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Full Length Research Paper

The use of liquorice, probiotic, potassium chloride and sodium bicarbonate to counteract the detrimental effects of heat stress on performance of broilers

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This study was undertaken to compare the effect of liquorice extract, probiotic, potassium chloride and sodium bicarbonate on productive performance of broilers exposed to heat stress. A total of 900 Fawbro broiler chicks were allocated at random into 6 treatments groups of 3 replicates each. Experimental treatments were as follows: Treatment 1: control group was subjected to heat stress; Treatment 2: control group was not subjected to heat stress; Treatment 3: Probiotic group were early exposed to 10^6 Colony Forming Unit (CFU) of *Lactobacilli* at their first day of age, and then subjected to heat stress; Treatment 4: heat distressed birds and supplemented with 0.5 % potassium chloride in their drinking water; Treatment 5: heat distressed birds and supplemented with 0.5% sodium bicarbonate in their drinking water; and Treatment 6: heat distressed birds and supplemented with 450 mg / liter liquorice extract in their drinking water. At the third week of age, birds in treatments 2, 3, 4, 5 and 6 were exposed to heat stress (38 – 43 ºC) for 6 hours(1200 – 1800 h) each day until the end of experiment (8^{th} week of age). Results revealed that treated the birds with probiotic or liquorice extract resulted in a significant improvement in mean body weight, feed conversion ratio, water consumption, cumulative body weight, cumulative weight gain, cumulative feed conversion ratio, livability, productive index, economic figure and dressing percentage with or without viscera as compared with control group which was subjected to heat stress, potassium chloride treatment and sodium bicarbonate treatment. Furthermore, liquorice extract treatment surpasses probiotic treatment in respect to mean body weight, water consumption, final body weight, cumulative feed consumption, livability, and dressing percentage with or without giblet. In conclusion, liquorice extract and probiotic can be used as an efficient tools in alleviate the deleterious effects of heat stress on productive performance of broiler chickens.

Keywords: Liquorice, probiotic, minerals, heat stress, broilers.

INTRODUCTION

Like all animals, poultry are most comfortable in a specific temperature range called the thermoneutral zone. The ideal environment for high growth rate after three weeks of age is 15 to 20ºC with a relative humidity of 50 % or less; however, their actual thermoneutral zone may extend up 27ºC, depending upon the relative humidity and the age of the bird. Birds kept in ambient temperatures outside their

thermoneutral zone have poorer productive efficiency (Ferket 1992).

Heat stress causes a decrease in plasma sodium and increase in plasma chloride. An alteration in sodium: chloride ratio resulted in blood alkalosis which also has a detrimental effect on productive performance (Simmons et al., 1989). Al-Daraji et al. (2003) concluded that supplementation of sodium bicarbonate and potassium chloride to drinking water had a positive role of relieve the effect of heat stress on broilers as indicated by positive changes in physiological traits. In another study (Smith and Teeter 1987), the effect of heat stress on growth and feed efficiency was partially alleviated by potassium chloride supplementation to drinking water. Naji et al. (2004) showed that early microbial exposure of broilers by *Lactobacilli* resulted in a significant improvement in body weight and feed conversion and significant decrease in mortality rate compared with the addition of salts or vinegar to drinking water. Al-Daraji et al. (2005) reported that early microbial exposure of heat stressed broiler to *Lactobacilli* or adding sodium bicarbonate and potassium chloride salts into the drinking water resulted in a significant improvement in all blood and plasma parameters compared with control group. However, *Lactobacilli* treatment surpasses the treatments of salts with regard to all hematological traits included in their study.

