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COMBINATION EFFECTS OF ASCORBIC ACID AND GLUCOSE IN DRINKING WATER ON THE BROILER PERFORMANCE UNDER ACUTE HEAT STRESS

E. Talebi and M. Khademi

Islamic Azad University, Darab Branch, Darab, Fars, IRAN

Tel: +987326233990-5; Fax: +987326233900
E-mail: talebi226@iaudarab.ac.ir

ABSTRACT: High environmental temperatures have deleterious effects, reducing the feed intake, live weight gain and feed efficiency of poultry. A study utilizing Ross 308 was conducted to evaluate the effects of vitamin C (Ascorbic acid) and glucose on broilers production reared under heat stress (32 ± 2 °C). One day-old, five hundred twenty five broilers were randomly assigned to 7 treatment groups with 3 replicates of 25 birds per each group. Broilers were exposed to temperature using electrical brooders for 4 hours a day from 36 to 49 days. The all combination of glucose with vitamin C in drinking water compared with control group resulted in higher body weight, feed efficiency and lower feed conversion ratio ($P < 0.05$) in both stages. This result suggests that combination of ascorbic acid with glucose in drinking water alleviates the influence of high ambient temperature on broiler in grower and finisher stage of growth.

Key words: Ascorbic acid, broiler, glucose, heat stress.

INTRODUCTION

Room temperature is a component of microclimate and has a significant effect on the productivity, health of broiler chickens and consequently on the profitability of poultry production. It is generally assumed that rearing temperature should be approximately 32°C on the first day and be gradually decreased to approximately 20°C at the 6 weeks of age (Leenstra and Cahaner, 1991; Zhou and Yamamoto, 1998). Too low or too high ambient temperature is highly undesirable during rearing of broiler chickens. Elevated temperature reduces the feed intake and body weight of broilers. It is well known the economic repercussion of heat stress in broiler, Özkan *et al*. (2003) had carried out a negative effect on economical and production for the farmer.

The poultry does not require any dietary source of vitamin C as it is able to synthesize it. But it was reported that the negative effects of environmental stress could be prevented by the use of some minerals and vitamin supplements such as vitamin C (McDowell, 1989; Daghir, 1995; Sahin *et al*., 2001). Pardue and Thaxton (1984) reported that particular environmental stressors could alter ascorbic acid utilization or synthesis in poultry. It has also been revealed that under stress conditions such as low or high environmental temperatures, humidity, high productive rate, and parasite infestation, ascorbic acid synthesis is inadequate (Freeman, 1967; Sykes, 1978; Hornig *et al*., 1984; McDowell, 1989; Cheng *et al*., 1990; Mowat, 1994; Bláha and Kroesna, 1997). Several researchers documented a beneficial effect of ascorbic acid supplementation on growth rate, egg production, egg shell strength and thickness in stressed poultry (Thornton, 1962; McDowell, 1989; Bains, 1996).

As well as, during periods of high temperature, it has been found that broilers which consumed a 4% glucose-water solution *ad libitum* from 35 d of age, had significantly lower mortality due to heat stress and higher live weight gain than those birds that received tap water (Iwasaki *et al*., 1997). Thaxton *et al*. (1974) reported that oral administration of glucose increased the body temperature of neonatal chickens that were exposed to 21°C and suggested that carbohydrate metabolism is involved in the physiological regulation of body temperature. Sahina *et al*. (2003) and Sabah *et al*. (2008) reported that nutritional modifications can be used to influence productivity, health and physiological processes occurring in the body of broilers reared in elevated ambient temperatures. Therefore, the aim of this investigation was to determine the effect of supplementing vitamins C and glucose in drinking water on productivity of broilers exposed to elevate ambient temperature (32 ± 2 °C) between 36 and 49 days of age.

MATERIAL AND METHODS

Animals and diets

This study was carried out at the Poultry Unit of Islamic Azad University, Darab Branch, Darab, Iran (Darab is a city that has a very hot climate in summer). Five hundred twenty five-old broiler chicks (Ross 308 strain) were obtained from a same hatchery. On the first day, the chicks were individually weighed, wing-tagged and randomly allocated to each group with stocking densities of 25 birds in each cage (with deep litter of wood shavings). The chicks were placed to 21 cages, consisting of 7 drinking water treatments (Control, 2% glucose with 200 ppm ascorbic acid, 2% glucose with 300 ppm ascorbic acid, 4% glucose with 200 ppm ascorbic acid, 4% glucose with 300 ppm ascorbic acid, 6% glucose with 200 ppm ascorbic acid, 6% glucose with 300 ppm ascorbic acid) with 3 replicates. The basal diets were formulated using NRC (1994) guideline and contained 20% (grower), 18% (finisher) crude protein (CP) and 3200 kcal/kg metabolizable energy (ME) (Table 1). Feed and water were supplied *ad libitum* accordance with animal welfare.

