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Research Article
Performance, Carcass Yield and Stress Level of Broilers Receiving a Ginger-Based Product in Diets with or Without Iodine

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Abstract

Background and Objective: Ginger has potential to be used in chicken nutrition because it exhibits several positive characteristics, such as being an antioxidant agent and possesses medicinal properties against digestive disorders. This study was conducted to evaluate the effect of a ginger-based product in diets with or without iodine addition on performance, carcass yield and stress level of broilers. **Materials and Methods:** Performance, carcass yield and stress level of broilers fed diets with ginger supplementation with or without iodine were evaluated. A total of 300 broilers were raised from 1-42 days. Groups of 10 broilers were distributed in 30 pens with feed and water ad libitum. The experiment consisted of three treatments: control diet, control diet with ginger and iodine and control diet with ginger and without iodine. Diets were formulated in starter, grower and finisher phases. Body weight, feed intake and feed conversion ratio were evaluated. Twenty birds per treatment were slaughtered to evaluate cuts and carcass yield, blood was collected of eight birds per treatment to analyze leukocytes, lymphocytes, heterophile and calculate heterophile to lymphocyte (H/L) ratio and behavior was observed. Data were analyzed using ANOVA and means were compared by Lsmeans. **Results:** No effects ($p>0.05$) were observed on feed intake, weight gain and feed conversion ratio in any periods, as well in commercial cuts and carcass yield. Treatments did not influence leukocytes, lymphocytes, heterophile and H/L ($p>0.05$) and animals showed no difference in behavior. **Conclusion:** The ginger supplemented in diets with or without iodine do not affect growth performance, carcass and commercial cuts yield. As well as do not affect broiler stress level.

Key words: Growth performance, broiler diet, ginger root powder, stress in poultry, heterophile, lymphocyte

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The pressure for reducing the use of antibiotic growth promoters (AGP) in broiler production is an irreversible process and several countries are adhering to the restrictions and ban on AGP usage. Various feed additives such as essential oils, copper sulfate, zinc oxide, probiotics and prebiotics have been studied aimed to replace AGP or reduce the negative effects of AGP ban on broiler performance[1-3]. Among the substances studied, ginger may act as a pro-nutrient for broilers because of its vast active compounds. Ginger is an underground rhizome of plant Zingiber Officinale belonging to the family Zingibeaceae[4]. Ginger contains several compounds such as borneol, camphene, citral, eucalyptol, linalool, phellandrene, zingberine, zingiberol (gingerol, zingerone and shogaol) and resin[5-7]. Phytochemical studies show that ginger has antioxidant, antimicrobial, anti-inflammatory and sedative activities and it could be used as medical treatment for certain diseases[7-9]. Positive effect of ginger on blood circulation, gastric secretion and enterokinesia were reported by Ali *et al.*[10] and Incharoen and Yamauchi[11]. Ginger has an anti-inflammatory effect and is distinguished from non-steroidal anti-inflammatory drugs by suppressing prostaglandin biosynthesis with inhibition of cyclooxygenase-1 and cyclooxygenase-2. It is also capable of suppressing leukotriene biosynthesis by inhibiting 5-lipoxygenase. Dual inhibition of cyclooxygenase and 5-lipoxygenase may provide a better therapeutic profile in response to chronic inflammation and modulation of the immune system with less side effect compared to non-steroidal anti-inflammatory drugs[12]. Broilers in finishing phase (21-42 days) fed diets with 5 g kg^{-1} of ginger significantly reduced the activity of malondialdehyde enzyme (MDA)[13]. The reduced level of MDA indicated that the addition of ginger alleviated the lipid peroxidative damage to the cell.