Liquorice is a group of plant that has a marked effect upon the endocrine system. The glucosides present have a structure that is similar to the natural steroids of the body. They explain the beneficial action that liquorice has in the treatment of adrenal gland problems such as Addison's disease (Kerstens and Dullaart 1999). Bernardi et al. (Bernardi et al., 1994) stated that liquorice root contains glycyrrhizin, 50 times sweeter than sucrose, which encourages the production of hormones such as hydrocortisone. This help to explain its anti – stress and anti – inflammatory action and also its role in stimulating the adrenal cortex after steroid therapy. Kageyama et al. (1994) found that glycyrrhizic acid caused a similar mineralcorticoid effect on reversing stress induced hypotension. It stimulates the adrenal gland and helps the body cope with stress (Kato et al., 1995). Other studies have shown that glycyrrhizin has a similar chemical structure to corticosteroids released by the adrenals and stimulates the excretion of hormones by the adrenal cortex; therefore it is a possible drug to prolong the action of cortisone (Schambelan 1994). Baker (1994) reported that glycyrrhetinic acid, the steroid like constituent of glycyrrhizic acid, inhibits an enzyme responsible for inactivating cortisol in the kidney. The treatment with liquorice essentially extends the lifetime of cortisol and hence reinforces the resistance of body to strss. Both liquoriceextract and glycyrrhtinic acid are shown to have desoxycorticosterone and ACTH – like effects, though with less toxicity than cortisone, encouraging its uses as an anti – stress agent (Farese et al., 1990).

The aim of this study was to evaluate the probable role of liquorice extract in counteracting the detriments of heat stress and make a comparison for this herb with certain materials (probiotic, potassium chloride and sodium bicarbonate) which have previously proved as good tools to alleviate the harmful effect of heat stress on productive performance of broiler chickens.

MATERIALS AND METHODS

study was conducted to determine the effect of liquorice extract, probiotic, potassium chloride and sodium bicarbonate on productive performance of broilers during heat stress. A total of 900 Fawbro broiler chicks, one day old were used. Birds were fed a starter diet (22.7 % crude protein and 3067.4 Kcal ME / Kg of diet) during the first 3 weeks of age and finisher diet (20.6 % crude protein and 2922 Kcal ME / Kg of diet) until the termination of the experiment (8 weeks of age). Chicks were allocated at random into 6 treatments groups of 3 replicates per group; each replicate constitutes 50 chicks (150 chicks per each treatment). Experimental treatments were as follows: Treatment 1: Control group which were subjected to heat stress (38 - 43 ˚C for 6 hours); Treatment 2: Control group which were not subjected to heat stress; Treatment 3: Probiotic group which were early exposed to 10^6 Colony Forming Unit (CFU) of *Lactobacilli* at their first day of age, and then subjected to acute heat stress. The isolates of *Lactobacilli* bacteria were taken from crops of broilers and then activated by infusion it in the MRS (De Man Rogosa and Sharp) broth at 37ºC. After 24 h these media were mixed with tap water which contains 20 % skim milk. This probiotic product was sprayed on the chicks at the first day of age by allocate 0.2 ml per each chick. This amount of probiotic was determined to contain 10^6 colony units of bacteria per chick (Al-Daraji et al., 2005); Treatment 4: Heat – distressed birds and supplemented with 0.5 % potassium chloride in their drinking water; Treatment 5: Heat – distressed birds and supplemented with 0.5 % sodium bicarbonate in their drinking water; Treatment 6: Heat – distressed birds and supplemented with 450 mg / liter liquorice extract in their drinking water.

At the third week of age, birds in treatments 2, 3, 4, 5 and 6 were exposed to heat stress (38 – 43 ºC) for 6 hours daily (1200 h – 1800h) until the end of experiment (8^{th} week of age). Gaseous brooders were used as a source of heat exposure in the experimental house. On the other hand, the supplementation of potassium chloride, sodium bicarbonate and liquorice extract to the drinking water of birds were started at the third week of age and continued until 56 d. of age.

Productive characteristics included in this study were: body weight (BW), weight gain (WG), feed consumption (FC), feed conversion ratio (FCR), water consumption (WC) and mortality (M) rate. However, Productive Index

Table 1. The effect of liquorice extract, probiotic, potassium chloride and sodium bicarbonate on mean body weight (g) of broilers exposed to heat stress.