During the experiment, light was provided continuously (23 hours light and 1 hour dark), and room temperature was maintained to 32 ± 2 °C using electrical brooders for 4 hours a day from 36 to 49 days. Feed intake and body weights were recorded at allotment, day 42 and day 49. Subsequently, feed conversion ratios were computed. At the end of the experiment (day 49), five male and five female chickens in each group with a body weight close to the group average, were selected and slaughtered to determine the carcass characteristics. The feathers, heads, legs and inner organs (except kidneys and lungs) of the chickens were removed. The carcasses were kept at the refrigerator for 24 h; afterwards the thigh, breast and abdominal fat were removed (The organs were weighed with the skin).

Data analysis

The experimental design was completely randomized with factorial structure. Two levels of ascorbic acids (i.e., 200 and 300 ppm) and three levels of glucose (i.e., 2, 4 and 6 %) were analyzed as 2×3 factorial design with control group by General Linear Model using SAS 9. Comparisons of the treatment means were performed with Duncan's new multiple range tests.

RESULTS AND DISCUSSION

The effects of supplemental vitamins C and glucose combination in drinking water during heat stress on body weight, feed intake and feed conversion of broilers are shown in Table 2. As can be seen, the body weight and feed intake were increased while the feed conversion improved in all treated groups compared with control ($P < 0.05$).

There were no significant effects of treated drinking water on carcass characteristics (Table 3). In the present study, the effects of vitamin C and glucose supplementation on body weight, feed intake, feed conversion ration and carcass composition in broiler reared under a high ambient temperature (32 ± 2 °C) were investigated. It was found that combination of vitamin C and glucose in drinking water alleviated the detrimental effects of hot stress.

The results of the present study are similar to those of Jaffar and Blaha (1996) who observed a 10.9 % increase in body weight of chicken supplemented Vitamin C at 20mg/bird/day in drinking water during acute heat stress (29 - 43°C with 40 - 85% of relative humidity). Blaha and Kreosna (1997) observed an even higher increase (18%) among chicken fed *ad libitum* with similar supplementation. Furthermore, Puron *et al*. (1994) examined the 200 ppm dietary Vitamin C supplements and found no effect on performance and survivability when the average environmental temperature was 26°C.

Sahin *et al*. (2001) also reported that supplemental vitamin C increased performance and better carcass traits in Japanese quails reared under heat stress (34°C). At temperatures above or below thermoneutral zone, corticosteroid secretion increases as a response to stress (Brown and Nestor, 1973). Kutlu and Forbes (1993) stated that ascorbic acid supplementation reduces the synthesis of corticosteroid hormones in birds reared under heat stress. By decreasing synthesis and secretion of corticosteroids, vitamin C alleviates the negative effects of stress such as heat or cold stress-related depression in performance of poultry (McDowell, 1989).

Table 1. Composition and chemical analysis of the diets for broiler chickens

Ingredients	Grower (36-42 days)	Finisher (43-49 days)
	% of DM	
Corn grain	69.12	73.16
Soybean meal (48% CP)	23.81	21.51
Fish meal (70% CP)	3.50	2.00
Oyster shell	1.88	1.67
Dicalciumphosphat	0.86	0.86
Salt (NaCl)	0.20	0.20
Premix (Vit. + Min.)	0.60	0.60
DL-Methionine	0.03	--
ME, Kcal/Kg	2936.76	2982.13
Crude protein	18.81	17.19
Lysine	1.04	0.89
Met + Cys	0.67	0.59
Ca, %	1.10	0.97
Avia. Phosphor.	0.38	0.34
Na	0.14	0.12

Table 2. Effects of ascorbic acid and glucose in drinking water on the BW, FI and FCR in broilers reared high ambient temperature (32 ± 2 °C)

