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EFFECT OF FEED RESTRICTION AND ASCORBIC ACID SUPPLEMENTATION ON GROWTH PERFORMANCE, RECTAL TEMPERATURE AND RESPIRATORY RATE OF BROILER CHICKEN

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ABSTRACT

A total of 252 two-week old Marshall broiler chickens were used in a 4 x 3 factorial experiment to determine the effect of feed restriction and ascorbic acid supplementation on growth performance, rectal temperature and respiratory rate of broiler chickens. The birds were weighed and randomly allotted to 12 treatments with 3 replicates of 7 birds each, subjected to 4 feed restriction levels: full feeding (AD), skip a day feeding (SAD), skip two days feeding (S2D) and skip three days feeding every week (S3D) for 24 hours from 15th to 35th day of age and 3 levels of ascorbic acid supplementation (0, 150, 300 mg/kg feed). Feed was provided *ad libitum* from days 36 to 56. Ascorbic acid supplementation had no effect ($p>0.05$) on the performance parameters measured during feed restriction. Birds on S3D fed diets containing 300 mg/kg ascorbic acid had the highest ($p<0.05$) weight gain during realimentation. Ascorbic acid lowered the rectal temperature in birds on S2D and S3D at the end of feed restriction. At the end of realimentation, birds on S3D fed diets containing 150 mg/kg ascorbic acid had the lowest ($p<0.05$) respiratory rate. Ascorbic acid supplementation at 150 mg/kg feed enhanced weight gain, rectal temperature and respiratory rate of broiler chickens on skip three days feeding every week.

Key words: Feed restriction, Ascorbic acid, Broiler performance, Rectal temperature, Respiratory rate.

INTRODUCTION

The fast growth rate of broiler chickens is often accompanied by problems such as metabolic disorders and incidence of skeletal diseases (Olkowski *et al*., 2008). This phenomenon has prompted the broiler industry to find lasting solutions to these problems. Researches have been conducted to find appropriate palliative measures such as controlling feed intake and weight gain by tempering optimal growth rate through feed restriction programmes. Pinheiro *et al.* (2004) demonstrated that although, early feed restriction reduces growth performance, compensatory growth in the realimentation period will be attained to reach market weight of the animal. Ozkan *et al*. (2006) reported that feed restriction for a short period in broilers did not have negative effect on growth performance at 56 days of age. Furthermore, for broiler chickens to perform at their best capacity, they need to maintain a thermobalance with their internal and external environment. Thermobalance is the stability attained between the heat produced and heat given off by living organism and this is at its maximal physiological level within the thermoneutral range of any given specie. The measurement of the rectal temperature and respiratory rate in broiler chickens has proved to be a true reflection of the internal body temperature and reliable thermal balance index (Ayo *et al*., 1998). Broiler chickens are homeotherms and their body system may allow certain variations in temperature range without considerable disturbance within their system (St-Pierre *et al*., 2003). So a possible approach to counteracting the stress initiated by feed restriction could be supplementation with ascorbic acid. Ascorbic acid plays a key role in gluconeogenesis. Ascorbic acid as an antioxidant interrupts free radical chain reactions in the body (Powers and Jackson, 2008). Exogenous supplementation of ascorbic acid has shown to be beneficial in reducing the adverse effects of stress (Ayo *et al*., 2007; Konca *et al*., 2009;Tawfeek *et al*., 2014) and improve the growth performance of broiler chickens (Sabah Elkheir *et al*., 2008; Elagib and Omer, 2012). Due to paucity of information on the combined effect of feed restriction and ascorbic acid supplementation on growth performance, rectal temperature and respiratory rate of broiler chickens, the aim of the present study was to determine the effect of feed restriction and ascorbic acid supplementation on growth performance, rectal temperature and respiratory rate of broiler chickens.

MATERIALS AND METHODS

The experiment was carried out at the Poultry Unit of the Directorate of University Farms (DUFARMS), Federal University of Agriculture, Abeokuta, Nigeria. The area lies on latitude 7˚ 13' 49.46" N, longitude 3° 26' 11.98" E, altitude of 76 metres above sea level (Google Earth, 2006). The climatic condition is humid with a mean annual rainfall of 1037mm and located in the rainforest vegetation zone of western Nigeria. The mean annual temperature and humidity are 34ºC and 87% respectively (Amujoyegbe *et al*., 2008). A total of 252 unsexed day-old Marshall broiler chickens were sourced and raised on ascorbic acid free diet in deep litter pens of an open-sided poultry house for 14 days. The birds were fed with a conventional corn soybean meal diet (2942.46 kcal ME/kg, 20.75% CP). Normal prophylactic medication and vaccination were administered as and when due. On the 14th day, the chicks were randomly distributed after balancing for live weights into 12 treatments consisting of 3 replicates of 7 birds each. The dietary experiment was laid out in a 4 x 3 factorial arrangement consisting of 4 feed restriction levels: full feeding (AD), skip a day feeding (S1D), skip two days feeding (S2D) and skip three days feeding (S3D) every week for 24 hours and 3 ascorbic acid supplementation levels (0, 150, 300 mg/kg feed). The experiment was carried out in two phases: feed restriction phase (days 15-35) and realimentation phase (days 36-56) during which feed was provided *ad libitum* to all the birds. The experiment lasted for 56 days. During the experiment, the initial weight, final live weight, body weight gain, feed intake, feed conversion ratio, rectal temperature and respiratory rate were measured.

