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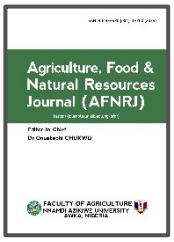

Original Article

Synergy of lemon grass and neem leaves as growth promoter on performance, digestibility and carcass yield of broiler finisher

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ABSTRACT

Herbal plants have been considered as an effective growth promoters feed additive, majorly because of their bioactive compounds. It is on this note that this study was conducted to assess the synergetic effects of lemon grass (LG) and neem leaves (NL) as growth promoter feed additives in broilers diet. LG and NL were harvested, chopped (2mm) and air-dried (DM≥75%). The air-dried samples were analyzed for phytochemicals, proximate composition and selected minerals before incorporated into broilers finisher diet at 5% each (T2 and T3), 2.5% each in combined treatment (T4). Four diet treatment were formulated to supply average of 20.73% CP and 3336kcal/kg ME. Each treatment comprises of 3 replicates with 10 birds/replicate. The results shows that the plants were rich in flavonoids, phenols, tannins, resins and terpenoids while they both had appreciable amounts of sterols and alkaloids. Lemon Grass was richer in crude protein, crude fibre and ash than NL while the later was richer in calcium, potassium and sodium. Inclusion of these plants as feed additives had significant (P<0.05) effect on performance, carcass yield and nutrient digestibility with birds on T4 recorded the highest weights in all the measure parameters. Notable effect on Feed efficiency ratio (1.32), which indicated that the birds on T4 utilized the feed better than other treatments. It was concluded that synergetic effect of LG and NL enhanced growth performance, nutrients digestibility and carcass yield of broiler chicken fed these plants as growth promoter feed additives.

KEYWORDS: *Broiler chicken, Lemon grass, Neem leave, Phytochemicals, Synergetic effect,*

INTRODUCTION

The use of medicinal plants for animal production and human health is growing globally due to the high concern of residual effects of conventional/ synthetic growth promoter in animal products (Daramola, 2019). These natural products have been considered as an effective alternative to feed antibiotics predominantly, to decline the residual effects in the animal product such as milk, meat, and eggs. The medicinal values of some of the ethno-medicinal plants used are found in their phytochemicals, nutrients and mineral composition (Ivanova *et al*., 2024) that produces definite physiological action in the body systems thereby promoting growth; enhance reproductive performance (Swelum *et al*., 2021), increases body immunity and general well-being of the animals (Lillehoj *et al*., 2018).

Lemon grass and Neem leaves has been used over the years as medicinal plants in animal production (Tiwari *et al*. 2018). Lemon grass is herbal plants, it has been proved to have nutritive and therapeutic benefits (Sambo *et al*., 2024). This grass contains flavonoids, phenolic compounds, terpenoids and essential oils (such as citral α, citral β, nerolgeraniol, citronellal, terpinolene, geranyl methylheptenone) which may be responsible for its different biological activities such as

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antibacterial antidiarrheal, antifungal, antioxidants, and as a growth promoter (Cheel *et al*., 2005; Uraku *et al*., 2015; Tiwari *et al*. 2018; Bawa *et al*., 2022). Neem leaves have a good therapeutic potential as anti-hyperglycemic agent, antibacterial agent and could be used for controlling air borne bacterial contamination in the residential premise (Pallav *et al*.,2014; Egbeyale *et al* 2021). *Azadirachta. indica* leaf exhibits a wide range of pharmacological activities viz., anti-inflammatory, anti-hyperglycaemic, anti-ulcer, anti-malarial, anti- fungal, anti-bacterial, anti-viral, anti-oxidant, anti-mutagenic anti-carcinogenic, immunomodulatory and various other properties without showing any adverse effects (Madaki *et al*., 2016; Otache & Agbajor, 2017).

