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Effect of Dietary Ascorbic Acid on Performance of Broiler Chickens Exposed to Different Lighting Regime

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Abstract: A 2 x 2 factorial experiment was conducted to determine the performance of 400 Anak broiler chicks exposed to two lighting regimes viz. 12 h light:12 h darkness and 24 h light:0 h darkness and fed diets containing two levels of ascorbic acid (0 and 250 mg AA/kg of feed). Each treatment was replicated four times with 25 birds per replicate. Results showed that at the starter phase of growth, chicks on continuous lighting regime recorded significantly ($p<0.05$) higher weight gain than those on limited lighting regime. Addition of ascorbic acid in the diet of chicks in the starter phase significantly ($p<0.05$) improved weight gain. At the grower phase, lighting regime recorded no significant ($p>0.05$) effect on weight gain but addition of ascorbic acid in the diet significantly ($p<0.05$) improved weight gain. There was significant ($p<0.05$) interaction as chicks on continuous lighting regime with ascorbic acid in their diet recorded higher weight gain than other treatments i.e limited lighting with no ascorbic acid in the diet. At the starter phase there was no significant difference ($p>0.05$) between continuous and limited lighting on feed: gain ratio. However, chicks with ascorbic in their diet recorded significantly ($p<0.05$) better feed: gain ratio than those without ascorbic acid. Inclusion of ascorbic acid in the diet significantly ($p<0.05$) reduced feed cost per kilogram weight gain. Ascorbic acid inclusion significantly ($p<0.05$) increased femur weight but not femur ash and tibia length. Continuous lighting and inclusion of ascorbic acid from diets increased incidence of leg abnormality significantly. Inclusion of ascorbic acid significantly ($p<0.05$) reduced the severity of leg abnormality. In conclusion continuous lighting and ascorbic acid in the diet may improve weight gain, feed: gain ratio, reduced feed cost per kilogram weight gain and reduction in the severity of leg abnormality. It may be recommended that under continuous lighting, inclusion of ascorbic acid in the diet may be recommended for balanced growth of the chicks.

Key words: Lighting regimes, ascorbic acid, broiler performance, bone

INTRODUCTION

Intensification of broiler production in the last several decades was conditioned by progress in selection activities, creating of genotypes which would enable faster growth rate in shorter period of time. This selection strategy has achieved some degree of success in the desired goals, but on the other hand it increased fat deposition, leg abnormalities and metabolic diseases such as ascites and sudden death syndrome (Rahimi *et al*., 2005). Consequently these set backs and the associated financial losses have led to a renewed interest in optimizing techniques in broiler rearing management. Broiler chickens have usually been reared under a continuous or nearly continuous lighting schedule so as to maximize feed intake and growth rate. However, earlier reports of Cave (1981) and Ohtani and Tanaka (1997) have shown that performance of broiler chickens is generally improved by intermittent lighting schedule compared with such continuous lighting.

Furthermore research work of Milosevic *et al*. (1999) also indicated possibility for improvement of production performances, fewer health problems and more rational production in discontinuous light programme. Tuleun and Njoku (2000) reported that depending on the season and type of housing available, higher production efficiency can be achieved by combining feed restriction with specific photoperiods. Lewis and Perry (1995) suggested stepping down the short lighting regime during the rearing period followed by stepping up the long lighting regime during the reproductive season. However, comprehensive information is still not available to explain exactly how light and feed restriction may act in a synergistic manner to control sexual maturity and overall reproductive performance in female breeder flock. There are however, some aspects of the principle behind lighting control which deserve careful understanding in the lowland, humid tropical environment with view to incorporating them into the housing and feeding of broiler chickens. Light withdrawal is a technique used in feed management, and fasting or starvation is reported to cause hunger and frustration in broiler chickens due to a high motivation for feeding (Hocking, 1993; Hocking *et al*., 1993; 1996: Savory and Moros, 1993; Savory *et al*., 1993 and De Jongs *et al*., 2002). Numerous reports have shown that

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fasting or starvation constitutes nutritional stress (Ketchik and Sykes, 1978; Savory *et al*., 1993). Furthermore, it has been demonstrated that birds under situation of stress exhibit borderline deficiency of ascorbic acid (Pardue and Thaxton, 1986; Njoku and Nwazota, 1989; Tuleun and Njoku, 2000; Ayo *et al*., 2007), thus compromising productivity. Under such conditions, exogenous supplementation with ascorbic acid has been advocated.