Statistical Analysis: Data collected were subjected to Analysis of Variance (ANOVA) in a completely randomized design in factorial arrangement using SAS (2002) Software Package. Differences among treatments were separated using Duncan's Multiple Range Tests.

RESULTS AND DISCUSSION

The effect of interaction of feed restriction and ascorbic acid supplementation on growth performance of broiler chickens during feed restriction (days 15-35) is presented on Table 1. Significant ($P<0.05$) differences were observed in final weight, weight gain, feed intake and feed conversion ratio. The lowest final weight and weight gain was observed in birds on S3D fed diets containing 0 mg/kg ascorbic acid. This could be attributed to reduced feed intake and hence, low nutrient intake. The improved feed conversion ratio in birds on S2D fed diets containing 0 mg/kg ascorbic acid may be attributed to reduced overall maintenance requirements caused by a temporary decrease in basal metabolic rate. This result agrees with the findings of Mohebodini *et al.* (2009) who reported a decrease in feed intake and body weight of broiler chickens as a result of feed restriction. Onbasilar *et al*. (2009) and Mehmood *et al.* (2013) observed improved feed conversion ratio in broiler chickens subjected to feed restriction. Ascorbic acid supplementation did not improve any of the parameters measured during feed restriction. This result can be supported by the findings of Konca *et al*. (2009) who stated that growth performance of broiler chickens were not influenced by ascorbic acid supplementation. In contrast, Farooqi *et al*. (2005) observed that when diet was supplemented with ascorbic acid, it brought about better growth performance in broiler chickens.

Table 2 shows the effect of interaction of feed restriction and ascorbic acid supplementation on growth performance of broiler chickens during realimentation (days 36-56). Significant ($P<0.05$) differences were observed in final weight, weight gain, feed intake and feed conversion ratio. The lowest final weight in birds on S3D fed diets containing 0 mg/kg ascorbic acid could be attributed to lower level of feed intake. The increased weight gain in birds on S2D fed diets containing 0 mg/kg ascorbic acid and birds on S3D fed diets containing 150 and 300 mg/kg ascorbic acid could be associated with lower maintenance energy required by birds under feed restriction (Yu and Robinson, 1992). This result supports the findings of Mahmud *et al.* (2008) who observed improved weight gain in feed restricted birds when compared with fully fed birds. In contrast, Benyi *et al*. (2011) reported reduced weight gain in feed restricted broiler chickens. Mbajiorgu *et al.* (2007) observed improved weight gain of broiler chickens fed ascorbic acid supplemented diets. The improved weight gain of the previously feed-restricted birds fed ascorbic acid supplemented diets indicate the ameliorative effect of ascorbic acid on weight gain of birds. This observation strengthened the findings of Onu (2009) who reported improvement in weight gain of broiler chickens due to ascorbic acid supplementation. Supplemental ascorbic acid did not improve feed conversion ratio in the birds during realimentation. This shows that the birds did not respond positively to the ascorbic acid in their diets. This agrees with the report of Lohakare *et al*. (2005) who also noted that ascorbic acid supplementation did not affect feed conversion ratio. In contrast, Tuleun and Njoku (2000) reported better feed conversion ratio subsequent to ascorbic acid supplementation in the diet of broiler chickens. Su *et al.* (1999) discovered that meal feeding brought about improvement in feed conversion ratio than physical feed restriction in broilers.

