table 1: Nutrient Composition of Straight Line Broiler Diet Containing Graded Levels of *Vernonia amygdalina* (bitter leaf), *Ocimum gratissimum* (Scent leaf), *Azadirachta indica* (Neem leaf), and *Carica papaya* (Pawpaw leaf)

Ingredients (%)	T_1 (control)	T_2	T_3	T_4	T_5	T_6
Maize	50.00	50.00	50.00	50.00	50.00	50.00
Soya bean	20.00	20.00	20.00	20.00	20.00	20.00
G.N.C	10.00	10.00	10.00	10.00	10.00	10.00
P.K.C	7.00	7.00	7.00	7.00	7.00	7.00
Wheat offal	5.50	5.50	5.50	5.50	5.50	5.50
Fish meal	4.00	4.00	4.00	4.00	4.00	4.00
Lysine	0.10	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10	0.10
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00
Salt (Nacl)	0.25	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Medicinal Plant Leaf	0.00	1.00	2.00	3.00	4.00	5.00
Calculated Chemical Analyses						
ME/Kcal	2889	2889	2889	2889	2889	2889
Protein (%)	22.31	22.31	22.31	22.31	22.31	22.31
Fat (%)	4.30	4.30	4.30	4.30	4.30	4.30
Fibre (%)	4.70	4.70	4.70	4.70	4.70	4.70
Calcium (%)	1.23	1.23	1.23	1.23	1.23	1.23
Phosphorus (%)	0.61	0.61	0.61	0.61	0.61	0.61

Experimental birds and management

A total of 180 day-old broiler chicks were procured from Agrited farms, Ibadan for this study. The chicks were brooded together with a charcoal pot and electric bulbs in a brooding pen for the first seven days, thereafter they were randomly divided into 6 groups of 30 birds each. Each group was further replicated into 3 replicates with 10 birds per replicate. The birds were raised in floor pens with wood shadings as litter material. Each group contained feeders and drinkers for the provision of *ad libitum* access to feed and water respectively for the six weeks period of the experiment. Birds were vaccinated against New Castle disease using Lasota vaccine at 7th and 21st days of life, Infectious Bursal disease using Gumbro vaccine at 14th and 28th days of life. Coccidiostats were also administered to the birds during the experiments.

The infusion levels of the leaves extracts were designated as follow:

Treatment 1 (T_1) without leaf extract, treatment 2 (T_2) contained 25 ml of each of the leaves extracts in 2 litres of water. Treatment 3 (T_3) contained 50 ml of each of the leaves extracts in 2 litres of water, treatment 4 (T_4) contained 75 ml of each of the leaves extracts in 2 litres of water, treatment 5 (T_5) contained 100 ml of each of the leaves extracts in 2 litres of water while treatment 6 (T_6) contained 125 ml of each of the leaves extracts in 2 litres of water. Feed and water infusion of the leaf extracts were given adibitum. Other routine management practices such as vaccination and coccidiostat medication were applied during the period of the experiment. The diet is shown in Table 2.

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Table 2: Experimental Diets Fed to Broiler Chickens with Medicinal Plant Leaf Extracts

Ingredients (%)	T_1 (control)	T_2	T_3	T_4	T_5	T_6
Maize	50.00	50.00	50.00	50.00	50.00	50.00
Soya bean	20.00	20.00	20.00	20.00	20.00	20.00
G.N.C	10.00	10.00	10.00	10.00	10.00	10.00
P.K.C	7.00	7.00	7.00	7.00	7.00	7.00
Wheat offal	5.50	5.50	5.50	5.50	5.50	5.50
Lysine	0.10	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10	0.10
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00
Salt (Nacl)	0.25	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Data collection

Growth performance

The initial live weight of the birds were taken at the beginning of the experiment and subsequently weighed at the end of every week using a weighing balance. Weight gain was obtained respectively by subtracting initial live weight from the final live weights at the end of experiment two and three. The quantity of feed offered to the birds daily and the left over the next morning were measured to ascertain feed intake. Feed conversion ratio was determined by dividing feed intake by weight gain. Mortality was also noted. The formulars were given below;

$$\text{Average feed intake/bird/ day (g)} = \frac{\text{Quantity of feed given} - \text{Quantity left over}}{\text{No of birds x No. of days}}$$

$$\text{Average daily weight gain/bird (g)} = \frac{\text{Final live weight} - \text{Initial live weight}}{\text{No. of birds x No. of days}}$$

$$\text{Feed Conversion Ratio (FCR)} = \frac{\text{Feed intake per bird}}{\text{Weight gain per bird}}$$

$$\text{Mortality (\%)} = \frac{\text{Number of Dead birds}}{\text{Number of Stock birds}} \times \frac{100}{1}$$