The purpose of the experiment reported herein was to determine the effect of ascorbic acid on performance of broiler chickens exposed to two lighting program.

MATERIALS AND METHODS

A total of 400 unsexed day old Anak broiler chicks were weighed in batches of 25 and placed in 16 deep litter pens of a tropical type open-sided poultry house. Black curtains were used to provide the poultry house with predetermined light regimes together with adequate ventilation.

A 2 x 2 factorial design involving two levels each of ascorbic acid and light regime was employed. The birds in the first set of eight pens were given 24 h (6.00 am-6.00 am) of light (+LT) while the birds in the remaining eight pens were given 12 h (6.00 am-6.00 pm) of light (-LT) per day. Within each set of light regimes, the birds were fed basal broiler starter and finisher diets. Furthermore, a chemically modified Ascorbic Acid (AA) to retard oxidation was added to the diets in four pens randomly selected within each light regime at levels of 0 (-AA) or 250 mg (+AA) per kilogram of diet (Table 1) . Feed and water were provided *ad libitum*. Birds and feed were weighed fortnightly. Mortality was recorded as it occurred.

At the 56^{th} day of age, the incidence and severity of leg abnormalities were scored in all pens. The incidence was defined as the percentage of birds in each pen showing at least some degree of leg disorder. Severity was recorded by a 3-step scoring systems; (1) Bird having slight difficulty in moving due to either hip, leg or foot defects, (2) Birds having moderate difficulty in moving and (3) Birds having severe difficulty in moving and lying down.

At the termination of the experiment, two broiler chickens were selected on the basis of average pen weight from each of the treatment replicates, slaughtered by cervical dislocation and dressed. The left femurs were carefully removed after limbs had been separated. The lengths of the bones were measured with vernier calipers, after which they were dried in the oven at 105°C for 48 h. The bones were crushed and defatted by defluxing for 12 h in a soxhlet apparatus. The percentage fat-free ash was determined by ashing samples of the bone in a silica dish. Data collected were subjected to a 2 x 2 factorial analysis of variance (Snedecor and Cochran, 1974). Comparisons of treatment means were made by Ducan's Multiple Range Tests (Steel and Torrie, 1980).

Table 1: Composition and calculated analysis of based diets

	Composition	
Ingredients	Broiler starter	Broiler Finisher
Maize	51.00	54.00
Rife offal	3.40	3.00
Groundnut cake	41.00	38.00
Fish meal	-	0.50
Dicalcium phosphate	2.50	2.00
Limestone	1.00	0.50
Lysine	0.20	0.20
Methionine	0.20	0.20
Vt. Min premix	0.30	0.25
Salt	0.30	0.25
Monensin	0.10	0.10
Total	100.00	100.00
Calculated nutrient levels		
Crude protein (%)	21.50	20.90
Metabolizable energy (kcal/Kg)	2823	2889
Calcium (%)	1.18	1.06
Phosphorus (total, %)	1.74	0.92
Phosphorus (Available, %)	0.52	0.64

RESULTS

The main effects of lighting regime and dietary ascorbic acid supplementation level on performance of broiler in starter and finisher phases are summarized in Table 2.

Effect of lighting regime: At the starter phase (0-4 weeks) chicks under continuous lighting regime (+LT) grew 36.19 gm more rapidly ($p<0.05$) than the chicks under limited lighting regime (-LT). The chicks under continuous lighting regime also showed a better feed: gain ratio (2.46). This was not significantly different ($p>0.05$) from the valve for chicks under limited lighting regime (2.65).

