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EFFECT OF DIETARY VITAMIN C AND SODIUM BICARBONATE SUPPLEMENTATION ON THE PERFORMANCE OF BROILER CHICKS SUBJECTED TO HEAT STRESS

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ABSTRACT: *The objectives of this investigation was to study the adverse effects of heat stress on performance and some blood plasma constituents of broiler chicks, and to alleviate these adverse effects by supplementation of Vit. C, or S.B. or their mixture by using three hundred 22 – day old Ross broiler chicks. All birds were individually weighed , and randomly assigned to five treatment groups (3 replicates of 20 birds each).*

The first group was fed a finisher diet (control) and reared under normal temperature (25- 27 °C). The second group was fed a finisher diet and exposed to a daily heat stress period (36-37°C) for 6 hours from 10 a m to 4 p m . Groups from the third to the fifth were exposed to a daily heat stress period (36-37°C) for 6 hours from 10 a m to 4 p m and fed a finisher diet supplemented with 100 mg Vit. C / kg diet 1% S.B. or its (100 mg Vit. C / kg diet + 1% S.B.), respectively.

The results indicated that: body weight , body weight gain, feed consumption, dressing , liver , gizzard and giblets % of broilers exposed to heat stress and fed control diet without any supplementation significantly decreased in comparison with birds of the control group that was reared under normal temperature. Heat stress caused significant deteriorations in feed conversion and recorded the highest mortality rate. There was a significant increase in plasma glucose of control group exposed to heat stress. Total protein, albumin, globulin in plasma of heat- stressed broiler chicks were significantly lower than the control group.

The mixture of Vit. C and S.B. treatments alleviated the detrimental effect of heat stress on body weight and body weight gain. Feed consumption, dressing, liver, gizzard and giblets percentages were increased by dietary supplementation under heat stress, compared to control + H treatment. Supplementation with Vit. C or S.B or their mixture overcame the deterioration effect of heat stress on feed conversion, recorded the lowest mortality rate, had beneficial effects on plasma total protein, albumin and globulin and caused a significant decrease in plasma T3 and T4 concentrations and increased economical efficiency.

Key words: *Vitamin C, Sodium Bicarbonate, Heat stress, Performance, broilers.*

INTRODUCTION

Broiler production plays a major role in food security for the rapidly increasing Egyptian human population. Their short production cycle, high feed efficiency and high biomass per unit of agricultural land are particularly attractive for the Egyptian production system. However, compared to other domestic animals, broiler chickens are more susceptible to changing environmental conditions (Nolan *et al.,* 1999).

In poultry production, heat stress can be described as acute or chronic. Acute heat stress refers to short and sudden periods of extremely high temperature, whereas chronic heat stress refers to extended periods of elevated temperature. Chronic stress has deleterious effects on birds reared in open- sided houses mainly through reducing feed consumption and increasing water consumption. Most of the reduction in feed consumption is due to reduced maintenance requirement. In broilers, growth rate, feed efficiency and carcass quality are negatively affected. Also, prolonged periods of elevated ambient temperature increase the broilers time to reach market weight and increased mortality (John 2008).

High ambient temperature depressed feed intake, weight gain and increased mortality rate among broilers (Ayo *et al.,* 1996). A possible approach to counteracting the negative effect of heat stress among chickens could be the supplementation of birds with vitamin C.

Vitamin C or L- ascorbic acid is an antioxidant which is normaly synthesized by the chicken (Khan, 2011). It is a simple compound which was initially detected in the mammalian adrenal gland. It was given the name hexuronic acid and later it was also known as cevitaminic acid scorbutamin and ant scorbutamin vitamin. Vitamin C has an important metabolic role as a result of its reducing properties and functions as elcteron doner (Elkheir *et al.,* 2008).

Vitamin C plays a major role in the biosynthesis of corticosterone (Bains, 1996), a primary glucocorticoid hormone involved in gluconeogenesis to enhance energy supply during stress (Frandson, 1986). However, under critically high ambient temperatures, the production of vitamin C in broilers is inadequate for optimum performance (Daghir, 1995).

Several researchers have reported beneficial effects of vitamin C supplements given either in diets and / in drinking water. Supplements enhanced performance of broiler chickens with experimentally induced hypothyroidism (Takahashi *et al.,* 1991 and Yanaka and Okumura, 1982), reduced stress related response (Pardue and Thaxton, 1985) and improved disease resistance of the birds (Amakye-Anim *et al.,* 2000). The fully practical relevance of such findings is however, yet to be concluded.

Stressors such as disease and heat stress may increase the chicken's need for vitamin C. During heat stress the chicken is not able to synthesis enough vitamin C to meet physiological demands, hence, the need for mineral and vitamin supplementation. Chickens require vitamin C for amino acid and mineral metabolism as well as for synthesis of hormones (John 2008).