Phytochemicals, nutritional and mineral reviews of these plants definitely could assist animal scientists tremendously in the establishment of non-toxic feed supplements, which could be used as sources of nutrients, and as replacements for synthetic antibiotics in livestock and poultry industries. It is on this note that this study aimed at evaluating the effect of synergy of Lemon grass and neem as growth promoter for broiler chicken at the finisher stage.

MATERIALS AND METHOD

The laboratory analysis was carried out at department of Biochemistry and Molecular Biology, Obafemi Awolowo University, Ile-ife, Nigeria. The experimental trial was carried out at the Animal Science Poultry Unit, Teaching and Research farm, College of Agriculture, Osun State University, Osogbo, Ejigbo campus, Osun state, Nigeria.

Chemical analysis of lemon grass and neem

Healthy leaves of lemon grass and neem were harvested and sorted to remove foreign materials, rinsed with clean water and air-dried under shade to a constant weight. The dried leaf samples were ground separately, to fine powder with grinding machine, packaged in glass jars and stored at 4˚C. Each of the leaves were analyzed for quantitative phytochemicals such as alkaloids, glucosides, phenols, flavonoids; and then proximate composition.

To determine the alkaloids content of the sample, five grams of ground sample each were weighed into a 250 ml beaker, and 200 ml of 20% acetic acid in ethanol was added and was covered to stand for 4 h. This was filtered and the extract was concentrated using a water bath to evaporate one-quarter of the original volume. The concentrated ammonium solution was added drop-wise to the extract until the precipitation was completed. The entire solution was allowed to settle and the precipitate was collected by filtration, after which it was weighed.

Also, for glucosides, five grams of the ground sample was soaked with 100 ml of distilled water for 3 hours in a beaker. It was filtered using whattman filter paper and funnel. The filtrate (2 ml) was piptted into a test tube; 2 ml of 3,5-dinitrosalicylic acid was added and put in a boiling water bath for 15 minutes. The test tube was removed and allowed to cool. Distilled water (5 ml) was added to serve as a dilution factor. The absorbance and concentration were read at 460 nm in a visible Spectrophotometer.

Fat free samples of each leaf were used for phenols determination. These were boiled with a 50 ml of ether for 14 minutes. Five millilitres of the extract were pipette into a 50 ml flask, and then 10 ml of distilled water was added. Two millilitres of ammonium hydroxide solution and 5 ml of concentrated ethyl alcohol were also added. The sample was made up to mark and left to react for 30 min for colour development. The absorbance of the solution was read using a visible spectrophotometer at 505 nm wavelength.

For flavonoids determination, 5g of the ground plant samples were weighed in a 250 ml titration flask, Standard quercetin with varying concentration 0.1, 0.2, 0.3, 0.4 and 0.5mg/ml was used as standard in comparison to the sample extract. This was carried out based on the aluminium chloride colorimetric assay method according to Zhilen *et al.,* (1999) as described by Miliauskas *et al.,* (2004). Also, 0.1ml of extract/standard was added 0.4ml of distilled water. This was followed by 0.1ml of 5% sodium nitrite. After 5minutes, 0.1ml of 10% Aluminum Chloride and 0.2ml of sodium hydroxide (1M) was added and the volume was made up to 2.5ml with distilled water. The absorbance at 510nm was measured against the blank. The total flavonoid content of the plant, expressed as mg quercetin equivalents per gram of the plant extract is calculated as:

$$X = q \times \frac{V}{w} \quad (1)$$

X = Total content of flavonoid compound in quercetin equivalent q= concentration of quercetin established from the standard curve V= volume of extract (ml) w= weight of the crude methanolic extract obtained.

The samples were analyzed for proximate compositions which include moisture content, fat/oil, ash, protein, fiber and carbohydrate contents according to the Official methods of AOAC (2013).

