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EVALUATION OF POTASSIUM CHLODRIDE AND ASCORBIC ACID AS ANTI-HEAT STRESS AGENTS IN BROILER CHICKS

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ABSTRACT

A total number of 1200 Avian unsexed day old broiler chicks was randomly assigned into completely randomized 2 X 3 factorial, with 4 replicates per treatment. The chicks were subjected to chronic sever or mild heat stress and fed commercial diet (Control) containing 23 and 21.5% crude protein and 3125 and 3050 Kcal ME /Kg for starter and grower diets, respectively , drink water supplemented with 0.3% KCl (KCl) or fed commercial diet supplemented with 1g ascorbic acid /1Kg feed (AA).

The objective of the study was evaluating the validity of using KCl and AA supplementations as relieving agents from heat stress for broiler chicks reared in hot arid environment. Following parameters: body weight, daily gain, feed intake, feed conversion, mortality and carcass parts and edible muscle composition were studied.

The results indicated that supplemental KCl under severe heat stress increased body weight and daily gain, decreased mortality percentage and increased wing weight compared to the control group. However, under mild heat stress supplemental KCl decreased body weight, daily gain, decrease feed intake, increased neck weight and abdominal fat, decreased inedible parts weight and decreased protein content in edible muscles compared to control group.

Supplemental AA under severe heat stress decreased mortality percentage, increased carcass and neck weights, decreased inedible weight, increased protein and decreased fat contents in edible muscles compared to control group. Under mild heat stress, supplemental AA decreased body weight, daily gain, feed intake, inedible part weights, increased neck and abdominal fat weights, decreased protein and fat contents of edible muscles compared to control group.

It could be concluded that supplemental KCl was better than AA to be recommended for broiler chicks under severe heat stress to improve the performance.

Keywords: Potassium chloride, ascorbic acid, heat stress, broiler chicks

INTRODUCTION

Chronic heat stress had adverse effects on grow-out performance as characterized by lowering growth rate, feed intake, feed:gain ratio and increasing mortality (Deaton *et al.,*1986; Leenstra and Cahaner, 1992; Geraert *et al.,* 1996; May *et al.,* 1998; and ELDeeb and Abou-Elmagd, 2001). These effects were more pronounced as body weight increased (Cahaner and Leenstra ,1992; Settar *et al.,* 1999 and Al-Batshan and Hussein, 2001). The magnitude of high environmental temperature are detrimental to the growth, feed intake and feed conversion of broilers (Chwalibog, 1990). Heat stress was found to affect also the nutrient deposition in bird's body, consequently, changing carcass characteristics and composition (Smith, 1993). The physiological changes that occur during exposure to chronic heat stress in acid-base balance, mineral balance, respiration rate and body temperature were thought to be responsible for the above mentioned effects of heat stress on grow-out performance and carcass characteristics (Meltzer, 1983; Smith, 1993 and Cooper and Washburn, 1998).

Several workers have tried to alleviate the effects of heat stress on grow-out performance and carcass characteristics throughout interfering with the physiological changes associated with heat stress. This had been done by using compounds such as ascorbic acid (Mckee and Harrison, 1995), potassium chloride (Smith and Teeter, 1987), potassium sulfate (Deetz and Ringrose, 1976), Ammonium Chloride (Teeter, and Smith, 1986) and sodium and potassium bicarbonate (Hayat *et al*., 1999). However, the most used agents were potassium compounds and ascorbic acid.

Potassium is the most abundant intracellular cation, that involved in many metabolic and physiological functions including intracellular osmolality and regulation of cell volume (Ait-Boulahsen *et al.*, 1995). Teeter and Smith (1986) suggested that blood pH and K were dependent factors. This dependency associated with the opposite movements of K and H ions into and out of cells (Tobin, 1958). Thence, supplementing heat-stressed broilers with KCl alleviated the changes in acid-base balance (Teeter *et al*., 1985), increased water intake (Belay and Teeter, 1993 and Shoukry, 2001 a), enhanced thermoregulation (Shoukry, 2001 a), improved weight gain (Smith and Teeter, 1987 and Teeter and Smith, 1986), partially alleviated the heat stress effect on feed efficiency (Smith and Teeter, 1987), improved insignificantly carcass weight and dressing percentage (Smith, 1994) and increased insignificantly abdominal fat (Whiting *et al*., 1991 and Smith, 1994).