Chemical and Data Analysis

The experiments were laid out in a completely randomized design (CRD). All data analyses were done using 1BM^R SPSS version 2022. The data were subjected to analysis of variance (ANOVA). Where treatment means are significant separation of means were done using the Duncan's Multiple Range Test (Duncan, 1955) at 5% level of significance. Chemical Analysis of *Vernonia amygdalina* (bitter leaf), *Ocimum gratissimum* (scent leaf), *Azadirachta indica* (Neem leaf), and *Carica papaya* (pawpaw leaf) was determined according to the methods of AOAC (2015). The proximate analysis of the test ingredients, *Vernonia amygdalina* (bitter leaf), *Ocimum gratissimum* (scent leaf), *Azadirachta indica* (Neem leaf) and *Carica papaya* (Pawpaw lea) leaf meals and the six experimental Diets were determined as well as the anti-nutritional factors like saponin, tannin, flavonoids, alkaloids and phenol in *Vernonia amygdalina* (bitter leaf), *Ocimum gratissimum* (scent leaf), *Azadirachta indica* (Neem leaf) and *Carica papaya* (Pawpaw lea) leaf meals using the techniques of the Association of Official Analytical Chemist (AOAC, 2015).

Experimental Design

The design of the experiment used was Completely Randomized Design (C.R.D) and the model shown below;

$X_{ij} = \mu + T_j + e_{ij}$

X_{ij} = Response variables of the observations on the jth treatment.

μ = Mean of the common effects on the whole experiment.

T_j = Effect of the jth treatment

e_{ij} = Random error present in the ith observation and the jth treatment.

RESULTS AND DISCUSSION

Experiment I

Proximate, Energy and Phytochemical Composition of Experimental Diets Containing Medicinal Plant Leaf Meals

Table 3 presents the proximate, energy and phytochemical composition of the medicinal leaf meal.

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Table 3: Proximate, Energy and Phytochemical Composition of Experimental Diet Containing Medicinal Plant Composite Leaf Meals

Parameters	T1	T2	T3	T4	T5	T6
DM (%)	91.37	91.33	91.31	91.26	91.23	91.19
Moisture (%)	8.63	8.67	8.69	8.74	8.77	8.81
CP (%)	21.60	21.75	21.80	21.95	22.15	22.25
EE (%)	3.40	3.45	3.45	3.47	3.49	3.52
CF (%)	4.13	4.26	4.38	4.54	4.72	4.96
Ash (%)	4.29	4.28	4.28	4.27	4.27	4.25
NFE (%)	57.95	57.55	57.40	57.03	56.60	56.24
ME (kcal/kg)	2897.92	2900.35	2900.64	2901.85	2903.82	2880.07

DM= Dry matter, CP= Crude protein, EE= Ether extract, CF= Crude fibre, NFE= Nitrogen free extract, ME= Metabolizable energy

In Table 3, the DM content of the treatments ranged from 91.23% - 91.37%, ash, 4.27% - 4.29%; CP, 21.60% - 22.25%; EE, 3.40% - 3.49%; CF, 4.13% - 4.96%; NFE, 57.03% - 57.95% and ME, 2880.07kcal/kg – 2903.82kcal/kg. The result revealed that the DM content of the diets reduces as the levels of inclusion increases, with T1 having the highest DM content of 91.37% and T6, the lowest (91.19%). Ash content also decreases with increase in inclusion levels. With T1 having the highest ash content (4.29%) and T6, the lowest (4.25). CP, EE, CF and ME increases across the treatment groups as the level of inclusion increases, with T1 having the least means and T6, the highest. The NFE of the diets were seen to be decreasing as the inclusion level increases.

According to PCAARRD (2000), the recommended moisture content of stored feedstuff should be less than 12% to prevent spoilage. Moreover, Mutayoba *et al.* (2011) and Hamito (2010) reported that feedstuff with a dry matter content of less than 85% is not recommended since mold growth will degrade feed quality, especially in tropical areas with high temperatures and relative humidity. The high proteins in the diets are important in the body for the production of hormones, enzymes and blood plasma. They are immune boosters and can help in cell division as well as in growth (Bouttwell, 1998).

The low crude fibre content in diets indicates its poor sources of lipids. Dietary fibre helps in digestion and functions the body to slow down the rate of glucose absorption into the blood stream thereby reducing the risk of hyperglycemia, the levels of plasma cholesterol and hence preventing colon cancer and cardiovascular diseases (Ilodibia *et al.*, 2014). Ash present in food explains largely the amount of minerals found in food or feed substance. The relatively high ash content in the in treatments is an indication of high minerals preserved in it (Awe *et al.*, 2018).

Proximate and Energy Composition of Experimental Diets Fed broiler Chickens with Medicinal Plant Leaf Extracts

Tables 4 present the proximate and energy composition of the medicinal plant leaves extract.