Treatments / Age (weeks)	Control	Control + heat stress	Liquorice extract	Probiotic	Potassium chloride	Sodium bicarbonate
4	D 538.42 ± 35.43	B 567.40 ± 34.09	A 581.78 ± 30.82	B 563.65 ± 36.40	C 553.67 ± 32.88	C 546.69 ± 33.16
5	E 732.53 ± 38.39	B 778.47 ± 36.40	A 794.10 ± 38.91	B 771.96 ± 40.11	C 761.58 ± 34.18	D 747.82 ± 37.52
6	E 933.46 ± 51.19	B 996.91 ± 50.12	A 1014.17 ± 47.47	B 993.34 ± 49.42	C 978.82 ± 44.03	D 963.17 ± 45.85
7	E 1154.92 ± 59.87	B 1235.19 ± 55.14	A 1251.26 ± 56.40	B 1230.86 ± 60.32	C 1206.88 ± 54.07	D 1186.26 ± 57.47
8	E 1415.04 ± 72.81	B 1506.81 ± 67.53	A 1522.53 ± 64.33	B 1501.39 ± 70.80	C 1478.30 ± 65.20	D 1454.56 ± 69.64

* Values in a raw with different superscripts differ significantly ($P < 0.05$).

(PI) and Economic Figure (EF) were also determined. At the end of experiment, 18 birds from each treatment (6 birds per each replicate) were sacrificed to determine dressing percentage with giblet (DPG) or without giblet (DPWV), and weights of visceral organs, *viz*. liver (L), heart (H), gizzard (G), and spleen (S) in addition to abdominal fat (AFT). Results were evaluated by analysis of variance. Differences between treatments means were analyzed by Duncan's multiple range test, using the ANOVA procedure in Statistical Analysis System (SAS 1996).

RESULTS

Results of this study evinced a highly significant ($p < 0.01$) increase in mean BW during the whole experimental period (4 – 8 weeks of age) in birds receiving liquorice extract in their drinking water as compared to all other treatments (Table 1). Results also revealed that probiotic treatment surpasses other treatments (control which was subjected to heat stress, potassium chloride treatment and sodium bicarbonate treatment) as concerns this trait, while there were no significant differences between probiotic treatment and control group which was not subjected to heat stress).

Compared with control group, the addition of probiotic, potassium chloride) or liquorice extract resulted in a significant ($p < 0.05$) improvement in WG during all weeks of the experiment, while sodium bicarbonate treatment was superior to control group which was subjected to heat stress just during 4, 5, and 6 weeks of experiment (Table 2). However, there were no significant differences between liquorice extract

treatment and control group which was not subjected to heat stress during all weeks of experiment, whereas there were no significant differences between probiotic treatment and control group which was not subjected to heat stress only during the 6^{th}, 7^{th} and 8^{th} weeks of age regarding WG (Table 2). Besides, there were no significant differences between all treatments groups involved in the present study with relation to FC (Table 3).

Results denoted that the addition of liquorice extract results in a significant ($p < 0.05$) improvement in FCR during 4^{th}, 5^{th}, 6^{th} and 7^{th} weeks of age in comparison with control which was subjected to heat stress, potassium chloride treatment and sodium bicarbonate treatment (Table 4). Furthermore, there were no significant differences between liquorice treatment, probiotic and control group which was not subjected to heat stress during 5^{th}, 6^{th}, 7^{th} and 8^{th} weeks of age as regards this characteristic. Moreover, there were no significant differences between all treatment groups during the 8^{th} week of age in relation to FCR (Table 4).

Results of this study also manifested that liquorice extract treatment recorded the highest values of WC followed by the results of probiotic group, whereas the lowest values where noticed with control group which was not subjected to heat stress (Table 5).

Data in Table 6 revealed that probiotic and liquorice treatments transcend other treatments groups (control which was subjected to heat stress, potassium chloride

Table 2. The effect of liquorice extract, probiotic, potassium chloride and sodium bicarbonate on weight gain (g) of broilers exposed to heat stress.

