GSAR Journal of Agriculture and Veterinary Sciences ISSN: 3048-9075 (Online)



GSAR Journal of Agriculture and Veterinary Sciences ISSN: 3048-9075 (Online) Abbreviated key title: Glob.J. Agri.Vet.Sci. Frequency: Monthly Published By GSAR Publishers Journal Homepage Link- https://gsarpublishers.com/journal-gjavs-home/



Effect of Ginger (*Zingiber officinale*), Garlic (*Allium sativum*) and Turmeric (*Curcumin longa*) on growth performance of broiler chickens

By

*Fadipe, T.W¹, Onunkwo, D.N², Anigbogu, N.M³ and Osuagwu, F.M⁴.

^{1,2,3,4}Department of Animal Nutrition and Forage Science, Michael Okpara University of Agriculture, Umudike, Abia

State, Nigeria.



Article History

Received: 01/05/2025 Accepted: 04/05/2025 Published: 06/05/2025

<u>Vol – 2 Issue – 5</u>

PP: -38-43

Abstract

This study was conducted to investigate the effects of dietary supplementation of ginger, garlic and turmeric on performance of broiler chickens. One hundred- and twenty-day-old Rox-8 broiler chicks were randomly distributed into 4 experimental groups, each consisting of 3 replicates of 10 chicks per replicate in a Completely Randomized Design (CRD). Four experimental diets were formulated such that Diet 1 (Control) is without the medicinal plants, Diet 2 (ginger), Diet 3 (garlic) and Diet 4 (Tumeric) at 0.50g/ 100kg each. The experiment lasted for 14 weeks. Results revealed that supplementation of 0.50% ginger, garlic and turmeric to the basal diet of the broiler chickens did not significantly (P>0.05) enhance the body weights of the bird, although the feed intake was significantly different (P<0.05) among the treatment groups with D₄ having the highest total feed intake (5021.33g), average feed intake (717.33g) and daily feed intake (102.48g). the result also showed a significant improvement (P<0.05) in the FCR of birds fed the medicinal plants, with D₄ having the least FCR value of 2.33. In conclusion, 0.50% turmeric supplementation was found to be the best due to its ability to efficient utilization of feed.

Keywords: Performance, Garlic, Ginger, Turmeric, medicinal plants

INTRODUCTION

Description of problem

Over the years, antibiotics has been used in production of broiler chickens, to some extent, it has proven to be beneficial to the farmer. However, the overuse of antibiotics in poultry production has led to the emergence of antibiotics resistant bacteria, which is not only detrimental to the animal, but also to humans who consumed them, leading to the development of drug-resistant microflora (1). Due to the negative effect of these antibiotics' resistant bacteria, natural antibiotic promoters have been sort after as an alternative to the conventional antibiotics that can improve the health and performance of the animal. (2) has stated that different types of herbal supplements have been used to improve the health of poultry birds. (3) has also stated that the beneficial effects of these natural herbs are much better than those observed in the orthodox antibiotics.

Ginger (*Zingiber officinale*), Garlic (*Allium sativum*) and Tumeric (*Curcumin longa*). Ginger h as been reported to possess useful pharmacological potent chemical substances and have antioxidants, antibacterial, anti-inflammatory, antiseptic, anti-parasitic and immune modulator properties (4). (5) reported that Garlic is considered as wonder drug because of its antibacterial, antifungal, antiparasitic, antiviral, antioxidant, anti-cholesteric, anticancerous and vasodilator characteristics. Ginger and garlic supplements in broiler chicken diets have been recognized for their strong invigorating effects on the immune and digestive systems in poultry birds (6), and also acting as a prebiotic with positive effects on the immune response of birds (7). (8) suggested that ginger had a positive effect on growth performance parameters in broiler chicks. On the contrary, (9) in their studies observed that ginger powder in broilers did not improve growth performance. (10) reported enhanced growth, FCR and feed intake in broilers fed diet containing garlic powder.