Average weight gain, feed intake and feed: gain ratio were not significantly ($p>0.05$) affected by lighting regime at the finisher phase (5-8 weeks). It was however observed that birds on continuous lighting programme throughout the study period (0-8 weeks) exhibited higher life weight value (1742.30 g) which was significantly different ($p<0.01$) from the value for birds under limited lighting regime (1705.40 g).

Effect on Ascorbic acid level: Broiler starter phase (0-4 weeks) chicks fed diet supplemented with 250 mg/kg ascorbic acid (+AA) consumed less feed ($p>0.05$) than those fed the non ascorbic (-AA) supplemented diet (Table 2). Birds on ascorbic acid treatment gained significantly ($p<0.05$) more weight and had better feed: gain ratio than those on diet without ascorbic acid supplementation. At this stage, chicks that had no ascorbic acid in their diet recorded a higher cost per kilogram gain (38.54) which was not significantly different ($p>0.05$) from those on ascorbic acid treatment group (35.49).

Table 2: Main effects of light regime and Ascorbic acid level on performance of broiler chickens

	Light Regimes			Ascorbic Acid Level (mg/kg feed)		
Parameters	+LT	-LT	SE	0	250	SE
0-4 weeks						
Av. Initial wt (g)	39.35	39.37	0.02[NS]	39.37	39.35	0.02[NS]
Av. Wt gin (g)	444.02[a]	407.83[b]	9.31*	405.55[d]	445.30[c]	9.31*
Av. Feed intake (g)	1088.30	1062.70	17.31[Ns]	1088.30	1062.70	17.31[Ns]
Feed/gain ratio	2.46	2.65	0.06[NS]	2.70[d]	2.41[c]	0.06*
Feed cost (N/kg gain)	37.14	36.88	0.84[NS]	38.54	35.49	0.84[NS]
5-8 weeks						
Av. Wt gain (g)	1298.30	1297.50	6.78[NS]	1251.30[d]	1344.50[c]	6.78**
Feed intake (g)	2933.60	3035.0	58.41[NS]	2965.20	3003.40	58.41[NS]
Feed/gain ratio	2.26	2.34	0.04[NS]	2.37	2.24	0.04[NS]
Feed cost (N/kg gain)	33.51	33.57	0.24[NS]	34.20[a]	32.88[b]	0.24*
Average life wt (g)	1742.30[a]	1705.4[b]	3.67*	1656.80[d]	1790.80[c]	3.67**
Mortality % (0-8 weeks)	3.20	2.85	0.17[NS]	3.30	.75	0.17[NS]

[ab]Means of the main effects of light regimes having different superscripts are significantly different (p<0.05)

[cd]Means of the main effects of Ascorbic acid level having different superscripts are significantly different (p<0.05; p<0.01)

The growth rates of the experimental finisher broiler (5-8 weeks) were significantly (p<0.01) depressed in the diet containing no ascorbic acid. Broiler on dietary AA had significantly higher weight (93.2 g) gain than their counterpart group. Also broiler chicks on the AA supplemented diet exhibited a better feed: gain ratio, though not significantly (p>0.05) different from those fed the unsupplemented diet. Furthermore broiler chickens on ascorbic acid diet throughout the experimental period recorded significantly (p<0.01) higher life weight (1790.8 g) compared with those without ascorbic acid supplementation (1656.80 g). During the finisher phase birds that had no ascorbic acid in their diet recorded a higher cost per kilogram gain (34.20). This was significantly different (p<0.05) from the value for birds that had AA in their diet (32.88).