Imbalances in acid – base balance occur in heat stressed birds. Therefore, inclusion of various compounds in the diet or water is a common practice to alleviate the adverse effect of heat stress. These include sodium bicarbonate ($NaHCO_3$), potassium chloride (KCl), calcium chloride ($CaCl_2$), and ammonium chloride (NH_4Cl) (John 2008).

The objectives of this investigation were to study:

1. the adverse effects of heat stress on performance , dressing , some internal organs percent and some plasma blood constituents of Ross broiler chicks.
2. to alleviate these adverse effects of heat stress by supplementation with Vit. C or S.B. or their mixture.

MATERIALS AND METHODS

Experimental birds and diets:

Three hundred 22 day - old Ross broiler chicks were used in this study. Chicks were wing - banded and kept under similar management and hygienic conditions. Feed and water were provided *ad libitum*. Artificial light was used to provide 24 hour photo period.

All birds were fed a starter diet (Table1) until 12 days of age , then three hundred chicks were individually weighed , and randomly assigned to five treatment groups (3 replicates of 20 birds each). Each replicate was kept in a separate pen.

The experimental groups were as follows:

1- The first group was fed a finisher diet (control) and reared under normal temperature (25-27 °C).

2-The second group was fed a finisher diet and exposed to a daily heat stress period (36- 37°C) for 6 hours from 10 a m to 4 p m .

3-The third group was fed a finisher diet supplemented with 100 mg Vit. C / kg diet and exposed to a daily heat stress period (36- 37°C) for 6 hours from 10 a m to 4 p m .

4-The fourth group was fed a finisher diet supplemented with 1% S.B. and exposed to a daily heat stress period (36-37°C) for 6 hours from 10 a m to 4 p m .

5- The fifth group was fed a finisher diet supplemented with a mixture of 100 mg Vit. C / kg diet and 1% S.B. and exposed to a daily heat stress period (36- 37°C) for 6 hours from 10 a m to 4 p m .

Composition and chemical analyses of the starter and finisher diets are shown in Table (1). The nutrient requirements were calculated according to the National Research Council (NRC 1994).

Climatological data:

Ambient air temperature and relative humidity were recorded daily at 2 pm for each pen during the experimental period. Ambient temperature was determined by using room thermometers (3 / pen) and relative humidity was determined by using a hygrometer. Relative humidity was ranged from 60-70 %.

Productive traits:

Live body weight and gain (g) of chicks were recorded at 3 , 4 , 5 and 6 weeks of age, while daily feed consumption (g) and feed conversion ratio (g Feed /g gain) were recorded and calculated weekly . Mortality was calculated.

Slaughter and Blood traits:

At the end of the experiment (42 days of age), 4 birds / treatment were randomly chosen, fasted for about 10 hours, weighed and slaughtered. Dressing and some organs were weighed. Individual blood samples were taken from the same slaughtered birds from each treatment.

Blood samples were collected into tubes containing heparin. Glucose, plasma total protein , albumin , calcium , sodium , potassium , triiodothyronine (T3) and thyroxin (T4) concentrations (free) were determined by diagnostic kits using Analyzer Au 400 according to A.O.A.C. (1990).

Statistical Analysis:

Experimental data obtained were evaluated for significance using ANOVA of SAS (SAS Institute, 2000) to assess the effect of dietary treatment on response variables. Treatment significance was determined by the new multiple range test of Duncan (1955). Percentage were transformed to the corresponding arcsin values before performing statistical analysis.

The model applied was: $Y_{ij} = \mu + \alpha_i + E_{ij}$

Where: Y_{ij} = an observation,

μ = Overall mean.

α_i = effect of treatment

(i = 1,2,3,4,..7), and

E_{ij} = experimental random error

RESULTS AND DISCUSSION

1- Effect of heat stress on broiler performance:

1.1. Body weight and body weight gain.

Results presented in Tables 2 and 3 indicated that body weight (g) at 3 , 4 , 5 and 6 wks and body weight gain (g) at periods 3 - 4, 4 - 5, 5 - 6 and 3 - 6 wks, respectively, were significantly ($P \leq 0.05$) decreased in the control group that was exposed to heat stress in comparison with birds of the control group that was reared under normal temperature, being 1769.8 vs. 2192.6g for body weight at 6 wks of age. With respect to body weight gain, values were 1083.6 vs. 1499.1g at 6 wks of age.

The adverse effects of heat stress include decreased body weight gain in broiler chickens, (Howlider and Rose, 1987; Marsden and Morris, 1987 and Yahav, 2000).

These results are in agreement with those obtained by Van der hel *et al* . (1992); Mitchell and Carlisle, (1992), and Deyhim and Teeter (1995). Most recent research studies, have also shown that high ambient temperature depressed body weight and weight gain of broilers (Roussan et *al*., 2008); El- Habbak *et al. (*2011).