Studies have been conducted with ginger supplementation in the chicken diet and contradictory results were reported about weight gain and feed conversion ratio. However, the studies did not take into consideration the possible interaction between ginger enzymes and dietary ions. Iodine (I) is an essential mineral for humans and animals, being required for the synthesis of the thyroid hormones triiodothyronine (T3) and tetraiodothyronine (T4). The appropriate iodine provision is important for a normal thyroid function and the associated physiological mechanisms[14]. The thyroid hormones accelerate reactions in most organs and tissues in the body, accelerating growth and increasing the oxygen consumption of the hole organism. They are also involved in immune defense, digestion and muscle function. In broiler diets, iodine is supplemented mainly in the form of $Ca(IO_3)$ or KI within the mineral premix, or iodized salt[15]. Iodine is an oxidizing agent and a strong anion and these properties can inactivate ginger enzyme (Zingibain), since the active site is cysteine, of thiol group[16] and the cavity in the enzyme where the substrate binds is blocked by large anions. Then, this study evaluated the effect of a ginger-based product in diets with or without iodine addition on performance, carcass yield and stress level of broilers.

MATERIALS AND METHODS

This study was conducted at the Animal Science Laboratory (LEZO) of the Universidade Federal do Rio Grande do Sul from January to July 2017. All procedures were approved by the Animal Care and Welfare Committee of Federal University of Rio Grande do Sul.

Bird husbandry: A total of 300 Cobb 500 broiler chickens were used, obtained directly from the hatchery and reared until 42 days. The broilers were housed in a building with 30 floor pens equipped with nipple drinkers and feeders. On the first day of life, groups of 10 birds were weighed and distributed in pens of 1 m^2. The variation in weight among group of birds did not exceed 3%. Each pen represented an experimental unit. Feed and water were provided ad libitum and environmental temperatures were managed with heaters to maintain birds in thermoneutral conditions during the experimental period.

Diets and treatments: During the trial, three mash diets were provided (starter: 1-21 days, grower: 22-35 days and finisher: 36-42 days) formulated with nutritional levels recommended by Poultry and Swine Brazilian Tables[17] (Table 1). The experiment consisted of three treatments: control diet (CD), control diet with ginger on top with iodine (GT) and control diet with ginger on top without iodine addition in the mineral premix and salt (GFI). The product used in this study is based on dry powder made from the three gingers (Zingiber officinale), stable at ambient temperatures. The ginger used in this study is produced by Biohawk (Biohawk Relief Ginger-Biohawk, 115, Bluestone Circuit Seventeen Mile Rocks QLD 4073, Australia). The ginger product was added on top in the feed following the amount recommended by the manufacturer. The amounts were: 0.0250% in the starter phase (1-21 days); 0.0368% in the growth phase (22-35 days) and 0.0476% in the final phase (36-45 days).

Table 1: Ingredients composition and nutritional levels of experimental diets fed to broilers receiving control diet supplemented with ginger on top

Items	Broiler starter (1-21 days)	Broiler grower (21-35 days)	Broiler finisher (35-49 days)
Ingredients g kg^{-1}			
Corn	0.58430	60.380	60.140
Soybean meal 46%	0.34610	32.100	32.140
Vegetal oil	0.03080	4.150	4.870
Dicalcium phosphate	0.01670	1.310	1.100
Limestone	0.00930	0.910	0.780
Salt	0.00510	0.460	0.460
DL-methionine	0.00320	0.280	0.230
L-lysine HCl	0.00270	0.240	0.140
L-threonine	0.00080	0.050	0.010
Cl-choline	0.00010	0.020	0.020
Ginger on top* (%)	0.00025	0.036	0.047
Mineral premix[1]	0.00040	0.045	0.045
Vitaminic premix[2]	0.00050	0.050	0.050
Metabolizable energy (kcal kg^{-1})	3050.00000	3150.000	3200.000
Crude protein (%)	21.20000	20.110	19.970
Calcium (%)	0.86000	0.760	0.660
Phosphorus disponible (%)	0.42000	0.350	0.310
Sodium (%)	0.22000	0.200	0.200
Lysine (%)	1.22000	1.130	1.060
Methionine+cysteine(%)	0.88000	0.820	0.770
Arginine (%)	1.31000	1.230	1.130
Tryptophan (%)	0.23000	0.200	0.200
Threonine (%)	0.79000	0.730	0.690
Linolenic acid	3.06000	3.630	3.660
Choline (mg kg^{-1})	1200.00000	1200.000	1200.000