Table 4: Proximate and Energy Composition of Experimental Diets Fed Broiler Chickens with Medicinal Plant Leaf Extracts

Parameters	T1	T2	T3	T4	T5	T6
DM (%)	91.37	91.40	91.38	91.40	91.37	91.37
CP (%)	21.60	21.60	21.60	21.60	21.60	21.60
Ash (%)	4.29	4.30	4.30	4.28	4.29	4.30
EE (%)	3.40	3.41	3.40	3.41	3.39	3.40
CF (%)	4.13	4.13	4.15	4.14	4.15	4.13
NFE (%)	57.95	57.96	57.93	57.97	57.94	57.94
ME (kcal/kg)	2897.92	2898.90	2897.69	2899.52	2897.59	2897.63

DM= Dry matter, CP= Crude protein, EE= Ether extract, CF= Crude fibre, NFE= Nitrogen free extract, ME= Metabolizable energy

In Table 4, the DM content of the diet ranged from 91.28% in T6 – 91.40% in T1 and T3, respectively. The ash content of the diets ranged from 4.22% in T6 – 4.30% in T1, T2 and T5, respectively. The CP of the diets was 21.60% and the EE ranged from 3.39% in T4 – 3.41% in T1 and T3. The CF was between 4.13% – 4.15%. The NFE ranged from 57.93% in T2 - 57.96% in T1 while the ME was between 2897.59kcal/kg – 2899.52kcal/kg.

The results showed no define pattern in the mean percent of the parameters across the treatment groups. The dry matter content was also within the recommended range of >85% recommended by Mutayoba *et al.* (2011) and Hamito (2010)

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for longer shelf life. Protein content analysis is basic for the characterization of food type (Jones, 1987). Adamu *et al.* (2017) in their study with *Aspillia Kotschyi* plant extract proximate analysis showed that, it contains crude protein (10.39%), crude fibre (9.06%), ash (4.03%) and free nitrogen (70.19%). Except the crude protein and ash, the values of crude fibre and NFE were higher than the values obtained in this study. The medicinal plant extract showed higher crude protein content, which is beneficial as protein contain amino acids utilized by the cells of the body to synthesize all the numerous proteins required for the function of the cell and also to furnish energy (Robinson, 1978 as cited by Adamu *et al.,* 2017). From the results also one can see that the fibre content in the plant extracts compared to the value obtained by Adamu, *et al.* (2017) as higher crude fibre had beneficial effect since it had been reported that food fibre aids absorption of trace elements in the gut and reduce absorption of cholesterol (Adamu, *et al.,* 2017). Crude fibre is also very essential for the digestion of food materials in the food canal of animals (Manalisha *et al.,* 2013). Also from the results Ash content of 4.28-4.30% was obtained. Ash in food contributes for residue remaining after all the moisture has been removed as well as organic material (fat, protein, carbohydrates, vitamins, organic acids etc) have been incinerated at a temperature of about 500^{o}C. Ash content is generally taken to be a measure of mineral content of original food (Onwuka, 2005).

Proximate and Energy Composition of Test Ingredients

The proximate and energy composition of test ingredients is presented in Tables 5.

Table 5: Proximate and Energy Composition of Test Ingredients

Parameters	Bitter leaf	Pawpaw leaf	Scent leaf	Neem leaf
DM (%)	83.61	85.32	83.05	86.66
CP (%)	5.50	9.40	7.85	11.20
EE (%)	0.13	0.15	0.09	0.12
CF (%)	8.98	8.42	8.60	8.26
Ash (%)	15.11	10.65	9.81	12.31
NFE (%)	53.89	56.70	56.70	54.77
ME (kcal/kg)	2101.81	2315.93	2259.05	2319.65

DM= Dry matter, CP= Crude protein, EE= Ether extract, CF= Crude fibre, NFE= Nitrogen free extract, ME= Metabolizable energy

The crude protein content of neem leaf (11.20%) was higher when compared to the protein contents of other test ingredients. The crude fibre of the four investigated leaves ranged from 8.26% in neem leaf – 8.98% in bitter leaf. The crude fibre content of the leaf meals fell within the reported values (8.50 – 20.90%) for some Nigerian vegetables (Isong and Idiong, 1997). Dietary fibre helps to lower serum cholesterol level, risk of coronary heart diseases, constipation and diabetes (Ishida *et al.,* 2000). The ether extract ranged from 0.09% in scent leaf-0.15% in pawpaw leaf, NFE ranged from 53.89% in bitter leaf-56.70% in pawpaw leaf and scent leaf, respectively. The ME ranged from 2101.81kcal/kg in bitter leaf-2319.65% in neem leaf. Bitter leaf contained higher ash content (15.11%), followed by neem leaf (12.31%) when compared to pawpaw leaf (10.65%) and scent leaf (9.81%). Ash content is of significant importance in foods as they account for the mineral constituents (Edema and Okiemen, 2000).

