

Growth and body morphometric parameters of broiler chickens orally administered varying levels of lemongrass extract, at finisher phase

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ABSTRACT: The study was conducted to evaluate the growth and body morphometric parameters of broiler chickens orally administered varying levels of lemongrass extract at finisher phase. A total of 150 ROS 308 day old broiler chicks were allotted into five (5) treatments containing ten (10) chicks with three replications in a completely randomized design. The diets consist of; T₁ control (not administered antibiotic or lemongrass extract), T₂ (administered 0.2 mls of antibiotic), T₃ (administered 0.2 mls of lemongrass extract), T₄ (administered 0.4 mls of lemongrass extract) and T₅ (administered 0.6 mls of lemongrass extract). Data were collected on growth performance and morphometric parameters. The collected data were analyzed using the analysis of variance (ANOVA) and the differences among mean were separated using Duncan Multiple range. The results showed that broiler chickens administered varying level of lemongrass extract had no significant difference ($p > 0.05$) in the growth parameters. The average body weight of broiler birds in T₃ was significantly ($p < 0.05$) higher as compared to those in T₁, T₂, T₄ and T₅. The birds administered varying level of lemon grass extract (T₃, T₄, T₅) recorded higher weight gain and feed intake than T₁ (control group) and T₂ (0.2mls antibiotic), and were not significantly affected ($P > 0.05$). Feed conversion ratio was significantly higher ($p < 0.05$) in T₅ (2.82) as compared to T₁ (2.81), T₂ (2.49), T₃ (2.77) and T₄ (2.73). Also, for the morphometric parameters, there were significant ($p < 0.05$) differences in average initial body width, final body girth, final shank length and shank length gain compared to other parameters which were not significantly ($p > 0.05$) affected. It can be concluded that the use of lemongrass extract improved the growth performance as well as better performance of the morphometric parameters, and can therefore be included at the levels 0.6 mls and 0.2 mls without adverse effect.

Keywords: Broiler, finisher phase, lemongrass extract, morphometric, oral administration, performance.

INTRODUCTION

Antibiotics have been routinely utilized as a growth promoter to improve growth and overall performance in poultry and livestock production for decades. Antibiotic use as a growth stimulant particularly at subtherapeutic dosages, has resulted in bacterial resistance, cross resistance, and multiple resistance (Gould, 2008). According to van den Bogaard and Stobberingh (2000), resistant bacteria can be spread from chicken products to the human population by consumption or handling of contaminated poultry meat. As a result of this, strict regulations have been placed on antibiotic growth

promoters, hence a lot of interests were now focussed on the search for substitute to antibiotic growth promoters. There are several studies that have utilized plant materials as alternative to antibiotics; for example, Bilalissi *et al.* (2019) investigated the antimicrobial properties of *Moringa oleifera* against various pathogenic micro-organisms and concluded that Moringa plant has the potential to be used as alternative therapy for various infections.

One of the natural plants alternatives to antibiotic which has been observed to increase performance in poultry is lemongrass (Peter and Babu, 2012). Lemongrass is a herb

that has been shown to offer medical and therapeutic advantages. Shah *et al.* (2011) noted that it contains phytochemical compounds like flavonoids, phenolic compounds, and essential oils like citral, nerolgeraniol, citronellal, terpinolene, and geranylmethylheptenone, which may be responsible for its antibacterial, antidiarrheal, antifungal, antioxidant, and growth promoter properties. Previous researchers had considered the use of lemongrass leaf meal in broiler diets. Mmereole (2010) noted that, the addition of lemongrass in the diet of poultry as feed additive gave improved performance of broiler chickens. However, lemongrass has a high fibre content of about 9.30% (Thorat *et al.*, 2017), which is higher than the 5% requirement for broilers (Olomu, 2011). This high fibre content thus will limit the utilization of lemongrass meal as a growth promoter despite its potential, thus reducing the ability of lemongrass meal to promote growth maximally due to the fact that minute quantity of the feed is being consumed by the birds because of the high fibre (Mathivanan *et al.*, 2012; Al-Yasiry and Kiczorowska, 2016). It is on this basis that this research contemplated the oral administration of lemongrass extract which contain no fibre. The mode of administration as well will ensure maximum intake and hoped to maximize the already established potential of lemongrass as growth promoting alternative, as should be evident in the growth and morphometric parameters of the broiler chickens. Thus, this study evaluated the growth performance and morphometric parameters of broiler chickens orally administered with diets containing varying levels of lemongrass extract at finisher phase.

