Performance, nutrients digestibility and economics of production of finisher broiler fed diets containing *Euphorbia heterophylla* leaf meal

¹Upah, S. O., ²Okwori, A. I. and ³Orayaga, K. T.

^{1,2}Department of Animal Production, College of Animal Science,
Federal University of Agriculture, Makurdi, Benue State, Nigeria.

³Department of Animal Nutrition, College of Animal Science,
Federal University of Agriculture, Makurdi, Benue State, Nigeria.

Abstract

Corresponding author: samsonupah64@gmail.com

The high cost of feed has become a great challenge in poultry production. Good quality and cheap feed is therefore crucial for optimal growth performance of poultry chickens. In this study the effect of *Euphorbia heterophylla* Leaf Meal (EHLM) on the performance, carcass characteristics, nutrients digestibility and economics were evaluated. Broiler chicks numbering one hundred and eighty (180) of Ross 308 strain were fed for 4 weeks. The birds were randomly allotted to six experimental diets with three replications of 10 birds each. The diets were formulated with the inclusion of EHLMat 0, 5, 10, 15, 20 and 25% levels, for T1, T2, T3, T4, T5 and T6 which replaces soyabean meal respectively and data collected were subjected to analysis of variance in a completely randomized design. Results obtained indicated that the experimental diets significantly ($P < 0.05$) affected the average feed intake and average daily protein intake, while the average daily weight gain, average feed conversion ratio, average daily protein efficiency ratio and average final live weight were not affected ($P > 0.05$); mortality was not affected ($P > 0.05$) by the diet. Carcass parameters, carcass cut and internal organs such as fasted liveweight, plucked weight, dressed weight, breast weight, thigh, drum stick, neck, shank and wings, heart, empty gizzard, lungs, spleen, pancreas, small intestine and esophagus weights showed no significant ($P > 0.05$) difference while back, head, liver, proventriculus, kidney, abdominal fat, large intestine and caeca weight were significantly ($P < 0.05$) different. The GIT length was affected ($P < 0.05$) by the diet except the caeca length. The nutrient digestibility of CP and NFE did not showed significant ($P > 0.05$) effect, but CF, EE and Ash were affected ($P < 0.05$) by the dietary treatments. The nutrient digestibility of 5%, 10%, 15% and 25% were higher than the control diet (0%) for the five nutrients evaluated. The economics of production showed that feed cost (N/kg weight gain), total income (birds sold) and total profit (net gain) were not significantly ($P > 0.05$) different while the feed cost (N/chicken), cost saving due to EHLM inclusion, total cost of production (N/chicken) and feed cost as percentage of total cost were significantly ($P < 0.05$) affected by the test diets. The result showed that birds fed diet containing 15% have better economic advantage for optimum benefit. Therefore 15% EHLM replacement of soya bean is recommended for adoption for optimum growth performance, carcass yield, nutrient digestibility and economics of production in finisher broiler chicken.

Keywords: Broiler finisher chickens, performance, carcass characteristics, nutrient digestibility

Performance, digestibilité des nutriments et économie de la production d'aliments pour poulets de chair de finition contenant de la farine de feuilles d'*Euphorbia heterophylla*

Résumé

Le coût élevé des aliments pour animaux est devenu un grand défi dans la production avicole.

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Une alimentation de bonne qualité et bon marché est donc cruciale pour des performances de croissance optimales des poulets de volaille. Dans cette étude, l'effet de la farine de feuilles d'Euphorbia heterophylla (EHLM) sur la performance, les caractéristiques de la carcasse, la digestibilité des nutriments et l'économie ont été évalués. Des poussins de chair au nombre de cent quatre-vingts (180) de souche Ross 308 ont été nourris pendant 4 semaines. Les oiseaux ont été répartis au hasard dans six régimes expérimentaux avec trois répétitions de 10 oiseaux chacune. Les régimes ont été formulés avec l'inclusion d'EHLM à 0, 5, 10, 15, 20 et 25%, pour T1, T2, T3, T4, T5 et T6 qui remplace respectivement le tourteau de soja et les données collectées ont été soumises à une analyse de variance. dans une conception complètement aléatoire. Les résultats obtenus ont indiqué que les régimes expérimentaux affectaient significativement ($P < 0,05$) la consommation alimentaire moyenne et la consommation quotidienne moyenne de protéines, tandis que le gain de poids quotidien moyen, le rapport de conversion alimentaire moyen, le rapport d'efficacité protéique moyen quotidien et le poids vif final moyen n'étaient pas affectés ($P > 0,05$) ; la mortalité n'a pas été affectée ($P > 0,05$) par le régime alimentaire. Les paramètres de la carcasse, la coupe de la carcasse et les organes internes tels que le poids vif à jeun, le poids plumé, le poids paré, le poids de la poitrine, le poids de la cuisse, de la baguette, du cou, du jarret et des ailes, le poids du cœur, du gésier vide, des poumons, de la rate, du pancréas, de l'intestin grêle et de l'œsophage ont été montrés aucune différence significative ($P > 0,05$) alors que le poids du dos, de la tête, du foie, du proventricule, des reins, de la graisse abdominale, du gros intestin et des caeca étaient significativement différents ($P < 0,05$). La longueur GIT a été affectée ($P < 0,05$) par le régime, à l'exception de la longueur des caeca. La digestibilité des nutriments du CP et du NFE n'a pas montré d'effet significatif ($P > 0,05$), mais CF, EE et Ash ont été affectés ($P < 0,05$) par les traitements diététiques. La digestibilité des nutriments de 5 %, 10 %, 15 % et 25 % était supérieure à celle du régime témoin (0 %) pour les cinq nutriments évalués. L'économie de la production a montré que le coût de l'alimentation (N/kg de gain de poids), le revenu total (oiseaux vendus) et le bénéfice total (gain net) n'étaient pas significativement différents ($P > 0,05$) alors que le coût de l'alimentation (N/poulet), la réduction des coûts en raison de l'inclusion de l'EHLM, le coût total de production (N/poulet) et le coût des aliments en pourcentage du coût total ont été significativement ($P < 0,05$) affectés par les régimes d'essai. Le résultat a montré que les oiseaux nourris avec un régime contenant 15 % ont un meilleur avantage économique pour un bénéfice optimal. Par conséquent, il est recommandé d'adopter un remplacement EHLM de 15 % du soja pour des performances de croissance optimales, un rendement en carcasse, une digestibilité des éléments nutritifs et des économies de production dans le poulet de chair de finition.