Turmeric is rich source of phenolic compounds, such as curcumin, demethoxycurcumin, and bisdemethoxy curcumin and tetrahydrocurcumin metabolites and these compounds have the wide range of biological properties such as antioxidant, antibacterial, antiviral, antifungal, antihypertensive, anti-inflammatory, and anti-carcinogenic activities (11). (12) reported that turmeric supplementation

*Corresponding Author: Fadipe, T.W



© Copyright 2025 GSAR Publishers All Rights Reserved

improves growth rate as it stimulates digestive system by enhancing intestinal lipase, maltase, and sucrases activities. Studies by different authors have shown that turmeric can improve growth performance, and feed efficiency, and reduce the incidence of disease in poultry (13), (14). Findings by (15) reported enhanced growth performance parameters with curcumin supplementation. (16) also reported that the addition of turmeric powder to the diet of broiler chickens resulted in improved feed intake, weight gain, and feed conversion ratio.

Limited research has been conducted on the effect of ginger, garlic and turmeric on performance of broilers (17). This study was therefore aimed to observe the individual effects of ginger, garlic and turmeric supplementation on the growth performance of broiler chickens.

Materials and Methods

Experimental site

The experiment was carried out at Sort Out Livestock Farms, Owo, Enugu State, Nigeria. Owo has a tropical wet and dry savannah climate with distinct temperature of 30.2°C and it is 0.74% higher than Nigeria's averages. Owo receives about 169.42 mm of precipitation and has 205.92 rainy days annually (https: // weather and climate.com. 2024) It is situated in Nkanu-east of Enugu state, Nigeria. its geographical coordinates are 6° 30' 0" North, 7° 41' 0" East.

Source of test ingredients and preparation

Curcumin longa (Tumeric), *Zingiber officinale* (ginger), *Allium sativum* (garlic) were purchased from Ogbete Market in Enugu State. These medicinal plants were thoroughly washed separately to remove debris. The method of processing adopted for the garlic was such that, it could reduce garlic bulbs to the smallest size. Garlic bulbs were cut with knife and air dried during the harmattan. The moisture content was reduced during the process while retaining the potency and prevent the complete volatilization of the active compound contained therein. This process of drying was carried out for 7-21 days and the dried garlic chips stored in an air-tight containers before being grinded and incorporated into the feed.

The ginger and turmeric were sliced and dried too during the harmattan in a well-ventilated room for short and effective air drying away from direct sunlight. The dried ginger and turmeric chips were stored in an air-tight containers separately before being grinded and mixed with the feed.

Experimental animal and management

A total of Rox-8 120-day-old broiler chicks which were purchased from Agrited farms, Ibadan, was used for this study. The chicks were randomly divided into 4 groups of 30 birds each. Each group was further replicated into 3 replicates with 10 birds per replicate, they were brood separately with a charcoal pot and solar bulbs in their different brooding pen for two weeks. The birds were raised in floor pens with wood shavings as litter material. Each group contains feeders and drinkers for the provision of ad-libitum access to feed and water respectively for the 7 weeks period of the experiment. Birds were not vaccinated against new castle disease, infectious bursal disease, Coccidiosis or any kind of poultry disease during the experiments. The study lasted for a period of fourteen (14) weeks. Four experimental broiler diets were formulated such that Diet 1 (Control) is without the medicinal plants, Diet 2 (ginger), Diet 3 (garlic) and Diet 4 (turmeric) at 0.50g/ 100kg each. The experimental diets are shown in Tables 1 and 2.

Ingredients	Diet 1 (Control)	Diet 2 (Ginger)	Diet 3 (Garlic)	Diet 4 (Turmeric)
Maize	48.00	48.00	48.00	48.00
Soya bean	30.00	30.00	30.00	30.00
РКС	8.00	8.00	8.00	8.00
Wheat offal	6.00	5.50	5.50	5.50
Fish meal	4.00	4.00	4.00	4.00
Bone meal	3.00	3.00	3.00	3.00
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Salt (NaCl)	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25
Ginger	-	0.50	-	-
Garlic	-	-	0.50	-
Tumeric	-	-	-	0.50
Total	100	100	100	100