*Ginger: The ginger product was added on top in the feed following the amount recommended by the manufacturer. [1]Mineral premix (kg of feed): Mn: 105 mg $MnSO_4$, Zn: 70 mg ZnO, Fe: from 56 mg $FeSO_4$, Cu: 10.5 mg CuO, I: 0.84 mg KI, Se: 0.3mg Na_2SeO_3. [2]Vitaminic premix (kg of feed): Vitamin A: 9280 IU retinol acetate, Vitamin D: 2240 IU of cholecalciferol, Vitamin E: 20.8 IU of DL-α-tocopherol, Vitamin K: 2.4 mg menadione bisulfite, Thiamine: 2.4 mg thiamine mononitrate, Riboflavin: 7.2 mg, Pyridoxine: 3.6 mg of pyridoxine hydrochloride, Cobalamin: 0.016 mg cyanocobalamin, Pantothenic acid: 17.6 mg of D-pantothenic acid, Niacin: 52.8 mg nicotinic acid, Folic acid: 0.96 mg, Biotin: 0.08 mg D-biotin

Performance evaluation: Body weight (BW), feed intake (FI), body weight gain (BWG) and feed conversion ratio (FCR) were evaluated weekly. The mortality rate was less than 3% and the weights of dead birds were used to adjust feed conversion ratios.

Carcass yield: To evaluate yield of commercial cuts (breast, thigh and drumstick) 20 male birds per treatment (2 birds per pen) were slaughtered at 42 day. The slaughter was performed by cervical dislocation and bleeding. The birds went through scalding, feather plucking and evisceration. The carcasses were weighed without head, feet and viscera. The carcasses were decomposed in commercial cuts by one specialized person; breast, thigh and drumstick were weighed to calculate the yield of each cut relative to the carcass weight.

Stress level: The behavior of the birds was observed daily and the level of agitation in the presence of humans was evaluated as an indicative of stress measurement. Two people passed among the pens every morning and the number of animals that modified behavior (lifting or stopping eating) was noted. During the experimental period, pictures were taken and the behavior of animals in each experimental unit were filmed to help identifying birds stress. At 42 days, blood was collected of eight birds per treatment (representative of weight average) and leukocytes, lymphocytes and heterophile were analyzed[18].

Statistical analysis: The experimental design was completely randomized, consisting of three treatments: (1) Control diet, (2) Control diet with ginger on top with iodine and (3) Control diet with ginger on top without iodine addition in the mineral premix and salt with ten replicates, each pen (replicate) was considered an experimental unit and contained 10 birds. Data were subject to analysis of variance (ANOVA) and, when F was significant, the means were compared by LS means using SAS statistical program ($p<0.05$).

RESULTS

Performance evaluation: Broilers consumed feed and gained weight according to the expected performance of the genotype throughout the trial. During the experimental

Table 2: Body weight gain (WG), feed intake (FI) and feed conversion ratio (FCR) of broilers in the experimental period

	Treatments				
Variables	Control	Ginger	Ginger free iodine	P[1]	CV[2]
1-21 days					
FI (g)	1289.000	1332.00	1333.000	0.295	5.28
WG (g)	942.000	954.00	959.000	0.824	6.69
FCR (g g^{-1})	1.370	1.39	1.390	0.234	2.49
22-42 days					
FI (g)	3199.000	3197.000	3169.000	0.885	4.50
WG (g)	1963.000	1980.000	1944.000	0.796	5.81
FCR (g g^{-1})	1.632	1.617	1.632	0.853	3.69
1-42 days					
FI (g)	4489.000	4525.000	4502.000	0.604	3.04
WG (g)	2908.000	2930.000	2903.000	0.850	3.60
FCR (g g^{-1})	1.545	1.545	1.551	0.912	2.27