Mots-clés : Poulets de finition, performances, caractéristiques de la carcasse, digestibilité des éléments nutritifs

Introduction

The cost of poultry feed has been recognized as the major factor affecting the development and expansion of poultry enterprise in Nigeria (Ode *et al.*, 2012). The feed ingredients that are rarely available for human consumption (groundnut cake and soya bean) are also been competed for by the livestock sector. This situation has resulted to drastic

decline in livestock production with a resultant shortfall in protein intake of the people in the less-developing countries (Ikeokwu, 2012; Tijani *et al.*, 2015). Presently, the high cost of poultry feed and day old chicks in Nigeria have thrown so many poultry farmers out of business or at best reduce their profit margin. The high cost, scarcity and insufficient supply of conventional plant protein ingredients

(soya bean and groundnut cake) has necessitated the need for a search for alternative source of protein for the poultry industry. The search for the least-cost formulation is currently exploring the replacement of these expensive feed raw materials with cheaper alternatives in the formulation of poultry ration. Farrell, (2013) suggested that the alternative plant protein should have comparative value to or preferably be cheaper than the conventional protein sources.

Since soya bean constitutes a major component of protein in diet of poultry in Nigeria, any increase in the price of soya bean increases the price of poultry products (Obun, 2008). Therefore, there is the need to find an alternative feed resource which can replace soyabean in the diet of broiler chickens. The use of *Euphorbia heterophylla* Leaf Meal (EHLM) as a feed source can be achieved in poultry diet after a careful study (N'Goranet *al.*, 2013). This will reduce the competition for soyabean and increase animal protein at a relatively lower cost, improving net profit (Farrell, 2013). *Euphorbia heterophylla* (Poison milk, Atumba-bua and Ume-abya in Tiv and Igede language respectively) is a common herb and weed of most plants (soya bean, cowpea, groundnut, cotton) freely accessible and abundantly found in the tropics and sub-tropical regions of the world especially Nigeria in West Africa. About 10.5 tons of *Euphorbia heterophylla* leaf can be produced annually compared to soya bean in Nigeria (Okeniyet *al.*, 2012). It has a short lifespan of 45-50 days and having many reproductive cycles in a year (N'Goranet *al.*, 2013). *Euphorbia heterophylla* leaf meal (EHLM) is high in crude protein (17-27.1%), crude fibre (22% of DM), Ether Extract (7.7% DM), alpha-linolenic acid (55.4%) which is used to improve significantly the n-3 polyunsaturated fatty acid (PUFA) content

of poultry meat, egg and carcass (Bindelleet *al.*, 2007; Kouakouet *al.*, 2013; N'Goranet *al.*, 2013). It is rich in n-3 PUFA (56.0%) such as eicosapentaenoic acid (EPA, C20:5n-3) and docosahexaenoic acid (C22:6n-3). It's anti-atherogenic, anti-thrombotic and anti-inflammatory effect and overall increase intake leads to reduce risk of coronary heart disease (CHD) in humans (ANSES, 2011). The increase in PUFA/SFA ratio (3.0%) and decrease in C18:2 n-6 / C18:n-3 (0.63%) and n-6/n-3 (0.3%) ratios which result in reduction of cholesterol in *Euphorbia heterophylla* diet (Edeogaet *al.*, 2005; Wood *et al.*, 2008; N'Goranet *al.*, 2013; N'Goranet *al.*, 2016) is of great interest in poultry nutrition. This study was carried out to access the effect of graded level of *euphorbia heterophylla* leaf meal on the performance, carcass characteristics, nutrient digestibility an economics of production of finisher broiler chickens.

Materials and methods

Experimentalsite

This study was conducted at Nogga Farms, Secretariat Road, Oju Local Government Area of Benue State Nigeria. Oju Local Government Area lies between Latitude 6°51' north and Longitude 8°25' east in the Southern Guinea Savannah Zone of Nigeria, with a climate that has two distinct seasons: wet and dry seasons. The wet season covers mid march to mid-November, while the dry season starts in late November to early March. High temperatures are experienced between February and April (OjuPhysical Setting Online Nigeria.com, 2003). Oju Local Government Area has an annual rainfall which ranges from 1200 mm to 1500 mm with an average minimum and maximum daily temperature of about 21°C and 35°C in the dry season and 16°C and 37°C in the wet season respectively. The relative humidity ranges from 60% to 80% (Akpen, 2019).

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Preparation of experimental materials

Euphorbia heterophylla plants were sourced from Oju metropolis and nearby communities. The plants were harvested by pulling them from the soil and the leaves detached from the stems. The leaves were air dried under a shade with regular turning by spreading them evenly on a mat to avoid mould growth; they were milled in a hammer mill fitted with 2 mm sieve before use to produce *Euphorbia heterophylla* leaf meal (EHLM). Prior to inclusion in the diet, the EHLM was sub-sampled and analyzed for proximate composition to guide in feed

formulation.