Interactions between lighting regime and ascorbic acid supplementation level: The effects of the lighting regime and ascorbic acid supplementation combinations are given in Table 3. At the chicks starter phase, there were no significant (p>0.05) lighting regime X ascorbic acid interaction effects on feed intake and cost per unit gain. However, mean weight gain and feed conversion ratio differed significantly (p<0.05) among the treatment groups. The broiler chicks on continuous lighting regime and ascorbic acid treatment (+LT x +AA) showed the highest average weight gain (456.05 g). This was significantly different (p<0.05) from the values for those on continuous lighting but with no ascorbic acid (432.00 g) and those on limited lighting but with ascorbic acid (436.55 g) treatments which were not significantly different from one another. The chicks on limited lighting regime and with no ascorbic acid recorded the lowest average weight gain (379.10 g), which was significantly (p<0.05) different from the others. The chicks on diets supplemented with ascorbic acid recorded the best feed: gain ratio (i.e lowest feed/gain ratio whether with continuous lighting (2.38) or with limited lighting (2.44). At the finisher phase, there were no significant (p>0.05) lighting regime x ascorbic acid interaction effect on feed intake and feed: gain ratio, feed cost and mortality. However average weight gain showed significant (p<0.01) lighting regime x ascorbic acid interactions. Average weight gain was significantly highest and similar for broiler chicks fed diets with ascorbic acid supplementation, whether with continuous lighting or limited lighting regime. These were followed by weight gain by chicks fed diets without ascorbic acid and under limited lighting regime. The lowest weight gain was recorded for the chicks fed diets without ascorbic acid but under continuous lighting regime.

There was significant (p<0.05) lighting regime x ascorbic acid level interaction effect on average life weight. Birds on continuous lighting with dietary AA supplementation of 250 mg/kg (+LT x +AA) recorded the highest life weight (1824.80 g) which was significantly different (p<0.05) from the other three treatments combinations. Limited lighting with ascorbic acid (-LT x +AA) recorded the second highest live weight (1756.80 g) which was significantly different (p<0.05) from the other two treatment combinations namely continuous lighting with no ascorbic acid (+LT x -AA) and limited lighting with no ascorbic acid (-LT x -AA) (which recorded 1659.80 and 1653.90 g, respectively). The last two treatment combinations were not significantly different (p>0.05).

The main effects of lighting regime and dietary ascorbic acid supplementation on measured bone parameters are shown in Table 4.

Effect of lighting regime: Incidence of leg abnormality was significantly higher (p<0.01) in broilers under continuous lighting regime compared with those under limited lighting regime. However, femur length, femur weight, femur ash, tibia length, tibia weight and severity of leg abnormality were similar under both lighting regimes.

Table 3: Interaction effects of light regimes and ascorbic acid supplementation on performance of broiler chickens

	Light Regimes (LT)		Ascorbic Level		
Parameters	+LT	-LT	0	250	SE
0-4 weeks					
Av. Initial wt (g)	39.34	39.35	39.39	39.35	0.02^{NS}
Av. Wt.G (g)	432.00^{b}	456.05^{a}	379.10^{c}	436.55^{b}	13.16*
Feed intake (g)	1092.50	1084.00	1084.00	1041.50	24.2^{NS}
Feed/gain ratio	2.54^{b}	2.38^{a}	2.86^{c}	2.44^{a}	0.08*
Feed cost (N/kg gain)	38.78	35.51	38.29	35.47	1.19^{NS}
5-8 weeks					
Av. W.G gain(g)					
Av. F.I (g)	1227.70^{c}	1368.80^{a}	1274.9^{b}	320.20^{a}	8.89**
Feed/gain ratio	2909.80	2957.40	3020.7	3049.40	82.6^{NS}
Feed cost (N/kg gain)	2.37	2.16	2.37	2.31	0.06^{NS}
Average Life wt (g)	33.90	33.12	34.50	32.64	0.35^{NS}
Mortality % (0-8 weeks)	1659.80^{c}	1824.80^{a}	1653.90^{d}	1756.8^{b}	5.19**
	3.60	2.80	3.00	2.72	0.24^{NS}

^{abc}Means having different subscripts differ significantly at the levels of probability indicated

Table 4: Effect of light regimes and ascorbic acid supplementation on bone measurement