Table 1: Composition of broiler starter diet

*Corresponding Author: Fadipe, T.W

© Copyright 2025 GSAR Publishers All Rights Reserved

ME/Kcal/kg	2854.41	2868.12	2868.23	2868.12		
Crude Protein (%)	21.25	21.29	21.29	21.29		
NFE (%)	52 45	52.81	52.84	52.77		
Crude Fibre (%)	5.46	5.48	5.47	5.48		
Table 2: Composition of broiler finisher diet						
Ingredients Diet 1 (Control) Diet 2 (Ginger) Diet 3 (Garlic) Diet 4 (Turmer)						
Maize	57.00	57.00	57.00	57.00		
Soya bean	21.00	21.00	21.00	21.00		
P.K.C.	10.00	10.00	10.00	10.00		
Wheat offal	4.00	3.50	3.50	3.50		
Fish meal	4.00	4.00	4.00	4.00		
Bone meal	3.00	3.00	3.00	3.00		
Lysine	0.25	0.25	0.25	0.25		
Methionine	0.25	0.25	0.25	0.25		
Salt (Nacl)	0.25	0.25	0.25	0.25		
Premix	0.25	0.25	0.25	0.25		
Ginger	-	0.50	-	-		
Garlic	-	-	0.50	-		
Tumeric	-	-	-	0.50		
Total	100	100	100	100		
ME/Kcal/kg	2855.78	2869.76	2869.59	2869.49		
Protein (%)	19.25	19.29	19.29	19.29		
NFE (%)	53.33	53.69	53.72	53.65		
Fibre (%)	6.24	6.26	6.25	6.26		

Data collection and analysis

Data were collected on initial weight, Weekly and final weight of the broilers. The daily feed consumption was recorded by calculating the difference between the quantity of feed supplied daily and quantity of feed left over in the feeding troughs. Mortality record was also kept. The experiments are laid out in a completely randomized design (CRD). The data was subjected to analysis of variance (ANOVA). Where treatment means are significant separation of means was done using the Duncan's Multiple Range Test (18) at 5% level of significance, according to (19) using Computer Software IBM SPSS Statistics version 25 (20).

Results

Growth performance of Broilers fed diets containing dried Ginger (*Zingiber officinale*), Garlic (*Allium sativum*) and Tumeric (*Curcumin longa*)

Table 3 presents the growth performance of birds fed diets dried ginger, garlic and turmeric.

Table 3: Growth	performance of	[•] Broilers fed d	liets containing o	dried Ginger.	Garlic and '	Furmeric
	perior		Leve convening	arrea oniger,		

Parameters	D ₁ (Control)	D ₂ (Ginger)	D ₃ (Garlic)	D ₄ (Turmeric)	SEM
Initial body weight (g)	40.00	40.00	40.00	40.00	0.41
Final body weight (g)	1955.67	1981.83	2026.50	2295.50	60.27
Weight gain (g)	1915.67	1941.83	1986.50	2255.50	60.39
Daily weight gain (g)	30.10	39.63	40.54	46.03	1.23

*Corresponding Author: Fadipe, T.W

Total feed intake (g)	4468.00 ^c	4907.33 ^{ab}	4690.33 ^{bc}	5021.33 ^a	72.69
Average feed intake (g)	638.29 ^c	701.05 ^{ab}	670.05 ^{bc}	717.33 ^a	10.38
Daily feed intake (g)	91.18 ^c	100.15 ^{ab}	95.72 ^{bc}	102.48 ^a	1.48
FCR	3.03 ^a	2.53 ^b	2.36 ^c	2.23 ^d	0.09

^{a-b-c:} means with different superscripts on the same row are significantly different (p<0.05), SEM: Standard error of mean, FCR=Feed Conversion Ratio.

The result showed that initial body weight, final body weight, weight gain and daily weight gain were not significantly (P>0.05) affected by the dietary treatments. Birds fed D_4 were significantly higher (P<0.05) in total feed intake (5021.33g), average feed intake (717.33g) and daily feed intake (102.48g). No specific pattern was observed in the feed intake; however, the birds fed the experimental diets had higher feed intake when compared to the control. The Feed Conversion Ratio (FCR) (3.03) was higher (P < 0.05) in birds fed D_1 , while birds fed D_4 had the least FCR of 2.23. D_4 had the highest numerical weight gain and daily weight gain (2255.50g and 46.03g) when compared to other groups, although they were not significantly different (P>0.05). D₄ also had the highest final body weight (2295.50g) numerically although statistically non-significant (P>0.05). These values can suggest best dosage of turmeric for performance of broiler chickens.