Experimental diets and experimental design

The feeding trial conducted for broiler finisher consisted of six (6) experimental diets tagged: T1, T2, T3, T4, T5 and T6 containing EHLM which replaced soyabean meal at 0% (control), 5%, 10%, 15%, 20% and 25% respectively in finisher diet as contained in Tables 1. Each treatment was replicated three times. The feeding trial which lasted for 28 days (4 weeks) commenced from 29th – 56th day in a completely randomized design.

Table 1: Ingredients composition of broiler finisher diets

Ingredients	T1(0% EHLM)	T2(5% EHLM)	T3(10% EHLM)	T4(15% EHLM)	T5(20% EHLM)	T6(25% EHLM)
Maize	55.60	55.60	55.60	55.60	55.60	55.60
SBM	31.00	29.45	27.90	26.35	24.80	23.25
EHLM	-	1.55	3.10	4.65	6.20	7.75
Blood Meal	2.25	2.25	2.25	2.25	2.25	2.25
Brewers Dried Grain	6.00	6.00	6.00	6.00	6.00	6.00
Bone Meal	3.20	3.20	3.20	3.20	3.20	3.20
Common Salt	0.25	0.25	0.25	0.25	0.25	0.25
Premix	0.30	0.30	0.30	0.30	0.30	0.30
Lysine	0.20	0.20	0.20	0.20	0.20	0.20
Methionine	0.25	0.25	0.25	0.25	0.25	0.25
Palm oil	0.95	0.95	0.95	0.95	0.95	0.95
	100	100	100	100	100	100
Calculated analysis						
ME(Kcal/kg)	2944.90	2943.69	2942.39	2941.13	2939.87	2938.61
Crude protein(%)	22.34	22.26	22.20	22.07	21.97	21.88
Crude fibre(%)	3.86	4.19	4.53	4.86	5.21	5.35
Ether extract(%)	4.76	4.76	4.77	4.78	4.79	4.79
Calcium (%)	1.28	1.28	1.27	1.27	1.27	1.27
Available Phosphorus (%)	0.47	0.46	0.46	0.46	0.45	0.45
Lysine(%)	1.41	1.37	1.33	1.29	1.24	1.20
Methionine(%)	0.47	0.47	0.46	0.46	0.46	0.46

¹Vitamin / mineral premix (Bio-mix brand) supplied per kilogramme: Vitamin A 450000 IU, Vitamin D3 9000 IU, Vitamin E 900 IU, Vitamin K 75 mg, Vitamin B 12 0.6 mg, Thiamine (B1) 60 mg, Riboflavin (B2) 180 mg, Pyridoxine (B6) 120mg, Niacin 1200 mg, pantothenic acid 300 mg, folic acid 30 mg, Biotin 2.4 mg, Choline chloride 15 g, Antioxidant 3.75 g, Manganese 2.88 g, Zinc 1.8 g, Iron 0.72 g, Copper 0.18 g, Iodine 0.042 g, Selenium 7.2 mg, Cobalt 7.2 mg.

Experimental animal housing and management

One hundred and eighty (180) day-old broiler chicks of Ross 308 strain were used for the study. They were randomly allotted to six (6) treatment diets and raised in a conventional deep litter poultry house with concrete floor, dwarf walls and zinc coated metal roofing with wire nettings, to enhance adequate ventilation and protection. Birds were given the experimental diets and water *ad-libitum*. The birds were given Newcastle disease vaccine (Lasota) at the 4th day and 24th day, while Gumboro vaccine was administered at the 10th and 16th day. Multivitamin, mineral and glucose were administered in drinking water on arrival. Anti-coccidial drug (Pantacox®) and antibiotic (Ciprofloxacin) were given to the birds in drinking water in alternate week while anti-stress was administered when necessary.

Performance parameters measured

The feed intake (FI), body weight gain (BWG), feed conversion ratio (FCR), Daily Protein Intake (DPI), and Protein Efficiency Ratio (PER) were determined. Feed intake was estimated as the difference between the amount of feed served and feed leftover. The body weight gain was determined by the difference between the initial weight and the final weight. The mean body weight was calculated as the average weight of the chickens for a week. The feed efficiency ratio was calculated as the ratio of feed intake to the corresponding liveweight gain of birds. The protein efficiency ratio was calculated as the ratio of live body weight gain to the amount of protein consumed in the diet. Daily protein intake was determined by multiplying the amount of feed consumed by a bird per day by the amount of protein in the diet divided by 100.

Carcass analysis

At the end of the experiment, one broiler chicken from each replicates (ie three per treatment) was randomly selected and

fasted for 12 hours and weighed to obtained their fasted liveweight, scalded de-feathered,slaughtered and eviscerated. The liveweight, plucked weight, bled weight, dressed weight, cut-up parts and organs were weighed and measured and expressed as percentage of liveweight.

Nutrient digestibility trial

At the end of the 4th and 8th weeks, one bird per replicate was randomly selected and moved to the metabolic cages. The chickens were allowed 3 days of acclimatization and four (4) days of faecal collection. A known weight of feed was given daily. The faeces voided each day per treatment per replicate were weighed fresh and oven dried to constant weight, ground and subjected to chemical analysis. The apparent nutrients digestibility was calculated.

Apparent digestibility coefficient =
$$\frac{\text{Nutrient intake in feed} - \text{Nutrient in voided faeces}}{\text{Nutrient intake in feed}} \times 100$$

Nutrient intake in feed

Statistical analysis

The data were subjected to one way analysis of variance (ANOVA) in a completely randomized design using the method described in Minitab (2014). Where significant difference between treatment means occurred, they were separated using the Fisher's method described in Minitab (2014).

