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Growth performance and nutrient metabolizability of Japanese Quails (*Coturnix coturnix japonica*) orally administered varying levels of Lemon grass (*Cymbopogon citratus*, Stapf) aqueous extract

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ABSTRACT

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A 42-days trial was conducted to evaluate the efficacy of lemon grass aqueous extract (LGAE) on growth performance and nutrient metabolizability of Japanese quails (*Coturnix coturnix japonica*). The 10 days old Japanese quails (n = 240) used in this study were allotted to 5 groups and were fed a common corn-soybean meal-basal diet unrestrictedly for a period of 42 days. The five treatments include the control group fed basal diet with no additive, the second group received antibiotics (Embacox® at 8g per litre) while the remaining three (3) treatments were administered LGAE in drinking water at varying levels of 0.20, 0.40, and 0.60 ml per litre once a week. The quails which received 0.2ml LGAE per litre had higher (P<0.05) body weight gain, and daily feed intake was increased by 3.88% when compared with antibiotic-treated group. FCR was higher (P<0.05) in quails exposed to 0.4 and 0.6ml LGAE while the least value was obtained in quails which received antibiotics (Embacox®). Significant increase in water intake (P<0.05) and water to feed ratio (P<0.001) was observed in growing quails which received 0.2ml LGAE when compared to other treatments. Japanese quails which received lemon grass extract in water showed higher (P<0.05) nutrient metabolizability, except crude fibre, than those in control group. Nutrient metabolizability increases (except for fibre) as the LGAE inclusion level increases. The study concluded that Japanese quail served 0.2ml LGAE per litre had similar growth rate with those on control groups while additional dosage resulted in negative effects. LGAE administered in drinking water up to 0.6ml per litre enhance nutrient metabolizability and utilization.

Keywords: Japanese Quails, lemon grass, antibiotics, growth parameters, nutrient digestibility

INTRODUCTION

Poultry farming has been experiencing progressive growth rate in production volumes over the last few decades compared to other livestock counterparts due to increasing demand for safe, affordable poultry products (Oni *et al.,* 2020). Protein supply from poultry meat and eggs contribute immensely to achieving food and nutritional security due to short production cycle, higher yields, and highly efficient feed-food ratio (Fafiolu *et al*., 2020). Besides the domestic chickens (broilers and layers), Japanese quails (*Coturnix coturnix japonica*) farming is on the increase nowadays as source of specialty egg and meat (Talsani *et al.,* 2021). They are currently the smallest poultry species with unique features including short life cycle, rapid growth, lower feed consumption, early sexual maturity, high rate of lay, good meat taste, and disease resistance (El-Katcha *et al.,* 2014; Bansod *et al.,* 2021).

The need to satisfy the increasing interest of end-users in natural food, and with an outlook to meet up the growing rate of demand, the poultry industry is paying attention on how to amplify the growth performance and focused at bringing up new foods that would be harmless to the health of humans (Alishah *et al*., 2013). In view of this, a wide range of phytobiotics such as spices, herbs and essential oils is currently being used as alternative to antibiotic growth promoter in poultry rearing (Parade *et al.,* 2019; Fafiolu *et al*., 2020; Alagawany *et al.,* 2021). Phytobiotics contain substantial quantity of various phenolic compounds. The combined effects of these bioactive substances in such plants usually produce the characteristic scent or flavour peculiar to each plant (Fafiolu *et al*. 2020). Generally, the mode of action of phytobiotics are basically taste modifying, digestion stimulating, and immunomodulatory effect. They also exert antioxidant, antimicrobials, anti-proliferate, hypolipidemic, and detoxifying properties (Khattak *et al*., 2014).

Lemongrass (*Cymbopogon citratus*, Stapf) is a widely distributed perennial herb belonging to Poaceae family which has been used by man and animals due to its numerous health benefits. It has the citrusy fragrance like that of lemon with which it gives pleasant taste and aroma to food and contains a very high amount of vitamin C. The bioactive substances in Lemongrass comprise of

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flavonoids, phenolic compounds, terpenoids as well as essential oils which include citral, isoneral, myrcene and linalool. These phytoactive constituents are responsible for various biological activities earlier documented in poultry birds (Parade *et al.,* 2019; Alagawany *et al.,* 2021). Various methods of extracting the bioactive compounds from lemongrass and the efficacy of such essential oils and extracts in both *in vivo* and *in vitro* studies have been documented (Oboh *et al.,* 2010; Shah *et al.,* 2011; Olorunnisola *et al.,* 2014; Ogbonna *et al.,* 2017; Mukarram *et al.,* 2022). However, the paucity of available information on the influence of administering lemongrass aqueous extract (LGAE) in drinking water of Japanese quails necessitates this study.

