EFFECTS OF ASCORBIC ACID (VITAMIN C) SUPPLEMENTATION IN LAYER AND BROILER DIETS IN THE TROPICS

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Summary

An experiment was conducted to study the effects of Ascorbic Acid (AA) supplementations in the layer and broiler diets kept in the natural hot humid tropical climate (20-35℃). The layers and the broilers were fed on normal commercial diet as control while supplementation of 400 and 600 mg/kg Ascorbic Acid made up the experimental diets. The results showed that AA supplementation in the layers significantly reduced egg weight and increased Haugh unit values of the eggs, but produced no significant effects on feed intake, body weight, egg production, respiratory rate and body temperature. The shell thickness was slightly improved, though not significantly, with AA supplementation. AA supplementation in broilers improved body weight gain and FCR and reduced the effect of heat stress as shown by lower body temperature and respiratory rates.

(**Key Words** : Ascorbic Acid, Layers, Broilers, Egg production, Body temperature, Respiratory rate)

Introduction

Stress has been generally associated with decline in production performances. It follows, therefore, that the use of supplemental ascorbic acid during certain stress episode could dampen production performance losses by lessening the deleterious effects of stress. The precise mechanism or actual role of ascorbic acid in reducing stress in birds is still not very clear, because there are contradictory results.

High environmental temperature is of major concern to broiler and layer producers. Cyclic high temperature led to increased mortality and reduced growth rate in broilers (Joiner and Huston, 1957; Smith and Oliver, 1971; Bottje and Harrison, 1985; Pardue et al., 1985), and economic losses due to heat prostration increased as broilers approached market age and mortality resulting from heat prostration of broilers increased as temperature approached 38℃.

The reduced intake of essential nutrients which accompanied this phenomenon had been implicated in the depression of egg production (Tanor et al., 1984; Miller and Sunde, 1975), egg weight (Muller, 1961; de Andrade et al., 1977) egg shell thickness (Warren and Schnepel, 1940; Ragab and Assem, 1953), and body weight (Dale and Fuller, 1980; Valencia et al., 1980). Therefore, a diet formulated to provide all the necessary nutrients for productive efficiency at a low environmental temperature becomes less adequate as temperature rises. Payne (1966) had recommended suitable dietary modifications to minimise the adverse effects of a constant high environmental temperature and de Andrade et al. (1977) obtained better performance in laying hens with high nutrient density diets.

Ascorbic acid or vitamin C had been characterised as a nonessential component of poultry diet (Garrick and Hauge, 1925) as it can be synthesised intrinsically by the bird (Chatterjee et al., 1975). There are, however, some reports which suggested that under certain stress condition, e.g. hot climates, supplementation with this vitamin was beneficial. Purdue and Thaxton (1986), showed a consistent positive response to vitamin C when some stress factors were present. Perek and Kendler (1963) showed that during periods of heat stress, the capacity of birds to synthesize vitamin C was reduced and that dietary supplementation reduced mortality.

From a study with layers, Thornton and Moreng (1959) reported that addition of dietary ascorbic acid prevented part of the decline in egg shell quality due to high temperature stress. In contrast, Harms and Waldroup (1961) and Nestor et al. (1972) found that added ascorbic

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Received August 23, 1994
Accepted June 29, 1995

acid did not effect shell quality or egg production. The present study was carried out to observe the short term effect of ascorbic acid supplementation on the performances of the layers and the broilers under natural tropical climate.

Materials and Methods

Animals and their management

1. Layers

Six hundreds, forty three-week old Hisex brown layers were used in this study. These layers were selected at random from the main flock in the farm. Each bird was placed in an individual battery cage in the experimental house. The birds were divided into three-treatment groups of one hundred birds per treatment and were replicated twice and randomly fed with the treatment diets for four weeks. The normal standard commercial layer diet was used as the basal feed and control while supplementation of 400 and 600 mg Ascorbic Acid per kg of feed make up for the treatment diets 2 and 3.

2. Broilers

Three hundreds, twenty-eight day old Avian broilers of mixed sexes were used in this experiment. These birds were randomly selected from a flock of birds after brooding and were transferred to raised floor cages. Fifty birds were placed in each cage-house. Three treatments were employed where each treatment was randomly allocated and replicated twice. Normal standard commercial broiler diet was used as the experimental feed for the control and a supplementation of 400 and 600 mg Ascorbic Acid per kg of feed for treatment diets 2 and 3. The experiment was carried out for 21 days.