	Light Regimes (LT)			Ascorbic Acid (mg/kg feed)		
Parameters	+LT	- LT	SE	0	250	SE
Average Life wt (g)	1742.30^{a}	1705.4^{b}	3.67*	1656.80^{d}	1790.80^{c}	3.67**
Femur length (cm)	11.20	11.22	0.10^{NS}	11.13	11.29	0.10^{NS}
Femur wt (g)	9.72	9.84	0.09^{NS}	9.46^{d}	10.10^{c}	0.09**
Femur ash (%)	8.49	8.57	0.08^{NS}	8.59	8.47	0.08^{NS}
Tibia Length (cm)	8.06	8.19	0.10^{NS}	8.13	8.11	0.10^{NS}
Tibia wt (g)	6.99	7.17	0.12^{NS}	6.91	7.26	0.12^{NS}
Incident of leg abnormality (%)	8.72^{a}	4.96^{b}	0.40**	7.65^{c}	6.03^{d}	0.40**
Severity of leg abnormality (%)	1.95	1.63	0.17^{NS}	2.34^{d}	1.24^{c}	0.17**

^{ab}Means of the main effect of light regimes having different superscripts are significantly different ($p<0.05$; $p<0.01$).
^{cd}Mean of the main effects of Ascorbic acid level having different superscripts are significantly different ($p<0.05$; $p<0.01$)

Effect of ascorbic acid supplementation level: Broiler chickens on dietary AA supplementation had significantly higher ($p<0.01$) average life weight, femur weight with significantly lower incidence and severity of leg abnormality in comparison with broiler chickens with AA supplementation. However both groups of broiler chickens were similar with respect to femur length femur ash, tibia length and tibia weight.

Interactions between lighting regime and ascorbic acid level: There were no significant lighting regime x Ascorbic acid level interactions for femur length, femur weight, femur ash percentage, tibia length, tibia weight and percent severity of leg abnormality (Table 5). However there were significant lighting regime x Ascorbic acid level (LT x AA) interactions incidence on leg abnormality. Thus broilers exposed to continuous lighting and without ascorbic acid in their diet (+LT x -AA) yielded significantly higher ($p<0.05$) percent leg abnormality (9.75%) than those on continuous lighting and fed ascorbic acid diet (+LT x +AA) (7.69%). Furthermore +LT x +AA recorded higher percent leg abnormality (7.69%) which was significantly different ($p<0.05$) from the value (5.55%) for -LT x -AA. Limited lighting x +AA interaction recorded the least percent leg abnormality (4.39%), which was significantly lower ($p<0.05$) than the valve obtained for the -LT x -AA treatment combinations. The severity of leg abnormality was significantly lower in broiler chickens fed diets supplemented with ascorbic acid under both lighting regimes.

DISCUSSION

In the current study, birds on 24 h light schedule had full access to feed during continuous light, had higher body weight gain and better feed/gain ratio than those on limited (12 h) lighting schedule with reduced feed intake and depressed growth rate at the starter phase. These findings contrasted the reports of Cave (1981) and Deaton *et al*. (1981) who observed improvement in performance of broiler exposed to intermittent lighting schedules compared with continuous lighting programme. Also results of other previous research relating to application of light programme, i.e. discontinuous light in broiler production indicate the possibility for improvement of production performances, fewer health problems and more rational production (Milosevic *et al*., 1999).

The observed improvements in feed intake and weight gain of broiler on limited lighting regime at the finisher

Table 5: Interaction effects of light regimes and ascorbic acid level on broiler bone measurements

	Light Regimes (LT)		Ascorbic Acid, mg/kg feed		
Parameters	+LT	-LT	0	250	SE
Av. Life wt (g)	1659.80^{c}	1824.80^{a}	1653.90^{c}	1756.8^{b}	5.19**
Femur wt (g)	9.43	10.01	9.49	10.19	0.12^{NS}
Femur length (cm)	11.08	11.31	11.18	11.27	0.14^{NS}
Femur ash (%)	8.59	8.39	8.59	8.54	0.11^{NS}
Tibia Length (cm)	7.95	8.16	8.30	8.06	0.14^{NS}
Tibia wt (g)	6.77	7.22	7.05	7.29	0.17^{NS}
Incident of leg abnormality (%)	9.75^{a}	7.69^{b}	5.55^{c}	4.37^{d}	0.57*
Severity of leg abnormality (%)	2.47^{a}	1.42^{b}	2.21^{a}	1.05^{b}	0.24*