MATERIALS AND METHOD

Experimental site

The experiment was carried out at the poultry unit of the Teaching and Research Farm, Federal University of Technology, Minna, Gidan kwano, Minna, Niger State, Nigeria. Minna is located at 09° 36' 50" north latitude and 06° 33' 25" east longitude. It is 700,000 meters above sea level and is surrounded by a river that travels from the northwestern to the southwestern parts of the state. It is located in the country's Southern Guinea Savannah agro-ecological zone. The daytime temperature ranges from 38°C in the start of the wet season to 28°C in the middle. The yearly rainfall average is 1209.7 mm (Idowu *et al.*, 2020).

Source of experimental materials

One hundred and fifty (150) ROS 308 day old broiler chicks were purchased from Agrited hatchery Ibadan, Oyo State, Nigeria. Lemongrass was harvested from households in Minna, Niger State, Nigeria dried at room temperature to

moisture content of 10% with air and grinded into powder form to make the extract. Commercial feed containing 18-20% crude protein and 2950-3210 kcal/kgDM (finisher feed) was purchased from an accredited feed dealer in Minna, Niger State, Nigeria.

Management of experimental birds and design

This research utilized a Completely Randomized Design (CRD) arrangement with five treatments such as T₁ control (not administered antibiotic or lemongrass extract), T₂ (administered 0.2 mls of oxytetracycline antibiotic), T₃ (administered 0.2 mls of lemongrass extract), T₄ (administered 0.4 mls of lemongrass extract) and T₅ (administered 0.6 mls of lemongrass extract), each with three replicates and ten birds per replicate. Thus, a total of 150 broiler chickens were used. The study lasted for 4 weeks of the finisher phase. A week before the birds arrived, the pen and cage were cleaned and disinfected, while the feeders and drinkers were also cleaned before being placed. Also, charcoal stoves were used as sources of heat during the brooding period, and lamp was used as source of light. Some management procedure that were carried out were washing of drinking and feeding troughs, removal of litter items, and providing feed on a regular basis.

Preparation of experimental lemongrass extract

Fresh lemongrass leaves were dried under room temperature to a moisture content of about 10% and ground. 20 g of this dried lemongrass was boiled in 1 litre of water at a temperature of 100°C for 10 minutes and then allowed to cool for 12 hours before oral administration to the birds. The levels of administration of the lemongrass extract are shown in Table 1.

Experimental diets

The birds were given a commercial feed and clean drinking water *ad libitum* throughout the duration of the study. Starter feed containing 22-24% crude protein and 2800-2900 kcal/kgDM was given for a period of 4 weeks. Finisher feed containing 18-20% crude protein and 2950-3210 kcal/kgDM was given from the fifth to eight weeks.

Data collection

Data on growth parameters collected were average feed intake, average daily feed intake, feed conversion ratio, average initial body weight, average final body weight, average body weight gain, average weekly body weight gain and average daily body weight gain. The body

Table 1. Levels of lemongrass extract administered.

Treatments	Levels of lemongrass extract administered
T1	0% antibiotic & 0% lemongrass extract (negative control)
T2	0.2 mls of synthetic antibiotic (positive control)
T3	0.2 mls of lemongrass extract
T4	0.4 mls of lemongrass extract
T5	0.6 mls of lemongrass extract

Table 2. Growth performance of broiler birds administered varying levels of lemongrass extract at finisher phase.