Discussion

Non-significant effects observed in the final weight and daily weight gain of the broiler chickens in this study showed that the phytogenic additives used did not influence those parameters. This is in agreements with findings (21, 22) that inclusion of garlic in diets for broiler chickens did not influence performance. Birds in all the treatment groups had similar final weight and daily weight gain, indicating that the stimulating effect of ground garlic, ginger and turmeric on feed intake did not translate to higher weight gain in the birds, similar observation was made by (23). This result also corroborates the report of (22) that garlic when fed alone had no significant effect on body weight. The observation in this study is similar to (24) who reported no significant difference in the body weight of broilers supplemented with ginger or garlic or turmeric at 0.25% each.

This study disagreed with the report of (25) who observed that incorporation of turmeric powder had non-significant effect on Feed intake of broiler birds. (26) also showed that the feed intake reduced significantly in broilers when supplied with diet containing 0.50 percent turmeric powder in comparison to control. (24) performed an experiment to find out the effect of supplementing broiler feeds with garlic, ginger, and turmeric powder on feed intake and observed that feed intake did not differ significantly for the diets supplemented with ginger (74.21 ± 0.70g), garlic (73.20 ± 1.02g) and turmeric powder (73.01 ± 0.57g) as compared with the basal diet (72.25 ± 0.47g). (27) also revealed that feed intake did not differ significantly for the broilers fed on diet added with turmeric powder. (28) observed that broilers receiving different levels of turmeric plus thyme powders had highest feed intake than that of control group. (29) conducted an experiment reported that feed intake was significantly lower in birds supplemented with turmeric then ginger as compared to control group. However, (30) revealed that inclusion of turmeric at the level of 0.50 percent resulted in significantly higher feed consumption (2135.9 \pm 51.9g) as compared to control (1555.7 \pm 43.6 g) at the end of third week; however, at the end of sixth week there was no significant difference in the feed consumption among the treatments as compared to control. Likewise, (22) also reported that use of garlic powder in the diet of broilers had no significant influence on feed consumption when fed 0.2 and 0.4% levels. (31) reported that supplementation of garlic as feed additive did not have effect on feed intake of broiler chickens. A significant (P<0.05) decreased feed intake was observed among the treatments fed garlic (D3) and this may be due to the strong odour of garlic as reported by (32). Among the treatment groups, D4 had a better FCR (2.23). (25) revealed that the use of turmeric powder as feed additive at level of 0.50 percent had the best FCR (2.08) as compared to control (2.47). (26) observed significant improvement (P < 0.01) in feed conversion ratio of broilers fed diet containing 0.50 percent turmeric powder as compared to control group. (33) reported that turmeric supplementation at1 g/kg feed significantly improved feed conversion ratio (FCR) as compared to control groups. (34) reported that turmeric supplementation at 0, 0.5, 1.0 and 1.5 percent feed improved conversion efficiency but supplementation at the rate of 1.5 percent showed the best results in comparison to control group.

The lower feed intake observed in D_3 disagreed with the findings of (35) who observed higher feed intake of rabbits fed garlic, which they attributed to the fructo-oligosaccharides present in garlic, which consequently stimulates an increase in feed intake due to their mild sweet taste. For the fact that D_4 consumed more and had better FCR than D_1 , D_2 and D_3 might be pointing to intrinsic factors (eg feed palatability) in turmeric that enhanced feed utilization which was dependent of the amount of feed consumed.

Conclusion and Application

- 1. The supplementation of ginger, garlic and turmeric exerted no influence on the growth performance of the birds although the feed intake of the birds varies.
- 2. Numerically, birds fed Diet 4 (turmeric) had higher final body weight and weight gain, which might be due to the higher feed intake of the bird. However, the birds fed turmeric had the best FCR, which shows that they efficiently utilized the feed taken.