Economics of production

The study was carried out using the input – output analysis of cost. The total cost of production was determined by the sum of the cost of day old chicks, feed cost, drugs and vaccine cost, operational services and labour. Feed cost per kg was calculated as the product of 1kg of feed and the unit cost of ingredients used in producing it. The feed cost per body weight gain was calculated as the product of feed conversion ratio and the unit cost of feed. The cost saving due to *EHL*M inclusion was determined as the difference between the cost of feed per kg of

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the control diet and other treatment diets respectively while the total profit or net income was determined as the difference between the total income (sales) and the total cost of production per treatment.

Results and discussion

The performance indices of finisher broiler chickens fed diets containing graded levels of Euphorbia heterophylla leaf meal

The effect of dietary *EHLM* on the performance of finisher broiler chickens (Table 2) showed that as the inclusion levels of *EHLM* increased and soya bean decreased in the diets the average final live weight decreased but it showed no definite pattern. The highest weight was recorded in treatment 1 (2301.70 g) and the lowest in treatment 5 (2227.00 g) which were not significantly ($P>0.05$) different among

dietary treatments. The highest feed intake was recorded in treatment 6 (112.92 g) followed by T5 (112.84 g) which were similar to treatment 2 (111.89 g) which in turn were significantly different from other dietary treatments. The average daily weight gain was highest in treatment 2 (48.28 g) and the lowest value was obtained in T5 (45.13 g) and T3 (45.13 g). The values of T1 (46.73 g) and T4 (47.56 g) are similar. The control has AWG of 46.73 g. The feed conversion ratio obtained in this study ranged from 2.32 to 2.50. FCR in T2 (2.32) showed most superiority followed by 15% *EHLM* (2.34). The average protein efficiency ratio was most superior in the control (2.05) and the least was in T3 (1.83). T2 and T4 recorded values of 1.92 and 1.93 respectively which were closer to the value in control diet. The mortality was only recorded in the control.

Table 2: Growth performance of finisher broiler chickens (5–8 weeks) fed graded levels of spurge weed (*euphorbia heterophylla*) leaf meal

PARAMETERS	EXPERIMENTAL DIET						S.E.M
	T1	T2	T3	T4	T5	T6	
Average initial live weight (g)	993.33 ^a	940.33 ^b	996.67 ^a	960.00 ^{ab}	963.33 ^{ab}	970.00 ^{ab}	28.00*
Average final live weight (g)	2301.70	2291.70	2260.33	2291.70	2227.00	2245.00	79.10 ns
Average daily feed intake (g)	111.00 ^b	111.89 ^{ab}	111.35 ^b	111.37 ^b	112.84 ^a	112.92 ^a	0.67*
Average daily weight gain(g)	46.73	48.28	45.13	47.56	45.13	45.54	2.83 ns
Average daily protein intake(g)	22.79 ^c	25.08 ^a	24.76 ^b	24.58 ^b	24.71 ^b	24.55 ^b	0.14*
Average feed conversion ratio	2.38	2.32	2.47	2.34	2.50	2.48	0.15 ns
Average daily protein efficiency ratio	2.05	1.92	1.82	1.93	1.83	1.85	0.12 ns
Mortality(%)	1.85	0.00	0.00	0.00	0.00	0.00	1.31 ns

* Means that do not share a letter are significantly different

EHLM = *Euphorbia heterophylla* leaf meal; SEM = Standard Error of the Mean; NS = not significant

The significant ($P<0.05$) effect in average feed intake (AFI) and average protein intake (API) may be due to high protein, amino acids and n-3 PUFA content and the palatability of the test diets. This is in agreement with Okeniyi *et al.* (2012) and Okwori and Attah(2016) who reported that forages high in protein and amino acids and the radical scavenging properties of

flavoniods improved flavour, odour, taste, palatability, digestion, absorption and utilization of nutrients by animals fed. The AFI in the present study (111.00 – 112.92 g) was higher than the value of 65.51 g reported by Obun (2008) while the API (22.79 – 25.08) was lower than 29.01 reported by Udayi (2016). However, the non-significant ($P>0.05$) difference in

AFW, AWG, AFCR, and APER among the dietary treatments may be due to the energy level which were similar in all the treatment groups. This is in agreement with the findings of Salami and Odunsi (2017) who reported that adequate energy level in the diet improve feed intake, protein intake and calories utilization by birds. The proximate energy level of the experimental diets in the present study (3144.86 – 3300.11 ME Kcal/kg) is within the energy requirement of broiler finisher as reported by Salami and Odunsi (2017) who opined that dietary energy level of 2800 to 3000 (Kcal/kg) ME has no significant ($P>0.05$) effect on AWG, FCR and AFW in finisher broiler chickens. The researchers found that on like the starter phase, the growth rate of finisher were similar across the energy levels which was partly attributed to better development of the gut resulting in nutrient digestion, absorption and utilization. The AFW in this study (2227 – 2301.07 g) was similar to the value of 2108.10 – 2320.41 g reported by Obun(2008) while the AWG (45.13 – 48.28 g) was higher than the value of 37.00 – 41.00 g and 43.3 g reported by Obun (2008) and Henn *et al.*(2014) respectively. The improved feed conversion ratio and protein efficiency ratio could be attributed to higher nutrients digestibility, absorption and utilization, probably due to good fatty acid composition especially n-3 PUFA (Omega-3), effect of phytochemicals (saponnins, flavonoid and tannins) (Abbas *et al.*, 2007; Okeniyi *et al.*, 2012) which promote beneficial microbial growth and inhibit harmful microbial growth, thereby improving gut health and intestinal morphology, digestive processes and protein and amino acids retention (Mitsch *et al.*, 2004; Hashemiet *al.*, 2008a).The FCR and APER in the work of Obun (2008) with the range values (1.59 – 1.77 and 2.46 – 2.93) was superior to the values (2.32 – 2.50 and 1.83 – 2.05) in the present study. This difference may be due to variation in feed