Table 1. Composition and chemical analysis of the experimental diets fed during starting (1-21) and finishing periods (22-42) days of age.

Ingredients	Diet Composition	
	Starter Diet 1 – 21 days	Finisher Diet 22 – 42 days
Ground yellow corn (8.5%)	50.25	56.86
Soybean meal (44%)	40.36	34.00
Cottonseed oil	5.86	4.57
Limestone , ground	1.11	1.08
Dicalcium phosphate	1.61	1.71
Vitamin and mineral mixture[1]	0.30	0.30
DL – methionine[2]	0.21	0.08
Sodium chloride	0.30	0.30
Sand	-	1.10
Total	100	100
Calculated nutrient content[3]:		
Crude protein, %	22.03	19.79
ME , k cal / kg diet	3099	3098
C / P ratio	141	155
Lysine, %	1.20	1.07
Methionine, %	0.55	0.39
Methionine, Lysine, %	0.90	0.72
Determined values :		
Dry matter %	89.96	89.98
Crude protein, %	22	19.62
Ether extract, %	6.02	8.28
Crude fiber, %	3.76	3.57
Calcium, %	0.90	0.90
Total phosphorous, %	0.70	0.70

[1] Vitamin and mineral mixture at 0.30 % of the diet supplies the following / kg of the diet: Vit. A, 12000 IU; Vit. D_3, 2500 IU;Vit. E, 10 mg; Vit. K_3 ,3 mg ;Vit B_1, 1 mg; Vit. B_2 ,4 mg; Pantothenic acid ,10 mg ;Nicotinic acid ,20 mg; Folic acid, 1 mg; Biotin, 0.05 mg; Niacin, 40 mg; Vit.B_6 ,3. mg; Vit B_{12}, 0.02mg; Choline chloride, 400 mg; Mn, 62 mg; Fe, 44 mg; Zn, 56 mg; I, 1 mg; Cu, 5 mg and Se, 0.01 mg.
[2]DL – methonine: 98% feed grade (98% Methionine). [3] calculated according to NRC (1994).

Table2

Table 3

Data in Tables 2 and 3 show the effect of vit. C or S.B. or their mixture on body weight and body weight gain of broilers during different periods. The results indicated that after one week from the beginning of heat stress; body weight and body weight gain were affected by supplementing vit. C, S.B. and their mixture, being 1084.4, 1127.5 and 1099.2g compared to 1072.1g for heat stressed group, respectively for body weight, as for body weight gain, values were 382.4, 420.2 and 406g in comparison with 375.9g.

During following periods, results that supplementation with vit. C or S.B. or their mixture reduced effect of heat stress. It was observed that the mixture of vit. C and S.B. treatment had the best effect (2229.2 vs. 1769.8g for body weight and 1536 vs. 1083.6g for body weight gain).

Ascorbic acid (AA) can be synthesized by poultry and it is not required to be supplemented in the diet under normal conditions. When birds are challenged with stressors, however, the supplementation of vit C might be beneficial for the performance of broilers (Pardue and Thaxton, 1982; Pardue *et al.*, 1984; Mckee and Hurrison, 1995).

The blood acid/base balance is disturbed by hyperventilation and results in respiratory alkalosis, which suppresses the growth of broiler chicken and impairs eggshell quality of laying hens. The suppression of growth in broilers can be partially alleviated by supplementation of 1% NH4Cl or 0.5% NaHCO3 (Teeter *et al.*, 1985), and 1.5 to 2.0% K in the form of KCl (Smith and Teeter, 1987). The supplementation effect of electrolyte depends on dietary electrolyte balance (DEB). Moderate dietary DEB values (from 120 to 240 mEq) have a favorable influence on the physiological response of heat-stressed broiler chickens (Borges *et al.*, 2004).

These results are in agreement with the findings of Farooq *et al.*(2005) and El – Habbak *et al* .(2011) who found that vit. C supplementation was very effective in ameliorating the adverse effect of heat stress. On the other hand, the present results were in disagreement with those observed by Borges (1997) who reported that adding S.B to the diet of broiler chicks under summer condition did not have any effect on performance.

1.2. Feed consumption and feed conversion.

Data concerning the effect of heat stress on feed consumption are shown in Table 4. Exposing birds to heat stress lead to a significant decrease in feed consumption ($P \leq 0.05$) by 18.9% throughout the different experimental periods, being 2663 vs. 3283g for heat-stressed and control broiler chicks. The effect of dietary vit. C or S.B. or their mixture on feed consumption of broiler chicks that reared at 35°C from 4-7 weeks of age are presented in Table 4. In general, during the experimental period, feed consumption was increased by dietary supplementation with vit. C or S.B. or their mixture in the feed of broilers subjected to heat stress, compared to control + H treatment; being 3219, 3340 and 3195g vs. 2663g at 6 wks of age.