Treatments / Age (weeks)	Control	Control + heat stress	Liquorice extract	Probiotic	Potassium chloride	Sodium bicarbonate
4	C 170.28 ± 17.75	A 185.69 ± 15.33	A 187.47 ± 16.06	B 180.65 ± 18.04	B 179.13 ± 16.91	B 177.29 ± 17.75
5	C 194.11 ± 18.73	A 211.07 ± 16.68	A 212.32 ± 17.20	B 208.31 ± 19.07	B 207.91 ± 17.0	B 201.13 ± 18.47
6	B 200.93 ± 22.07	A 218.44 ± 19.74	A 220.07 ± 20.25	A 221.38 ± 19.15	A 217.24 ± 19.01	A 216.0 ± 18.44
7	C 221.46 ± 26.09	A 238.28 ± 24.36	A 237.09 ± 23.18	A 237.52 ± 23.25	B 228.06 ± 25.17	BC 223.09 ± 24.0
8	B 260.12 ± 28.85	A 271.62 ± 27.76	A 272.27 ± 27.14	A 270.53 V 28.03	A 271.42 ± 26.19	B 268.30 ± 26.49

* Values in a raw with different superscripts differ significantly (P < 0.05).

Table 3. The effect of liquorice extract, probiotic, potassium chloride and sodium bicarbonate on daily feed consumption (g) of broilers exposed to heat stress.

Treatments / Age (weeks)	Control	Control + heat stress	Liquorice extract	Probiotic	Potassium chloride	Sodium bicarbonate
4	A 72.97 ± 4.23	A 75.27 ± 3.82	A 74.12 ± 4.35	A 74.83 ± 4.38	A 73.81 ± 4.76	A 73.56 ± 4.32
5	A 81.31 ± 5.27	A 82.86 ± 4.93	A 83.08 ± 5.12	A 82.73 ± 5.67	A 82.96 ± 4.92	A 82.34 ± 5.42
6	A 90.34 ± 5.90	A 91.25 ± 5.24	A 92.44 ± 6.33	A 91.16 ± 5.34	A 92.14 ± 5.70	A 92.01 ± 5.26
7	A 102.98 ± 7.45	A 105.21 ± 6.93	A 104.93 ± 7.03	A 104.65 ± 6.71	A 103.87 ± 7.54	A 103.41 ± 7.52
8	A 110.42 ± 8.46	A 112.47 ± 8.29	A 112.22 ± 8.16	A 112.17 ± 6.62	A 112.44 ± 7.82	A 112.31 ± 8.51
Total feed consumption (g)	A 458.02 ± 13.8	A 467.06 ± 9.63	A 465.54 ± 12.0	A 465.22 ±12.3	A 463.63 ± 7.30	A 466.79 ±8.80

* Values in a raw with different superscripts differ significantly (P < 0.05).

Table 4. The effect of liquorice extract, probiotic, potassium chloride and sodium bicarbonate on feed conversion efficiency (FC / WG) of broilers exposed to heat stress.

Treatments / Age (weeks)	Control	Control + heat stress	Liquorice extract	Probiotic	Potassium chloride	Sodium bicarbonate
4	A 3.00 ± 0.041	C 2.84 ± 0.044	D 2.76 ± 0.033	B 2.89 ± 0.056	BC 2.88 ± 0.037	B 2.91 ± 0.054
5	A 2.93 ± 0.056	C 2.75 ± 0.052	C 2.74 ± 0.040	C 2.78 ± 0.061	AB 2.88 ± 0.041	B 2.87 ± 0.047
6	A 3.14 ± 0.051	C 2.92 ± 0.055	C 2.94 ± 0.052	C 2.89 ± 0.054	B 2.97 ± 0.047	B 2.98 ± 0.050
7	A 3.26 ± 0.077	C 3.10 ± 0.064	C 3.10 ± 0.060	C 3.08 ± 0.076	B 3.19 ± 0.069	AB 3.24 ± 0.071
8	A 2.97 ± 0.053	B 2.90 ± 0.061	B 2.89 ± 0.053	B 2.90 ± 0.061	B 2.90 ± 0.051	AB 2.93 ± 0.054

* Values in a raw with different superscripts differ significantly (P < 0.05).

Table 5. The effect of liquorice extract, probiotic, potassium chloride and sodium bicarbonate on daily water consumption (ml) of broilers exposed to heat stress.

