

Performance of Japanese quail chicks fed combined inclusion levels of meals of garlic (*Allium sativum*), turmeric (*Curcuma longa*) and oxytetracycline

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Abstract

In poultry industry, antibiotics are the most frequently used additive in poultry feeds to increase productivity. The residue effects on human health, resulting from the consumption of birds whose feeds contain antibiotics, makes finding an appropriate alternative of great importance. As a result of their nature, phyto-genic feed additive could be specifically considered for this purpose. This study was conducted to investigate the effect of supplementing Japanese quail chick's diets with combined garlic, turmeric meal and Oxytetracycline on the growth performance and digestibility trial. The phyto-genics were supplemented in the diets as feed additives and were randomly allocated to five dietary treatments of 120 birds each and were replicated three times in a completely randomized design with 40 birds per replicate. They were fed five experimental diets containing (25%garlic+75%turmeric, 50%garlic+50%turmeric, 75%garlic+25%turmeric) and un-supplemented (negative control) and antibiotic (oxytetracycline). The parameters measured are initial body weight, final body weight, weight gain, feed intake, feed conversion ratio and feed cost per kg gain. There were significant differences in final weight, weight gain, average daily weight gain, total feed intake and feed conversion ratio across the treatment groups. No mortality was observed across the treatments. It was observed that quails fed dietary level of 75%garlic meal +25% turmeric meal had the best results in terms of all the parameters for performance and nutrient digestibility, except for crude protein and crude fibre that are statistically similar at 75% garlic + 25% turmeric, 50% garlic + 50% turmeric and 50% garlic + 50% turmeric, oxytetracycline, respectively and no significant difference for nitrogen free extracts. For optimal productivity 75% garlic meal +25% turmeric meal is therefore recommended.

Keywords: Performance, Japanese quail, garlic, turmeric, oxytetracycline

Performance des poussins de caille japonaise nourris avec des niveaux d'inclusion combinés de farines d'ail (*Allium sativum*), de curcuma (*Curcuma longa*) et d'oxytétracycline



Résumé

Dans l'industrie de la volaille, les antibiotiques sont l'additif le plus fréquemment utilisé dans les aliments pour volailles pour augmenter la productivité. Les effets résiduels sur la santé humaine, résultant de la consommation d'oiseaux dont les aliments contiennent des antibiotiques, rendent la recherche d'une alternative appropriée d'une grande importance. En raison de leur nature, les additifs alimentaires phyto-géniques pourraient être spécifiquement envisagés à cette fin. Cette étude a été menée pour étudier l'effet de la supplémentation des régimes alimentaires des poussins de caille japonais avec une combinaison d'ail, de farine de curcuma et d'oxytétracycline sur les performances de croissance et l'essai de digestibilité. Les phyto-géniques ont été complétés dans les régimes en tant qu'additifs alimentaires et ont été répartis au hasard dans cinq traitements diététiques de 120 oiseaux chacun et ont été répliqués trois fois dans une conception complètement

aléatoire avec 40 oiseaux par répétition. Ils ont été nourris avec cinq régimes expérimentaux contenant (25 % d'ail + 75 % de curcuma, 50 % d'ail + 50 % de curcuma, 75 % d'ail + 25 % de curcuma) et non supplémentés (témoin négatif) et des antibiotiques (oxytétracycline). Les paramètres mesurés sont le poids vif initial, le poids vif final, le gain de poids, la prise alimentaire, l'indice de conversion alimentaire et le coût alimentaire par kg de gain. Il y avait des différences significatives dans le poids final, le gain de poids, le gain de poids quotidien moyen, l'apport alimentaire total et le taux de conversion alimentaire entre les groupes de traitement. Aucune mortalité n'a été observée dans les traitements. Il a été observé que les cailles nourries avec un niveau alimentaire de 75 % de farine d'ail + 25 % de farine de curcuma avaient les meilleurs résultats en termes de tous les paramètres de performance et de digestibilité des nutriments, à l'exception des protéines brutes et des fibres brutes qui sont statistiquement similaires à 75 % d'ail + 25. % curcuma, 50 % ail + 50 % curcuma et 50 % ail + 50 % curcuma, oxytétracycline respectivement et aucune différence significative pour les extraits sans azote. Pour une productivité optimale, 75 % de tourteau d'ail + 25 % de tourteau de curcuma sont donc recommandés.