The decreased nutrient intake at high temperature also has repercussions on the intake of micronutrients such as Vitamin A, E, C, etc., which play important roles in the performance and immune function of poultry. The supplementation of these nutrients might also be helpful for the maintenance of performance and immune function of heat stressed birds (Ferket and Qureshi, 1992).

Similar findings on feed consumption and feed conversion were reported by Farooq *et al.* (2005) and El-Habbak *et al.* (2011).

Data shown in Table 5 indicated significant effects of heat stress on feed conversion. Heat stress reduced the efficiency of feed conversion by 12%. Values of feed conversion (g feed/g gain) were 2.19 vs. 2.46 for control and heat-stressed group in a respective order at 6 weeks of age. With respect to the effect of supplementation with vit. C or S.B. or their mixture, feed conversion values were 2.24, 2.29 and 2.08 in comparison with 2.46, respectively at 6 weeks of age, indicating the beneficial effect of this supplementation

Table 4

Table 5

to overcome the deterioration effect of heat stress. Vit C supplementation reduces the respiratory quotient in heat-stressed broiler chickens by emphasizing an increase in fatty acid oxidation over the increase in protein-derived gluconeogenesis (McKee *et al.*, 1997). At high temperature, broiler chicken seems to have a special appetite for vit. C and tends to consume more diet supplementing of vit. C (Kutlu and Forbes, 1993).

On the other hand, the feeding status should be considered in the adjustment of dietary electrolyte balance. At high temperature, feed restricted broiler chickens have adverse changes in pCO_2 and pH, with a decline in pH and increase in pCO_2, compared to *ad libitum*-fed counterparts (Hocking *et al.*, 1994).

1.3. Mortality rate:

Data in Table 6 presented the effect of supplemental vit. C or S.B. or their mixture on mortality percentage. The control + H-treatment recorded the highest rate of mortality being 7.5% at the first period (3-4 wks), 5% at the second period (4-5 wks) and 2.5% at the third period (5-6 wks). In general heat stress lead to 15.0% mortality rate comparing to 2.5% of the control group for the entire experimental period (3–6 wks).

These results are in good agreement with those found by Van der hel *et al.* (1992); Yahav (2000); Gonzalez and Lesson (2006) and El–Habbak *et al.* (2011). On the other hand, results reported herein disagree with findings of De-Andrde *et al.* (1977) and Donkoh, (1989) who showed that mortality rate was not affected by high ambient temperatures, when broiler chicks were reared under different temperatures (20, 25, 30 and 35°C) from 3 to 7 weeks of age.

The effect of dietary supplementation of vit. C or S.B. or their mixture on mortality rate of heat-stressed broiler chicks is shown in Table 6. It is apparent that the combination of vit. C and S.B. treatment recorded the lowest mortality rate being 2.5% at the end of the experimental period (6 wks).

Ascorbic acid is involved in the production of white blood cells and thus enhances the immune status of birds (Ferket and Qureshi, 1992).

Vitamin C could still play a role in the synthesis of leukocytes especially phagocytes and neutrophiles which play a part in the defense system of the chickens (Null, 2001).These findings are in harmony with those reported by Pardue and Thaxton (1985).

On the other hand, Abd El-Samee (1998) reported that adding S.B. to broiler chick's diet under summer conditions did not have any effect on mortality rate.

2. Effect of heat stress on some carcass characteristics:

Results in Table 7 show the percentages of dressing and some internal organs at 42 days of age. In general, heat stress caused a significant decrease in dressing, liver, gizzard and giblets percentages of control+ H treatment; being 70.49; 2.81; 1.78 and 5.36%; whereas these values of the control treatment were 74.54, 3.61, 3.08 and 7.4%, in a respective order. These findings were in agreement with those found by Smith (1993) and Yahav *et al.* (1997).

Data presented in Table 7 show the effect of supplemental vit. C and S.B. on dressing and some internal organs percentage of heat-stressed broiler chicks. In general, it is indicated that there are highly significant beneficial effects of VIT. C, S.B. and their mixture on dressing, liver, gizzard and giblets percentages. Heart percentage was not affected. Values were 74.56, 3.75, 3.11 and 7.60% for the mixture of vit. C+S.B. in comparison with 70.94, 2.81, 1.78 and 5.36% for heat-stressed control group.

Ascorbic acid supplementation improves carcass quality and produces higher carcass weight and carcass CP content, while reducing carcass crude fat content (Kutlu, 2001). Furthermore, as ascorbic acid is one of the most important antioxidants in biological system and heat stress could induce oxidative injuries to chickens (Lin and Zhang 2000), the supplementation of AA is relevant to the maintenance of redox balance in heat-stressed birds.