Experimental birds and feeding trials

A total of 150 one-day-old chicks (Arbor Acres) were purchased from a reputable hatchery. These birds were raised under intensive management system on a deep litter in two (2) phases (the starter phase and the finisher phase). The starter phase last for 4 weeks (0-4th week) while the finisher phase last for another 4 weeks (4th-8thweeks). The chicks were brooded for the first two (2) weeks and were fed *ad libitum* with broiler starter diet without additives from 0-4 weeks. The starter diet was compounded to supply 24.07% crude protein and 2870kcal/kg metabolizable energy.

At the end of the 4th week of the experiment, one hundred twenty birds were distributed based on weight equalization from the pool into four treatments of three replicates each with ten birds per replicate. The value for initial weight was closed

to each other because birds chosen from the pool were carefully selected to eliminate bias. The experimental samples (lemon grass and neem leaves) were incorporated into the diets at 5% inclusion. The finisher diet included four treatments with varying level and combination of the leaves. These were compounded to supply average of 21.32% crude protein and 3360kcal/kg metabolizable energy. Treatment 1(T1) was the control without the additives. Lemon grass was included in T2 while Neem leaves was included in T3 both at 5%. T4 comprises of both Lemon grass and Neem leaves at 2.5% each making up to 5% of the diet. The gross composition of the starter and finisher diets are presented in table 1. The experiment was arranged in a completely randomized design (CRD).

Normal daily routine management for broilers production was carried out during the course of study and occasional management practices such as vaccination and medication programs was carried out at the appropriate time. Both routine and occasional management practices were thoroughly carried out with strict hygiene measures and the birds were fed *ad libitum*.

Table 1: Gross composition of Starter and Finisher diets

Components (%)	Starter	Finisher			
		T1	T2	T3	T4
Maize	50.25	56.00	56.00	56.00	56.00
Soyabean meal	15.00	12.00	12.00	12.00	12.00
Groundnut cake	13.00	10.00	10.00	10.00	10.00
Fish meal	5.00	4.00	4.00	4.00	4.00
Brewer's dried grains	11.50	13.45	13.45	13.45	13.45
Bone meal	4.00	3.50	3.50	3.50	3.50
*Premix	0.50	0.30	0.30	0.30	0.30
Methionine	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Feed additives		0.50	0.50	0.50	0.50
Calculated Metabolisable energy (Kcal/kg)	3236	3332	3335	3337	3332
Determined Protein (%)	23.57	20.76	20.73	20.76	20.74

**Premix (added at 2.5 kg/ton of feed) contained Vit. A, 8.5 M IU; Vit. D3, 150000 IU; Vit. E, 10,000 mg; Vit. K3, 1,500 mg; Vit. B1, 1,600 mg; Vit. B2, 4,000 mg; Niacin, 20,000 mg; Pantothenic acid, 5,000 mg; Vit.B6, 1,500 mg; Vit. B12, 10 mg; Folic acid, 500; Biotin, 750 mg; Choline chloride, 175,000 mg; Cobalt, 200 mg; Copper, 3000 mg; Iodine, 1,000 mg; Iron, 1,000 mg; Mn, 40,000 mg; Se, 200 mg; Antioxidant,1250 m. T1: Control (Zero feed additives); T2:5% Lemon grass; T3: 5% Neem leaves; T4: 2.5% lemon grass and 2.5% neem leaves.*

Data collection

During the feeding trials, performance parameters such as weekly weight and feed intake were collected while weekly weight gain was determined. At the beginning of the 8th week, one bird from each replicate were transferred in to metabolic cages, they were served with known weight of feed and feacal samples were collected daily for a period of seven days. Feeds and feacal samples were analysed for proximate composition to determine the percentage nutrient digestibility by the experimental birds using the formular below

$$\%\text{nutrient digestibility} = \frac{\text{Nutrient in the feed} - \text{Nutrient in the feaces}}{\text{Nutrient in the feed}} \times 100 \quad (2)$$

At the last day of the experiment, carcass yield was weighed. Slaughter weights (SW) were determined by weighing the carcass after defeathering. Carcass weight (CW) was recorded as weight after evisceration of internal organs and removal of head, neck and shank. Dressing percentage (DP) was calculated using the following formular:

$$\text{Dressing percentage} = \frac{\text{Carcass weight}}{\text{Live weight}} \times 100 \quad (3)$$

The cuts parts such as neck, drum stick (DS), breast, thigh, wings, shank and back were weighed. Belly fat was also eviscerated and weighed. All these weights were expressed as the percentage of carcass weight (%CW).