Treatments / Age (weeks)	Control	Control + heat stress	Liquorice extract	Probiotic	Potassium chloride	Sodium bicarbonate
4	D 170.55 ± 20.78	E 157.54 ± 16.44	A 192.61 ± 18.52	B 183.42 ± 17.32	C 178.56 ± 19.47	C 174.82 ± 20.18
5	D 195.93 ± 22.18	E 174.72 ± 18.50	A 229.46 ± 20.47	B 213.62 ± 19.22	C 206.47 ± 20.09	C 200.33 ± 21.27
6	E 284.56 ± 26.18	F 225.56 ± 23.18	A 297.76 ± 25.19	B 286.75 ± 24.47	C 272.47 ± 29.02	D 261.11 ± 28.43
7	D 299.52 ± 30.22	E 265.20 ± 27.41	A 329.61 ± 30.36	B 317.33 ± 29.90	BC 314.54 ± 32.25	C 308.65 ± 30.11
8	D 320.94 ± 30.76	E 302.73 ± 33.68	A 351.71 ± 36.12	B 340.39 ± 34.77	C 333.60 ± 32.49	C 329.84 ± 35.62

* Values in a raw with different superscripts differ significantly (P < 0.05).

Table 6. The effect of liquorice extract, probiotic, potassium chloride and sodium bicarbonate on certain productive characteristics of broilers exposed to heat stress.

Treatments / Traits	Control	Control + heat stress	Liquorice extract	Probiotic	Potassium chloride	Sodium bicarbonate
Final body weight (gm)	E 1415.04 ± 72.81	B 1506.81 ± 67.53	A 1522.53 ± 64.33	B 1501.39 ± 70.80	C 1478.30 ± 65.20	D 1454.56 ± 69.64
Mean weight gain (4 – 8; g)	C 209.38 ± 23.45	A 225.02 ± 23.81	A 225.84 ± 22.34	A 223.68 ± 22.35	B 220.75 ± 22.18	B 217.16 ± 23.04
Mean feed consumption (4 – 8; g)	D 3206.14 ± 235.28	A 3269.42 ± 230.07	A 3267.53 ± 245.60	B 3258.78 ± 257.53	B 3256.54 ± 261.76	C 3245.41 ± 259.79
Mean feed conversion efficiency (4–8 weeks)	A 3.06 ± 0.044	C 2.90 ± 0.058	C 2.88 ± 0.049	C 2.91 ± 0.055	B 2.96 ± 0.050	AB 2.99 ± 0.047
Total mortality (%)	A 11.11 ± 0.036	D 1.94 ± 0.019	D 1.97 ± 0.022	C 3.01 ± 0.035	B 5.16 ± 0.028	B 5.21 ± 0.030
Productive Index	C 119.11 ± 14.32	A 145.32 ± 14.73	A 147.56 ± 15.77	A 142.97 ± 15.63	B 125.37 ± 13.47	BC 123.39 ± 14.12
Economic Figure	C 118.93 ± 13.49	A 145.11 ± 15.18	A 147.26 ± 16.34	A 142.85 ± 14.76	B 125.19 ± 14.56	BC 123.07 ± 14.17

* Values in a raw with different superscripts differ significantly ($P < 0.05$).

Table7. The effect of liquorice extract, probiotic, potassium chloride and sodium bicarbonate on dressing percentage and organ weights of broilers exposed to heat stress.

Treatments / Traits	Control	Control + heat stress	Liquorice extract	Probiotic	Potassium chloride	Sodium bicarbonate
Dressing percentage (with giblet)	C 72.06 ± 7.83	A 76.76 ± 6.93	A 76.70 ± 7.63	B 74.63 ± 7.14	C 73.24 ± 6.90	C 73.20 ± 7.11
Dressing percentage (without giblet)	D 62.49 ± 6.67	A 67.95 ± 5.28	A 67.91 ± 6.46	B 65.82 ± 6.17	C 63.97 ± 5.19	C 63.89 ± 5.42
Abdominal fat (%)	A 1.83 ± 0.037	C 1.49 ± 0.029	C 1.51 ± 0.033	C 1.50 ± 0.036	B 1.67 ± 0.027	B 1.68 ± 0.031
Liver weight (%)	A 3.95 ± 0.077	C 3.62 ± 0.066	C 3.61 ± 0.071	C 3.61 ± 0.067	B 3.84 ± 0.073	AB 3.89 ± 0.070
Gizzard weight (%)	A 2.70 ± 0.066	A 2.69 ± 0.069	A 2.68 ± 0.057	A 2.69 ± 0.054	A 2.70 ± 0.055	A 2.69 ± 0.062