Data collection

Data collection included body weight, and feed intake which were taken at weekly intervals. Egg number, and egg weight were recorded daily. For Haugh units score and the egg shell thickness, ten eggs were used per treatment per week and the average were obtained. At the end of the experiment ten birds per treatment were randomly taken to measure the rectal temperature (by using an electronic thermometer) and respiratory rate (by counting the thoracic movements visually). All the data were analysed by using the linear model statistical programme package SAS.

Results and Discussion

Layers

The effects of vitamin C supplementation on the performances of the layers are shown in table 1. Egg production was slightly increased, though not significant, when the layers received AA supplementation in the feed. However, the egg weight decreased slightly with the AA supplementation and the significant effect was observed with the layers on 400 mg/kg. Haugh Units improved with the AA supplementation, the highest being the group fed on 600 mg/kg. The shell thickness was improved from 0.3575 mm to 0.3775 mm at 400 mg/kg and 0.3675 mm at 600 mg/kg of vitamin C inclusions. However, these improvements were not significantly different. Feed intake was also not affected by vitamin C supplementation.

The results from this experiment showed a conflicting effect of vitamin C supplementation in the layer diet. This could be due to age and the breed of the birds. The adaptability status of the birds also played a role in the final response of the layers. These layers were already forty-three weeks old and some adaptability process had taken place as was shown by the stability of the body temperature and the respiratory rate (table 2).

The present data tend to support some of the earlier findings of the action of AA in that little or no beneficial response by the laying hens. These data are in contrast to the findings of Thornoton and Moreng (1959), and Peebles and Brake (1985) which showed beneficial responses due to AA supplementation particularly where heat stress was involved. However, Schmeling and Nockles (1978) showed that ascorbic acid is also known to reduce the concentration of corticosterone in the plasma of mature

TABLE 1. EFFECT OF ASCORBIC ACID SUPPLEMENTATION ON PERFORMANCE OF LAYING HENS

Treatment	Added Ascorbic Acid (mg/kg)	Feed intake (g/b/d)	Egg weight (g)	Weight gain (g/b/d)	Egg production (%)	Haugh units	Shell thickness (mm)
1	0	$89.3^a \pm 2.00$	$62.14^a \pm 1.15$	$4.3^a \pm 0.05$	$78.22^a \pm 1.50$	$73^a \pm 5$	0.3575^a
2	400	$89.3^a \pm 2.20$	$58.87^b \pm 2.55$	$4.2^a \pm 0.03$	$78.50^a \pm 1.60$	$75^b \pm 2$	0.3775^a
3	600	$88.2^a \pm 2.10$	$61.87^a \pm 1.50$	$4.3^a \pm 0.08$	$78.54^a \pm 1.90$	$76^b \pm 3$	0.3675^a

[a,b] Means within a column with different superscripts are significantly different ($p < .05$)

female birds, while North (1980) explained that birds with low plasma corticosterone were more docile, faster growth rate, low heart rate, produced more and larger eggs, showed higher resistance to many infections and responded well to vaccination. Consequently, ascorbic acid has the capacity of an anti-stress in layers exposed to hot ambient temperature as seen in the present experiment.

TABLE 2. EFFECT OF ASCORBIC ACID SUPPLEMENTATION ON BODY TEMPERATURE (℃) AND RESPIRATORY RATE (BREATH/MIN) OF LAYERS

Treamtent/ Time	Body Temperature				
	08:00 H	12:00 H	14:00 H	16:00 H	X
0 ppm	41.05	41.43	41.48	41.55	41.38
400 ppm	40.88	41.08	41.45	41.58	41.25
600 ppm	40.88	40.98	41.43	41.55	41.21
	Respiratory Rate				X
0 ppm	51	49	46	51	49
400 ppm	55	54	54	51	53
600 ppm	58	52	54	54	54

The results are not significant.