Also, feed efficiency ratio was calculated using the following formular:

$$\text{Dressing percentage} = \frac{\text{Weight gained (g)}}{\text{Feed intake (g)}} \quad (4)$$

Statistical Analysis

All data obtained were subjected to one-way analysis of variance (ANOVA) using the statistical analysis system (SAS version 9.1.2008) and significant differences was compared using Duncan multiple range test (DMRT).

RESULTS

Phytochemicals

Table 2 shows the quantitative phytochemicals of lemon grass and neem leaf. The results showed that both lemon grass and Neem leaves has higher level of flavonoids, phenols, tannins, resins and terpenoids. Also, these plants contain appreciable number of alkaloids, and steroids; and both are deficient in phlobatannins. The results indicated that lemon grass has appreciable number of glycosides which are deficient in neem leaves while the later has appreciable number of saponins which are deficient in lemon grass.

Table 2: Qualitative Phytochemicals of Lemon grass and Neem leaf

Phytochemicals	Lemon grass	Neem leaf
Flavonoids	++	++
Phenols	++	++
Alkaloids	+	+
Glycosides	+	-
Tannins	++	++
Saponins	-	+
Resins	++	++
Sterols	+	+
Terpenoids	++	++
Phlobatannins	-	-

++ =very present, + = present, - =not present

Proximate composition

The proximate composition of lemon grass and neem leaves are illustrated on Fig 1. The results revealed that lemon grass is richer in crude protein (18.28%), crude fibre (25.30%), ash (8.40%) and a little more in ether extract (3.90%) than neem leaves. However, neem leaves recorded higher values in the moisture content and soluble carbohydrates (13.50 & 69.18% respectively).

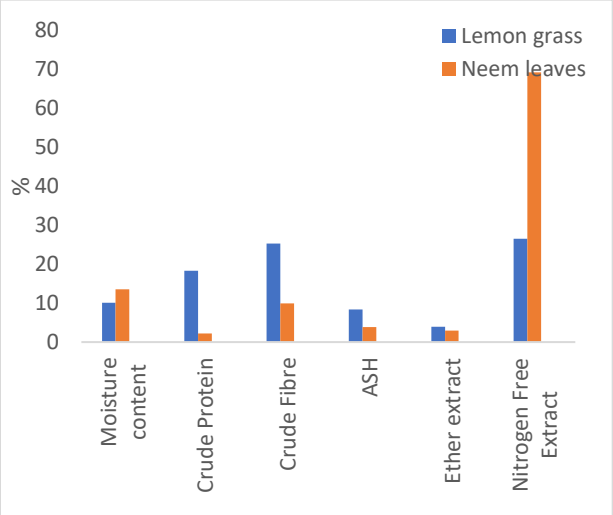

Figure 1: proximate composition of lemon grass and neem leaves

Mineral content

The results of the selected mineral content of lemon grass and neem leaves is presented in Fig 2. The results shows that neem leaves recorded higher values of content in all the minerals selected for analysis. Calcium content of neem leaves is 176.51 mg/100g as against lemon grass (36.44 mg/100g), Potassium content of neem leaves is 229.16 mg/100g while that of lemon grass is 46.52 mg/100g and sodium content of neem is 179.65 mg/100g while lemon grass is 38.56mg/100g