Table 6

Table 7

These results are in agreement with those found by Ahmed *et al*. (2006).

On the contrary, Abd El-Samee (1998) reported that adding S.B., under summer condition did not have any effect on slaughter traits.

3. Effect of heat stress on some blood biochemical parameters:

Results presented in Table 8 showed that there was a significant increase in plasma glucose of control + H treatment (163.5mg/dl) compared to control treatment (154.0mg/dl). This result is in harmony with that found by Kotb (1984) who indicated that blood glucose concentration is directly related to the increase in glucocorticoids which can result from heat stress. On the contrary, results reported herein disagree with findings of Tollba and Hassan (2003) and El–Habbak *et al*. (2011). This conflict may be due to the differences of the experimental conditions such as the degree of temperature, the exposure period, strain of birds and their age. In general, all plasma constituents of heat-stressed broiler chicks were significantly lower than the control treatment.

Results reported herein are in harmony with those obtained by Zhou *et al.* (1998); Hassan (1999); Kalamah (2001) and El-Sheikh *et al*. (2004).

The effect of heat stress on plasma ion concentrations (Table 8) show significant decrease in heat-stressed group compared to control group. For example, values for Na^+ concentration were 125.5 vs. 106.5 meq/L for control and heat–stressed broiler chicks, respectively.

The improved performance is associated with the suppressed stress responses indicated by the reduction in plasma corticosterone level (Mckee and Hurrison, 1995; Mahmoud *et al.*, 2004), adrenocorticotropic hormone, increased serum insulin and T3 and T4 (thyronine) concentrations (Sahin *et al.*, 2003).

These results are in agreement with the findings of Borges (1997); Salvador *et al.* (1999); Kalamah (2001) and Borges *et al*. (2004). However, Arad *et al*. (1983) and Koelkebeck and Odam (1995) demonstrated that heat stress did not cause a decrease in plasma total protein (tP) and Ca. Whitehead and Keller (2003) observed that the nature and magnitude of adjustments depend upon the degree of heat stress imposed.

In the present study, plasma T3 was significantly decreased with heat stress and plasma T4 was increased. Plasma T4 concentration of control + H group was significantly higher than the control group; being 1.5 vs. 0.45 ng/ml, respectively. The findings of Mitchell and Carlisle (1992) and Lin *et al*. (2008) are in agreement with the results obtained in this study. But, other studies have reported conflicting results of heat stress, showing reduction in both T3 and T4 concentration (Yahav and Hurwitz, 1996 and Kalamah, 2001).

Experimental findings on the effect of supplemental vit. C and S.B. and their mixture on some plasma constituents of heat-stressed broiler chicks are summarized in Table 8. Plasma glucose was significantly increased as a result of heat stress. The mixture of vit. C and S.B. caused a significant decrease; being 163.5 vs. 153.5mg/dl for heat–stress control group compared to supplemented group.

Exposure of birds to heat stress caused a significant decrease in blood total protein, albumin and globulin. vit. C or S.B. supplementation had beneficial effect. However, the best values were achieved by using the mixture of vit. C and S.B. A similar trend was found with respect to plasma Ca, tP, Na and K.

In general, these results are very similar to those obtained by Osman (2000); Salvador *et al*. (1999) and Borges *et al*. (2004). In addition, data in Table 8 indicated that plasma T_3 was significantly decreased in the control + H group, whereas the addition of vit. C and S.B. increased T_3 concentration. Also it can be observed that there are no significant differences between the mixture of vit. C and S.B. treatment and control group.

Table 8. Effect of supplemental Vit .C or sodium bicarbonate (S.B.) or its mixture on plasma constituents of heat- stressed broiler chicks (means + SE).