3. Therefore, ginger, garlic and turmeric can be used in place of antibiotics as growth promoters.

References

- Abd El-Hack Mohamed, E., Mohamed T., El-Saadony M. E. S., Shaza Y. A. Q., Gaber E. B., Asmaa F. K., Abdel-Moneim E. A., and Mahmoud A... 2020. Probiotics in poultry feed: a comprehensive review. J. Anim. Physiol. Anim. Nutr. (Berl) 104:1835 1850.
- Ademolue, R. O., Sanwo, K. A., Sobayo, R., Ayo-Ajasa, O., and Okanlawon, E. (2024). Effect of turmeric, garlic, ginger powder and their blends on growth performance and carcass yield of rabbits. *Adan Journal of Agriculture*, 5(1).
- Aggarwal, B.B. and Harikumar, K.B. 2009. Potential therapeutic effects of curcumin, the antiinflammatory agent, against neurodegenerative, cardiovascular, pulmonary, metabolic, autoimmune and neoplastic diseases. *The International Journal of Biochemistry and Cell Biology*, 41: 40-59.
- Ahmed, H.A., Sadek, K.M. and Taha, A.E. (2015). Impact of two herbal seeds supplementation on growth performance and some biochemical blood and tissue parameters of broiler chickens. *International Journal of Animal and Veterinary Sciences*, 9 (3): 279-284.
- Al-Jaleel RA Abd (2012). Use of tumeric (Curcuma longa) on the performance and some physiological traits on the broiler diets. *The Iraqi Journal of Veterinary Medicine*, 36(1): 51-57.
- Al-Shuwaili, M.A., Ibrahim, E.I. and AlBayati, M.T. (2015). Effect of dietary herbal plants supplement in turkey diet on performance and some blood biochemical parameters. *Global Journal of Bioscience and Biotechnology*, 4 (1): 85-89
- AL-Sultan, S.I. (2003). The effects of Curcuma longa (turmeric) on overall performance of broiler chickens. *International Journal of Poultry Sciences*, 2(5): 351-353.
- Arshad, M., Kakar, A.H., Durrani, F.R., Akhtar, A., Sanaullah, S. and Niamatullah, M. (2012). Economical and immunological impact of ginger extract on broiler chicks. *Pakistan Journal of Science*, 64 (1): 46–48
- Arslan M, Haq AU, Ashraf M, Iqbal J and Mund MD (2017). Effects of turmeric (Curcuma longa) supplementation on growth performance, immune response, carcass characteristics and cholesterol profile in broilers. Veterinaria, 66(1): 16-20.
- Casewell, M., Friis, C., Marco, E., McMullin, P. and Phillips, I. 2003. The European ban on growth promoting antibiotics and emerging consequences for human and animal health. *Journal of Antimicrobial Chemotherapy*, 52: 159-161.
- 11. Demir, E., Sarica, S., Ozcan, M.A. and Suicmez, M. (2013). The use of natural feed additives as

alternatives for an antibiotic growth promoter in broiler diets. *British Journal of Poultry Science*, 44: S44–S45.

- Dieumou, F.E., Teguia, A., Kuiate, J.R., Tamokou, J.D., Fonge, N.B. and Donogmo, M.C. 2009. Effect of ginger (Zingiber officinale) and garlic (Allium sativum) essential oils on growth performance and gut microbial population of broiler chicks. Livestock Research for Rural Development, 21: 21-33.
- 13. Doley, S., Gupta, J.J. and Reddy, P.B. (2009). Effect of supplementation of ginger, garlic and turmeric in broiler chicken. *Indian Veterinary Journal*, 86: 644-645.
- 14. Duncan, D.B (1955). Multiple Ranges and Multiple F-tests: A Biometric 1:1-42
- Durrani, F.R., Ismail, M., Sultan, A., Suhail, S.M., Chand, N. and Durrani, Z. (2006). Effect of different levels of feed added turmeric (Curcuma Longa) on the performance of broiler chicks. *Journal of Agricultural and Biological Science*, 1(2): 9-11.
- 16. Fallah, R and Mirzaei, E. (2016). Effect of dietary inclusion of turmeric and thyme powders on performance, blood parameters and immune system of broiler chickens. *Journal of Livestock Science*, 7: 180-186.
- Hanieh, H., Narabara, K., Piao, M., Gerile, C., Abe, A. and Kondo Y. (2010). Modulatory effects of two levels of dietary Alliums on immune responses. *Animal Science Journal*, 81: 673-680.
- 18. IBM Corp (2017). IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.
- Irekhore O. T., Alli O. O., Bello K. O., Oluwalana E. O. A. (2020). Growth performance and cost benefits of broiler chickens Fed diets containing garlic and ginger powder as additives. Nigerian Society for Animal Production (NSAP) 45th Annual Conference - Bauchi 2020 Book of Proceedings.
- Issa, K.J. and Omar, J.A. (2012). Effect of garlic powder on performance and lipid profile of broilers. *Open Journal of Animal Sciences*, 2. DOI: 10.4236/ojas.2012.22010.
- 21. Kafi, A., Uddin, M.N., Uddin, M.J., Khan, M.M.H. and Haque, M.E. (2017). Effect of dietary supplementation of turmeric (Curcuma longa), ginger (Zingiber officinale) and their combination as feed additives on feed intake, Growth performanceand economics of broiler. In*ternational Journal of Poultry Science*, 16: 257-265.
- 22. Manesh, M.K., Kazemi, S. and Asfari, M. (2012). Influence of poly germander (Teucrium polium) and watercress (Nasturtium officinale) extract on performance, carcass quality and blood metabolites of male broilers. Research Opinions in Animal and Veterinary Science, 2: 66-68. http://roavs.com/pdffiles/Issue 2 2012/66 68.pdf