^{abc}Means having different superscripts differ significantly at the level of probability indicated (* = p<0.05; ** = p<0.01)

phase were not unexpected because it is known that birds can learn to eat in the dark thus the compensary growth. Rahimi *et al*. (2005) reported that birds under intermittent light will be quiet during night period; it is assumed that the reduction in activity during darkness may result in lower heat production, higher feed efficiency or both. According to earlier report of Peterson (2004), broilers cannot be in continuous light and need to have at least 8 h of dark period in a day. Rendem *et al*. (1991) and Ohtani and Tanaka (1998) also opined that the upper digestive tract might have been empty during the darkness and the birds immediately again ready to eat when light comes on. Feed conversion efficiency of chicks reared under intermittent light was better than the continuous.

The increases recorded in body weight gain at both phases of the experiment of broiler fed ascorbic acid supplemented diet are consistent with the findings of Alisheihov (1980) and Njoku (1986) who had earlier showed that ascorbic acid supplementation in diet improved final body weight. Pardue *et al*. (1985) using commercial male chicks observed significant faster growth rate when the birds were exposed to acute high environmental temperature and fed 1000 pm of supplemental ascorbic acid. Also Kafri and Cherry (1984) reported significant increases in the body weights of 36-day old females supplemented with 1000 pm AA and subjected to three temperature regimes. Males receiving 100 ppm AA exhibited significantly greater body weights when maintained at 32°C but not at 23°C, where a significant reduction was noted. Similarly, the practical benefits of AA supplementation on broiler performance have also been reported by Kutlu (2001) that supplementation with 250 mg AA/kg feed improved performance in broiler exposed to 35-37°C for 8 h/day. Furthermore, Raja and Qureshi (2000), based on an experiment on chicks during the hot season, finding that supplementation of 100 mg AA/kg feed improved body weight feed efficiency and livability compared to unsupplemented, stressed birds. In the current study, it is of noteworthy that broiler chickens fed diet supplemented with 250 mg AA/kg feed at both phases of growth performed better than those on the unsupplemented diet. The feed intake and feed conversion ratio were indicators of a better utilization of feed for the AA supplemented diets. Several reports of improvement of feed conversion ratio following AA supplementation have also been made by Njoku and Nwazota (1989), Njoku *et al*. (1990), Jafar and Blaha (1996) and Tuleun and Njoku (2000). This AA may be important in facilitating utilization of some nutrients under conditions of stress. Ascorbic acid had been suggested to promote mineral mobilization from bone (Thornton, 1970), increase plasma calcium (Sifri *et al*., 1977). Church and Pond (1975) also indicated that calcium and phosphorus cannot be deposited normally in bone when the matrix formation is impaired by AA deficiency. Similarly Criste *et al*. (1996) reported that AA increases iron (Fe) absorption; increase Fe retention in liver and increases serum Fe concentration in growing chickens. Of significant interest is the saving in the cost of feed required to produce a unit of body weight gain from the addition of ascorbic acid to broiler diet at both phases of production. For the birds fed on the unsupplemented diet, there were additional feed and extra period required to bring them to this defined market weight thereby reducing the number of production cycles to be undertaken per year. Financial benefits have also been highlighted by Njoku (1986) in broiler chickens fed AA supplemented diet during the period of heat stress.