The comparative advantages of using LGAE include, but not limited to, the following: 1). Availability: Selected phytobiotics are readily available. They can be grown or harvested in the vicinity or sourced at the local markets with little cost. 2). Ease of processing: lemon grass can be air dried and milled using household grinder or milling machine. 3). Ease of administration: Quail farmers who use commercial feeds can explore the medicinal and health benefits in lemon grass by applying the aqueous extract in drinking water. Therefore, the purpose of this study was to assess the effect of lemon grass aqueous extract on the growth performance and nutrient metabolizability of growing Japanese quails.

MATERIALS AND METHODS

Study Ethics

This study was conducted at the Poultry Unit, Animal Production Teaching and Research Farms of the Federal University of Technology Minna, Niger State, Nigeria, and the experimental procedures were performed in accordance with the approved research protocols by the University's Animal Care and Use Review Committee.

Management of experimental birds

The conventional cage system placed in a pen were used to rear the Quails where they got unbiased care and supervision. The quail pen used was properly cleaned and disinfected with the use of germicides a week before the birds arrived. Openings (windows) of the quail pen were appropriately enclosed with tarpaulin as well as the cage floor with newspapers to facilitate heat conservation during the brooding stage. Brooding was done following recommended ambient temperature regimens while proper animal husbandry management and biosecurity measures were strictly adhered to (Pourakbari *et al.*, 2016). All birds were reared under the same management practices for the 42-days experimental period with free access to the water and feed (mash form).

Preparation of Lemon Grass extract

Lemon Grass aqueous extract was prepared using the method of Orrego *et al.* (2009). The plant materials underwent room-temperature air-drying to 10% moisture content and milled into fine powder using the hammer mill grinding machine. After grinding the lemon grass leaves, the grinded lemon grass leaves were weighed (10 g) and poured into weighed boiled water (1 litre) which was covered and left-over night. The lemon grass was sieved/filtered the next morning and was administered in drinking water at different inclusion levels while the residue was discarded. This method is also in accordance with the hot water extract method (Oboh *et al.,* 2010).

Study design and treatments

A total of 240 Japanese quails (10-day old) used for this experiment were randomly allotted to 5 groups of 48 chicks in 6 replicates (8 per replicate) in a completely randomized design. The five treatments include the control group fed basal diet with no additive (Table 1), the second group received antibiotics (Embacox® at 8g per litre) while the remaining three (3) treatments were administered lemon grass aqueous extract in drinking water at varying levels of 0.20, 0.40, and 0.60 ml per litre. The antibiotics and lemon grass aqueous extract were administered in drinking water to each bird once a week.

Table 1: Ingredients and nutrient contents of the Japanese quail diet

Ingredients	Composition (g/kg)
Maize	521.70
Soybean meal (45% CP)	357.00
Guar meal (42% CP)	32.50
Wheat offal	32.10
Soybean oil	18.00
Dicalcium phosphate (18%)	16.50
Limestone ($CaCO_3$)	13.50
Common Salt (NaCl)	3.00
L-Lysine HCl	1.00
DL-Methionine	1.20
Vitamins and trace minerals premix*,1	1.25
Toxin binder (T5X Binding)[2]	0.50
Nutrient composition	
Metabolizable energy (Kcal/kg)	2951.00
Crude protein	223.60
Crude fibre	39.60
Ether extract	43.00
Ash	30.40
Nitrogen free extract	572.40
Dry matter	909.00
Calcium	10.30
Available phosphorus	4.20
Lysine	11.50
Methionine	4.40

*Premix supplied contain; Vit. A: 12 MIU, Vit. D_3: 3MIU, Vit. E :30g, Vit. K_3: 2.5g, Vit. B_1: 2g, Vit. B_2: 5g, Vit. B_6: 3.5g, Vit. B_{12}: 20mg, Folic acid: 1g, Niacin: 40g, Calpan: 10g, Biotin: 80 mg, Antioxidant: 125g, Co: 250mg; Se: 250mg, Ý: 1.2g, Fe: 40g, Mn: 70g, Cu: 8g, Zn: 60g, ChCl: 200g. [1]Produced by Animal Care Services Konsult (Nig.) Ltd., Nigeria; [2]Produced by Wisium SA (PTY) Ltd., South Africa

Growth performance indices

Live weight of the Japanese quails was measured prior to the commencement of the experiment to avoid biasness in randomization. Thereafter, Birds were weighed per cage on a weekly basis in order to compute weight gain (Bansod *et al.,* 2021). Daily feed intake was also measured per replicate cage as the difference between the feed given and those not consumed. Number of dead birds were noted in each replicate (Oni *et al.,* 2020). The average of body weight gain per bird, feed intake per bird on daily basis, and feed conversion ratio were computed (Talsani *et al.,* 2021) as shown in the formulae below. A known quantity of water was served to each replicate daily, and quantity not consumed were measured with calibrated measuring cylinder to estimate water intake and water: feed ratio.