[1] [a,b]Means followed by different letters in the same row are different ($p<0.05$), [2]CV (%): Coefficient of variation

Table 3: Yield carcass and cuts of male and female broiler chickens fed control diet supplemented with ginger on top with or without iodine addition at 42 day of life

	Treatments				
Yield (%)	Control	Ginger	Ginger free iodine	P[1]	CV[2]
Carcass	72.78	72.45	72.81	0.925	4.39
Breast	41.75	41.54	41.35	0.852	5.47
Drumstick	12.78	12.78	12.53	0.371	5.04
Thigh	18.28	17.95	17.97	0.611	6.48

[1] [a,b]Means followed by different letters in the same row are different ($p<0.05$), [2]CV (%): Coefficient of variation

Table 4: Leukocytes, lymphocytes and heterophile of 42 days old broiler chickens fed control diet supplemented with ginger on top with or without iodine addition

		Lymphocytes		Heterophyle		
Treatments	Leukocyte (×10/μL^3)	×10/μL^3	Percentage	×10/μL^3	Percentage	H/L[2]
Control	10.230	5.980	58.490	3.930	32.220	0.680
Ginger	8.990	5.930	64.180	2.750	32.270	0.550
Ginger free iodine	10.000	6.420	63.870	3.100	31.250	0.520
CV[1] (%)	2.770	3.720	3.210	4.260	9.140	17.000
p-value[2]	0.565	0.752	0.208	0.207	0.416	0.476

[1]CV (%): Coefficient of variation, H/L[2]: Heterophile/Lymphocytes. [2]p-value: Means followed by different letters in the same row are different ($p<0.05$)

period, no health problems were observed and mortality was below 3%. Means according to broiler rearing periods are presented in the Table 2. In the initial, final and total period of the trial, the ginger supplementation with or without iodine did not affect performance ($p>0.05$).

Carcass yield: The supplementation of ginger with or without iodine also did not affect ($p>0.05$) the carcass yield and commercial cuts (breast, thigh and drumstick; Table 3).

Stress level: The result of the blood analysis (Table 4) shows that treatments did not significantly ($p>0.05$) affect the leukocytes, lymphocytes and heterophile, neither the heterophile: lymphocytes relation. These results are consistent with the behavior observed during the trial and in the videos made. No differences among treatments for the broiler reaction in the presence of humans were noted and no changes in the stress level were observed.

DISCUSSION

Although, in the literature several benefits associated with ginger have been described, it was not possible to perceive benefits in the performance of the broilers in this study. The absence of differences in performance may be related to a result dependent on the amount of ginger added in the diet. Zhang *et al.*[13] observed that diet containing 5 g kg^{-1} of ginger did not affect the growth performance. In contrast, Al-Homidan[19] observed reduced growth rate of broilers at 28 days when ginger was fed at the rates of 20 and 60 g kg^{-1}. Studies using small doses of supplementation have contradictory results, El-Deek *et al.*[20] observed that diet containing 1 g kg^{-1} of ginger did not affect the growth performance, in contrast Tekeli *et al.*[21] stated that 0.12, 0.24 and 0.36 g kg^{-1} improved BWG in broilers. Also, Onu[22] reported that the addition of ginger (0.25%) in the basal diet of broiler resulted in improved FCR although FI did not change.