According to PCAARRD (2000), the recommended MC of stored feedstuff must be less than 12% to prevent spoilage, this values obtained for MC in this study were higher than the referenced value. . Moreover, Mutayoba *et al.* (2011) and Hamito (2010) reported that feedstuff with a dry matter content of less than 85% is not recommended since mold growth will degrade feed quality, especially in tropical areas with high temperatures and relative humidity. The crude protein content of the PLM used in the current study was lower than the analysis reported by Onyimonyi and Ernest (2009) and Ebenebe *et al*. (2011) who reported that PLM has 30.12% and 28.20% CP, respectively. Moreover, the CP content of PLM is lower than the CP analysis of papaya seed meal reported by Bolu *et al.* (2009) with 30.08%. This CP analysis of neem plant leaf meal is lower compared to *Azadirachta indica* leaf meal with 24.06% CP (Onyimonyi and Ernest, 2009).

Proteins are important in the body for the production of hormones, enzymes and blood plasma. They are immune boosters and can help in cell division as well as in growth (Bouttwell, 1998). The high moisture contents showed that the leaves are more prone to deterioration since foods with high moisture are prone to deterioration (Bouttwell, 1998). Moisture dissolves other substances and carries nutrients throughout the systems leading to effective performance of the organs (Okeke and Ekekwa, 2006). Crude Fibre was 7.21 ± 0.01% in *V. amygdalina* and 6.00 ± 0.03% in *O. gratissimum* was reported by Mgbemena and Amako (2020), lower than the values obtained in this study. Generally dietary fibre helps in digestion and functions the body to slow down the rate of glucose absorption into the blood stream thereby reducing the risk of hyperglycemia, the levels of plasma choresterol and hence preventing colon cancer and cardiovascular diseases (Ilodibia *et al.,* 2014). The high crude fibre in the test ingredients makes them a good source of lipids.

Akanmu and Adeyemo (2012) reported that Neem leaf proximate results showed a dry matter, crude protein, crude fibre and ether extract of 92.34, 23.50, 13.40 and 7.1% respectively, Pawpaw leaf gave a lower dry matter content of 86.14%, higher crude protein (27.2%), lower crude fibre (6.0%) and ether extract of 2.4 %. These values were higher than the values reported in this study. It has been reported that neem plant is one of the plant species that do not shed leaves all year round, in this study fresh and blooming leaves from young neem plants were harvested and this is evidenced by the high crude protein, low crude fibre and high ether extract

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recorded in this study which was in line with the observations of Akanmu and Adeyemo (2012). The proximate composition of paw paw leaf meal showed that the crude protein in this study was higher than the value reported by Onyimonyi *et al*. (2009). The high moisture content found in leaf meals further suggests their capacity to supplying the necessary active ingredients like papain and chymopapain as observed by Akanmu and Adeyemo (2012). Adewole (2014) shows that the moisture content of *Ocimum Gratissimum* was 10.30±0.01%, high moisture content is an index of spoilage, the protein content was (16.51 ±0.40), the high protein content buttressed the use of the plant leaf as flavor soup and spice meat, and also the crude fibre was 9.07±0.27%, which was slightly higher than the values obtained in this study.

Obikaonu (2012) reported that neem leaf meal contained 18.10% crude protein, 15.56% crude fibre, 2.50% ether extract, 5.26% ash and 58.22% nitrogen free extract. They observed that the neem leaf meal displayed same characteristics as leaf meals from other tropical browse plants – high crude fibre and moderate crude protein content as reported for *Jacaranda mimosifolia* (Okorie, 2006) and for *Microdesmis puberula* (Esonu *et al.,* 2002). With relatively high crude fibre content, (15.56%), the metabolizable energy must be low even though its gross energy content was high (4.16 Kcal/g). Ampode (2019) reported the chemical composition of papaya leaf meal (PLM) to contained 10.72% moisture content (MC), 89.28% dry matter (DM) and 32.13% crude protein (CP). Akinola *et al* (1021) shows the result of the proximate analysis scent leaves to be; 9.98% CF, 2.45%ash and 16.69% CP.

Mgbemena and Amako (2020) showed the result of proximate analysis of *V. amygdalina* and *O. gratissimum* leaves extracts, crude protein was 35.37 ± 0.11% in *V. amygdalina* and 22.20 ± 0.02% in O.gratissimum. The high CP may be due to the processing method, as the once used in this study was leaf meal. Eating of *V. amygdalina* leaves are encouraged because of its high protein content as stated by Mgbemena and Amako (2020). Moisture content was 12.28 ± 0.02% in *V. amygdalina* and 10.80 ± 0.01% *in O. gratissimum*. *O. gratissimum* as reported by Mgbemena and Amako (2020), which was lower than the values obtained in this study. Mgbemena and Amako (2020) also reported the ash contents of 5.87 ± 0.03% in *V. amygdalina* and 3.4 ± 0.03 % in *O. gratissimum.* Ash content obtained in this study was higher. Higher ash content in the leaves of *V. amygdalina* is an indication of high minerals preserved in it (Awe *et al.,* 2018).