Broilers

The effects of vitamin C supplementation on the broiler performances are shown in table 3. There were no significant differences in the feed intake of the birds fed different levels of ascorbic acid. However, the feed conversion ratio (FCR) was significantly different with different levels of vitamin C, where FCR improved from 2.3 to 1.84 (table 3). Increasing AA supplementation had some positive effect on the body weight but not on the feed intake of broilers. Other studies had indicated positive responses especially immediately after heat stress (Thaxton and Pardue, 1984). It had been suggested that AA may reduce glucocorticoid levels during heat stress, resulting in less tissue degradation (Frankel, 1970), thus allowing the birds to gain more weight following the heat stress period (Thaxton and Pardue, 1984). AA supplementation during heat stress could be beneficial to the growth of the broilers, as heat induced corticosteroids would be suppressed (Edens and Siegel, 1975).

Chicken can synthesise AA primarily in the kindey (Roy and Guha, 1958). The quantity synthesised would be sufficient for the normal growth and metabolism (Sealock and Goodland, 1951), but under stressful conditions synthesised AA may not be adequate for physiological requirement (Freeman, 1971; Siegal, 1971; Horning et al., 1984).

It was also observed that the broilers fed on AA supplemented diet were less stressed than the control as shown by changes in body temperature and respiratory rate. As shown in table 4 the changes in these parameters were lesser in the treated birds. AA has enabled the birds to reduce the effect of the heat stress. Though the results from these experiments were inconclusive but it has been shown that addition of AA has reduced the effect of heat stress and produced better performances of the broilers.

TABLE 3. EFFECT OF ASCORBIC ACID SUPPLEMENTATION ON PERFORMANCE OF BROILERS (28 DAYS TO 49 DAYS)

Treat-ment	Added ascorbic acid (mg/kg)	Weight gain (g/b/d)	Feed intake (g/b/d)	Feed conversion ratio (FCR)
1	0	40.0[a]	92.4[a]	2.3[a]
		± 0.10	± 2.69	± 0.01
2	400	49.0[b]	93.8[a]	1.9[b]
		± 0.05	± 2.47	± 0.02
3	600	50.0[b]	91.9[a]	1.8[b]
		± 0.05	± 2.60	± 0.02

[a,b] Means in a column with different superscripts are significantly different ($p < .05$).

TABLE 4. EFFECT OF ASCORBIC ACID SUPPLEMENTATION ON BODY TEMPERATURE (℃) AND RESPIRATORY RATE (BREATH/MIN) OF BROILERS

Treamtent/ Time	Body Temperature				
	08:00 H	12:00 H	14:00 H	16:00 H	X
0 ppm	40.95[a]	42.75[a]	42.22[a]	42.93[a]	42.21
400 ppm	40.96[a]	42.58[a]	42.05[a]	42.18[b]	41.94
600 ppm	40.93[a]	41.90[b]	42.05[a]	41.65[c]	41.63
	Respiratory rate				X
0 ppm	60[a]	102[a]	120[a]	65[a]	86
400 ppm	60[a]	91[b]	84[b]	64[a]	74
600 ppm	62[a]	71[c]	68[c]	62[a]	65

[a,b,c] Means within a column with different superscripts are significantly differently ($p < .05$)

Literature Cited

Bottje, W. G. and P. C. Harrison. 1985. Effect of carbonated water on growth performance of cockerels subjected to constant and cyclic heat stress temperatures. Poult. Sci. 64:1285-1292.

Chatterjee, I. B., A. K. Majumder, B. K. Nandi and N. Subramaniam. 1975. Synthesis and some major functions of vitamin C in animals. Annals of the New York Academy of Sciences, 258:24-47.

Dale, N. M. and H. L. Fuller. 1980. Effect of diet composition on feed intake and growth of chick under heat stress. Poult. Sci. 59:1434-1441.

De Andrade, A. N., J. C. Rogler, W. R. Featherston and C. W. Alliston. 1977. Interrelationship between diet and elevated temperature (cyclic and constant) on egg production and shell quality. Poult. Sci. 56:1178-1188.

Edens, F. W. and H. S. Siegel. 1975. Adrenal responses in high and low ACTH response lines of chickens during acute heat stress. Gen. Comp. Endocrinol. 25:64-73.

Frankel, A. I. 1970. Neurohumoral control of the avian adrenal. A review. Poult. Sci. 49:869-921.

Freeman, B. M. 1971. Stress and the domestic fowl : A physiological appraisal. Poult. Sci. 27:263-275.