Table7. Continue

Spleen weight (%)	A 0.39 V 0.001	A 0.33 ± 0.005	B 0.31 ± 0.006	B 0.32 ± 0.005	A 0.37 ± 0.006	A 0.37 ± 0.004
Heart weight (%)	A 0.70 ± 0.015	A 0.68 ± 0.011	A 0.68 ± 0.009	A 0.69 ± 0.010	A 0.69 ± 0.008	A 0.68 ± 0.009

* Values in a raw with different superscripts differ significantly (P < 0.05).

treatment and sodium bicarbonate treatment) concerning cumulative BW, WG, FCR, livability, PI and EF. In addition, liquorice treatment overtops probiotic treatment as regards cumulative BW, FC and livability.

Results of dressing percentage and relative weights of visceral organs are seen in Table 7. It was noticed that liquorice treatment excel other treatments (control which was subjected to heat stress, probiotic treatment, potassium chloride treatment and sodium bicarbonate treatment) in relation to DPG and DPWG characters. However, liquorice and probiotic treatments recorded the lowest means of AFT, L and S in comparison with control which was subjected to heat stress, potassium chloride treatment and sodium bicarbonate treatment. While, there were no significant differences among all treatments groups included in this study as concerns H and G traits.

DISCUSSION

The positive result which achieved by using the probiotic in this study as indicated by counteracting the noxious effect of heat stress on productive performance of broilers is in accordance with the previous study of Al-Daraji et al. (2005) who found that early treatment with probiotic significantly contributed in easement the effect of heat stress on broiler chickens, as indicated by the preeminence of this treatment on other salt treatments regarding all physiological parameters included in their study. Furthermore, these authors concluded that these advantageous changes may be in part due to the production of acids by these bacteria during the fermentation of sugars which reflected in upshot by the suppression of the effects of heat stress on birds. The acids produced by these bacteria exert their role through the neutralizing of respiratory alkalosis that occurs when birds are housed at a high temperature. The hyperventilation and respiratory alkalosis are reflected in a loss of carbon dioxide from the blood and associated losses of bicarbonate from the blood and body fluids (Simmons et al.,1989). Deyhim and Teeter (1991) pointed out that heat – distressed birds exhibit increased respiration rate and respiratory alkalosis. The alkalosis induced by heat distress has been related to negative mineral balance for K^+ as well as Na^+ and elevated blood corticosterone. Other explanations for positive changes that occured in productive traits and associated with probiotic treatment may be due to the competitive inhibition of *Lactobacilli* bacteria against several pathological bacteria (Stern et al., 2001) and increase in the activity of digestive enzymes (Yeo and Kim 1997) which led to the amelioration in digestive coefficient and increase in the availability of many nutrients (16). These changes were reflected in an improvement of productive performance and reinforcement in the general health of broiler. Oyetayo et al. (2003) stated that *Lactobacilli* are important for the maintenance of the intestinal microbial ecosystem, growth enhancement of farm animals, protection from pathogens including many harmful bacteria, viruses and fungi, alleviation of lactose intolerance, relief of constipation, anti cholesterolaemic effect and immunostimulation. *Lactobacilli* play their protective therapeutic effect through production of antimicrobial compounds, reduction of gut pH by stimulating the lactic acid producing microflora, competition for binding of receptor sites that pathogens occupy, liver function improvement, stimulation of immunomodulatory cells and competition with pathogens for available nutrients (Rolfe 2000). However, the use of probiotics in order to competitively exclude the colonization of intestinal pathogens has been proposed for poultry, especially after the European Commission banned certain antibiotics frequently

included in feeding stuffs as growth promoters (Pascual et al., 1999).