Phytochemical Composition of Bitter Leaf, Pawpaw Leaf, Scent Leaf and Neem Leaf

Tables 6 present the phytochemical analysis of the leaves of the test ingredients.

Table 6: Phytochemical Composition of Bitter Leaf, Pawpaw Leaf, Scent Leaf and Neem Leaf

Parameters	Bitter leaf	Pawpaw leaf	Scent leaf	Neem leaf
Saponin (% of DM)	4.88	3.33	5.11	3.55
Tannin (% of DM)	2.66	2.80	3.20	3.10
Flavonoids (% of DM)	2.04	1.50	2.50	4.30
Alkaloids (% of DM)	2.67	3.10	4.80	3.55
Phenol (% of DM)	2.44	2.10	2.33	3.20

The phytochemical analysis in percentages shows that saponin ranged from 3.33% in pawpaw leaf -5.11% in scent leaf. Tannin ranged from 2.66% in bitter leaf- 3.20% in scent leaf, flavonoid ranged from 1.50% in pawpaw leaf-4.30% in neem leaf. Alkaloid was 2.67% in bitter leaf-4.80% in scent leaf, while phenol ranged from 2.10%-3.20% in neem leaf. Mgbemena and Amako (2020) in their study on the qualitative phytochemical analysis of *Ocimum gratissimum* and *Vernonia amygdalina* revealed the presence of saponin, tannin, flavonoids, steroids, terpenoids and alkaloids. The quantitative phytochemical analysis revealed the presence of all the secondary metabolites in varied quantities in both leaves extracts. Saponin was the highest among the phytochemicals determined in both leaves extracts with the value 5.71 ± 0.12 mg/g in *V. amygdalina a*nd 3.52±0.01 mg/g in *O. gratissimum*, this is followed by terpenoids with 3.40±0.11 mg/g in *O. gratissimum*, tannin 4.90 ±0.23 mg/g in *V. amygdalina* and 2.48 ± 0.03 mg/g in *O. gratissimum*, flavonoids 4.60± 0.01 mg/g in *V. amygdalina* and 2.00± 0.03 mg/g in *O. gratissimum*, alkaloids 3.16 ± 0.16 mg/g in *V. amygdalina* and 2.00 ± 0.02 mg/g in *O. gratissimum*, steroids 0.50 ± 0.02 mg/g in *V. amygdalina* and 0.48 ± 0.0 2 mg/g in *O. gratissimum*.

Akinola *et al*. (2021) reported that Scent leaf has significantly high alkaloids (12.17%), tannins (10.25 mg GAE/g), and saponins (9.65 mg/100g) contents when compared to bay leaf, which has alkaloids (2.45%), tannins (5.31 mg GAE/g), and saponins (4.47 mg/100g) and celery leaf, which has alkaloids (4.26%), tannins (6.88 mg GAE/g), and saponins (0.20 mg/100g). Ogundele *et al*. (2022) reported the values obtained for alkaloids to range from 1.473 to 1.621. The higher value was obtained in the mature leaf (1.621 g/100g) while the lower value (1.473 g/100g) was obtained in the young leaf. Alkaloid value of 2.04 had been reported by Singhal and Kulkarni (2007) and 4.60 reported by Ali *et al.* (2020) for leaves of *V. amygdalina*. The authors reported the values obtained for phenol to range from 0.397 to 0.642. The higher value was obtained in the mature leaf (0.642 g/100g) while the lower value (0.397 g/100g) was obtained in the young leaf. Phenol content of 0.76 g/100g has been obtained by Teye *et al.* (2019) for air dried *V. amygdalina* leaf and 1.64 g/100g obtained by Teye *et al.* (2019) for oven dried *V. amygdalina* leaf. 0.34 and 0.35 phenol content has been reported by Ojewuyi *et al.* (2014) for mature and young leaves of *P. longifolia* respectively. Phenolic compounds have been

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recorded to contain antioxidant property which inhibits oxidative damage of cell owing to the existent of free radical scavengers. Phenolic compounds reduce the danger of heart diseases and provide anti-inflammatory action due to their capacity to nullify or neutralize free radicals as reported by Okechukwu *et al.* (2015). Ogundele *et al*. (2022) also reported that saponin ranged from 0.064 g/100g to 0.072 g/100g, they observed that saponin was found to be higher in mature leaf 0.072 g/100g than in young 0.064 g/100g. Saponin content of 2.70 g/100g has been reported by Ali *et al.* (2020) 0.21 g/100g reported by Okoli *et al.* (2021). Saponin is known to possess both anti-inflammatory and antimicrobial activities (Hassan *et al.*, 2012).