Plasma constituents	Treatments				
	Control	Control +H	Vit.C + H	S.B. + H	Vit.C+S.B.+H
Glucose mg/dl	154.0 ± 1.8^{c}	163.5 ± 1.2^{a}	159.0 ± 1.2^{b}	160.5 ± 1.3^{b}	153.5 ± 1.3^{1c}
Total protein g/dl	2.2 ± 0.19^{a}	1.6 ± 0.14^{c}	1.9 ± 0.15^{b}	1.9 ± 0.16^{b}	2.1 ± 0.17^{a}
Allumin g/dl	1.05 ± 0.05^{a}	0.6 ± 0.09^{c}	0.8 ± 0.04^{b}	0.9 ± 0.08^{ab}	0.95 ± 0.05^{ab}
Globulin g/dl	1.15 ± 0.09^{a}	1.0 ± 0.10^{b}	1.10 ± 0.08^{ab}	1.0 ± 0.05^{ab}	1.15 ± 0.10^{a}
Ca mg /dl	6.7 ± 0.4^{a}	4.05 ± 0.2^{c}	5.2 ± 0.3^{b}	5.05 ± 0.4^{b}	6.5 ± 0.5^{a}
I.P mg / dl	9.9 ± 0.7^{a}	7.6 ± 0.8^{c}	8.6 ±0.8^{b}	8.9 ± 0.81^{b}	9.5 ± 0.65^{a}
Na meq / l	125.5 ± 1.1^{a}	106.5 ± 1.4^{c}	116.0 ± 1.4^{b}	126.0 ± 1.3^{a}	125.0 ± 1.1^{a}
K meq / l	13.24 ± 1.1^{a}	10.48 ± 1.2^{c}	11.25 ± 1.3^{b}	12.53 ± 1.7^{a}	13.48 ± 1.2^{a}
T3 ng / ml	3.96 ± 0.21^{a}	3.15 ± 0.13^{c}	3.57 ± 0.19^{b}	3.69 ± 0.17^{b}	3.81 ± 0.15^{a}
T4 ng / ml	0.45 ± 0.03^{c}	1.5 ± 0.02^{a}	0.71 ± 0.01^{b}	0.65 ± 0.03^{b}	0.60 ± 0.01^{b}

1 a,b,c. Means in the same row within age with different superscript letters are significantly different (P < 0.05).
2 calculated as % of live body weight.

In contrast, plasma T_4 was increased by exposure to heat stress. Supplementing diets with vit. C or S.B. or their mixture caused a significant decrease. These finding are in agreement with those reported by El-Habbak *et al*. (2011).

4. Economical efficiency:

The economical efficiencies of experimental diets are shown in Table (9. Data show that highest economical efficiency, relative economical and European productive efficiency were obtained with the diet supplemented with a mixture of 100 mg vit. C + 1% S.B.

Results indicate that supplementation of 100 mg vit. C + 1% S.B. to heat – stressed broiler diets increased economical, relative economical and European productive efficiency.

CONCLUSION

Based on the findings of the present study, it may be stated that 100 mg Vit. C + 1% S.B. supplementation is effective in improving performance and economical efficiency of broilers under heat stress conditions.

TABLE 9

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تأثير اضافة فيتامين C وبيكربونات الصوديوم على أداء كتاكيت اللحم تحت ظروف الإجهاد الحرارى

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الملخص العربى

أجريت هذه الدراسة خلال مارس وأبريل ٢٠١٠ م, وكان الغرض منها هو دراسة التأثيرات السيئة الناجمة عن الإجهاد الحرارى لبدارى اللحم على الأداء الإنتاجى ونسبة التصافى وبعض صفات الذبيحة وبعض مكونات بلازما الدم ، وكيف يمكن معالجة هذه الآثار الضارة بإضافة فيتامين C أو بيكربونات الصوديوم أو خليط منهما . وقد استخدم فى هذه الدراسة عدد ٣٠٠ كتكوت روس عمر ٢١يوم, واشتملت التجربة على خمس معاملات كل منها يتضمن ثلاثة مكررات (بكل مكررة ٢٠ كتكوت).

المجموعة الأولى: مجموعة الكنترول (المقارنة) تمت التربية تحت الظروف الطبيعية مع التغذية على العليقة الناهى, بينما المجموعات من الثانية حتى الخامسة تم تعريضها للإجهاد الحرارى (٣٦– ٣٧م°) لمدة ٦ ساعات يوميا من الساعة ١٠ صباحا حتى الساعة ٤ مساءا. تم إضافة ١٠٠ مجم فيتامين C / كجم عليقة أو ١% بيكربونات الصوديوم / كجم عليقة, أو إضافة خليطهما (١٠٠ مجم فيتامين C + ١% بيكربونات الصوديوم) إلى المجموعات الثالثة والرابعة والخامسة على التوالى.

وفيما يلى أهم النتائج: أظهرت المعاملة الثانية التى تعرضت فيها الطيور للإجهاد الحرارى والتى غذيت على عليقة خالية من فيتامين C أو بيكربونات الصوديوم إنخفاضاً معنوياً فى كل من: وزن الجسم الحى , الوزن المكتسب, كمية الغذاء المستهلك, نسبة التصافى, ونسب كل من: الكبد والقونصة والأجزاء المأكولة, وكذلك نسبة كل من: البروتين الكلى ، والألبيومين والجلوبيولين فى بلازما الدم مقارنة بطيور المجموعة الأولى (مجموعة المقارنة), كذلك كان بهذه المجموعة أعلى نسبة نفوق وأعلى نسبة جلوكوز بالبلازما وأسوأ معدل تحويل للغذاء.