- 23. Mikailu, M. M., Jega, Z. S., Dalhatu, A. M., Aljameel, K. M and Sanusi, A. Z. (2020). Performance and serum biochemistry of broiler chicken fed graded levels of garlic (Allium sativum) powder at starter phase in Sokoto, Nigeria. Nigerian Society for Animal Production (NSAP) 45th Annual Conference - Bauchi 2020 Book of Proceedings.
- 24. Namdeo, S., Baghel, R.P.S., Nayak, S., Khare, A. and Pal, R.P. (2024). Dietary supplementation of ginger, garlic and turmeric on the performance of broiler chicken. Animal Nutrition and Feed Technology, 24: 373-385.
- 25. Nouzarian, R., Tabeidian, S.A., Toghyani, M., Ghalamkari, G and Toghyani, M. (2011). Effect of turmeric powder on performance, carcass traits, humoral immune responses and serum metabolites in broiler chickens. Journal of Ani. and Feed Sci., 20: 389-400.
- 26. Onu, P.N. (2010). Evaluation of two herbal spices as feed additives for finisher broilers. Biotechnology in Animal Husbandry, 26: 383-392.
- 27. Platel, K. and Srinivasan, K. (2000). Influence of dietary spices and their active principles on pancreatic digestive enzymes in albino rats. Food Nahrung, 44: 42-46.
- 28. Qorbanpour, M., Fahim, T., Javandel, F., Nosrati, M., Paz, E., Seidavi, A., Ragni, M., Laudadio, V. and Tufarelli, V. (2018). Effect of dietary ginger (Zingiber officinale Roscoe) and multi-strain probiotic on growth and carcass traits, blood biochemistry, immune responses and intestinal microflora in broiler chickens. Animals, 8 (7): 1-9.
- 29. Rastad, A. (2020). Effects of antibiotic replacement with garlic powder and probiotic on performance,

carcass characteristics, oxidative enzymes and intestinal morphology of broiler chickens. Acta Scientiarum. Animal Sciences, 42: e48734. https://doi.org/10.4025/actascianimsci.v42 i1.48734

- 30. Sayed, M. A., Shahta M. A., Ali N. M., Kotob M. H., Mahmoud U. T., Mahmoud M. A., and Amen O. A... 2023. Evaluate the effect of some phytobiotics on the control of necrotic enteritis in broilers chicken. Assiut Vet. Med. J. 89:89-104.
- 31. Steel, R.G.D. and Torrie, J.H. (1980). Principles and Procedures of Statistics. A Biometrical Approach. 2nd Edition, McGraw-Hill, New York, 20-90.
- 32. Ürüsan, H., and Bölükbasi C. (2017). Effects of dietary supplementation levels of turmeric powder (Curcuma longa) on performance, carcass characteristics and gut microflora in broiler chickens. J. Anim. Plant Sci. 27:732-736.
- 33. Yesuf, K.Y., Mersso, B.T. and Bekele, T.E. (2017). Effects of different levels of turmeric, fenugreek and black cumin on carcass characteristics of broiler chicken. Journal of Livestock Sciences, 8: 11-17.
- 34. Zena, K., Mengistu, A. and Singh, H. (2017). Effect of oyster mushroom, garlic and ginger as feed additives on feed intake, growth performance and economic efficiency of broilers. British Journal of Poultry Science, 6 (1): 07-15.
- 35. Zhang, J., Bai K. W., He J., Niu Y., Lu Y., Zhang L., and Wang T... 2018. Curcumin attenuates hepatic mitochondrial dysfunction through the maintenance of thiol pool, inhibition of DNA damage, and stimulation of the mitochondrial thioredoxin system in heat-stressed broilers. J. Anim. Sci. 96:867-879.