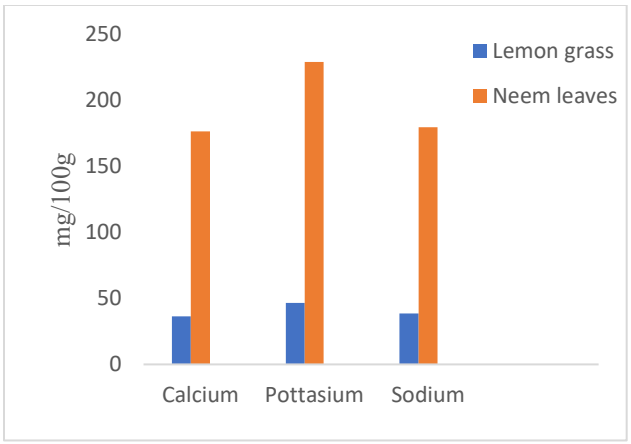

Figure 2: Mineral composition of lemon grass and neem leaves

Growth Performance

The results of growth performance of broiler chicken fed lemon grass and neem leaves is presented on Table 3. The results showed that the final weights (FW), weight gained (WG), average weekly weight gained (AWG) and feed efficiency ratio (FER) were significant across the treatments. Birds on T4 recorded highest FW (3.89kg) while the birds on T3 recorded the lowest (2.94 kg). The results of the WG and AWG revealed that birds on T4 gained weight significantly higher than birds on other treatments except those on T2. The same trend was observed in the results of FER.

Digestibility

The results of percentage digestibility of nutrients by broiler chicken fed lemon grass and neem leaves as feed additives is presented on Table 5. It was observed that experimental birds on T4 were able to digest dry matter (78.15%), crude protein (73.15%), crude fibre (75.68%) and ash (38.45%) content of the diet significantly ($P<0.05$) higher than birds on other treatments. The digestibility of these nutrients followed the same trend with T4 recording highest values while T3 recorded the lowest.

Carcass characteristics and Cut parts

Table 4 shows the results of characteristics of carcass yield by the broiler chicken fed lemon grass and neem leaves as feed additives, as well as the relative weights of cut parts of the carcass. It was observed that inclusion of lemon grass and neem leaf exert significant ($P< 0.05$) effects on all the parameters measured except SW, wings and shank of the experimental birds. The results of CW, DP, DS, Breast and thigh followed the same trend and shows that birds on T4 recorded highest values than other treatments (2.91kg, 76.40%, 13.33, 31.89 and 18.17%CW respectively). Birds on T3 recorded the highest relative weight of back cut part (19.23%CW) while T1 recorded highest relative weight of neck (5.77%CW).

Table 3: Growth Performance of Broiler chicken fed Lemon grass and Neem leaves as Additives at finisher phase

Parameter	T1	T2	T3	T4	SEM	P value
Initial weights (Kg)	1.31	1.27	1.23	1.18	0.03	0.6216
Final weights (Kg)	3.25^{c}	3.61^{b}	2.94^{d}	3.89^{a}	0.11	<0.0001
Weight gained	2.05^{b}	2.45^{a}	1.70^{c}	2.66^{a}	0.11	<0.0001
Av. Weekly Weight gained (Kg)	0.54^{bc}	0.62^{ab}	0.42^{c}	0.68^{a}	0.03	0.0076
Av. Weekly feed intake (Kg)	0.51	0.52	0.48	0.50	0.01	0.6351
Feed efficiency ratio	0.99^{b}	1.25^{a}	0.96^{b}	1.32^{a}	0.05	<0.0001

^{abc} *Means on the same row with different superscript are significantly different (P<0.05). *T1: Control (Zero feed additives); T2:5% Lemon grass; T3: 5% Neem leaves; T4: 2.5% lemon grass and 2.5% neem leaves. Av.: Average*

Table 5: Percentage Digestibility of nutrients by broiler finisher fed Lemon grass and Neem leaves as Additives