There is a theory that iodine could interfere in the ginger activity and thus reduce the beneficial effects on performance. According to Herawati and Atmini[23] the benefits in performance may be attributed to the two types of digestive enzymes in ginger; protease and lipase, which are present as part of the plants. Iodine is a strong ion and could inactivate the ginger enzyme, since the active site is a thiol group (cysteine) and can be blocked by anions[16]. Plant thiol proteases require a free SH-group for activity. Some possible routes for ginger enzyme deactivation are oxidation of the active site SH-group and SH-group binding with heavy metal ions. Ginger enzyme could also bind to tannins by hydrogen bonding or electrostatic interactions[24]. In this study it was not possible to verify the inactivity of ginger by iodine, since the effect of the treatments on performance of broilers was similar and this may be related to the factors already mentioned, such as the dose of ginger used.

As occurs in the performance, the carcass yield results also vary greatly in previous studies with ginger and, in this study, the treatments did not affect carcass yield and commercial cuts. In accordance to this result, El-Deek *et al*.[20] found that dressing percentage did not differ between control and ginger treated broilers. Likewise, Onu[22] affirmed that 0.25% of ginger addition did not result in significant differences in carcass characteristics. In contrast, Zhang *et al*.[13] observed that birds fed 0.5% of ginger produced higher carcass weights and suggested that it may be associated with the antioxidant effect of ginger which enhances protein and fat metabolism.

The relation between heterophile and lymphocyte (H/L) has been accepted as a reliable index for determining stress in poultry[13,25]. The treatments did not influence leukocytes, lymphocytes, heterophile and H/L and this is in accordance with the behavior observed in the animals. Broilers showed no difference in agitation in the presence of humans, remaining lying or eating during the passage of people among pens. Results found in this study were similar to Hasheimi *et al*.[26], where no effect of ginger supplementation on heterophile: lymphocyte ratio was observed. Some studies evaluating heat stress have found positive results for the use of ginger. Mushawwir *et al*.[27] observed that neutrophils to lymphocytes ratio dropped dramatically with ginger supplementation; and Habibi *et al*.[28] reported increasing serum TAC and liver TSOD activity, which subsequently enhance the capacity of broilers to clear out the oxygen free radicals, indicating that ginger could improve the antioxidant status in broilers under high ambient temperature. Possibly the presence of humans was not able to trigger a stress response as strong as heat stress.

Opinion in the literature is divided regarding the influence of ginger supplementation on broiler and the difference in results may be associated with several factors, as health challenge, presence of iodine in the diet, particle size, dosage or the supply route. Ginger can also be applied via drinking water or combined with other plant products[29,30]. Qorbanpour *et al*.[31] concluded that dietary supplementation with ginger and probiotics showed an influence on immune response of broilers, probably because ginger had strong antioxidant activity, whereas microbial feed supplement stimulated natural antibodies production. Due to many factors that have not yet been clarified, further studies on the effects of ginger supplementation for broilers are needed.

CONCLUSION

The level of ginger supplemented in diets assessed in this study, with or without iodine, do not affect growth performance, carcass yield and breast, thigh and drumstick cuts of broiler. As well as the ginger do not affect broiler stress level. An in-depth study of the relationship between ginger and anions present in the diet is needed.

SIGNIFICANCE STATEMENT

This study discovered the possible effect of ginger-based product with or without iodine on the performance and stress level of broilers, which can be beneficial for the poultry sector because there is a search for substitutes for antibiotic growth promoter. This study will help the researcher to uncover the critical area of the effect of ginger on the performance and stress level of broilers, as well as the interaction between ginger and iodine, which many researchers have not been able to explore. Thus, a new theory on the combination of ginger and iodine and interference factors in the use of ginger in the broilers diet can be achieved.

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REFERENCES

1. Garima, T., R. Anshu, K. Ashoka and K. Anil, 2019. Influence of supplementing Giloe and Cinnamon on production performance in commercial broiler chicken. Indian J. Anim. Nutr., 36: 94-98.
2. Peng, Q.Y., J.D. Li, Z. Li, Z.Y. Duan and Y.P. Wu, 2016. Effects of dietary supplementation with oregano essential oil on growth performance, carcass traits and jejunal morphology in broiler chickens. Anim. Feed Sci. Technol., 214: 148-153.