Parameters	T1	T2	T3	T4	T5	SEM	LS
AFI (g)	359.87	3152.33	4039.16	3777.33	4063.40	201.52	NS
AWFI (g)	898.22	788.08	1009.79	944.33	1015.85	55.04	NS
ADF I(g)	128.32	112.59	144.26	134.91	145.12	7.86	NS
FCR	2.81	2.49	2.77	2.73	2.82	0.99	NS
AIBW (g)	531.70 ^{ab}	501.38 ^{ab}	603.67 ^a	511.08 ^{ab}	477.40 ^b	17.21	*
AFBW (g)	1781.48	1767.59	2061.90	1897.62	1898.31	46.42	NS
ABWG (g)	1249.78	1266.22	1458.24	1386.54	1420.91	39.65	NS
AWBWG (g)	312.44	316.56	364.56	346.64	355.23	9.91	NS
ADBWG (g)	44.63	45.22	52.08	49.52	50.75	1.42	NS

Key-SEM: standard error of mean, LS: level of significance; NS: No significant difference; *: There is significant difference; T1; control, T2 ; 0.2mls of antibiotic, T3; 0.2mls of LGX, T4; 0.4mls of LGX, T5; 0.6mls of LGX, LGX = lemongrass extract, AFI = average feed intake, ADFI = average daily feed intake, FCR = feed conversion ratio, AIBW = average initial body weight, AFBW = average final body weight, ABWG = average body weight gain, AWBWG = average weekly body weight gain, ADBWG = average daily body weight gain.

morphometric traits that were assessed were body length (BL), body girth (BG), shank length (SL), body width (BW), neck length (NL)

Data analysis

All data collected in this study were statistically analyzed using one-way analysis of variance (ANOVA) with confidence limits set at 95% (significance at $p < 0.05$ probability level) using of SPSS 16.0 version (statistical package for the social sciences). Duncan multiple range testing was used to separate mean values of the treatments where they arise.

RESULTS

Growth performance of broiler chickens administered varying levels of lemongrass extract at finisher phase

The results of the growth performance of broiler chickens orally administered varying levels of lemon grass extract at finisher phase is shown in Table 2. The results showed that broiler chickens administered varying level of lemongrass extract had no significant difference ($p > 0.05$) in the growth parameters. There were significant different ($p < 0.05$) across the treatments for the initial body weight (at 5th

weeks). Broiler chickens administered 0.2 ml in T₃ of lemongrass extract has the highest initial body weight (603.67 g) than those administered 0.6 ml of lemon grass extract in T₅ (477.40 g). However, the feed intake, weekly feed intake, daily feed intake, feed conversion ratio, final body weight body weight gain, weekly body weight gain and daily weight gain were not significantly ($p > 0.05$) affected. Broiler chickens administered 0.6 ml of lemon grass extract in T₅ has the highest feed intake (4063.40 g), weekly feed intake (1015.85 g), daily feed intake (145.12 g) and feed conversion ratio (2.82) while the chickens in T₁ control group has the least feed intake (359.87 g). Broiler chickens administered synthetic antibiotics in T₂ has the lowest weekly feed intake, daily feed intake and feed conversation of 788.08 g, 112.59 g and 2.49 respectively. The least final body weight was observed in T₂ (1767.5 g) of birds administered synthetic antibiotic. The lowest body weight gain, weekly body weight gain and daily weight gain were obtained in birds in the T₁ (control) as 1249.78 g 312.44 g and 44.63 g respectively.

Morphometric performance of broiler chickens orally administered varying levels of lemongrass extract at finisher phase

The results of the morphometric parameters of broilers birds orally administered varying levels of lemon grass

Table 3. Morphometric parameters of broiler birds administered varying levels of lemongrass extract at finisher phase.