Mots-clés : Performance, caille japonaise, ail, curcuma, oxytétracycline

Introduction

Antibiotics growth promoters (AGP) have been used in animal production for many years to improve intestinal health, promote growth performance and prevent diseases (Dibner and Richard 2005). However, with the long term abuse of AGP, public concerns have increased regarding antibiotic drug residues and resistant bacteria (Yang *et al.*, 2019). In recent years, the European Union has banned the use of antibiotics as growth promoters for poultry (Baruget *et al.*, 2006). The use of AGP in animal feed has been banned in China since July 1st 2020. Consequently, animal husbandry suffered a great challenge including reduction in growth performance, disease resistant and financial profit loss, which increased pressure to develop safe and effective strategies to maintain intestinal health of animals. Plant-derived additives used in poultry nutrition to improve performance have been called "phytogenic feed additives" (Windich *et al.*, 2005). This form of feed additives has recently become of particular interest for use in poultry production and there have been an increasing number of scientific publications since the ban of in-feed antibiotics growth promoters in 2006. They

are used for poultry birds not only to treat (Olatoye and Ehinmowo, 2009) and protect (Nisha, 2008) the birds from different diseases, but also to promote growth of the birds and to improve feed conversion ratio (FCR), to increase weight gain and to maximize economic returns from the individual bird (Aammer *et al.*, 2000; Costa *et al.*, 2007; Akinwumi *et al.*, 2013). Enzymes, probiotics, prebiotics, acidifiers and phytogenics are several approaches that can replace feed antibiotics and simultaneously improve chicken performance (Al-Daraji, 2012; Al-Kassie 2010). Under this ban, scientists have searched for safe and efficient alternatives to maintain efficient poultry production. Phytogenics, a category that involves herbs and their extracts, possess a number of biologically active compounds that are supposed to promote growth, enhance feed intake, activate digestive enzymes and stimulate immune function (Olatoye and Ehinmowo, 2009). Among phytogenics, garlic, turmeric, black pepper, oregano, onion, thyme, peppermint, green tea, licorice *et.c* have been reported to possess several activities. Garlic (*allium sativum*) is a species of bulbous flowering plant in the genus *Allium*. It was known to ancient

Egyptians and has been used as both food flavouring and a traditional medicine (National center for complementary and integrative health 2012). Garlic (*allium sativum*) and turmeric (*curcumin longa*) are widely used to cure and prevent diseases in human beings and animals (National center for complementary and integrative health 2012, Delaha and Garagusi 1985; Somasundaran *et al.*, 2002), (Khan *et al.*, 2003 and Gujral *et al.*, 2002) reported better performances of broilers by feeding herbal products. Turmeric (*Curcuma longa*) is an indigenous herb of the ginger family Zingibireceae, the rhizomes of which are used in cooking (Singh *et al.*, 2009). Turmeric has been widely used for centuries in indigenous medicine for the treatment of a variety of inflammatory conditions and other diseases. Its medicinal properties have been attributed mainly to the curcuminoids and the main component present in the rhizome is curcumin. Curcumin is a natural component of the rhizome of turmeric (*Curcuma longa*) and one of the most powerful chemopreventive and anticancer agents. Its biological effects range from antioxidant, anti-inflammatory to inhibition of angiogenesis and is also shown to possess specific antitumoral activity. Curcumin has been shown to possess wide range of pharmacological activities including anti-inflammatory, anti-cancer, anti-oxidant, wound healing and anti-microbial effects.