Ascorbic acid had been used to reduce the effects of heat stress in poultry since the work of Thornton and Moreng (1958). The physiological role of ascorbic acid during stress is illustrated by Matrin (1985) where it is essential for the conversion of dopamine to norepinephrine, thence severe deficiency in ascorbic acid impairs catecholamine biosynthesis, however, ACTH may cause a dose-related depletion in ascorbic acid. The role of ascorbic acid as anti-heat stress agent for broilers could be summarized as it ameliorated the steroid-mediated immunosuppression (Pardue and Thaxton, 1984), decreased body temperature (Attia, 1976 and Shoukry, 2001 a), increased feed intake (McKee and Harrison, 1995), decreased mortality and increased body weight gain (Pardue *et al*., 1985 a), increased liver weight and it had not affected abdominal fat (Kafri *et al*., 1988).

The objective of the present study is to compare and evaluate the effects of KCl and ascorbic acid on grow-out performance and carcass characteristics of heat- stressed broiler chicks under the same environmental conditions in small-scale industry facility.

MATERIALS AND METHODS

This study was performed in Agricultural Experimental Station of the Faculty of Meteorology, Environment and Arid Land Agriculture, King Abdulaziz University, Jeddah, Saudi Arabia.

Experimental birds and management of the flock: A total number of 1200 Avian unsexed day-old broiler chicks were used in the study. The birds were brooded in floor pens of temperature-controlled houses at 34 ºC during the first two weeks of age. Stocking density was 10 birds/m^2 . The birds had free access to feed and water and a photoperiod of 23 L:1 D was followed allover the experimental period. A commercial broiler starter diet of 23% crude protein and 3125 Kcal ME /Kg was offered during the period from hatch to 21 days of age, then birds were switched to a commercial grower diet containing 21.5% crude protein and 3050 Kcal ME /Kg up to the end of the experiment. A standard vaccination program was followed.

Experimental design and procedures: The experiment lasted for 28 days from 14 to 42 days of age. At the beginning of the experiment at 14 days old the chicks were randomly assigned into completely randomized 2 X 3 factorial, with 4 replicates per treatment. Each replicate contained 50 birds. The treatments were firstly, heat stress with two levels, mild (HS-M) and severe (HS-S) and secondly, the compounds with three levels viz., control, potassium chloride (KCl) and ascorbic acid (AA).

In HS-M group the evaporative cooling pads of the chicks house were working during the hottest part of the day (10 a.m. to 10 p.m.). These cooling pads reduced the ambient temperature by about 6 ºC. Meanwhile, cooling pads were stopped completely all the day in the house of HS-S group. The chicks of Control, KCl and AA groups fed the commercial starter and grower diets as formerly specified. The KCl group drink water supplemented with 0.3 % KCl, meanwhile, group AA fed diets supplemented with L-ascorbic acid (1g/ 1kg feed). Ascorbic acid was mixed with feed twice weekly to be as fresh as possible.

During the period from hatch to the end of the experiment, birds were individually weighed on weekly basis (BWT) and weekly daily gain (DG) was calculated. Following measurements were recoded on a replicate basis, weekly feed intake (FI), weekly feed conversion (FC) and daily mortality (M). The weekly or daily records were summed to get the record of 6 weeks per bird for DG, FI, FC and M percentage.

At 6 weeks of age, 6 birds from each replicate (3 males and 3 females) were sacrificed for carcass traits. Following parts were taken and weighed: empty carcass, thighs, breast, back, wings, neck, liver, heart, gizzard, giblets, inedible part weights, abdominal fat and dressing percentage. Breast and thigh muscles were sampled and pooled on equal weights for subsequent chemical analyses. A sample of 5 g from each part of the bird was dried in forced air oven on 105 ºC for 3 hours to measure the moisture content. Other samples of 20 g each were taken and dried by forced air oven on 70 ºC for 24 hours for chemical analyses. Two grams of dried samples were burned on benzen burner then ashed in muffle furnace on 550 ºC for 8 hours to get the ash percentage. Quart a gram (250 mg) of dried samples was used for protein analysis by Kjeldahl method (N x 6.25) using Kjeltec Auto 1030 Analyzer (Tecator, Sweden). Three grams of dried samples were extracted by petroleum ether 60-40 using Soxhlet method by Soxtec System HT (Tecator, Sweden). All chemical analyses were done according to AOAC (1984).