$$\text{Average body weight gain (ABWG)} = \frac{\text{Weight Changes (g)}}{\text{No. of Quails per replicate}}$$

$$\text{Average daily feed intake (ADFI)} = \frac{\text{Feed offered (g)} - \text{Feed left over (g)}}{\text{No. of Quails per replicate}}$$

$$\text{Feed conversion ratio (FCR) (ADFI)} = \frac{\text{Average body weight gain (g)}}{\text{Average daily feed intake (g)}}$$

$$\text{Average water intake (ml)} = \frac{\text{Water served (ml)} - \text{Water not consumed (ml)}}{\text{No of Quails per replicate}}$$

$$\text{Water: feed ratio} = \frac{\text{Average water intake}}{\text{Average daily feed intake}}$$

Nutrient metabolizability

Three replicate cages (24 birds per treatment) were selected at random at the last week of the research to measure nutrient metabolizability. Feed consumption and total excreta output were monitored per cage for 5 days. Droppings collected were oven-dried till a constant weight is achieved (Oni *et al.,* 2020). Proximate composition of feed and dried excreta samples was analyzed for dry matter (Method 934.01), crude protein by the Kjeldahl method (N×6.25; Method 990.03), crude ûbre (Method 978.01), ether extract (Method 920.39), and ash (Method 942.05) using standard methods of AOAC (2000). The metabolizability of nutrient constituents such as dry matter, crude protein, ether extract, crude fibre, ash and nitrogen free extract for the five treatment groups were estimated using the formulae below:-

$$\text{Nutrient metabolizability (\%)} = \frac{\text{(Nutrient in feed condumed} - \text{Nutrient in excreta voided)}}{\text{(Nutrient in feed consumed)}}$$

NFE= 100–(moisture + crude protein + fibre + ether extract + ash)

Statistical analysis

All data on growth performance, water consumption and nutrient metabolizability of growing Japanese quails were analyzed with a generalized linear model procedure in a One-way analysis of variance (ANOVA) of SPSS version 20.0 Statistical Software (IBM SPSS, 2017) where each replicate pen serve as the experimental unit. Differences among mean values were separated with Duncan Multiple Range Test with a $P<0.05$ indicating significance. Statistical model used was: $Y_{ij}= \mu+T_i+E_{ij}$. Y_{ij} is the experimental observation, μ is overall mean, T_i is the effect of lemon grass aqueous extract, and E_{ij} is random error.

RESULTS AND DISCUSSION

Growth performance

The effects of LGAE in drinking water of growing quails on growth performance are presented in Table 2. The birds which received 0.2ml LGAE per litre had higher ($P<0.05$) final weight and body weight gain which was similar to the control groups whereas those served 0.4ml LGAE had lower body gain. Body weight is regarded as one of the most important production indices due to its strong positive correlation to the meat (carcass) yield, and consequential influence on market value and farmers' profit margin. Previous studies by Alagawany *et al.* (2021) reported that dietary inclusion of lemon grass essential oil (150-600 mg/kg) resulted in linear and quadratic increase in body weight gain of growing Japanese quails. Daily feed intake was significantly ($P<0.05$) increased in the quails received 0.2ml LGAE compared with others, even of the antibiotic group by 3.88%. This could be attributed to the presence of appreciable amounts of phytochemicals including flavonoids which gives pleasant taste and aroma that enhance feed palatability. This was consistent with the reports of Mmereole (2010) and Khattak *et al.* (2014) who observed significant improvement in the growth rate of broiler chicks fed diets supplemented with Lemon grass (*Cymbopogon citratus*) compared to the control group. Similarly, Mukhtar *et al.* (2012) reported higher weight gain and increased feed consumption with the addition of Lemon grass extract oil in broiler chicks' diets.

Feed conversion ratio was higher ($P<0.05$) in quails exposed to 0.4 and 0.6ml LGAE while the least value was obtained in quails which received antibiotics (Embacox®). This contradicts the reports of Mukhtar *et al.* (2012), Khattak *et al.* (2014) and Alagawany *et al.* (2021) who reported improved FCR with lemon grass or its essential oil. Ogbonna *et al*. (2017) stated that the inclusion of lemongrass leaf meal (up to 2%) in aflatoxin-contaminated broiler chicks' diet produced similar weight gain and FCR with chicks fed non-contaminated diets. The variation in results findings implies that the efficacy

Table 2: Growth performance of Japanese quails administered varying levels of lemon grass aqueous extract