According to (Priyadarsini 2014), the rhizome is widely used as spice, colouring agent and medicinal remedies. Turmeric rhizome powder (TRP) contains several bioactive principles; tetrahydrocurcuminoids, curcumin, demethoxycurcumin and bisdemethoxycurcumin (Emadi *et al.*, 2007) that exhibit antioxidative anticarcinogenic (Jurenka 2009), digestive and antimicrobial properties which are required for the production of healthy

poultry and safe products (Amalraj *et al.*, 2017).

Oxytetracycline, the broad-spectrum antibiotic of the tetracycline family that utilized to control poultry enteric and respiratory bacterial diseases, was included in one of the study treatments as a positive control. The Japanese quail belongs to the order *Galiformes*, family *Phasidae*, genus *Coturnix* and species *japonica*, different from the common quail "*Coturnixcoturnix*" which is also known as Coturnix quail, pharaoh's quail, stubble quail and eastern quail (Kermanshahi and Riasi, 2010; Thear, 1998). Species or subspecies of the genus *Coturnix* is native to all continents except the Americas (Mizutani, 2003). So the objective of this study was to explore the potential use of the feed additives and Oxytetracycline on performance, nutrient digestibility and carcass in Japanese quail chicks.

Materials and methods

Experimental site

The experiment was conducted at the Poultry Unit, Kabba College of Agriculture, Division of Agricultural Colleges, Ahmadu Bello University, Zaria, Kaduna State. Kabba is located in the Southern Guinea Savannah Ecological Zone of Nigeria on the Latitude 7°53' N, Longitude 6 °02 E (Babalola and Yahqub2019) with an average rainfall of about and 1500mm per annum with an average temperature ranges from 18°C -32°C. It is 427m above sea level (Kabba College of Agriculture Metrological Section 2015).

Source and processing of garlic bulb and turmeric rhizome

Garlic bulb and turmeric rhizome were purchased from a local market in Kabba, Kogi State. The garlic bulb and turmeric rhizome were washed, sliced, shade-dried

for 7 days and milled before incorporated into the experimental diets.

Source of experimental birds

A total of 600 two weeks old Japanese quails of mixed sexes (*Coturnixcoturnix japonica*) were obtained from a Segmo farm in Ibadan, Oyo State.

Source of oxytetracycline

It was purchased from a reputable Pharmaceutical store.

Experimental diets

Five experimental diets were formulated for the experiment

Control 0% inclusion of experimental diet

Treatment 1 –25%Garlic meal + 75%Turmeric meal

Treatment 2 –50%Garlic meal + 50%Turmeric meal

Treatment 3 –75%Garlic meal + 25%Turmeric meal

Treatment 4—Oxytetracycline as recommended by the manufacturer

The diets were formulated to contain 25%

crude protein.

Design and management of experimental birds

A completely randomized design was used. The quails were randomly assigned to five dietary treatments with 120 quails per each treatment. Each treatment was replicated three times with 40 quails each in a completely randomized design. The diets were formulated to meet the nutrient requirements of Japanese quails during growth period according to the National Research Council requirements AOAC (2010). Though quail is known to be resistant to most viral diseases of poultry, also, good hygiene, cleanliness and biosecurity measures were ensured throughout the experimental period. The chemical composition of the experimental diets was determined using proximate analysis procedure according to AOAC (2005). The experiment was conducted in the growing phase.

Table 1: Composition of experimental diets for Japanese quails containing combined inclusion levels of garlic meal, turmeric meal and oxytetracycline (2 - 6 weeks)