Parameters (cm)	Treatments					SEM	LS
	T1	T2	T3	T4	T5		
Average initial body length	24.66	24.31	25.06	24.50	24.60	0.15	NS
Average final body length	39.96	39.45	40.01	41.50	39.42	0.53	NS
Average body length gain	15.29	15.14	14.95	17.00	14.82	0.55	NS
Average weekly body length gain	3.82	3.79	3.74	4.25	3.71	0.14	NS
Average daily body length gain	0.54	0.54	0.53	0.61	0.53	0.02	NS
Average initial body width	16.85 ^a	16.99 ^a	16.79 ^a	16.43 ^a	15.58 ^b	0.17	*
Average final body width	27.56	26.97	27.62	26.15	26.75	0.27	NS
Average body width gain	10.71	9.97	10.83	9.72	11.17	0.27	NS
Average weekly body width gain	2.68	2.49	2.71	2.43	2.79	0.07	NS
Average daily body width gain	0.38	0.36	0.39	0.35	0.39	0.01	NS
Average initial body girth	24.51	24.57	24.48	24.77	24.01	0.25	NS
Average final body girth	41.95 ^{ab}	41.42 ^{ab}	42.63 ^a	41.11 ^{ab}	40.74 ^b	0.27	*
Average weekly body girth gain	4.36	4.21	4.54	4.09	4.18	0.07	NS
Average daily body girth gain	0.62	0.60	0.65	0.58	0.59	0.01	NS
Average initial shank length	11.73	11.39	12.28	12.32	12.03	0.20	NS
Average final shank length	18.63 ^a	17.83 ^{ab}	18.29 ^{ab}	17.54 ^b	17.50 ^b	0.16	*
Average shank length gain	6.89 ^a	6.45 ^{ab}	6.01 ^{ab}	5.22 ^b	5.47 ^{ab}	0.25	*
Average body girth gain	17.43	16.85	18.15	16.34	16.74	0.27	NS
Average weekly shank length gain	1.72 ^a	1.61 ^{ab}	1.50 ^{ab}	1.31 ^b	1.36 ^{ab}	0.06	*
Average daily shank length gain	0.25 ^a	0.23 ^{ab}	0.21 ^{ab}	0.18 ^b	0.19 ^{ab}	0.01	*
Average initial neck length	8.19	7.75	7.60	8.24	7.63	0.14	NS
Average final neck length	14.94	15.41	15.96	15.59	15.31	0.19	NS
Average neck length gain	6.75	7.66	8.36	7.36	7.68	0.28	NS
Average weekly neck length gain	1.69	1.92	2.09	1.84	1.92	0.07	NS
Average daily neck length gain	0.24	0.27	0.29	0.26	0.28	0.01	NS

Key- SEM: standard error of mean; LS: Level of significance; NS: No significant difference; *: there is significant difference; LGT; Lemongrass extract. T1; control, T2; 0.2mls of antibiotic, T3; 0.2mls of LGX, T4; 0.4mls of LGX, T5; 0.6mls of LGX.

extract is shown in Table 3. The results obtained showed that the initial body width, final body girth, final shank length, shank length gain, weekly shank length gain and daily shank length gain were significantly ($p < 0.05$) different with T₂ having the highest initial body width (16.99 cm) while T₅ recorded the least (15.58 cm). T₃ had the highest final body girth (42.63 cm) while T₅ recorded the least (40.74 cm). the highest final, shank length gain, weekly shank length gain and daily shank length gain were recorded in T₁ (control) as 18.63 cm, 6.89 cm, 1.72 cm and 0.25 cm respectively while the lowest final, shank length gain, weekly shank length gain and daily shank length were observed in T₅ as 17.50 cm, 5.47 cm, 1.36 cm and 0.19 cm respectively. However there were no significant differences ($p > 0.05$) in the initial body length, final body length, body length gain, weekly body length gain, daily length gain, final body width, body width gain, weekly body width gain, daily body width gain, initial body girth, body girth gain, weekly body girth gain, daily body girth gain, initial shank length, initial neck length, final neck length, neck length gain, weekly neck length gain and daily neck length gain.

DISCUSSION

The growth performance parameters of broiler chickens administered varying levels of lemongrass extract in drinking water studied were not significantly ($p > 0.05$) affected across the treatment groups, could be attributed to the mode of administration of the lemongrass extract and the short duration of its administration. This agrees with the findings of some few researchers (Sariozkan *et al.*, 2016; Bhattarai *et al.*, 2019; Adegbeye and Ojediran, 2019; Mohamed and El-Sayed, 2018) who reported that lemongrass supplementation had no effect on the growth performance parameters such as body weight gain, feed intake and feed conversion ratio without any significant ($p > 0.05$) different. However, the findings of this study is at variance with the reports of Mmereole (2010) and Khattak *et al.* (2014) who stated that the inclusion of *Cymbopogon citratus* (lemongrass) leaf meal in poultry diet resulted in a significant difference in the performance of the growth parameters of the broiler birds possibly because of the speculated ability of lemongrass to work well as a toxin binder in feed, thus enhancing feed intake and nutrient

utilization. More so, Tiwari *et al.* (2018) reported that lemongrass leaf meal supplementation in broiler chicken significantly increased feed consumption. Another study by Ahammad *et al.* (2018) reported some positive effects of lemongrass on the growth performance of broilers due to its antimicrobial and antioxidant properties. The disagreement between the findings of this study and report of previous works could have been due to the mode of administration of the lemongrass extract. The authors administered lemongrass as feed additive and this could have resulted in the continuous feeding and accumulated effect of the lemongrass, that could have reflected in the significant difference observed in the growth parameters as against the oral administration of lemongrass extract at weekly bases carried out in this study.