أما بالنسبة لمعاملات الإضافة فقد أدت إضافة المخلوط من فيتامين C + بيكربونات الصوديوم إلى تلافى التاثيرات السلبية للإجهاد الحرارى على كل من وزن الجسم و معدل الزيادة فى الوزن. كما ازداد كل من الغذاء المستهلك ونسبة الأجزاء المأكولة وكل من البروتين والألبيومين والجلوبيولين فى بلازما الدم. وكذلك تحسنت الكفاءة الغذائية والإقتصادية, وانخفضت كل من نسبة النفوق و نسبة هرمونى T3, T4 انخفاضاً معنوياً مقارنه بمجموعة الكنترول تحت ظروف الإجهاد الحرارى (المجموعة الثانية).

Table 2. Effect of supplemental Vit .C or sodium bicarbonate (S.B.) or its mixture on body weight (g) of heat - stressed broiler chicks (Means ± SE).

Treatments	Age weeks			
	3	4	5	6
……………………g……………………				
Control	693.5 ± 7.6	1107.4 ± 11.8^{a}	1552.3 ± 15.1^{a}	2192.6 ± 19.11^{ab}
Control + Heat stress	696.2 ± 7.1	1072.1 ± 11.3^{c}	1374.5 ± 14.8^{c}	1769.8 ± 18.9^{c}
Vit. C + Heat stress	702.0 ± 7.2	1084.4 ± 11.4^{bc}	1472.4 ± 13.9^{b}	2139.7 ± 18.7^{b}
S.B. + Heat stress	707.3 ± 6.9	1127.5 ± 10.9^{a}	1534.7 ± 15.1^{a}	2167.9 ± 19.2^{b}
Vit.C+S.B.+ Heat stress	693.2 ± 7.2	1099.2 ± 11.3^{ab}	1522.3 ± 14.9^{a}	2229.2 ± 19.3^{a}

1 a,b,c. Means in the same column within age with different superscript letters are significantly different ($P < 0.05$).

Table 3. Effect of supplemental Vit .C or sodium bicarbonate (S.B.) or its mixture on body weight gain (g) of heat - stressed broiler chicks (Means ± SE).

Treatments	Periods			
	3 - 4 wk	4 - 5 wk	5 - 6 wk	3 - 6 wk
……………………g……………………				
Control	413.9 ± 4.5^{ab}	444.9 ± 7.1^{a}	640.3 ± 12.5^{c}	1499.1 ± 18.61^{b}
Control + Heat stress	375.9 ± 4.4^{c}	302.4 ± 6.9^{d}	395.3 ± 13.2^{d}	1083.6 ± 18.7^{d}
Vit. C + Heat stress	382.4 ± 4.5^{c}	388.0 ± 7.2^{c}	667.3 ± 13.1^{bc}	1437.7 ± 19.1^{bc}
S.B. + Heat stress	420.2 ± 4.5^{a}	407.2 ± 7.1^{b}	633.2 ± 13.0^{c}	1460.6 ± 18.8^{c}
Vit.C+S.B.+ Heat stress	406.0 ± 4.6^{b}	423.1 ± 7.2^{b}	706.9 ± 12.8^{a}	1536.0 ± 19.1^{a}

1 a,b,c. Means in the same column within age with different superscript letters are significantly different ($P < 0.05$).

Table 4. Effect of supplemental Vit .C or sodium bicarbonate (S.B.) or its mixture on feed consumption (g) of heat - stressed broiler chicks (Means ± SE).

Treatments	Periods			
	3 - 4 wk	4 - 5 wk	5 - 6 wk	3 - 6 wk
……………………g……………………				
Control	912.8 ± 11.31^{a}	1001.0 ± 15.91^{a}	1369.2 ± 15.13^{a}	$3283.0 \pm 21.7^{1\ ab}$
Control + Heat stress	715.8 ± 9.81^{c}	844.4 ± 12.3^{c}	1102.7 ± 20.7^{b}	2663.00 ± 30.6^{c}
Vit. C + Heat stress	840.0 ± 10.21^{c}	934.7 ± 14.31^{b}	1444.2 ± 21.12^{a}	3219.00 ± 22.1^{b}
S.B. + Heat stress	900.0 ± 11.41^{a}	1054.5 ± 15.2^{a}	1385.5 ± 17.6^{a}	3340.0 ± 26.7^{a}
Vit.C+S.B.+ Heat stress	882.0 ± 9.77^{a}	1065.0 ± 12.12^{a}	1433.8 ± 18.9^{a}	3195.00 ± 30.7^{b}

1 a,b,c. Means in the same column within age with different superscript letters are significantly different (P < 0.05).

Table 5. Effect of supplemental Vit .C or sodium bicarbonate (S.B.) or its mixture on feed conversion of heat- stressed broiler chicks (Means ± SE).