Realization of significantly greater body weight gain and better feed conversion ratio in broiler chickens fed AA supplemented diet compared to the unsupplemented group at both levels of lighting regimes indicates the beneficial role of AA as antioxidant in ameliorating adverse effects of stress on modern poultry production. Several stressors are known to alter AA utilization and/or synthesis in the fowl. This includes high environmental humidity and temperature, high productivity rate, pathological and nutritional stresses. In addition, the supplementation of poultry diets with AA is demonstrated to influence various physiological parameters, particularly in stressed birds (Pardue and Thaxton, 1986; Ayo *et al*., 1996). Fasting or starvation is known to affect tissue AA concentration of mammals. Sykes (1978) reported that removal of feed for as brief a period of 10 h depleted duodenal AA, while AA depletion of the liver occurred within 24 h. Also earlier report of

Davidson (1975) showed that under light and dark, glycogen concentration were lower during the darkness as the birds do not eat and that this could increase the synthesis of glucorticoids, leading to tissue degradation and hence the loss in weight of the birds. According to Frankel *et al*. (1975) the improvement in body weight gain in AA supplemented group could possibly be that AA supplementation may have reduced glucorticoids level during the dark hour, resulting in less tissue degradation. In particular, dietary supplementation with AA can alleviate the dangers specifically associated with the rise in plasma corticosteroids. Pardue *et al*. (1985) reported that supplementation with 100 mg AA/kg decrease by about 50% the rise in plasma glucocorticoid concentration induced by a short period of acute heat stress in 4 week old chicks. Kutlu and Forbes (1993) studied AA supplements in the range 250-1000 mg/kg and found that 250 mg/kg gave on optimum effect in normalizing plasma hormone and metabolite concentration and organ weight. Similar mechanism may operate in chickens, as suggested by Mckee *et al*. (1997) who obtained evidence that AA supplementation (150 mg/kg) lowered the respiratory quotient of heat stressed chicks, indicative of an increase in fatty acid oxidation. It was concluded that supplemental AA influences body energy stores that are used for energy production purposes during period of reduced feed intake.

Leg weakness problems associated with abnormal bone growth are a major problem in broiler production under intensive management system. The significant increase in percent incidence of leg abnormality of broiler exposed to continuous light was expected. Broilers provided with 24 h light were observed to be extremely docile whereas the birds given 12 h light were more active during the period when light was on. The 12 h period of light and 12 h period of dark provided a regimented schedule of activity which may have been conducive to stronger leg development. These observations are in line with the reports of Thornton (1970) who observed that the administration of AA early in life resulted in increased bone matrix content as collagen synthesis is with the consequent reduction in bone ash of birds. Horning *et al*. (1984) also reported that AA deficiency could lead to reduced dry weights of collagen content of bone and cartilage and hence the leg weakness in the broilers. Likewise, Doan and Giang (1998) reported that dietary supplementation with 150 mg AA/kg decreased ($p<0.01$) mortality and the incidence of leg weakness at 21 days in broiler reared under tropical conditions. Doan (2002) later fed diets containing 11 or 8.5 g calcium in combination with 0 or 150 mg AA/kg and found lowest mortality and incidence of crooked legs and highest bone ash content with the diet containing 11 g calcium and 150 mg AA/kg and highest mortality and incidence of crooked legs from the diet with lower calcium content unsupplemented with AA. The author suggested a possible role for AA in promoting more normal bone growth.

The interactions between lighting regimes and AA supplementation indicate realized significant reduction in the incidence of leg abnormality in both limited and continuous light programme. AA is important in the biosynthesis of collagen, an important component of connective tissues. AA is a cofactor in the hydroxylation reactions of collagen. The disruption of collagen synthesis arising from lack of AA results in the widespread connective tissue abnormality characteristics of scurvy.

Conclusion: From the practical point of view, broiler chickens raised under 24 h lighting schedule had higher weight gain and better feed conversion ratio. However, the incidence and severity of leg abnormalities were more pronounced in broilers subjected to this lighting schedule than those reared under 12 h lighting schedule. Exogenous supplementation of broiler chicken feed with 250 mg ascorbic acid per kilogram feed at both phases of the study has been shown under these lighting schedules to produce positive responses in growth rate, feed conversion efficiency, financial return and reversed leg abnormalities.

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