3. Moraes, P.O., I. Andretta, K.M. Cardinal, M. Ceron and L. Vilella *et al*., 2019. Effect of functional oils on the immune response of broilers challenged with *Eimeria* spp. Animal, 13: 2190-2198.
4. Kumar, G., L. Karthik and K.V.B. Rao, 2011. A review on pharmacological and phytochemical properties of *Zingiber officinale* roscoe (Zingiberaceae). J. Pharm. Res., 4: 2963-2966.
5. Guo, Y., J. Bai and Z. Zhang, 2007. Plant regeneration from embryogenic suspension-derived protoplasts of ginger (*Zingiber officinale* Rosc.). Plant Cell Tissue Organ Cult., 89: 151-157.
6. Zhao, X., Z.B. Yang, W.R. Yang, Y. Wang, S.Z. Jiang and G.G. Zhang, 2011. Effects of ginger root (*Zingiber officinale*) on laying performance and antioxidant status of laying hens and on dietary oxidation stability. Poult. Sci., 90: 1720-1727.
7. An, K., D. Zhao, Z. Wang, J. Wu, Y. Xu and G. Xiao, 2016. Comparison of different drying methods on Chinese ginger (*Zingiber officinale* Roscoe): Changes in volatiles, chemical profile, antioxidant properties and microstructure. Food Chem., 197: 1292-1300.
8. Tapsell, L.C., I. Hemphill, L. Cobiac, C.S. Patch and D.R. Sullivan *et al*., 2006. Health benefits of herbs and spices: The past, the present, the future. Med. J. Aust., 185: S4-S24.
9. Shukla, Y. and M. Singh, 2007. Cancer preventive properties of ginger: A brief review. Food Chem. Toxicol., 45: 683-690.
10. Ali, B.H., G. Blunden, M.O. Tanira and A. Nemmar, 2008. Some phytochemical, pharmacological and toxicological properties of ginger (*Zingiber officinale* Roscoe): A review of recent research. Food Chem. Toxicol., 46: 409-420.
11. Incharoen, T., K. Yamauchi and N. Thongwittaya, 2010. Intestinal villus histological alterations in broilers fed dietary dried fermented ginger. J. Anim. Physiol. Anim. Nutr., 94: e130-e137.
12. Grzanna, R., L. Lindmark and C.G. Frondoza, 2005. Ginger-an herbal medicinal product with broad anti-inflammatory actions. J. Med. Food., 8: 125-132.
13. Zhang, G.F., Z.B. Yang, Y. Wang, W.R. Yang, S.Z. Jiang and G.S. Gai, 2009. Effects of ginger root (*Zingiber officinale*) processed to different particle sizes on growth performance, antioxidant status and serum metabolites of broiler chickens. Poult. Sci., 88: 2159-2166.
14. Rottger, A.S., I. Halle, H. Wagner, G. Breves and G. Flachowsky, 2011. The effect of various iodine supplementations and two different iodine sources on performance and iodine concentrations in different tissues of broilers. Br. Poult. Sci., 52: 115-123.
15. Opaliński, S., B. Dolińska, M. Korczyński, K. Chojnacka, Z. Dobrzański and F. Ryszka, 2012. Effect of iodine-enriched yeast supplementation of diet on performance of laying hens, egg traits and egg iodine content. Poult. Sci., 91: 1627-1632.
16. Grudkowska, M. and B. Zagdanska, 2004. Multifunctional role of plant cysteine proteinases. Acta Biochim. Pol., 51: 609-624.
17. Rostagno, H.S., L.F.T. Albino, J.L. Donzele, P.C. Gomes and R.F. de Oliveira *et al*., 2011. Tabelas Brasileiras Para Aves e Suinos: Composicao de Alimentos e Exigencias Nutricionais. 3rd Edn., Universidade Federal de Vicosa, Vicosa, MG, Brasil, ISBN: 9788560249725, Pages: 252.