Wet and dry bulb temperatures (Ta) were measured four times daily at 5:30 a.m., 10:30 a.m., and 3:30 p.m. and 10:30 p.m. by sling psychrometer. Relative humidity (RH) and temperature humidity index (THI) were then calculated according to Esmay (1978). The HS-S group were exposed to an average maximum Ta range from 37.5 to 41.3 ºC and minimum Ta range from 24.7 to 30.3 ºC during the course of experiment. Meanwhile, the corresponding ranges for HS-M group were 32.3 to 34.3 and 24.3 to 25.4 ºC for a maximum and minimum Ta , respectively. In HS-S group the evaporative cooling avenues of the birds were blocked as THI was maintained above 75 allover the experimental period (Esmay, 1978). Meanwhile, THI of HS-M's thermal environment was under 75 at dawn and above 75 at afternoon in most days of the experiment. This indicated that the birds of this group could dissipate the heat gained in the previous day. The detailed characterization of HS-S and HS-M environments were described by Shoukry (2001 b).

Statistical analysis: Two-way analysis of variance was used to test the significant effects of the treatments. Analysis of covariance with live body weight as a covariate was used for analyzing carcass parts. All statistical analyses were according to Winer (1971). Statistical analyses were performed by SAS (1988) using GLM procedure and least squares means for mean separations.

RESULTS AND DISCUSSION

Grow-out performance:

Heat stress had significant ($P \leq 0.01$) effects on body weight (BWT) at 3, 4, 5 and 6 weeks of age, similarly, the supplemental treatment was significantly ($P \leq 0.05$) affected it at all ages except at 4 weeks old (Table, 1). Significant interactions were found in body weight at 3 ($P \leq 0.05$), 5 and 6 ($P \leq 0.01$) weeks of age (Table, 1). Heat stress had significant effects ($P \leq 0.01$) on daily gain (DG), feed intake (FI), ($P \leq 0.01$) and feed conversion (FC), ($P \leq 0.05$) as shown in table (1). Treatment and its interaction with heat stress had significant ($P \leq 0.05$) effects on DG. However, the treatments and their interactions were not significantly affected FC and FI. No significant effects of heat stress, treatments and their interaction on mortality (M), (Table, 1).

The only insignificant interaction in BWT was noticed at 4 weeks of age, thus a general inference could be made. The birds reared under HS-S environment showed significant ($P \leq 0.05$) higher BWT than those reared under HS-M environment at 4 weeks of age (Table, 1). On the other hand, the birds reared under HS-S environment showed less BWT than those reared under HS-M at 5 and 6 weeks of age. Birds reared under HS-S environment showed significantly ($P \leq 0.05$) poorer FC and less FI during the grow-out period than those of the birds reared under HS-M environment. These effects of heat stress on BWT, DG, FC and FI are in agreement with the findings of Yahav *et al*. (1996) and Cooper and Washburn (1998).

Under HS-S environment, figure (1) shows that KCl had a significant ($P \leq 0.05$) higher market BWT (at 6 weeks of age) than those of AA and control groups, where the later groups did not differ significantly in their body weight. An opposite trend was noticed under HS-M environment, where control group showed significantly ($P \leq 0.05$) the highest BWT at 6 weeks of age compared to KCl and AA groups, where they did not show any significant differences in BWT (Fig., 1). The same trend was noticed for DG, where the privilege was noticed for KCl group under HS-S environment but control group had the privilege in this regard under HS-M environment (Fig., 2). Under HS-S environment, no significant differences were found in FI and FC among control, KCl and AA groups (Fig., 2). Meanwhile, control group significantly ($P \leq 0.05$) consumed more feed during the 6 weeks of rearing compared to that of AA group under HS-M environment. Under this environment KCl group consumed intermediate amount of feed between the two other groups, which did not differ significantly from them (Fig., 2). The FC under HS-M environment did not differ significantly between the three groups of treatments.