Inclusion Levels of garlic and turmeric (%)					
Ingredients (Kg)	0	25G+75T	50G+50T	75G+25T	OXY
Maize	52.10	52.10	52.10	52.10	52.10
Soya Bean Cake	27.00	27.00	27.00	27.00	27.00
GNC	15.00	15.00	15.00	15.00	15.00
Bone Meal	1.70	1.70	1.70	1.70	1.70
Limestone	2.00	2.00	2.00	2.00	2.00
Garlic Meal	0.00	0.25	0.50	0.75	0.00
Turmeric Meal	0.00	0.75	0.50	0.25	0.00
Salt	0.15	0.15	0.15	0.15	0.15
Lysine	1.30	1.30	1.30	1.30	1.30
Methionine	0.50	0.50	0.50	0.50	0.50
Vit-premix	0.25	0.25	0.25	0.25	0.25
Total (%)	100	100	100	100	100
Calculated Analysis					
ME (Kcal/Kg)	2789	2795	2777	2786	2789
Crude protein (%)	25.00	25.00	25.00	25.00	25.00
Crude fibre (%)	4.29	4.37	4.52	4.45	4.29
Ether extract (%)	4.86	4.89	4.77	4.83	4.86
Calcium (%)	1.26	1.26	1.26	1.26	1.26
Available Phosphorus (%)	0.35	0.35	0.35	0.35	0.35
Lysine (%)	2.27	2.27	2.27	2.27	2.27
Methionine+Cysteine (%)	0.70	0.70	0.70	0.70	0.70
Feed cost#/Kg	124.19.	130.94	129.69	128.44	125.09

GNC = Groundnut cake, OXY= Oxytetracycline, ME = Metabolisable Energy.

Performance parameters measured include initial body weight, final body weight, weight gain, feed intake, feed conversion ratio and feed cost per kg gain. Feed intake and body weight gain were taken weekly. Feed intake (g) = feed given (g) – left over feed (g) on daily basis.

Body weight=

$\frac{\text{Total weight of quails (replicate) (g)}}{\text{Number of quails (replicate)}}$

Weight gain= weight of the current week - weight of preceded week (g).

This was used to calculate average or daily feed intake and weight gain. Feed conversion ratio (FCR) was calculated on the basis of unit of feed consumed to unit of body weight gain.

$\text{FCR} = \frac{\text{Feed consumed (g)}}{\text{Weight gain (g)}}$

Cost/weight gain (-/Kg) = Feed Conversion Ratio x Average feed cost (-/Kg).

Mortality Rate:

The percentage mortality was estimated for the first 6 weeks on weekly basis. This was estimated using the formula:

Mortality rate =

$\frac{\text{Number of dead quail over the week x } 100}{\text{Number of quails at the beginning of the week}}$

Digestibility trial

Digestibility trial was carried out at the last week of the growing phase after sexing (6 weeks of age). Four male birds from each replicate were taken to a clean, separate and disinfected metabolic cage with polythene bag attached to the beneath of the cage. They were allowed three days for acclimatization before the commencement of the study. A known weight of feed was fed to the birds by 8:00am daily during the digestibility trial. Faeces were collected daily for a period of four days. The dried faecal samples were weighed and ground after which faecal samples along with the sample of the feed given were taken to the Biochemical Laboratory, Department of Animal Science, Faculty of Agriculture,

Ahmadu Bello University, Zaria, to determine the proximate composition according to the methods described by A.O.A.C (2005). Nutrient retention was determined for crude protein, crude fibre, ether extract, ash, and nitrogen free extract.

$\text{Nutrient retention} = \frac{\text{Nutrient intake} - \text{Nutrient output}}{\text{Nutrient intake}} \times 100$

Carcass analysis

At the end of the 6th week, five birds from each pen were used. The birds fasted overnight in order for emptying of the gastro-intestinal tract (GIT) and weighed. The selected birds were slaughtered for carcass analysis by severing the neck with a sharp knife and allowed bleed completely. They were de-feathered and eviscerated. The liver, gizzard, thigh and breast were weighed and expressed as percentages of live body weight and carcass weight respectively. The intestinal length was measured in centimetres.

Statistical analysis

Data generated were statistically analyzed using the general linear model procedure of statistical analysis system SAS, (2002). Significant different between treatments means were separated using the Duncan Multiple Range Test, Duncan (1955).