intake which was higher in the present study. The FCR in this study was similar to the value of 2.45 reported by Sanghamitra *et al.* 2020) for broilers at 56 days. This present study is in agreement with the finding of Nobakht *et al.* (2011) who reported improved FCR and growth performance of broilers fed dietary supplementation with sunflower and canola oil. The low mortality rate in this study which was only observed on control diet may be due to the immune-modulatory and anti-inflammatory property of *EHLM* which enhanced immunity and health of the birds. This study agrees with the findings of Scalbert (1991);Edeogaet *al.* (2005); Hashemi and Davoodi (2010) and Okeniyiet *al.* (2012) who reported immune-modulatory and anti-inflammatory property of *Euphorbia heterophylla leaf*. The survival rate in this study suggests that the broiler chickens could tolerate *EHLM* in their diets. The performance of broiler chickens in this study suggests that *EHLM* effectively support the growth of broiler and can replace soya bean meal.

Carcass characteristics of finisher broiler chickens fed graded levels of *Euphorbia heterophylla leaf meal (EHLM)*

The carcass parameter and weight of carcass cuts of finisher broiler chickens are presented in Table 3. The result showed no significant ($P>0.05$) difference in fasted live weight, plucked,dress, breast, thigh, drum stick, neck and shank weightsamong dietary groups. However, the highest back weight was observed in treatment 6 which was similar with the values in treatments 5,4 and 1 (control) but differs significantly ($P<0.05$) from the values of treatments 2, 3, 4, 5 and 1 that are similar. The highest head weight was observed in treatment 2 which was similar to the values of treatments 3, 4, 5, 6 and 1 (which is the least). The highest dressing percentage of 74.66%, 73.66% and 74.48% observed for treatments 2, 4 and 6 compared to the control (74.69%)

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respectively was influenced by the weight at slaughter. The birds fed treatments 1, 2, 4 and 6 which higher slaughter weight have superior weight gain, better FCR and APER which suggest they have better ability to utilize nutrient more efficiently thus the higher carcass yield. This agreed with the findings of Olusegun *et al.* (2020) who reported that carcass yield in respective of strain or sex was significantly ($P < 0.01$) influenced by slaughter weight. Olusegun *et al.* (2020) opined that most carcass quality is strain, sex and slaughter weight dependent. The dressed, breast, thigh, drum stick, back and wings weights from this study were higher than the values of 71.09, 18.91, 13.26, 11.26, 17.43 and 10.10 as percentage of fasted live weight respectively reported for Ross strain by Olusegun *et al.* (2020). This may be due to the effect of EHLMon carcass yield which agrees with the earlier report of N'Goranet *al.* (2013). The dressed weight in this study was higher than the value of 66.72% reported by Olawumiet *al.* (2012) while the

breast, thigh and shank weights were similar to the values of 34.09%, 21.80% and 13.41%. However, the values of drum stick, wings and back in this study were lower than 28.80%, 22.90% and 33.94% reported by Olawumiet *al.* (2012) respectively. This variation may be due to strain and sex interaction. This corroborate the findings of Olawumiet *al.* (2012) and Udeet *al.* (2015) who reported that sex and genotype affect the carcass yields such as drum stick, wings, back, thigh and breast weight of Ross, Marshal and Arbor strains of broiler. The similarity in carcass yield of most carcass parameter in this study may be due to mixed sex effect and the quality of diet which was similar among dietary treatments. This corroborate the findings of Castellini and Mugnai (2014) who reported no significant ($P > 0.05$) difference among the carcass of Ross, Arbor Acres and Marshal strains and sexes of broilers and Pushalaet *al.* (2015); Uhliovaet *al.* (2018) who acknowledge that generally nutrition, breed, oldness and sex are major factors that influenced carcass and meat quality of broiler chickens, respectively.

Table 3: Carcass cut and offals of finisherbroiler chickens (5- 8 weeks) fed graded levels of spurge weed (*Euphorbia heterophylla*) leaf meal

CARCASS INDICES	EXPERIMENTAL DIET						
	T1	T2	T3	T4	T5	T6	S.E.M
Fasted liveweight(g)	2246.70	2233.30	2133.30	2230.00	2170.00	2183.30	91.70 ns
Plucked weight (% LW)	90.88	90.73	88.79	89.91	89.52	89.76	1.39 ns
Dressed weight (%LW)	74.69	74.66	71.93	73.66	72.69	74.48	2.77 ns
Breast weight (%LW)	31.39	31.17	30.04	30.09	30.85	30.85	1.48 ns
Tigh weight (% LW)	19.13	19.00	18.82	19.07	18.81	18.66	0.55 ns
Drum stick (%LW)	18.94	19.93	19.40	19.80	19.37	19.61	0.63 ns
Back weight (%LW)	18.48 ^{ab}	17.97 ^b	17.99 ^b	18.11 ^{ab}	18.11 ^{ab}	18.55 ^a	0.29 *
Neck weight (% LW)	13.81	13.87	13.86	14.21	13.76	13.65	0.39 ns
Head weight (% LW)	7.95 ^b	8.63 ^a	8.18 ^{ab}	8.39 ^{ab}	8.34 ^{ab}	8.48 ^{ab}	0.35*
Shank weight (%LW)	11.05	11.97	11.36	11.60	11.47	11.78	0.73 ns
Wings (%LW)	16.92	16.98	16.69	17.19	16.56	17.08	0.41 ns

* Means that do not share a letter are significantly different.