Mckee and Harrison (1995) found that supplemental high AA (300 ppm) to heat-stressed broilers (28 to 33 ºC) did not affect DG, FI and FC, however, low supplementation (150 ppm) increased DG and FI significantly but not FC. Supplemental AA (150 ppm) failed to improve DG, FI and FC of heat-stressed broilers (33.8 ºC) as reported by Mckee *et al*. (1997) and DG as reported by Subaschandran and Balloun (1967) with 38 ºC, heat stress and 66 ppm AA. Takahashi *et al*. (1991) and Orban *et al*. (1993) found that 1000 to 3000 and 3000 ppm AA, respectively did not improve DG, FI and FC of broiler chicks at thermoneutral temperature. However, Pardue *et al*. (1985 a) found that AA supplementation (1000 ppm) improved DG after exposure to acute heat stress (43 ºC for 30 min in each of 3 consecutive hours), in addition Pardue *et al*. (1985 b) found that the AA supplementation (1000 ppm) improved DG but not FC of female broiler chicks after exposure to chronic heat stress (38.3 ºC for 8 hours in 2 consecutive days). In general, AA did not show an improvement in broiler growth, FI and/or FC under heat stress. The apparent contradictory in the before mentioned reports concerning DG would be mainly due to the type of heat stress and less extent to the level of AA supplementation. The instability of AA would also be a factor (Mckee and Harrison, 1995). In the present study, no significant differences were found between AA and control concerning BWT, DG, FI and FC under HS-S environment, which is in agreement with the former workers. However, at less magnitude of heat stress (HS-M environment) AA group showed less BWT, DG and FI during 6 weeks of grow-out period compared to the control group. No significant differences were found between them in FC. It could be suggested that AA-supplemented birds consumed less feed and, in turn, less nutrients including AA than the control ones, consequently they gained less BWT. As previously stated the type of heat stress and AA dose could affect the response of bird growth to AA supplementation. The effect of AA supplementation on FI remained obscure (Mckee and Harrison , 1995).

Concerning KCl group, Smith and Teeter (1987) stated that deleterious effects of heat stress on growth and feed efficiency were partially alleviated by KCl supplementation in drinking water. They added that supplemental KCl in ration has not consistently enhanced body weight gain. Smith (1994) found that supplemental KCl (0.48%) did not affect DG and FI of heat-stressed (35 ºC) broilers. Teeter and Smith (1986) found that supplemental KCl (0.5, 0.1, 0.15%) linearly increased BWT in heat-stressed

(35 ºC) broilers. Supplemental KCl decreased body and skin temperatures, enhanced thermoregulation and increased water intake of heat-stressed broiler chicks (Shoukry, 2001 a). These beneficial effects of KCl could be responsible for improving BWT of heat-stressed broilers under severe heat stress (HS-S environment) as suggested by Smith and Teeter (1987).

Under HS-S environment control group showed significantly ($P \leq 0.05$) highest M than those of KCl and AA groups (Fig., 2). No significant differences in M were noticed between KCl and AA groups under this environment. Under HS-M environment no significant differences in M were noticed among all groups (Fig., 2). The finding that AA-supplementation reduced significantly M compared to control group under severe heat stress (HS-S) is in agreement with Pardue and Thaxton (1984), Pardue *et al*., (1985 a), Pardue *et al*., (1985 b) in broilers and Perek and Kendler (1962) in laying hens. Pardue and Thaxton (1984) suggested that AA supplementation enhanced the immune response of broilers by enhancing interferon production and lymphocyte transformation. They found also that AA ameliorated the steroid-mediated immunosuppression. Andreasen and Frank (1999) found an increase of *in vitro* bacterial killing effect of heterophils of AA-treated broilers. Shoukry (2001 a) found that supplemental AA decreased body temperature and enhanced thermoregulation of heat-stressed broilers. The beneficial effect of AA on M could be attributed to its beneficial effect on immune responses and/or thermoregulation.

Concerning KCl supplementation, Deyhim and Teeter (1991) found that supplemental KCl (0.5%) improved livability of heat-stressed (35 ºC) broiler chicks. They attributed the beneficial effect of supplemental KCl on livability to increased water consumption over the control. The beneficial effects of supplemental KCl on thermoregulation and water intake under heat stress as found by Shoukry (2001 a) could be responsible for the decrease of M in the present study.

Carcass characteristics:

Heat stress showed significant effects on carcass weight ($P \leq 0.05$), dressing percentage ($P \leq 0.05$), thighs weight ($P \leq 0.01$), back weight ($P \leq 0.01$), neck weight ($P \leq 0.05$), wings weight ($P \leq 0.05$) and inedible weight ($P \leq 0.05$), (Table, 2). The treatment showed also significant effects on neck weight ($P \leq 0.01$), abdominal fat weight ($P \leq 0.05$) and inedible weight ($P \leq 0.05$), (Table, 2). Significant ($P \leq 0.05$) interactions were noticed in back and neck weights.

As general inference, birds of HS-S environment had significantly ($P \leq 0.05$) less values of carcass, thighs and wing weights and dressing percentage and significantly ($P \leq 0.05$) heavier inedible weight than those of HS-M environment (Table, 2). The reports indicated that heat stress increased breast muscles percentages (Leenstra and Cahaner, 1992), reduced thighs weight (Smith, 1993) or decreased abdominal fat (ELDeeb and Abou-Elmagd, 2001). The reduction of thighs weight in the present study under severe heat stress (HS-S) agreed with Smith (1993). The reduction of carcass weight and dressing percentages were in agreement with the results of BWT (Table, 1). This indicates that the reduction of empty carcass weight might be responsible for the reduction in BWT under HS-S environment .