Parameters	T1	T2	T3	T4	T5	SEM	P value
Initial weight (g)	22.17	21.88	20.42	21.75	20.96	0.31	0.067
Final weight (g)	179.33^{a}	179.29^{a}	179.13^{a}	172.25^{c}	173.50^{b}	0.81	0.006
Average body weight gain (g/day)	3.74^{a}	3.75^{a}	3.78^{a}	3.58^{c}	3.63^{b}	0.10	0.005
Average daily feed intake (g/day)	10.60^{c}	10.32^{d}	10.72^{a}	10.61^{c}	10.66^{b}	0.73	0.012
Feed conversion ratio (g/g)	2.83^{b}	2.75^{c}	2.84^{b}	2.96^{a}	2.93^{a}	0.10	0.004
Water intake (ml)	956.06^{b}	949.07^{c}	989.38^{a}	964.33^{b}	945.42^{c}	0.25	0.017
Water: feed ratio (ml/g)	2.15^{c}	2.19^{b}	2.21^{a}	2.16^{c}	2.12^{d}	0.18	<0.001

^{abcd}Means on the same row are significantly different (P<0.05); SEM: Standard error of meansT1: no additive; T2: 8g Embacox®; T3: 0.2ml LGAE; T4: 0.4ml LGAE; T5: 0.6ml LGAE

of phytobiotics on birds' performance depends on such factors as profile of bioactive components present in the extracts used, inclusion dose, duration of administration as well as physiological and health status of the birds (Diaz-Sanchez *et al.*, 2015; Fafiolu *et al.*, 2020). Significant increase in water intake (P<0.05) and water to feed ratio (P<0.001) was observed in growing quails which received 0.2ml LGAE when compared to other treatments. This probably explains the reason for increase feed intake. Increase in LGAE inclusion level resulted in linear decrease in water intake and water to feed ratio. This likely suggests that Japanese quails' taste bud is more sensitive to the citrusy flavour of lemon grass. More so, the water to feed ratio observed in this study ranged from 2.12 to 2.21 ml per gram of feed. This means the assertion that water requirement of birds is usually twice the amount of feed consumed is also applicable to Japanese quails.

Nutrient metabolizability

The results of nutrient metabolizability presented in Table 3 revealed that Japanese quails which received lemon grass extract in water showed higher (P<0.05) nutrient metabolizability, except crude fibre, than those in control group. Digestion and absorption of dietary nutrients increased (except for fibre) as the LGAE inclusion level increases. In poultry, the production and growth depend upon the digestion and efficient utilization of absorbed nutrients in the feed as accomplished by the intestinal health (Alagawany *et al.*, 2021). It has been documented that the pleasant flavour or fragrance of phytogenics stimulates oronasal and gastro-intestinal tracts thereby impacting palatability and feed intake positively. It also enhances digestive secretions as well as gut functions for better nutrient break-down and assimilation thus resulting in improved growth rate (Diaz-Sanchez *et al*., 2015; Fafiolu *et al*., 2020). Lemon grass contains citral that helps to digest food, while polyphenols increase the use of energy and enhances the oxidation of fatty acids in the body. This probably explains the higher protein, fat and ash digestions obtained in quails that drink LGAE-treated water. Furthermore, Silva *et al.* (2011) reported that Lemongrass essential oils promoted digestion and nutrient absorption due to its antimicrobial and antioxidant effects. The enhancement in dry matter metabolizability following LGAE in drinking water was in line with improvements in the metabolizability values of crude protein, crude fat, ash, and soluble carbohydrates (NFE).

CONCLUSION

Japanese quail served 0.2ml LGAE per litre produced similar growth performance as those on control groups while higher dose caused reduce weight gain. LGAE administered in drinking water up to 0.6ml per litre improves nutrient utilization. Further studies are needed to validate lemon grass aqueous extract dosage in drinking water to improve Japanese quails' growth performance.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Table 3: Nutrient metabolizability of Japanese quails administered varying levels of lemon grass aqueous extract

Nutrients (%)	T1	T2	T3	T4	T5	SEM	P value
Dry Matter (DM)	73.87^{d}	74.31^{d}	74.86^{c}	75.79^{b}	76.11^{a}	0.25	0.002
Crude Protein (CP)	72.02^{d}	72.49^{d}	73.49^{c}	74.18^{b}	75.65^{a}	0.34	<0.001
Crude Fibre (CF)	78.60^{b}	79.38^{a}	77.60^{c}	76.82^{d}	72.67^{e}	1.29	0.005
Ether Extract (EE)	79.22^{d}	79.49^{d}	80.24^{c}	81.14^{b}	83.00^{a}	0.36	<0.001
Ash	67.21^{b}	66.18^{c}	69.32^{a}	68.51^{ab}	69.26^{a}	1.73	0.004
Nitrogen free extract (NFE)	56.55^{d}	57.15^{c}	57.11^{c}	57.50^{b}	58.12^{a}	0.14	0.017

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