Garrick, C. W. and S. M. Hauge. 1925. Presence of the antiscorbutic substance in the livers of chickens fed on scorbutic diet. J. Biol. Chem. 63:115-122.

Harms, R. H. and P. W. Waldroup. 1961. The influence of dietary calcium level and supplementary ascorbic acid and/or dienestrol diacetate upon performance of egg production type hen. Poult. Sci. 40:1345-1348.

Horning, D., B. Glatthaar and U. Moser. 1984. General aspects of ascorbic acid function and metabolism. Proceedings-Ascorbic Acid in Domestic animals. Royal Danish Agri. Soc., Copenhagen, Denmark.

Joiner, W. P. and T. M. Huston. 1957. The influence of high environmental temperature on immature fowl. Poult. Sci. 36:973-978.

Miller, P. C. and M. L. Sunde. 1975. The effects of pricise constant and cyclic environments on shell quality and other lay performance factors with Leghorn pullets. Poult. Sci. 54:36-46.

Muller, W. J. 1961. The effect of constant and fluctuating environmental temperatures on the biological performance of laying pullet. Poult. Sci. 40:1562-1571.

Nestor, K. E., S. P. Touchburn and M. Treiber. 1972. The influence of dietary ascorbic acid on blood ascorbic acid level and egg production in turkeys. Poult. Sci. 51:1676-1680.

North, M. O. 1980. Stress : What it is and how to recognise it. Poult. Digest. February pp. 80-86.

Pardue, S. L. and J. P. Thaxton. 1986. Ascorbic acid in Poultry. A review. World's Poult. Sci., 42:107-123.

Pardue, S. L., J. P. Thaxton, and J. Brake. 1985. Influence of suplemental ascorbic acid on broiler performance following exposure to high environmental temperature. Poult. Sci. 64:1334-1338.

Payne, C. G. 1966. Practical aspects of environmental temperature for laying hens. World's Poult. Sci. J., 22:126-139.

Peebles, E. D. and J. Brake. 1985. Relationship of dietary ascorbic acid to broiler breeder performance. Poult. Sci. 64:2041-2048.

Perek, M. and J. Kendler. 1963. Ascorbic acid as a dietary supplement for White Leghorn hens under conditions of climatic stress. Brit. Poult. Sci. 4:191-200.

Ragab, M. T. and M. A. Assem. 1953. Effect of atmospheric temperature and day light on egg weight and egg yield in Fayomi and Baladi Fowls. Poult. Sci. 32:1021-1027.

Roy, R. N. and B. C. Guha. 1985. Species differences in regard to the biosynthesis of ascorbic acid. Nature 182:319-320.

Schmeling, S. R. and C. F. Nokels. 1978. Effect of age, sex and ascorbic aicd ingestion on chicken plasma Corticosterone levels. Poult. Sci. 57:527-533.

Sealock, R. R. and R. L. Goodland. 1951. Ascorbic acid a coenzyme in tyrosine oxidation. Science. 114:645-646.

Siegel, H. S. 1971. Adrenals, stress and the environment. World's Poult. Sci. J.27:327-349.

Smith, A. J. and J. Oliver. 1971. Some physiological effects of high environmental temperature on the laying hen. Poult. Sci. 50:912-925.

Tanor, M. A., S. Leeson and J. D. Summers. 1984. Effect of heat stress and diet composition on performance of White Leghorn hens. Poult. Sci. 63:304-310.

Thaxton, J. P. and S. L. Pardue. 1984. Ascorbic acid and physiological stress. Proceedings-Ascorbic Acid in Domestic Animals. Royal Danish Agric. Soc., Copenhagen, Denmark.

Thornton, P. A. and R. E. Moreng. 1959. Further evidence on the value of ascorbic acid for maintenance of shell quality in warm environmental temperature. Poult. Sci. 38:594-599.

Valencia, M. E., P. M. Maiorino and B. L. Reid. 1980. Energy utilisation by laying hens. Ⅱ. Energetic efficiency of added tallow at 18.3 and 35℃. Poult. Sci. 59:2071-2076.

Warren, D. C. and P. D. Schnepel. 1940. The effect of air temperatures on egg shell thickness in the fowl. Poult. Sci. 19:67-72.