18. Laganà, D., G. Carrafiello, M. Mangini, L. Boni and G. Dionigi *et al*., 2006. Radiofrequency ablation of primary and metastatic lung tumors: Preliminary experience with a single center device. Surg. Endosc. Interventional Techn., 20: 1262-1267.
19. Al-Homidan, A.A., 2005. Efficacy of using different sources and levels of *Allium sativum* and *Zingiber officinale* on broiler chicks performance. Saudi J. Biol. Sci., 12: 96-102.
20. El-Deek, A.A., Y.A. Attia and M.M. Hannfy, 2002. Effect of anise (*Pimpinella anisum*), ginger (*Zingiber officinale roscoe*) and fennel (*Foeniculum vulgare*) and their mixture on performance of broilers. Arch. Geflugelkd, 67: 92-96.
21. Tekeli, A., H.R. Kutlu and L. Celik, 2011. Effects of *Z. officinale* and propolis extracts on the performance, carcass and some blood parameters of broiler chicks. Curr. Res. Poult. Sci., 1: 12-23.
22. Onu, P.N., 2010. Evaluation of two herbal spices as feed additives for finisher broilers. Biotechnol. Anim. Husbandry, 26: 383-392.
23. Herawati, T. and S. Atmini, 2010. Perbedaan perilaku auditor dalam situasi konflik audit dilihat dari segi gender: Peran locus of control, Komitmen Profesi, dan Kesadaran Etis. J. Aplikasi Manajemen, 8: 531-545.
24. Adulyatham, P. and R. Owusu Apenten, 2005. Stabilization and partial purification of a protease from ginger rhizome (*Zingiber offinale* Roscoe). J. Food Sci., 70: 231-234.
25. Altan, O., A. Pabuccuoglu, A. Altan, S. Konyalioglu and H. Bayraktar, 2003. Effect of heat stress on oxidative stress, lipid peroxidation and some stress parameters in broilers. Br. Poult. Sci., 44: 545-550.
26. Hasheimi, S.R., I. Zulkifli, M.N. Somchit, Z. Zunita, T.C. Loh, A.F. Soleimani and S.C. Tang, 2013. Dietary supplementation of *Zingiber officinale* and *Zingiber zerumbet* to heat-stressed broiler chickens and its effect on heat shock protein 70 expression, blood parameters and body temperature. J. Anim. Physiol. Anim. Nutr., 97: 632-638.
27. Mushawwir, A., U.H. Tanuwiria, K.A. Kamil, L. Adriani, R. Wiradimadja and N. Suwarno, 2018. Evaluation of haematological responses and blood biochemical parameters of heat-stressed broilers with dietary supplementation of javanese ginger powder (*Curcuma xanthorrhiza*) and garlic extract (Allium sativum). Int. J. Poult. Sci., 17: 452-458.

28. Habibi, R., G.H. Sadeghi and A. Karimi, 2014. Effect of different concentrations of ginger root powder and its essential oil on growth performance, serum metabolites and antioxidant status in broiler chicks under heat stress. Br. Poult. Sci., 55: 228-237.
29. Javed, M., F.R. Durrani, A. Hafeez, R.U. Khan and I. Ahmad, 2009. Effect of aqueous extract of plant mixture on carcass quality of broiler chicks. ARPN J. Agric. Biol. Sci., 4: 37-40.
30. Moorthy, M., S. Ravi, M. Ravikuma, K. Viswanathan and S.C. Edwin, 2009. Ginger, pepper and curry leaf powder as feed additives in broiler diet. Int. J. Poult. Sci., 8: 779-782.
31. Qorbanpour, M., T. Fahim, F. Javandel, M. Nosrati and E. Paz *et al*. 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, Vol. 8, No. 7. 10.3390/ani8070117