The improvement of productive performance of broiler exposed to heat stress and supplemented with liquorice extract in their drinking water may be attributed to that liquorice has properties similar to corticosterone and ACTH hormones and hence its role in enhancement the resistance of body to stress (Shibata 2000). Edens and Siegel (1976) found that corticosterone concentration reached a peak after 70 min of heat exposure of broilers to 45 ºC and afterward rapidly reduced. This reduction in corticosterone level was accompanied by the reduction in survivability of birds which indicated by the depression of adrenal efficiency that ultimately reflected in the occurrence of heat prostration which led at last to death of all the birds with the continuance of heat exposure. Freeman (1988) reported that the third stage of stress which called exhaustion phase is characterized by the depletion of birds' body stores and insufficiency of adrenal gland to produce glucocorticoids hormones in suitable quantity. Thus the birds were surrender to the stressor factor and the death will happened.

Some compounds found in liquorice are thought to help the adrenal gland function more smoothly in conditions of

stress and exhaustion. The adrenal glands are responsible for hormones that keep the body systems balanced. Naturopaths have used liquorice in treating hypoglycemia, diabetes and Addison's disease, which is a malfunction of the adrenal glands (Ruszymah et al., 1995). By enhancing cortisol activity, glycyrrhizin helps to increase energy, ease stress, and reduce the symptoms of aliments sensitive to cortisol levels, such as chronic fatigue syndrome and fibromylagia. In the 1800s, liquorice extract was a common remedy for a type of persistent fatigue known as neurasthenia, the condition known as chronic fatigue syndrome (Snow 1996). Ferrari et al. (2001) reported that activity of 11 – β – hydroxysteroid dehydrogenase type 2 (11 β – HSD – 2) potently is blocked *in vivo* and *in vitro* by glycyrrhetinic acid (GA), the active compound of liquorice, by 2 mechanisms, direct competitive inhibition and pretranslational inhibition. When 11 β – HSD activity is decreased, urinary excretion of active cortisol (tetrahydrocortisol) to inactive cortisone (tetrahydrocortisone) metabolites increased. It was reported in early literature that GA enhances endogenous glucocorticoid action by suppressing the metabolism of glucocorticoids (Kumagi et al., 1957), and a recent report showed that GA administration to normal mice inhibits 11 β – HSD activities in immune tissue such as thymus, spleen, and peripheral lymph nodes in a dose – dependent manner (Hennebold et al., 1996). Quaschning et al. (2001) pointed out that in GA – induced hypertension, both aldosterone receptor antagonism and endothelin receptor antagonism normalize blood pressure and improve renovascular function and, thus, may represent a new therapeutic approach in cardiovascular disease associated with impaired 11 β – HSD – 2 activity. In addition to its established role as a competitive inhibitor of 11 β – HSD, liquorice result in pretranslational inhibition of 11 β – HSD both *in vitro* and *in vivo*. 11 β – HSD is clearly an important mechanism in regulating tissue levels of active glucocorticoid and, hence, ligand supply to the glucocorticoid receptor (Whorewood et al., 1993).

On the other hand, the beneficial role of liquorice extract that found in the present study in which it reinforced the resistance of birds to heat stress as indicated by the amelioration in the productive performance of broiler chickens exposed to heat stress could be also explained by that liquorice treatment resulted in a significant increase in water consumption during the entire period of the experiment in comparison with other treatments included in this study. Cooney and Fitzsimons (1996) found that treatment the rat with liquorice extract, glycyrrhizic acid or glycyrrhetinic acid resulted in a significant increase in sodium appetite, thirst and water consumption. Simmons et al. (1989) found that mortality during exposure to high temperature was reduced when birds consuming more water which was partly attributed to the wetting of the litter from increased urination and the possible cooling of the bird upon burrowing into the litter. Branton et al. (1986) concluded that the increase in fluid consumption was determined to contribute more to increase survival during exposure to high temperature than did the reduction in blood pH. Deaton (1994) stated that increased fluid consumption decreased mortality from heat prostration. Subsequently, decreased fluid consumption increased mortality. It was noticeable that with increased fluid consumption more water was excreted into the litter making a difference in litter moisture.

CONCLUSION

In conclusion results of this study clearly indicated that probiotic and liquorice extract treatments are potent tools in counteracting the noxious effects of heat stress as indicated by the improvement in productive traits of broiler chickens exposed to heat stress. Moreover, liquorice extract treatment outmatched probiotic treatment as concerns mean BW during all weeks of experiment, WC, cumulative BW, cumulative FC, livability, DPG, and DPWG.

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