On the other hand, AA group showed significant ($P \leq 0.05$) higher carcass weight, dressing percentages and abdominal fat and significant ($P \leq 0.05$) less inedible weight than those of control group. Supplemental KCl group showed intermediate values of carcass, dressing and abdominal fat compared to the other two groups, where the differences were not significant (Table, 2). These findings were in agreement with Smith (1994). Wings weight was significantly ($P \leq 0.05$) heavier in KCl group than the other two groups (Table, 2).

Under HS-M environment, AA group had significant ($P \leq 0.05$) heavier carcass and neck weights and dressing percentage and significant ($P \leq 0.05$) less inedible weight compared to control and KCl groups (Fig., 3). However, KCl group showed significant ($P \leq 0.05$) heavier wing weights and significant ($P \leq 0.05$) less back weight than those of control and AA groups. In addition, no significant differences among the three treatment groups in breast, thighs, abdominal fat, and giblet weights of the birds reared under HS-M group (Fig., 3).

Under HS-S environment AA and KCl groups had significant ($P \leq 0.05$) heavier carcass, abdominal fat and significant ($P \leq 0.05$) less inedible weight than those of control group (Fig., 3). Neck weigh was significantly ($P \leq 0.05$) heavier in AA group followed by KCl and control groups in a descending order. No significant differences were found among control, KCl and AA groups in breast, thighs, back, wings, giblet weights and dressing percentage under HS-S environment (Fig., 3).

The increase of carcass weight in AA group could be attributed to the AA suppression of corticosterone metabolism which may led to reduce the catabolism of bodily tissues and cytotoxic effect of corticosteroids under stress (Schmeling and Nockels, 1978 and Pardue *et al*., 1985 a). In addition, the increase of dressing percentage is due to the decrease in inedible wt. The increase of abdominal fat of AA group in the present study disagreed with Kafri *et al*. (1988) who did not find response of abdominal fat to dietary AA. This could be due the difference in the AA dosage in the two studies, which were 300 versus 1000 ppm in the present study. The beneficial effects of KCl on carcass characteristics could be attributed to its alleviating the alkalosis changes during heat stress (Teeter *et al*., 1985). In addition, both supplemental AA and KCl was found to enhance thermoregulation of heat-stressed broilers (Shoukry, 2001 a), which may have an influence on carcass characteristics.

Heat stress and the treatments showed no significant effects on chemical composition of edible muscles viz., moisture, fat, protein and ash (Table., 3). The interaction between main effects was significant ($P \leq 0.01$) in protein content. Control group showed significant ($P \leq 0.05$) higher fat content than that of AA group, however, KCl showed intermediate value between the two groups, which did not differ significantly from them (Table., 3).

Under HS-M environment, AA group had significant ($P \leq 0.05$) highest protein content in edible muscles compared to the other groups (Fig., 4). The AA group also had significant ($P \leq 0.05$) lower fat content than that of control group, meanwhile, KCl had intermediate value between the other groups, which did not differ significantly from them in fat content. No significant differences were noticed in moisture and ash contents among the three treatments under HS-M environment (Fig., 4).

Under HS-S environment, AA and KCl groups had significant ($P \leq 0.05$) lower protein content in edible muscles than that of the control group, meanwhile, protein content did not differ significantly in AA and KCl groups (Fig., 4). Fat content was significantly ($P \leq 0.05$) lower in AA groups compared to the control group. However, fat content in KCl group showed intermediate value, which did not differ significantly from the other two groups. No significant differences were noticed in moisture and ash contents among the three treatments under HS-S environment (Fig., 4).

The increase of protein content and decrease of fat content of AA group in the present study could be explained as supplemental AA of heat-stressed broilers affected the nutrient metabolism by lowering the respiratory quotients which emphasized an increase in fatty acid oxidation over an increase in protein-derived gluconeogenesis (Mckee *et al*., 1997).

Performance-based Evaluation:

A simulated example based on the biological performance of a flock size of 1000 birds was illustrated in table (4). The data used in the simulation were obtained from the present study. The most prominent features of using supplemental KCl and AA are found under severe heat stress, where significant decrease in mortality (Fig., 2) and significant increase in carcass weight was observed in both groups compared to control (Fig., 3). Supplemental KCl had the best live body weight under severe heat stress (Fig., 1).