Adewole (2014) in his study shows that tree basil has high content of alkaloid (11.43±0.09), phenol (7.50±0.06), tannin (10.90±0.06), flavonoid (8.20±0.06) and saponin (12.87 ±0.19). Alexandra (2016) and Udochukwu *et al*. (2015) had reported the abundance of bioactive components in these leaves. The presence of these metabolites showed the great potentials of these leaves vegetables as good sources of useful phytomedicines. The presence of saponins in plants is responsible for the various biological benefits like anti-inflammatory, anti- diabetic, anti- HIV and anti-atherosclerosis. It is very effective in maintaining liver function, lowering blood cholesterol, preventing peptic ulcer (Mgbemena and Amako, 2020). Saponin has found to reduce nutrient utilization and conversion efficiency as in ruminants (Kashiwada *et al.,* 2009). The non sugar part of saponin has direct antioxidant activities which may result in other benefits such as reduced risk of cancer and heart diseases in man (Rhoades, 2009).

Many alkaloids are used as drugs some of which include; nicotine, quinine, caffeine, cocaine and morphine. They have wide range of pharmacological activities such as antimalarial (quinine), anti-asthma (ephedrine), anticancer, analgesics, (morphine), caffeine in tea, coffee stimulate and balance the nervous system (Qui *et al.*, 2004). Alkaloids play an important metabolic roles and development in the system of living organisms. Alkaloids are known for their antimicrobial properties which accounted for its antimicrobial action (Kadiri and Olawoye, 2016). Flavonoids are polyphenolic compounds which contribute to many other colours found in nature. They have been reported to have anti - viral and anti-allergic activities. Flavonoid, quercetin is known for its ability to relieve hay fever, eczema and asthma (Prabhavathi *et al.*, 2016). The antioxidants present in flavonoids may act in synergy with other phytochemicals in the leaves *to* produce the medical benefits inherent in their leaves as stated by Mgbemena and Amako (2020).

Many plants used in traditional medicines worldwide contain some certain level of the phytochemical contents, which can often account for their therapeutic action (Anupam *et al.*, 2018). The results of phytochemical analysis of this study revealed the presence of enough secondary metabolite in leaves.

Experiment II

Growth Performance of Broiler Chickens Fed of Medicinal Plant Leaves

The growth performance of finisher broiler chickens fed medicinal plant composite leaf meal is shown in Table 7.

Table 7: Effect of Medicinal Plant Composite Leaf Meal on Growth Performance of Broiler Chickens

Parameters	T1	T2	T3	T4	T5	T6	SEM
Initial body weight (g)	39.00	40.33	40.33	40.67	40.00	40.00	0.28
Final body weight (g)	3025.00	3041.67	3041.67	3050.00	2966.67	3058.56	17.22
Weight gain (g)	2986.00	3001.33	3001.67	3009.33	2929.67	3018.33	17.12
Daily weight gain (g)	71.10^{d}	71.46^{c}	71.47^{c}	71.65^{b}	69.75^{e}	71.87^{a}	0.17
Total feed intake (g)	5228.33^{ab}	5326.67^{a}	5265.00^{ab}	5268.33^{ab}	5195.00^{b}	5246.67^{ab}	15.15
Daily feed intake (g)	124.48^{e}	126.81^{a}	125.36^{c}	125.43^{b}	123.69^{f}	124.90^{d}	0.23
FCR	0.57	0.56	0.57	0.57	0.56	0.58	0.00
Total water intake	9.18^{ab}	9.19^{a}	9.14^{bc}	9.13^{c}	9.18^{a}	9.18^{a}	0.01
Daily water intake	0.19	0.19	0.19	0.19	0.19	0.19	0.00

$^{a\text{-}b}$ means for each parameters in a row with different superscripts are significantly different (P<0.05); SEM = Standard error of the mean, FCR= Feed conversion ratio

There were significant (P<0.05) differences among the treatment groups for daily weight gain, average total feed intake and average total water intake. No significant (P>0.05) difference were observed for initial weight, final body weight, daily feed intake, FCR, feed efficiency, and average daily water intake. Birds fed T6 were significantly higher (P<0.05) in the daily weight gain (71.87g). Birds fed T2 were statistically (P<0.05) higher in average total feed intake but similar when compared with birds fed T1, T3, T4 and T6. The birds fed T2, T5 and T6 had significant higher (P<0.05) total water intake than T3 and T4 but similar (P>0.05) to birds fed T1.

Medicinal plants like garlic, ginger, neem, bitter leaf and moringa etc. are the most popular option as growth promoters as stated by Elangovan *et al.* (2000), Hanuš *et al.* (2005), Esonu *et al*. (2006) and Garba *et al*. (2010) as they serve to

*Corresponding Author: **Osuagwu, F. M.**

alter gut microbial interactions to the benefit of the animals. The data from this present study showed that the performance of broiler chickens was not affected (P>0.05) by the dietary treatment (except total feed and water intake). This result was in contrast to the reports of Ayeni *et al*. (2022) who observed a significant difference (P<0.05) in the growth performance of broiler chickens fed composite leaf mix additives in their diets. These was also in contrast to the report of Gheisar *et al*. (2015) that feeding broiler chickens with diet containing phytogenic blend led to an improvement in weight gain. This study also contradicted the report of Daramola (2019) who reported that the mixture of bitter leaf meal and moringa leaf meal enhanced growth performance of broiler birds.