Results and discussion

Effects of combination of garlic-turmeric meal on growth performance of Japanese quails

In the study, feeding of combination of garlic and turmeric meal had significant effects on final body weight, weight gain, average daily weight gain, total feed intake, average feed intake, feed conversion ratio and feed cost per kg gain. Quail chicks fed 75% garlic meal + 25% turmeric meal performed better in terms of the final weight, weight gain; average daily weight gain and feed conversion ratio compared with the quail chicks fed the control diet. The result shows that the higher the level of

garlic meal in the combinations, the higher the final weight and weight gain. This implies that higher levels of garlic meal have growth promoting effect in Japanese quails than the lower levels. Final weight (172.77g/b) and weight gain (122.14g/b), average daily weight gain (4.36g/b/d) all have higher values at 75% garlic meal + 25% turmeric meal. The improving in body weight and body weight gain of quail chicks due to addition of garlic meal to feed diet could be attributed to their ability to destroy pathogens in the digestive system and consequently increasing the production of digestive enzymes which improve utilization of digestive products (Hernandez 2004). Obtained results of this study agreed with those reported by Alcicek *et al.* (2003); Jamroz *et al.* (2003) and Bozkurt *et al.* (2009) who found an improvement in body weight and body weight gain of broilers fed on diets supplemented with medicinal plant extracts. Feed intake increases as level of garlic meal increases in the diet at 75% garlic meal + 25% turmeric meal (458.99g/b). Feed conversion ratio and feed cost per kg weight gain were better in birds fed diet containing oxytetracycline as antibiotic growth promoter (AGP). This result agreed with those obtained by Cabuk *et al.* (2014) who indicated that herbs, plant extracts was significantly improved by essential oil mixture and antibiotics supplementation for feed conversion ratio. The findings of this study show that combination of garlic meal and turmeric meal at 75%GM + 25%TM levels in quail diets exert positive effect in improving final weight and weight gain. Several studied have shown positive effect of phytogetic materials on poultry health and growth performance. These materials due to their antibacterial activity have been reported to be able to modify the composition of gut microflora and to exert beneficial effects on the performance of poultry birds (Mitsch *et*

al., 2004; Hume 2011; Broz and Paulus, 2015). The synergetic and additive effects of essential oils when in combination has been reported to reduce pathogenic microbial load leading to higher growth performance as reported by Bassole and Juliani (2012) and Salihu *et al.* (2020).

Effects of combination of garlic-turmeric meal on nutrient digestibility of Japanese quails

The result showed that significant effects were observed for all measured parameters except for NFE digestibility coefficients. Dry matter, Crude protein and Crude fibre digestibility coefficients were higher in quails fed diet containing 50% of garlic meal and 50% turmeric meal while 50% of garlic meal and 50% turmeric meal and 75% of garlic meal and 25% turmeric meal are statistically similar for crude protein compared to the control and oxytetracycline. 75% of garlic meal and 25% turmeric meal had the higher value for ether extract compared to the control and oxytetracycline. Digestibility coefficient values were higher in quails fed dietary supplements of combinations of garlic meal and turmeric meal indicating nutrient usage by the birds. Mansoub (2011) reported that feed additives improved body weight gain and feed conversion ratio due to their active materials that increases feed nutrient digestibility, resulting in higher nutrient utilization and greater efficiency. There was no significant effect on quails fed combination of garlic-turmeric meal, oxytetracycline and the control for nitrogen free extracts.

Effects of combination of garlic-turmeric meal on carcass characteristics of Japanese quails

In this present study dietary supplementation of garlic with turmeric meal and oxytetracycline had significant effects on live weights, slaughtered weights, dressed weight, dressing percentage, breast, wings, thigh, drum

sticks, liver, gizzard, back and intestine expressed as percentage of the carcass weights. Birds fed 75%GM+25%TM had comparatively the highest value in all the parameters measured. This result disagreed with the findings of Rezaei *et al.* (2004) who reported that carcass yield, carcass quality and breast yield were significantly decreased with low supplementation of amino acids in both the starter and grower phases. The live weight, dressed weight and eviscerated weights of Japanese quails had a significant effect on the treatments. The weight of all the organs was higher at quails fed 75%GM+25%TM compared to the control and oxytetracycline. It was observed that the values of carcass characteristics of Japanese quails in this study increase with an increase in the inclusion level of garlic meal but decreased with increase in inclusion level of turmeric meal. This may be linked to the activities of the antioxidants in the garlic, the negative effects of turmeric meal supplementation on the carcass traits being recorded in this study disagree with Daneshyar *et al.* (2011) who reported an insignificant effects of turmeric supplementations (0%, 2.5%, 5.0% and 7.5%) on broiler chickens. This variation may be as a result of the differences in the methods of turmeric processing and environmental factors. A significantly higher intestinal weight was