Under mild heat stress, supplemental AA and KCl did not improve the mortality, on contrary they had an adverse effect on live body weight (Figs., 2,1). Supplemental AA showed the best carcass weight under mild heat stress (Fig., 3). Supplemental AA showed lower fat in edible muscles under both environments and higher protein contents under mild heat stress compared to the control (Fig., 4).

Table (4) shows that under sever heat stress supplemental KCl and AA groups gained 116 and 42 Kg live body weight per initial 1000 birds, respectively, over the control. Both groups gained 46 Kg carcass weight per initial 1000 birds over the control under the same environment. However, under mild heat stress supplemental KCl and AA lost 85 Kg live body weight per initial 1000 birds compared to the control. Meanwhile, supplemental AA gained 29 Kg carcass weight per initial 1000 birds over the control. At the same time, supplemental KCl did not show any improvement in carcass weight under mild heat stress.

Providing that there were no differences in the fixed and almost feed costs, in addition, the use of high dietary AA for long period had shown some toxic effects in rat viz., depression of copper absorption (Van den Berg *et al*., 1996) and dose-dependent inhibition of insulin secretion (Bergsten *et al*., 1994), it could be concluded that supplemental KCl was the best to be recommended for broiler chicks under severe heat stress to improve the performance. Supplemental AA should be the second choice under the same environment because of its lower revenue and higher cost compared to KCl taking care not to be used for periods longer than that of the present study.

منTable 3: ANOVA for edible muscles composition of heat-stressed broiler chicks fed Supplemental KCl and AA.

SOV	d.f	Moisture (%)	Fat (g/100 g dry wt)	Protein (g/100 g dry wt)	Ash (g/100 g dry wt)
Heat Stress	1	NS	NS	NS	NS
Treatments	2	NS	NS	NS	NS
Interaction	2	NS	NS	**	NS
Main Effects§					
Heat Stress:					
HS-S		71.581±0.34[1]	21.131±1.14	69.654±0.61	2.880±0.10
HS-M		71.670±0.36	23.631±1.08	68.663±0.65	2.815±0.10
Treatments:					
KCl		71.301±0.44	22.744±1.39ab	68.317±0.79	2.819±0.13
AA		71.462±0.42	20.284±1.34b	69.468±0.76	2.798±0.12
Control		72.114±0.43	24.115±1.35a	69.690±0.77	2.925±0.12

[1] Least Squares Means±Pooled SE

NS Not significant, * P≤ 0.05, ** P≤ 0.01.

[a,b] Means having different letter exponents within column in a main effect are significantly different (P≤0.05).

§ Letter exponents are not shown above the means of the effects having significant interaction.

Table4:Performance-based evaluation by simulation of broiler flock of 1000 birds fed diets supplemented with AA or KCl under severe or mild heats tress.

Variable	Severe Heat Stress (HS-S)			Mild Heat Stress (HS-M)		
	KCl	**AA**	**Control**	**KCl**	**AA**	**Control**
Initial Number	1000	1000	1000	1000	1000	1000
Mortality (%)	7.5[1] b (7)	6.5 b (7)	10a	5.5 a (5.7)	6 a (5.7)	5.5 a (5.7)
Number after 6 wks (birds)	930	930	900	943	943	943
BWT at 6 wks (Kg)*	1.47a	1.37 b (1.39)	1.39 b (1.39)	1.53b (1.55)	1.57b (1.55)	1.64a
Gross live BWT produced (Kg)	1367	1293	1251	1462	1462	1547
Difference compared to control (Kg)	+116	+42	0	-85	-85	0
Carcass weight (Kg)**	0.93a	0.93a	0.91b	0.94b	0.97a	0.94b
Gross carcass weight produced (Kg)	865	865	819	886	915	886
Difference compared to control (Kg)	+46	+46	0	0	+29	0

[1] Least Squares Means (Average of means of insignificant treatments).

[a,b] Means having different letter exponents within row in a main effect are significantly different (P≤0.05).