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. Similarity in body weight, feed intake, water intake and feed conversion ratio of birds across the treatment groups in the present study showed that anti-nutritional factors in treatments were not harmful to these experimental birds as stated by Nnena and Okey (2013). Monzer *et al*. (2018) also reported that feed intake and feed conversion were not significantly (P>0.05) affected due to application of medicinal plants used and their mixtures. Osman and El- Barody (1999) found that the addition of *Nigella sativa* seeds (a medicinal plant) at levels (0.2 %, 0.4 %, 0.6 %, 0.8 % and 1.0 %) in broiler diets had insignificant effect on average body weight at all age intervals.

Daramola (2019) observed significant differences (P<0.05) in the final weight, daily weight gain, total feed intake and daily feed intake of the birds. The author reported that the final weight and daily weight of birds fed moringa and bitter leaf meal composite was significantly higher (P<0.05) than when they were used individually, with the mean weight of 2008.33g and 71.73g, respectively. he also observed that the lowest FCR value was recorded for birds fed the control diet (1.91±0.01), followed by bitter leaf and moringa composite (2.03±0.02) while the highest FCR was recorded for birds fed bitter leaf meal only (2.41 ± 0.02). The general improvement by equal mixture of BLM and MOLM on final live-weight and daily weight gain revealed that the mixture of herbs (BLM and MOLM), enhanced growth performance of broiler birds. However, the opposite is the case in this study as the medicinal plants leaf meal composite did not have any effect on the growth performance of the birds except total feed and water intake. It has been shown that the combination of herbs in broiler chicken diet might have improved the production and activities of digestive enzymes (Daramola, 2019).

The use of additive consisting of quillaja, anise, and thyme in a diet at a level of 0.075% has been known to have a positive effect on the body weight of meat-type ducks and broiler chickens (Gheisar *et al*. 2015; Ismail *et al*. 2021). The same study also showed that the addition of a mixture of phytobiotic plants improved the taste of the feed, increasing its intake, and stimulated both the secretion of digestive enzymes and antibacterial activity, which resulted in an increased in bird productivity in their experimental groups (Alagawany *et al*. 2021) as was witnessed in this study. According to Lipin´ski *et al*. (2019), the addition of a herbal preparation consisting of a mixture of the following plant species: *Ichnocarpus frutescens, Terminalia chebula, Sida cordifolia, Terminalia arjuna, Phyllanthus emblica, Tephrosia purpurea, Fumaria indica, Andrographis paniculata, Azadirachta indica, Tinospora cordifolia, Achyranthes aspera, Boerhavia diffusa, Solanum nigrum, Citrullus colocynthis, Eclipta alba, Aphanamixis polystachya and Phyllanthus niruri*, had a positive effect on the growth and protection of the liver and contributed to the improvement of growth performance parameters (body weight, average daily weight gain, feed conversion ratio) in broiler chickens (Alagawany *et al*. 2021). In a study by Ayeni *et al*. (2022) on efficacy of additive composite leaf mix from selected tropical plants on the performance of broiler chickens, it revealed that there were significant differences (p<0.05) in the final weight, total weight gain, daily weight gain, feed conversion ratio and daily feed intake of the birds. The highest final weight (2399.33 ± 67.00) and (2404.00 ± 146.00g) were recorded in birds fed Diet containing 15 g/kg CLM (mixture of fresh *Vernonia amygdalina, Moringa oleifera, Ocimum gratissimum* and *Azadirachta indica* leaves) and Diet containing 20 g/kg feed CLM) respectively. The authors also observed the same trend for total weight gain and daily weight gain.

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. It had been reported that the difference between feeding single herbal plants versus herbal mixture might be due to some antimicrobial components present in the ingredients of the herbal plants used (Saleh *et al.*, 2018) and various studies have reported that herbal plants and leaf meals used alone or in different combinations had positive, negative, or no effects at all on broilers performances. However, the comparable performance of the dietary treatments with the control indicated why medicinal plants may be used as alternative to growth promoters because they exhibit antimicrobial properties and thus can form integral part of poultry nutrition as suggested by Onibi *et al*. (2009).

Experiment III

Growth Performance of Broiler Chickens Fed Medicinal Leaves Extract

The growth performance of finisher broiler chickens fed medicinal leaves extract is shown in Table 8.