Parameters	T1	T2	T3	T4	SEM	P value
Dry matter	70.91^{b}	75.56^{b}	68.69^{c}	78.15^{a}	1.18	0.0002
Crude protein	68.20^{b}	70.70^{ab}	65.41^{c}	73.15^{a}	0.93	0.0006
Crude fibre	72.46^{b}	74.22^{ab}	69.99^{c}	75.68^{a}	0.81	0.0010
Ether extract	82.25	80.77	80.59	80.46	0.36	0.2800
NFE	68.77	68.32	67.23	68.46	0.28	0.2248

^{abc} *Means on the same row with different superscript are significantly different (P<0.05). *T1: Control (Zero feed additives); T2:5% Lemon grass; T3: 5% Neem leaves; T4: 2.5% lemon grass and 2.5% neem leaves*.

Table 4: Carcass characteristics and Relative weights of Cut parts

Parameters	T1	T2	T3	T4	SEM	P value
Live weights (kg)	3.25^{c}	3.61^{b}	2.94^{d}	3.89^{a}	0.11	<0.0001
Slaughter weight (kg)	2.79	3.07	2.66	3.24	0.09	0.4547
Carcass weight (kg)	2.31^{c}	2.64^{b}	1.83^{d}	2.91^{a}	0.12	<0.0001
Dressing percentage (%)	70.67^{b}	72.50^{b}	62.48^{c}	76.40^{a}	15.55	<0.0001
Cut parts (%CW)						
Neck	5.77^{a}	5.21^{c}	5.52^{b}	5.30^{c}	0.07	0.0010
Wing with drummer	12.22	12.41	12.19	12.27	4.06	0.6207
Shank	2.79	2.82	2.34	2.80	0.06	0.4507
Drum stick	12.72^{b}	12.89^{b}	11.71^{c}	13.33^{a}	8.28	<0.0001
Breast	30.31^{b}	31.41^{a}	28.43^{c}	31.89^{a}	10.18	<0.0001
Thighs	16.82^{b}	17.27^{b}	15.77^{c}	18.17^{a}	11.42	<0.0001
Back	17.87^{b}	17.77^{b}	19.23^{a}	17.68^{b}	12.27	0.0002
Abdominal fat	2.48^{a}	1.83^{b}	1.03^{c}	1.31^{c}	0.21	<0.0001

^{abc} Means on the same row with different superscript are significantly different (P<0.05). *T1: Control (Zero feed additives); T2:5% Lemon grass; T3: 5% Neem leaves; T4: 2.5% lemon grass and 2.5% neem leaves.

DISCUSSION

Flavonoids are abundant both in lemon grass and neem leaves. This is an indication that both plants are rich in antioxidants as flavonoids contains antioxidants properties that neutralize free radicals, reducing oxidative stress and inflammation in animals (Sharma *et al*. 2018; Sharma *et al*. 2021; Kumar *et al*. 2023). The phenols are also abundance in both leaves. Phenols have been shown to have antioxidant and modulation of enzyme activity (Trieu *et al*., 2019). The combination of simple phenols and polyphenols (flavonoids) will increase the antioxidant activities of the leaves. Alkaloids are known to increase alertness and energy in animals (Swelum *et al*. 2021), it has antioxidant and immunomodulatory properties (Bachhav & Sambathkumar, 2016). The results of the analysis shows that alkaloids are present both in lemon grass and neem leaves, this can be of good use for the animals. Alkaloids have pain reliving properties. Glycosides have antioxidant and anti-inflammatory effects.

Lemon grass with its natural antimicrobial and anti-inflammatory properties can aid digestion by stimulating the digestive tract and improve nutrients absorption by soothing the stomach, reduce bloating and promoting the breakdown of food. On the other hand, NL, rich in bioactive compounds like tannins, can positively impact nutrient digestibility by potentially enhance protein utilization leading to better amino acids absorption in the small intestine. Hydrolysable tannins at

moderate level have been shown recently to reduce mortality rate, improve FCR, weight gain and intestinal health (Lillehoj *et al*., 2018; Buyse *et al*., 2022), however, high level may interfere with digestibility of nutrients (Min *et al*., 2003).