Treatments	**Periods**			
	3 - 4 wk	4 - 5 wk	5 - 6 wk	3 - 6 wk
……………………**g feed /g gain**……………………				
Control	2.21 ± 0.02^{b}	2.25 ± 0.03^{d}	2.14 ± 0.04^{b}	2.19 ± 0.02^{1b}
Control + Heat stress	2.25 ± 0.04^{a}	2.79 ± 0.05^{a}	2.79 ± 0.06^{a}	2.46 ± 0.04^{a}
Vit. C + Heat stress	2.20 ± 0.03^{c}	2.41 ± 0.06^{c}	2.16 ± 0.04^{b}	2.24 ± 0.03^{b}
S.B. + Heat stress	2.14 ± 0.04^{bc}	2.59 ± 0.05^{b}	2.19 ± 0.03^{b}	2.29 ± 0.04^{b}
Vit.C+S.B.+ Heat stress	2.17 ± 0.04^{bc}	2.52 ± 0.06^{b}	2.03 ± 0.01^{c}	2.08 ± 0.02^{c}

1 a,b,c. Means in the same column within age with different superscript letters are significantly different (P < 0.05).

Table 6. Effect of supplemental Vit .C or sodium bicarbonate (S.B.) or its mixture on mortality (%) during different periods .

Treatments	Periods			
	3 - 4 wk	4 - 5 wk	5 - 6 wk	3 - 6 wk
Control	2.5	0.0	0.0	2.5
Control + Heat stress	7.5	5.0	2.5	15.0
Vit. C + Heat stress	5.0	2.5	0.0	7.5
S.B. + Heat stress	5.0	5.0	0.0	10.0
Vit.C+S.B.+ Heat stress	2.5	0.0	0.0	2.5

Table 7. Effect of supplemental Vit .C or sodium bicarbonate (S.B.) or its mixture on dressing and some internal organs % of heat- stressed broiler chicks.

Treatments	Carcass traits % at 42 days^{2}				
	Dressing	Liver	Gizzard	Heart	Giblets
Control	74.54^{a}	3.61^{a}	3.08^{a}	0.71	7.40 ^{1a}
Control + Heat stress	70.49^{b}	2.81^{b}	1.78^{c}	0.77	5.36^{b}
Vit. C + Heat stress	73.94^{a}	3.73^{a}	2.75^{b}	0.73	7.21^{a}
S.B. + Heat stress	74.1^{a}	3.80^{a}	3.01^{a}	0.75	7.56^{a}
Vit.C+S.B.+ Heat stress	74.56^{a}	3.75^{a}	3.11^{a}	0.74	7.60^{a}
SEM	± 1.82	± 0.23	± 0.19	± 0.03	± 0.42

1 a,b,c. Means in the same column within age with different superscript letters are significantly different ($P < 0.05$). 2 calculated as % of live body weight.

Table 9: The economical efficiency as affected by Vit .C or sodium bicarbonate (S.B.) or its mixture supplementation.

Items	Dietary treatments[1]				
	T_1	T_2	T_3	T_4	T_5
Chicks total number at the beginning of the experimental	60	60	60	60	60
Initial body weight, (g)	693.50	696.20	702.00	707.30	693.20
Final body weight, (kg)	2192.60	1769.80	2139.70	2167.90	2229.2
Mortality values (%)	2.5	15	7.5	10	2.5
Chicks total number at the end of the experiments	58.5	51	55.5	54	58.5
Body weight gain, (kg)	87.75	54.57	79.92	78.84	90.09
Revenue from gain,(L.E/ bird)	1053.00	655.00	959.00	946.00	1081.00
Feed intake, (kg)	192	136	179	180	187
Price of kg feed,(L.E)	3.08	3.08	3.36	3.13	3.41
Feed cost, (L.E)	591	418	600	565	638
Net revenue,(L.E)[2]	462	237	359	382	443
Economical efficiency[3], %.	78.17	56.72	59.72	67.59	69.44
Relative economical efficiency, (%)	-------	100	105.29	119.16	122.43
European Productive efficiency, (EPE, %)	233.20	158.54	213.17	215	232.14

[1] T_1; control diet without supplements, T_2; Heat- stressed control diet, T_3; Heat- stressed control diet + 100 mg vit C., T_4; Heat- stressed control diet + 1% S.B., and T_5; Heat- stressed control diet + 100 mg vit C+ 1% S.B. [2]Net revenue = Revenue from gain - Feed cost.

[3] Economical Efficiency= (net revenue/ feed cost) ×100.

Price of one kg live body weight was 12 L.E. Price of one kg VIT C and S.B. were 25 and 5 L.E.

% EPE =(Mean body weight (kg) × livability % × 100) / (feed conversion × marketing age, days), cited by Soltan and Kusainova, 2012 .