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Table 8: Effect of Medicinal Leaves Extract on Growth Performance of Broiler Chickens

Parameters	T1	T2	T3	T4	T5	T6	SEM
Initial body weight (g)	40.33	40.00	39.00	40.00	40.67	40.00	0.28
Final body weight (g)	3041.67	3058.33	3025.00	3041.67	3050.00	2966.67	17.22
Weight gain (g)	3001.33	3018.33	2986.00	3001.67	3009.33	2911.67	17.55
Daily weight gain (g)	71.46	71.87	71.10	71.47	71.65	69.32	0.76
Total feed intake (g)	5326.67	5246.67	5228.33	5265.00	5268.33	5221.67	14.94
Daily feed intake (g)	108.72	107.07	113.36	107.45	107.51	106.01	1.03
FCR	0.65	0.67	0.63	0.66	0.67	0.65	0.00
Average total water intake	9.19[a]	9.18[ab]	9.17[ab]	9.14[bc]	9.13[c]	9.18[ab]	0.01
Average daily water intake	0.19	0.19	0.19	0.18	0.19	0.18	0.00

[a, b, c] means for each parameters in a row with different superscripts are significantly different (P<0.05); SEM = Standard error of the mean

With the exception of average total water intake, all the growth performance parameters were not significantly (P>0.05) affected by the dietary treatment. Average total water intake was significantly higher (P<0.05) in birds fed the control (T1), with the mean value of 9.19. However, the total water intake of T1was not significantly different (P>0.05) from the birds fed T2 (9.18), T3 (9.17) and T6 (9.18). Birds fed T5 had the lowest water intake with the mean value of 9.13.

The results of this work corroborated the findings of Nnena and Okey (2013) who reported non-significant (P>0.05) difference on all growth performance parameters of broiler chicks served aqueous neem leaf extract at 20, 40 and 60ml per litre of drinking water. Vidanarachchi *et al.* (2010) observed no significant difference (*P* > 0.05) in bodyweight gain (BWG) or feed intake in broilers fed diets supplemented with the plant extracts. Patterson *et al*. (1997), Zdunczyk *et al*. (2005) and Geier *et al*. (2009) also found no beneficial effects on the performance of poultry due to diets supplemented with prebiotic and bioactive compounds, which was in line with the findings of this present study. Mudalal *et al*. (2020) reported that birds fed 0.2ml/L and 0.3ml/L of birds fed herb extract (HE) [(is a mixture of pure honey with an extract of several medicinal plants: fenugreek (*Tigonella foenum graecum*), chamomile (*Anthemis ecutita*), nettle (*Urtica dioica*), thyme (*Thymusvulgaris*), mint (*Menthola*), black seed (*Nigella sativa*)].were not significantly different (P<0.05) in feed intake at 1-48 days, when compared to the control. They reported the values of 35.52g and 36.09g for birds fed 0.2ml and 0.3ml, respectively. The authors also observed that the body weight of the birds were significantly different (P<0.05) among the treatment groups, with birds fed 0.3ml/L having significant heavier (P<0.05) body with the mean value of 2671.40g at the end of 42days.

The final body weight of broilers subjected to the different dietary groups are high values, higher than recommended live weight of 1733 to 2283g reported by Sese *et al*. (2013) for broilers. The FCR was also significantly different (P<0.05) among the birds fed birds fed 0.2ml/L and 0.3ml/L of birds fed herb extract with birds fed 0.3ml/L had a best conversion ratio of 1.66 (Mudalal *et al*., 2020). Nodu *et al*. (2016) reported the water intake of birds administered 3g and 4g *Azadirachta indica* extract to be 13.92ml and 13.69ml which were not significantly different (P>0.05) from each other. This was in contradiction with the report of this study which revealed that the different levels of medicinal plant extract had significant effect (P<0.05) on the water intake of the birds. However, the quantity of water consumed in this present study was lower than the quantity reported by Nodu *et al*. (2016).

Summary

This study aimed to determine the effect of some medicinal plant leaves on broiler production. The experiment was divided in to three separate experiments. Experiment 1 showed the proximate and energy composition of the experimental diets as well as the phytochemical composition in the experimental plant leaves. In Experiment 2, the medicinal plant leave was grounded into composite leaf meal and were added to their diets at 2.50g, 5.0g, 7.50g, 10.0g and 12.50g levels, while in Experiment 3, the leaves were processed into liquid extract and was administered into the drinking water at 25ml, 50ml, 75ml, 100ml and 125ml. In experiment 2, the growth performance showed that birds fed T6 ate less feed but had the highest daily weight gain. In experiment 3, no significant difference (P>0.05) as seen in the growth performance parameters.

Conclusion

The daily weight gain and feed intake of the birds in Experiment 2, tends to be influenced (P<0.05) by the experimental diets, this was expected as inclusion of leaf meals had been known to affect growth performances of birds, unlike Experiment 3, were treatment influence were not observed (P>0.05) in the birds. Birds fed T6 had higher CP retention when compared to those in experiment 3.

Recommendation

From the results of these experiments, it is therefore recommended 12.5g medicinal composite leaf meal should be

*Corresponding Author: **Osuagwu, F. M.**

used for effective broiler chicken production rather than the extract form.

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*Corresponding Author: **Osuagwu, F. M.**