observed in quails fed garlic-turmeric meal compared to the control and oxytetracycline, this may have positive effect on the intestinal microflora. The results of this study are in agreement with the findings of (Jamroz *et al.*, 2003). However, Ahmad (2005) observed that supplementation of garlic-turmeric and kalongi exhibited a significant effect on relative intestinal weight of the broilers. This result agreed with (Chantiratikkul *et al.*, 2010) who reported a range of 74.49 – 90.17% as dressing percentage in Japanese quails fed diets containing wolffia meal as a protein replacement for soybean meal. However, this result does not agree with (Omage *et al.*, 2007) who observed no significant difference in dressing percentage of rabbits fed ginger waste meal. The weight of thigh and drumstick were significantly different across the treatments. These dietary effects may be attributed to an assertion by Zhang *et al.* (2000) which suggested that improved carcass quality may be associated with the antioxidant effect of ginger (herbal plants) which enhances protein and gut metabolism. The carcass characteristics observed in this study was affected by dietary treatments; this is entirely different from that of Onu (2011) who reported that the addition of ginger (0.25%) in basal diets of broiler chicks did not result in significant differences in carcass characteristics.

Table 2: Growth performance of Japanese quails fed combined inclusion levels of garlic, turmeric meal and oxytetracycline

Ingredients (Kg)	Inclusion Levels of garlic and turmeric (%)					SEM
	0	25G+75T	50G+50T	75G+25T	OXY	
Initial weight(g/b)	50.63	50.61	50.57	50.63	50.67	0.06
Final weight (g/b)	151.70 ^d	161.47 ^c	166.60 ^b	172.77 ^a	165.20 ^b	0.74
Weight gain(g/b)	101.07 ^d	110.86 ^c	116.03 ^b	122.14 ^a	114.53 ^b	0.73
Average Daily Weight gain (g/b/d)	3.61 ^d	3.96 ^c	4.14 ^b	4.36 ^a	4.09 ^b	0.03
Feed Intake (g/b)	385.03 ^d	399.93 ^c	424.67 ^b	458.99 ^a	400.18 ^c	1.44
Daily Feed Intake (g/b/d)	13.75 ^d	14.28 ^c	15.17 ^b	16.39 ^a	14.29 ^c	0.05
Feed Conversion Ratio	3.81 ^c	3.61 ^b	3.66 ^b	3.76 ^c	3.49 ^a	0.03
FeedCost/Kg weight gain	473.14 ^c	472.47 ^c	474.69 ^c	482.69 ^b	437.14 ^a	3.42
Mortality	0.00	0.00	0.00	0.00	0.00	0.00

abc: Means with different superscripts on the same row are significantly different (P<0.05), 25G:25% garlic meal, 50%G: 50% garlic meal, 75%G: 75%garlic meal, 25T:25% turmeric meal, 50%T: 50% turmeric meal, 75%T: 75% turmeric meal,Oxy: Oxytetracycline, SEM = Standard Error of Mean.