Treatment	42 day			49 day		
	Body weight (gm)	Feed intake (gm)	Feed conversion ratio	Body weight (gm)	Feed intake (gm)	Feed conversion ratio
Control	1381.5 ± 32.70 ^{b}	3295.6 ± 27.00 ^{ab}	2.39 ± 0.07 ^{a}	1859.3 ± 20.80 ^{c}	4456.4 ± 42.10	2.40 ± 0.07 ^{a}
g1v1	1499.0 ± 43.90 ^{ab}	3297.6 ± 33.80 ^{ab}	2.21 ± 0.06 ^{ab}	1977.5 ± 20.30 ^{a}	4461.6 ± 34.60	2.26 ± 0.06 ^{ab}
g1v2	1557.8 ± 35.10 ^{a}	3315.7 ± 43.30 ^{ab}	2.13 ± 0.05 ^{b}	2012.5 ± 23.40 ^{a}	4438.1 ± 33.70	2.21 ± 0.05 ^{b}
g2v1	1534.0 ± 24.20 ^{a}	3194.4 ± 15.00 ^{b}	2.09 ± 0.04 ^{b}	1895.0 ± 16.10 ^{bc}	4380.6 ± 22.30	2.31 ± 0.04 ^{ab}
g2v2	1547.8 ± 17.60 ^{a}	3246.9 ± 29.70 ^{ab}	2.10 ± 0.04 ^{b}	1994.6 ± 23.30 ^{a}	4387.4 ± 20.20	2.20 ± 0.04 ^{b}
g3v1	1495.3 ± 25.30 ^{ab}	3225.8 ± 30.20 ^{b}	2.16 ± 0.03 ^{b}	1949.9 ± 20.50 ^{ab}	4371.6 ± 43.00	2.24 ± 0.03 ^{b}
g3v2	1611.5 ± 26.00 ^{a}	3364.7 ± 52.40 ^{a}	2.09 ± 0.04 ^{b}	2018.9 ± 7.98 ^{a}	4489.9 ± 56.50	2.22 ± 0.04 ^{b}
$CD_{5\%}$	67.9	78.0	0.109	43.70	84.70	0.074

Control: without adding the glucose and ascorbic acid in drinking water,
g1v1: 2% glucose with 200 ppm ascorbic acid, g1v2: 2% glucose with 300 ppm ascorbic acid,
g2v1: 4% glucose with 200 ppm ascorbic acid, g2v2: 4% glucose with 300 ppm ascorbic acid,
g3v1: 6% glucose with 200 ppm ascorbic acid, g3v2: 6% glucose with 300 ppm ascorbic acid,
Means having the same superscript letters do not differ significantly at 5% level.

Table 3. Effects of ascorbic acid and glucose in drinking water on the carcass compositions in broilers reared high ambient temperature (32 ± 2 °C)

Treatment	Carcass yield	Breast muscle	Thigh muscles	Abdominal fat
Control	55.65 ± 3.97	32.33 ± 7.17	40.85 ± 3.97	9.08 ± 3.01
g1v1	56.22 ± 4.14	32.26 ± 3.53	40.71 ± 4.46	9.46 ± 2.81
g1v2	56.55 ± 3.17	33.11 ± 3.63	40.76 ± 4.63	9.56 ± 2.56
g2v1	56.111 ± 3.07	32.17 ± 5.02	40.41 ± 4.26	9.18 ± 3.51
g2v2	55.797 ± 7.14	32.22 ± 5.02	40.23 ± 5.06	9.19 ± 3.50
g3v1	56.21 ± 5.52	33.31 ± 5.00	40.85 ± 4.96	9.55 ± 3.74
g3v2	55.63 ± 5.38	32.17 ± 6.50	40.49 ± 6.01	9.10 ± 3.99
$CD_{5\%}$	4.821	5.274	4.804	3.337

Control: without adding the glucose and ascorbic acid in drinking water,
g1v1: 2% glucose with 200 ppm ascorbic acid, g1v2: 2% glucose with 300 ppm ascorbic acid,
g2v1: 4% glucose with 200 ppm ascorbic acid, g2v2: 4% glucose with 300 ppm ascorbic acid,
g3v1: 6% glucose with 200 ppm ascorbic acid, g3v2: 6% glucose with 300 ppm ascorbic acid.

Thaxton *et al*. (1974) reported that oral administration of glucose increased the body temperature of neonatal chickens that were exposed to 21 °C and suggested that carbohydrate metabolism is involved in the physiological regulation of body temperature. Glucose intake may influence blood viscosity, because blood is not only a medium for transporting nutrients, metabolic waste products, and gases, around the body, but also plays an important role in the diffusion of body heat. The effect of glucose may be involved not only in improving performance, but also in thermoregulation. During high ambient temperature, birds that received a glucose-water solution exhibited lower rectal temperatures than those birds that received only water (Iwasaki *et al*., 1997). In addition, Iwasaki *et al*. (1997) also observed that there was lower mortality from heat exposure in birds that consumed a glucose-water solution than in those that received only water during heat exposure. Zhou *et al*. (1998) indicate that thermoregulation may function more efficiently in the birds drinking glucose-water solution than in birds drinking tap water under high ambient temperature, because broiler mortality attributable to heat stress appears to be caused by a loss in thermoregulatory ability.

This result suggests that combination of ascorbic acid with glucose in drinking water alleviates the influence of high ambient temperature on broiler in grower and finisher stage of growth.

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