The results of the morphometric parameters of broilers birds orally administered varying levels of lemon grass extract showed that the initial body width, final body girth, final shank length, shank length gain, weekly shank length gain and daily shank length gain were significantly ($p < 0.05$) different with T_2 having the highest initial body width (16.99 cm) while T_5 recorded the least (15.58 cm). T_3 had the highest final body girth (42.63 cm) while T_5 recorded the least (40.74 cm). The highest final, shank length gain, weekly shank length gain and daily shank length gain were recorded in T_1 (control) as 18.63 cm, 6.89 cm, 1.72 cm and 0.25 cm respectively while the lowest final, shank length gain, weekly shank length gain and daily shank length were observed in T_5 as 17.50 cm, 5.47 cm, 1.36 cm and 0.19 cm respectively. The findings in this study agreed with the observation of Adeyemi *et al.* (2014) and Ratriyanto *et al.* (2018) who investigated the effects of lemongrass aqueous extract and lemongrass oil on morphometric parameters, and found significant increase in shank length, and shank circumference of broiler chickens. Contrary to this study finding, Chowdhury *et al.* (2019) and Islam *et al.* (2020), found no significant effect of lemongrass inclusion on the morphometric parameters and mentioned that the reason could be as result of dosage used or other external factors that may have influenced the results. However, there were no significant differences ($p > 0.05$) in the initial body length, final body length, body length gain, weekly body length gain, daily length gain, final body width, body width gain, weekly body width gain, daily body width gain, initial body girth, body girth gain, weekly body girth gain, daily body girth gain, initial shank length, initial neck length, final neck length, neck length gain, weekly neck length gain and daily neck length gain. The variation in the results recorded in this study could have been due to different levels of administration of lemongrass extract.

Conclusion

Based on the available results, it is concluded that the use of lemongrass extracts could offer similar and some cases

better performance than the use of synthetic antibiotics; this showed that antibiotic administration had no superiority over lemongrass extract. The results of this study show that 0.6 ml and 0.2 ml of lemongrass extract can be recommended to give better performance of birds in terms of feed intake, body weight, body weight gain, average final body girth and average shank length gain.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

- Adegbeye, M. J., & Ojediran, T. K. (2019). Effect of dietary supplementation of lemongrass (*Cymbopogon citrates*) leaf extract on the performance & carcass characteristics of broiler chickens. *Agricultural Advances*, 8(3), 33-37.
- Adeyemi, O. A., Awobajo, O. O., & Wafaranti, J. A. (2014). Effect of aqueous extract of lemongrass (*Cymbopogon citrates*) on some Morphometric parameters in broilers. *Journal of Environmental Science, Toxicology & Food Technology*, 8(3), 26-29.
- Ahammad, M. U., Islam, K. M. S., Khan, M. M. R., Chowdhury, S. D., Islam, N., & Howlider, M. A. R. (2018). Effect of dietary supplementation of lemongrass (*Cymbopogon citrates*) on growth performance, immune response & gut health of broiler chickens. *Veterinary & Animal Science*, 6, 52-58.
- Al-Yasiry, A. R. M. & Kiczorowska, B. (2016). Evaluation of phytochemicals, antioxidant activity & amelioration of pulmonary fibrosis with *Myrtus communis* leaves. *Scientific Reports*, 6, 32420.
- Bhattarai, S., Chae, H. S., Yun, J. W., & Park, J. K. (2017). Effect of lemongrass (*Cymbopogon citrates*) extract on growth performance, nutrient retention, & blood characteristics of broiler chickens. *Journal of Applied Poultry Research*, 26(3), 369-377.
- Bilalissi, H., Habbachi, W., & Es-Safi, N. E. (2019). *Moringa oleifera*: A potential alternative to conventional antibiotics. *Advances in Traditional Medicine*, 1(1), 11-19.
- Chowdhury, S. A., Sarker, M. S. K., Ashraf, A. B., Islam, M. J., Miah, A. G., & Uddin, M. M. (2019). Effects of lemongrass (*Cymbopogon citratus*) on growth performance, carcass characteristics & meat quality of broiler chickens. *Bangladesh Journal of Animal Science*, 48(1), 86-93.
- Gould, I. M. (2008). The epidemiology of antibiotic resistance. *International Journal of Antimicrobial Agents*, 32, S2-S9.
- Idowu, O. O., Bako, A. I., & Aduloju, O. T. B. (2020). Analysis of the trend of peri-urban development in Minna, Niger State. *Journal of Geographic Information System*, 12, 411-431.
- Islam, M. A., Rahim, M. A., Amin, M. R., Das, G. N., & Rahman, M. T. (2020). Effect of lemongrass (*Cymbopogon citratus*) extracts on the growth performance & carcass traits of broilers. *Asian Journal of Poultry Science*, 14(1), 46-52.
- Khattak, F., Ronchi, A., Castelli, P., & Sparks, N. (2014). Effects of natural blend of essential oil on growth performance, blood biochemistry, cecal morphology, and carcass quality of broiler chickens. *Poultry Science*, 93(1), 132-137.
- Mathivanan, R., Selvaraj, P., Nanjappan, K., & Palanisamy, S.