Table 3: Digestibility trial of Japanese quails fed combined inclusion levels of garlic, turmeric meal and oxytetracycline (2- 6weeks)

Inclusion Levels of garlic and turmeric (%)						
Parameters (%)	0	25G+75T	50G+50T	75G+25T	OXY	SEM
Dry matter	84.03 ^e	85.23 ^c	87.96 ^a	85.21 ^d	85.65 ^b	0.38
Crude protein	77.97 ^b	80.03 ^{ab}	86.92 ^a	84.01 ^a	80.13 ^{ab}	2.01
Crude fibre	56.86 ^d	61.85 ^b	65.44 ^a	58.47 ^c	66.61 ^a	2.43
Ether extract	43.31 ^d	57.95 ^b	52.95 ^c	68.17 ^a	57.95 ^b	4.19
Ash retention	55.30 ^c	60.35 ^b	51.24 ^c	66.72 ^a	54.54 ^d	0.31
NFE	70.63	76.14	76.84	76.26	72.63	3.17

abc: Means with different superscripts on the same row are significantly different (P<0.05),), 25G:25% garlic meal, 50%G: 50% garlic meal, 75%G: 75%garlic meal, 25T:25% turmeric meal, 50%T: 50% turmeric meal, 75%T: 75% turmeric meal, Oxy: Oxytetracycline, SEM = Standard Error of Mean, NFE= Nitrogen free extract

Table 4: Carcass characteristics of Japanese quails fed combined inclusion levels of garlic, turmeric meal and oxytetracycline (2- 6weeks)

Inclusion Levels of garlic and turmeric (%)						
Parameters	0	25G+75T	50G+50T	75G+25T	OXY	SEM
Live weight (g)	151.70 ^d	161.47 ^c	166.60 ^b	172.77 ^a	165.20 ^b	0.74
Slaughter weight (g)	150.10 ^d	158.33 ^c	164.00 ^b	169.33 ^a	160.67 ^c	0.71
Dressed weight (g)	113.80 ^c	120.0 ^c	127.00 ^b	128.67 ^b	142.00 ^a	3.26
Dressing (%)	75.01 ^b	74.31 ^b	76.23 ^b	74.47 ^b	85.96 ^a	1.95
Prime Cuts Expressed as Percent of Live weights (%)						
Leg (%)	7.63 ^c	8.34 ^b	8.40 ^b	11.14 ^a	7.51 ^c	0.21
Head (%)	5.31 ^b	5.83 ^a	5.25 ^b	5.19 ^b	4.47 ^c	0.25
Neck (%)	4.42 ^c	5.83 ^b	5.25 ^c	6.22 ^a	4.93 ^d	0.16
Back (%)	13.82 ^c	15.57 ^c	17.31 ^b	20.73 ^a	13.14 ^d	0.63
Gizzard (%)	2.86 ^c	3.72 ^b	3.60 ^b	4.44 ^a	3.63 ^b	0.12
Blood weight (%)	2.07 ^c	3.13 ^b	2.53 ^c	3.43 ^b	4.53 ^a	0.37
Shank (%)	0.88 ^d	1.12 ^c	1.57 ^b	2.33 ^a	0.94 ^d	0.17
Wings (%)	2.65 ^c	3.33 ^b	3.42 ^b	4.15 ^a	2.82 ^c	0.20
Thigh (%)	4.42 ^c	5.56 ^b	5.52 ^b	7.25 ^a	4.45 ^c	0.37
Drumstick (%)	2.38 ^c	3.89 ^a	3.94 ^a	4.41 ^a	3.52 ^b	0.24
Organs Express as Percent of Live weights (%)						
Liver (%)	1.32 ^b	1.65 ^b	1.60 ^b	2.70 ^a	1.61 ^b	0.18
Intestine (%)	37.99 ^b	40.69 ^b	43.22 ^a	45.92 ^a	41.57 ^b	1.27
Breast (%)	20.24 ^d	26.94 ^c	28.65 ^b	32.12 ^a	25.83 ^c	0.57

abcdefg: means within the same row with different superscripts differ significantly (P<0.05), SEM: Standard error means.

Conclusion

The study indicated that addition of garlic-turmeric meal in the diets of Japanese quail did not have any adverse effect on the health status and competed favourably with oxytetracycline (antibiotic) supplemented diets to improve growth performance, nutrient digestibility and carcass characteristics of Japanese quails. Addition of garlic-turmeric meal at 75% and 25% respectively led to higher final body weight and lower feed conversion ratio.

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