EHLM = *Euphorbia heterophylla* leaf meal, SEM = Standard Error of the mean

NS = Not significant

The internal organs weight of broiler finisher chickens fed graded levels of *EHL*M diets are presented in Table 4. Result showed that heart, empty gizzard, lungs, spleen, pancreas, small intestine and oesophagus' weight were not significantly ($P>0.05$) affected by the diet. However, heart and empty gizzard weights which increased with increasing levels of *EHL*M in the diet suggest diet effect. The liver weight increased with the increasing level of *EHL*M in the diet with the highest value in treatment 6 and the least in control. The highest value of proventriculus was observed in the control which was similar to the value of T5. The least value was observed in T2 which was similar to the values in Treatments 3, 4 and 6. The kidney recorded the highest weight in Treatment 5 which was similar to the values of treatment 4, 2 and 1 but significantly ($P<0.05$) different from the value of treatments 6, 4, 3, 2 and 1 which are similar. The variation could be due to differences in feed intake and sex interaction and not any toxic effect of *EHL*M as the obtained values are similar the control. The abdominal fat was observed only in the birds fed control diet but significantly ($P<0.05$) different in other dietary treatments. This may be due to higher fat content in soya bean meal. Study has shown that high concentration of PUFA (Polyunsaturated Fatty Acids) in *EHL*M diet which result in increase in PUFA SFA ratio and robust decrease in C18:2 n-6/ C18:3 n-3 regulate fat deposition by birds fed *EHL*M as reported by N'Goran *et al.* (2016). The increased percent carcass and organ weight of liver and gizzard among diets 5, 6, 4, 3 and 2 compared to the control suggest that the different dietary *EHL*M levels promoted the development of carcass and organs (liver and gizzard) while similar increase in heart and kidney was due to diet effect but the weight were similar with the control. This agreed with the findings of N'Goran *et al.* (2013) who reported that increase in

liver, heart and gizzard was due to high concentration of PUFA and balance of protein, amino acids and fatty acid ratios in *EHL*M diet. The highest weight of large intestine was observed in treatment 5 which was similar to the values of treatment 6, 5 and 3 but significantly different from the weight in treatment 6, 4, 3, 1 and 2 which are similar. The caeca weight was highest in treatment 6 and are similar with the values in treatments 5, 4, 2 but differs ($P<0.05$) from the values of treatment 5, 4, 3, 2 and 1. The variation in kidney, proventriculus, large intestine and caeca weight among treatments may be due to variation in individual differences among birds in feed consumption and mixed sex interaction. This agreed with the findings of Olawumi *et al.* (2012) who opined that male broiler grow faster and consume more feed than female and has higher weight gain, carcass yield and organ development.

The length of Gastro-Intestinal Tract (GIT) of broiler finisher chickens fed graded levels of *EHL*M diets are presented in Table 5. The result showed that GIT length were affected (by the dietary treatments). However, caecum length did not show significant ($P>0.05$) different among the dietary treatments. The increase in total length of GIT and small intestine in treatments 5, 6, 4 and 3 which are significantly ($P<0.05$) different from the control showed diet effect. The large intestine and oesophagus length increased significantly ($P<0.05$) in treatment 2, 3, 4 and 5 respectively compared to the control diet which showed the least value. This increase in length of GIT may be due to combined effect of high concentration of PUFA in *EHL*M which increased significantly the n-3 PUFA in the carcass, organ and plasma and the phytochemical properties of flavonoids, saponin, tannin and terpenes which results in improved morphological and physiological development in GIT. This finding agreed

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Table 4: Internal organs of finisher broiler chickens (5 – 8 weeks) fed graded levels of spurge weed (*euphorbia heterophylla*) leaf meal

PARAMETERS	EXPERIMENTAL DIET						S.E.M
	T1	T2	T3	T4	T5	T6	
AVERAGE							
Heart	3.43	3.53	3.54	3.67	3.85	3.69	0.36 ns
Liver	7.24 ^f	7.96 ^c	8.64 ^d	9.37 ^c	9.87 ^b	10.65 ^a	0.02 *
Empty gizzard	7.17	7.47	7.47	7.54	7.88	7.77	0.43 ns
Lungs	5.00	4.35	4.52	4.59	4.42	4.77	0.45 ns
Spleen	1.69	1.84	1.37	1.64	1.84	1.72	0.32 ns
Pancreas	2.68	2.45	2.33	2.77	2.48	2.99	0.37 ns
Proventriculus	3.41 ^a	2.92 ^c	3.06 ^{bc}	3.03 ^{bc}	3.34 ^{ab}	3.02 ^{bc}	0.17 *
Kidney	4.21 ^{ab}	4.10 ^{ab}	3.58 ^b	4.03 ^{ab}	4.55 ^a	3.86 ^b	0.38*
Gall bladder and bile	1.76	2.20	1.80	2.09	2.63	2.40	0.57 ns
Crop	3.24 ^{abc}	3.08 ^{bc}	3.03 ^c	3.65 ^a	3.47 ^{ab}	3.40 ^{abc}	0.25*
Abdominal fat	2.14 ^a	0.00 ^b	0.00 ^b	0.00 ^b	0.00 ^b	0.00 ^b	0.76*
Small intestine	10.16	10.63	10.52	10.00	11.36	10.14	1.19 ns
Large intestine	3.36 ^b	3.27 ^b	3.82 ^{ab}	4.15 ^{ab}	4.60 ^a	3.67 ^{ab}	0.60*
Caeca	3.78 ^b	4.25 ^{ab}	3.83 ^b	3.97 ^{ab}	3.98 ^{ab}	4.50 ^a	0.35 *
Oesophagus	2.56	2.56	2.45	2.58	3.39	2.60	0.59 ns