*** Average of 200 birds.**

**** Average of 24 birds.**

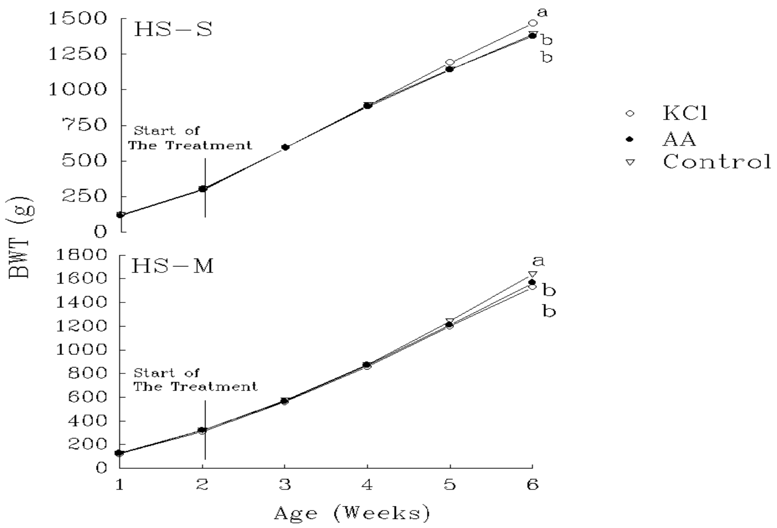

Figure (1):Body weight of broiler chicks reared under severe heat stress (HS-S) or mild heat stress (HS-M) and treated with potassium chloride (KCl), ascorbic acid (AA) and non of them (Control).

a,b Means with different letters are significantly different (P≤0.05).

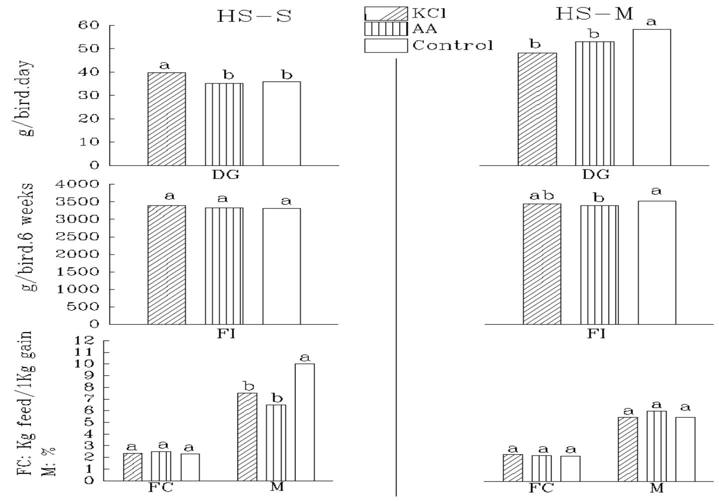

Figure (2):Daily gain (DG), feed intake (FI), feed conversion (FC) and mortality (M) of broiler chicks reared under severe heat stress (HS-S) or mild heat stress (HS-M) and treated with potassium chloride (KCl), ascorbic acid (AA) and non of them (Control).

a,b Means with different letters are significantly different (P≤0.05).

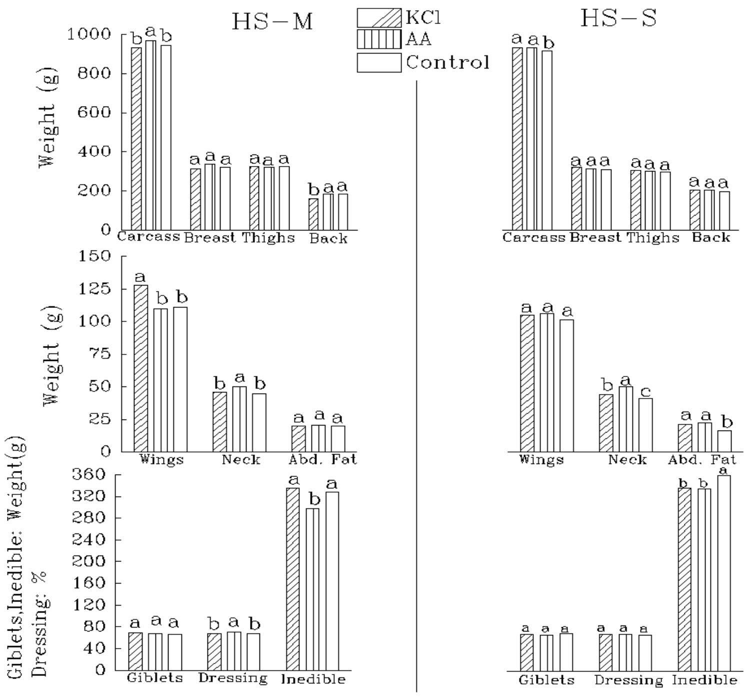

Figure (3): Weights of Carcass, breast, thighs, back, wings, neck, abdominal fat, giblets, dressing percentage and inedible parts of broiler chicks reared under severe heat stress (HS-S) or mild heat stress (HS-M) and treated with potassium chloride (KCl), ascorbic acid (AA) and non of them (Control).

a,b Means with different letters are significantly different ($P \leq 0.05$).