- (2012). Effects of dietary supplementation of lemongrass meal on the growth performance, carcass characteristics & serum biochemistry of broiler chickens. *Journal of Poultry Science*, 49(1), 70-77.
- Mmereole, F. U. C. (2010). Effects of lemmon grass (*Cymbopogon citratus*) leaf meal feed supplement on growth performance of broiler chicks. *International Journal of Poultry Science*, 9(12), 1107-1111.
- Mohamed, H. I. S., & El-Sayed, H. M. (2018). Effect of dietary supplementation of lemongrass (*Cymbopogon citrates*) extract on growth performance, carcass traits, & some blood parameters of broilers. *Journal of Agricultural Science* 10(7), 283-290.
- Olomu J. M. (2011). *Monogastric nutrition, principles & practice*. Second edition St. Jackson Publishing.
- Peter, K. V. & Babu, K. N. (2012). Introduction to herbs and spices: Medicinal uses and sustainable production. In: *Hand book of herbs and spices* (second edition), 2,1-16.
- Ratriyanto, A., Indreswari, R., & Kusumanti, E. (2018). The effect of lemongrass (*Cymbopogon citrates*) essential oil on growth, orphometric and histological parameters, and meat quality of broiler chickens. *IOP Conference Series: Earth & Environmental Science*, 207(1), 012040.
- Sariozkan, S., Konca, Y., Kocaoglu, B., Aktug, M. K., Ozkan, S., & Tugrul, S. (2016). The effect of dietary supplementation of lemon grass (*Cymbopogon citratus*) on performance, carcass quality, & marketing of quail (*Coturnix coturnix Japonica*). *Journal of Scientific Works. Series C. Veterinary Medicine*, 63(1), 98-103.
- Shah, G., Shri, R., Panchal, V., Sharma, N., Singh, B., & Mann, A. S. (2011). Scientific basis for the therapeutic use of *Cymbopogon citratus*, stapf (lemon grass). *Journal of Advanced Pharmaceutical Technology & Research*, 2(1), 3=8.
- Thorat, P. P., Sawate, A. R, Patil, B. M., & Kshirsagar, R. B. (2017). Proximate & phytonutrients Content of lemongrass leaf extract & preparation of herbal cookies. *International Journal of Chemical Studies*, 5(6), 758-762.
- Tiwari, M. R., Jha, P. K., Sah, B., Kunwar, G., & Jha, A. K. (2018). Performance of lemongrass (*Cymbopogon citrates*) oil as growth promoter in broiler: Lemongrass oil in broiler diet. *Bangladesh Journal of Animal Science*, 47(2), 85-91.
- van den Bogaard, A. E., & Stobberingh, E. E. (2000). Epidemiology of resistance to antibiotics: links between animals and humans. *International Journal of Antimicrobial Agents*, 14(4), 327-335.