* Means that do not share a letter are significantly different

EHLM = *Euphorbia heterophylla* leaf meal, SEM = Standard Error of the mean

NS = Not significant

Table 5: Gastrointestinal tractlength of finisher broiler chickens (5 – 8 weeks) fed graded levels of spurge weed (*euphorbia heterophylla*) leaf meal

PARAMETERS	EXPERIMENTAL DIET						S.E.M
	T1	T2	T3	T4	T5	T6	
Average small intestine length (cm)	216.08 ^b	216.00 ^b	224.33 ^b	226.41 ^{ab}	240.33 ^a	231.00 ^{ab}	8.77*
Average large intestine length (cm)	12.10 ^b	15.33 ^a	13.33 ^{ab}	14.33 ^{ab}	14.67 ^{ab}	12.67 ^b	1.49*
Average ceecal length (cm)	39.67	39.33	35.33	35.67	35.67	36.67	4.79 ns
Average oesophagus length (cm)	11.00 ^b	13.00 ^a	11.67 ^b	12.00 ^{ab}	12.00 ^{ab}	11.67 ^b	0.67*
Average of total GIT length (cm)	278.67 ^b	283.67 ^{ab}	284.67 ^{ab}	288.41 ^{ab}	302.67 ^a	292.67 ^{ab}	12.29*

* Means that do not share a letter are significantly different

GIT = Gastro – intestinal tract

with N'Goran *et al.* (2013) and Valenzuela - Grijalva *et al.* (2017) who reported increased digestive secretion, decrease bacteria count and pathogen loads via antibacterial and anti-oxidative effect, prevention of adhesion of pathogens on the intestinal villi resulting in improved gut health, gut morphology, intestinal integrity and increased absorptive surface area of the villi of birds fed diet containing PUFA. The values of total GIT and small intestine in this study (278.67 – 302.67 cm and 216.08 – 240.33 cm) respectively were higher than the values (182.02 cm and 163.10 cm) reported by Mabellebele *et al.* (2014) for Ross 308 broiler chicken suggest diet effect. The result of the present study corroborate

with the work of Panda *et al.* (2006) who reported that morphological changes in gastro-intestinal tract result in increase in intestinal length, villous height and density which is accompanied by rising in pancreatic and digestive enzymes activities resulting in increased digestibility and absorption of nutrient.

The apparent nutrient digestibility

The nutrient digestibility of CP and NFE showed no significant ($P>0.05$) different among dietary treatments. The highest value of crude fibre was obtained in T3 which was similar to the value of T4 and T6 but significantly ($P<0.05$) different from the values of T6, T5, T4, T2 and T1 (which is

the least). Ether extract showed the highest value in T2 which is similar to the values of T1, T3, T4 and T5 but significantly different from the values of T1, T3, T4, T5 and T6 (which is the least). The highest ash value was obtained in T6, T2 and T5 which are similar to the values of T3 and T4 but significantly different from the values of T3, T4 and T1 which is the least. The high CP digestibility could be as a result of high protein content and balanced amino acids in *EHLM* diets. This agree with Okwori and Attah (2016) who reported that CP contents in forages can have significant effect in digestibility and performance of animals fed diets. The high digestibility of crude protein, ether extract and nitrogen free extracts among all dietary treatments by the finisher broiler probably may be due to better intestinal absorption of nutrients in the diets containing polyunsaturated fatty acids, and a balance between the host, intestinal microbiota, intestinal microscopic features and diets, resulting in improved gut health, intestinal morphology, improved digestive processes, increase digestibility, absorption and retention of protein and amino acids as reported by Hashemi *et al.* (2008a) and Biasata *et al.* (2018). The higher digestibility of fat in birds fed 5%, 10%, 15%, and 20% *EHLM* inclusion compared with the control (0%) might be due to the higher content of PUFA which enhance higher lipase activity and bile secretion. This agreed with the findings of Noy and Sklan (1996) and Baiao and Lara (2005) who reported that fats containing

higher unsaturated fatty acids or mixed with SFA enhance bile secretion and lipase activity, which promote digestibility of young chickens by increasing the ability to form micelles, which enhance digestibility and absorption of fats. The higher digestibility of nutrients in this study may probably be due to modulation of intestinal morphology by the PUFA effects of *EHL* in intestinal length which might result in increased intestinal lengths of birds fed the test diets. The increase in intestinal length is positively correlated to an increase in the length of villi and increased absorptive surface area available for digestion and absorption of nutrients. The present study agreed with the earlier observations that villi greatly expand the surface area of the intestinal lining in the avian gut (Hoerr 2001) and positive correlation of long villi with improved gut health, and increased in duodenal and jejuna height (Baurho *et al.*, 2000). The low crude fibre and ash digestibility in this study may be due to the laxative effect of saponins, phenols and terpenes caused by intestinal motility thus, excreting fibre while the low absorption of ash could be as a result of the formation of calcium-phytate complexes, and insoluble soap in the gut lumen of the intestine which is common with plant sources. This is in agreement with the findings of Falodun and Agbakwuru (2004) and Selle *et al.* (2009) which reported on crude fibre and ash digestion and absorption respectively. For all the parameter measured, digestibility was superior in birds fed treatments 3 and 4.