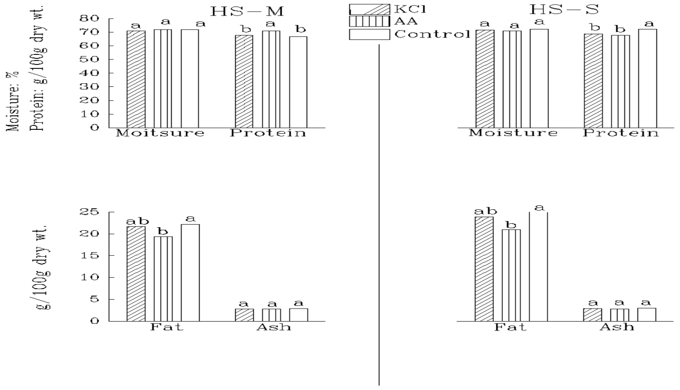

Figure (4): Chemical composition of edible muscles of broiler chicks reared under severe heat stress (HS-S) or mild heat stress (HS-M) and treated with potassium chloride (KCl), ascorbic acid (AA) and non of them (Control).

a,b Means with different letters are significantly different ($P \leq 0.05$).

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تقييم كلوريد البوتاسيوم وحمض الأسكوربيك كعوامل مضادة للإجهاد الحرارى فى كتاكيت التسمين

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أستخدم فى التجربه عدد ١٢٠٠ كتكوت تسمين عمر يوم غير مجنس من نوع إفيان. وقد عرضت الكتاكيت لمستويين من الإجهاد الحرارى طويل المدة (خفيف اوشديد) وغذيت على علف تسمين تجارى (المجموعه الضابطه) أو مضاف للعلف ١ جم حمض أسكوربيك/ كجم علف أو مضاف لماء الشرب ٠,٣% كلوريد البوتاسيوم وذلك فى تصميم إحصائى عاملى (٢×٣) مع وجود مكررات عددها ٤ مكررات لكل معامله من المعاملات. وكان الهدف من الدراسة تقييم كلوريد البوتاسيوم وحمض الأسكوربيك كعوامل مضادة للإجهاد الحرارى على الأداء الإنتاجى وخصائص الذبيحة فى كتاكيت التسمين.

أخذت عدة قياسات هى وزن الجسم والزيادة اليومية فى الوزن وإستهلاك الغذاء و معامل التحويل الغذائى و نسبة الوفيات و أوزان أجزاء الذبيحة و التحليل الكيماوى للعضلات المأكولة.

ودلت النتائج على أن كلوريد البوتاسيوم تحت الإجهاد الحرارى الشديد زاد منً وزن الجسم والزيادة اليوميه فى الوزن ووزن الأجنحه وخفض نسبة الوفيات بالمقارنه بالمجموعه الضابطه. وتحت تأثير الإجهاد الحرارى الخفيف خفض من وزن الجسم والزياده اليوميه فى الوزن و إستهلاك الغذاء وزاد من وزن الرقبه ودهن البطن وخفض وزن الأجزاء الغير مأكوله وخفض محتوى العضلات المأكوله من البروتين بالمقارنه بالمجموعه الضابطه.

أدى تدعيم العلف بحمض الأسكوربيك تحت ظروف الإجهاد الحرارى الشديد إلى خفض نسبة الوفيات وزيادة وزن الذبيحه والرقبه وخفض وزن الأجزاء الغير مأكوله ومن محتوى البروتين وخفض محتوى الدهن فى العضلات المأكوله بالمقارنه بالمجموعه الضابطه. وتحت ظروف الإجهاد الحرارى الخفيف أدى حمض الأسكوربيك إلى خفض وزن الجسم و الزياده اليوميه فى الوزن وإستهلاك الغذاء ووزن الأجزاء الغير مأكوله وزيادة وزن الرقبه ودهن البطن وخفض محتوى البروتين والدهن فى العضلات المأكوله بالمقارنه بالمجموعه الضابطه.

يمكن إستخلاص أن إستخدام كلوريد البوتاسيوم كان أفضل من حمض الأسكوربيك تحت ظروف الإجهاد الحرارى الشديد فى تحسين الأداء الإنتاجى.

Table (1): ANOVA for grow – out performance of heat – stressed broiler chicks fed supplemental KCl and AA.

Table (2): ANOVA for carcass part weights as adjusted to live body weight by covariance of heat – stressed broiler chicks fed supplemental KCL and AA.