The result of the performance showed that birds on T4 has the overall best performance in terms of weight gained and final weight. However, T3 recorded the lowest FER, that indicate that diet 3 was the best. This observation in T4 may be due to the synergy of lemon grass and neem leaves. The test ingredients complement each other in terms of the proximate composition. It was observed from the results that birds on T4 utilized the feed more efficiently than other treatments, this could be attributed to the synergy of the phytochemicals in the two plants. These phytochemicals have been shown to enhance feed utilization in animals and thus promote growth. Apart from these phytochemicals present in these plants, research has shown that they also contain essential oils (Majewska *et al*., 2019; Islas *et al*., 2020) that can function as growth promoters (Abdelnour *et al*., 2018), therefore the effects of these plants as growth promoters on the experimental broiler chickens cannot be overemphasize.

The results of the growth performance transient into the significant effect exerted on the fleshy cut parts and the dressing percentage of the experimental birds. The birds on T4 performed best in terms of growth and these birds recorded the fleshiest cut parts (Drumstick, breast and thigh) and also the Dressing percentage. This is an indication that the birds were able to convert the feed to flesh faster than other treatments. These results are of economic value to the farmers as it has been reported that consumers prefer these fleshiest cut parts (Adedire *et al*., 2023). This observation can be attributed to the fact that synergy of LG and NL enhanced muscle production.

Phytochemicals have been shown to interact with in the digestive system and at higher level may affect the cellular uptake of essential nutrients such as protein, carbohydrates, minerals and lipid either by forming complexes or inhibit absorption of these nutrients (Pan *et al*., 2022). The results recorded indicate that the level of the phytochemicals in the experimental plants used and the level of inclusion are very safe for consumption by the experimental birds. The results of digestibility revealed that the birds on T4 were able to digested all nutrients significantly higher than all other treatments. The efficient utilization of these nutrients was evidence in the performance and the carcass yield.

This result may be attributed to the synergy of the plants used, as research has shown that these plants when single used by various researchers and on different animals recorded tremendous success. Safwat *et al*., (2021) reported that inclusion level of LG extract powder at 4g/kg feed improved the growth performance, carcass yield and digestibility in rabbits. The authors concluded that LG extract powder can be used as a natural phytogenic feed additive in growing rabbit's diet. El-kony *et al*., (2020) also reported improved digestibility in rabbits fed lemon grass. Okoruwa & Edoror (2021) used up to 2% LG powder in goat; Fahad & Al-wazeer (2021) used LG in Awassi lambs and they both reported enhanced digestibility of nutrients by the animals.

On the other hand, El-zaiat *et al*., (2022) reported increase in protein digestibility when include NL powder in broiler diet. Aruwayo *et al*., (2025) included up to 15% of NL meal in the diet of Yankassa rams and reported that inclusion level of 10% and 15% performed and digested nutrients better than those without NL meal. Ayuba *et al*., (2021) included up to 20% of sundried NL in the diet of rabbits and reported that inclusion level above 15% affected the performance of the rabbits.

CONCLUSION AND RECOMMENDATIONS

It can be concluded based on this study that, the synergetic effect of lemon grass and neem leaves enhanced growth performance, nutrients digestibility and carcass yield of broiler chicken fed these plants as growth promoter feed additives. The authors recommend higher level of inclusion in further study.

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Authors Contribution

Data Collection, Writing of first draft of the manuscript & Material Support: TOOa & TOOb. Interpretation of Data: AOA & SKA.

Writing of manuscript and Development of methodology: AOA. Review of manuscript and Data analysis: SKA. All authors read and approved the final manuscript.

Ethical Statement

All procedures were followed according to the legal requirements of Nigeria.

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