Table 6: Apparent nutrients digestibility of finisher broiler chickens (5 – 8 weeks) fed graded levels of spurge weed (*Euphorbiaheterophylla*) leaf meal

PARAMETERS	EXPERIMENTAL DIETS						S.E.M
	T1	T2	T3	T4	T5	T6	
Crude protein (%)	78.10	81.52	82.23	81.26	78.35	81.65	3.13 ns
Crude fibre (%)	52.71 ^b	54.58 ^b	60.58 ^a	54.78 ^{ab}	53.90 ^b	58.18 ^{ab}	3.37*
Ether extract (%)	87.91 ^{ab}	90.11 ^a	88.47 ^{ab}	88.39 ^{ab}	85.25 ^{ab}	84.25 ^b	3.18*
NFE (%)	88.67	90.42	91.13	89.34	87.87	87.63	2.51 ns
ASH(%)	51.29 ^b	64.45 ^a	59.12 ^{ab}	58.57 ^{ab}	61.15 ^a	65.14 ^a	4.55*

* Means that do not share a letter are significantly different

EHLM = *Euphorbiaheterophylla* Leave Meal, SEM = Standard Error of the Mean.

NFE = Nitrogen Free Extract.

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Economics of production

The economics analysis of production of finisher broiler chickens fed graded inclusion levels of *EHLM* is presented in Table 7. The results were affected by the levels of replacement since there was a relationship between the cost of feed intake, total weight gain and feed cost. The highest feed cost, total cost of production, finisher feed cost as percentage of total cost were observed in treatments 1 and 2 which were significantly ($P<0.05$) different from the

rest of the dietary treatments that are similar. These costs decreased with increasing level of *EHLM* in the diet. The lowest total cost of feed intake per kg weight gain was obtained in birds fed treatments 6, 5 and 4. The cost of saving was superior with increasing levels of *EHLM* in the diets. The economic gain was highest in birds fed diets in the order of 4, 2, 6 and 5. The feed cost as percentage of total cost of production decreased with increasing levels of *EHLM* in the diets. This result showed that birds fed diets containing 15% *EHLM* have better economic advantage.

Table 6: Economics of production of finisher broiler chickens (5 – 8 weeks) fed graded levels of spurge weed (*euphorbia heterophylla*) leaf meal

PARAMETERS	EXPERIMENTAL DIETS						S.E.M
	T1	T2	T3	T4	T5	T6	
Cost of day old chicks (N/chick)	340.00	340.00	340.00	340.00	340.00	340.00	0.00 ns
Finisher feed cost (N/kg weight gain)	363.00	357.47	361.44	325.23	320.94	313.15	78.70 ns
Finisher total feed cost (N/chicken)	477.86 ^a	476.40 ^a	453.27 ^b	454.03 ^b	445.29 ^b	443.52 ^b	6.97*
Operational cost (N/chick)	26.17	26.17	26.17	26.17	26.17	26.17	0.00 ns
Cost saving due to EHLM I (N/kg)	0.00 ^e	5.79 ^d	19.32 ^c	20.44 ^{bc}	25.72 ^{ab}	26.82 ^a	3.40*
Finisher total cost of production	844.03 ^a	842.57 ^a	819.44 ^b	820.20 ^b	811.56 ^b	809.69 ^b	6.94*
Finisher feed cost as %of total cost	56.61 ^a	56.54 ^a	55.31 ^b	55.35 ^b	54.88 ^b	54.78 ^b	0.37*
Day old chick cost as % of total cost	40.29 ^b	40.35 ^b	41.50 ^a	41.46 ^a	41.50 ^a	41.99 ^a	0.35*
Total cost of production (starter & finisher)	1430.57 ^a	1420.20 ^a	1393.13 ^b	1393.23 ^b	1384.86 ^b	1382.70 ^b	7.81*
Total income (N/chicken)	2368.50	2368.50	2276.80	2355.40	2356.00	2326.00	83.7 ns
Total profit (N/chicken)	937.90	947.60	883.50	962.10	937.80	943.40	81.10 ns

* Means that do not share a letter are significantly different, while means that do not carry a superscript are not significantly different.

EHLM = *Euphorbia heterophylla* Leave Meal; EHLM I = *Euphorbia heterophylla* Leaf Meal Inclusion;

SEM = Standard Error of the Mean.

This suggests that *EHLM* inclusion leads to reduction in feed cost. This agreed with Carewet *al.* (2011) who reported that feed cost decreased with increasing levels of rice offal inclusion. Carewet *al.* (2011) also observed that treatment of rice offal with urea also leads to an economic advantage as inclusion reduces the cost of production. Although, *EHLM* was not used as a major ingredient in this study, it economic benefits can be very huge in a large scale commercial farm. However, 15% inclusion level of *EHLM* could provide a huge economic

benefit in finisher broiler diet in view of the low cost of feed intake, superior weight gain and feed conversion ratio. The total feed cost as percentage of total cost of production (54.78 – 56.61%) obtained in the present study was significantly lower than the values of 65 – 75% reported by Tion and Wuanor (2009). This is an indication of a huge economic benefit of *EHLM* in poultry nutrition. Thus, ingredients of minimum economic weight gain will give rise to the most economic diet. The most economic diet was 15% *EHLM*.

Conclusion

The study demonstrated that *Euphorbia heterophylla* leave meal (EHLM) is a potential feed resource that can replace soya bean. The replacement of soya bean meal with 15% EHLM has no adverse effect on performance, nutrient utilization and digestibility, carcass and organ weight with a lot of financial savings for the farmer.

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