The effect of interaction of feed restriction and ascorbic acid supplementation on growth performance of broiler chickens during the entire experimental period (days 15-56) is presented on Table 3. Significant ($P<0.05$) differences were observed in final weight, weight gain, feed intake and feed conversion ratio. Birds on S3D fed diets containing 0 mg/kg ascorbic acid had the lowest final weight, feed intake, weight gain and best feed conversion ratio. This finding showed that the severity of feed restriction in S3D treatments was high and so these birds were unable to attain compensatory growth at 56 days. In accordance with the findings of Saleh *et al.* (2005), though the broiler chickens that were initially feed restricted exhibited increased potential to grow during the realimentation period, however, they could not attain the complete growth. On the other hand, Khetani *et al.* (2009) reported that feed restriction in the early growth stage brought about complete compensatory growth and inconsequential disparity in body weight between feed restricted and fully fed birds at market age. Another probable cause of incomplete compensatory growth in the feed-restricted birds may be the length of feed restriction (21 days) and realimentation period (21 days) not being sufficient enough for complete recovery of weight loss. Zubair and Leeson (1994) reported that over a period of 3 weeks is required for feed restricted birds to attain full growth recovery. As suggested by Doyle and Leeson (2003), feed-restricted broiler chickens must attain a normal weight for age prior to market, show improved growth efficiency and exhibit superior carcass characteristics for the concept of feed restriction to be of economic importance.

Table 4 shows the effect of interaction of feed restriction and ascorbic acid supplementation on the rectal temperature and respiratory rate of broiler chickens. At the end of feed restriction, significant ($P<0.05$) difference was observed in the rectal temperature. Birds on S2D and S3D fed diets containing 0, 150 and 300 mg/kg ascorbic acid had the lowest rectal temperature. The rectal temperature of the broilers (40.73-41.30ºC) fell within the normal range of 39.88 - 41.91ºC (Isidahomen *et al.*, 2012) reported for optimal performance of domestic chickens. The variation in temperature might have been due to the space available to the birds enabling air circulation and thermal changes between the birds and the environment. Also, the reduction in the rectal temperature of birds on S2D and S3D suggests the ability of ascorbic acid in reducing free radicals generated during stress periods and consequently, a reduction in the body temperature of birds. This result agrees with the findings of Adenkola and Ayo (2009) who stated that ascorbic acid lowered the unpleasant effect of stress by adjusting the rectal temperature in turkeys. The rectal temperature of broiler chickens should remain within the suitable limit of 41ºC if wellbeing is to be protected and production preserved at acceptable levels (Justin, 2004). In contrast to the insignificant ($P>0.05$) difference observed in the respiratory rate of the broiler chickens at the end of feed restriction, significant difference ($P<0.05$) was observed at the end of realimentation. The respiratory rate (41.67-45.00 breaths/mins) was similar to the respiratory band of 40 to 60 breaths/mins in Avian and Cobb strains of broiler chickens (Sheila *et al*., 2012). Garcia *et al.* (1992) did not observe any noticeable difference in the respiratory rate of broiler chickens as a result of feed restriction. Curca *et al.* (2004) reported that supplementation of ascorbic acid reduces environmental stress. The lower respiratory rate observed in birds on S3D fed diets containing 150 mg/kg ascorbic acid during realimentation could be attributed to the beneficial effect of ascorbic acid in maintaining standard metabolic rate and stable gaseous exchange (Afolabi *et al*., 2008). The possible explanation for the insignificant ($P>0.05$) difference in rectal temperature during realimentation may be due to the fact that the temperature was not high enough to impose stress on the broiler chickens.

Table 1. Effect of interaction of feed restriction and ascorbic acid supplementation on growth performance of broiler chickens during feed restriction (days 15-35)

Restriction levels	AD			S1D			S2D			S3D			SEM
Ascorbic acid levels	0mg/ kg	150mg/ kg	300mg/ kg	0mg/ kg	150mg/ kg	300mg/ kg	0mg/ kg	150mg/ kg	300mg / kg	0mg/ kg	150mg / kg	300mg/ kg	
Parameters													
Initial weight (g/b)	307.30	307.20	307.17	307.20	307.20	307.30	307.17	307.20	307.23	307.17	307.30	307.23	0.02
Final weight (g/b)	1260.53^{a}	1240.63^{b}	1230.53^{c}	1201.80^{e}	1211.90^{d}	1225.57^{c}	944.90^{h}	966.77^{g}	987.93^{f}	809.83^{k}	831.57^{j}	855.90^{i}	29.11
Weight gain (g/b/d)	45.40^{a}	44.43^{b}	44.00^{c}	42.60^{e}	43.10^{d}	43.73^{c}	30.40^{h}	31.43^{g}	32.43^{f}	23.97^{k}	24.97^{j}	26.13^{i}	1.39
Feed intake (g/b/d)	90.60^{a}	85.37^{c}	81.40^{d}	81.60^{d}	84.67^{c}	88.40^{b}	55.27^{g}	59.03^{f}	62.67^{e}	44.07^{j}	48.70^{i}	51.97^{h}	2.81
FCR	1.99^{ab}	1.92^{cd}	1.85^{ef}	1.92^{cd}	1.97^{abc}	2.02^{a}	1.82^{f}	1.88^{de}	1.93^{bcd}	1.84^{ef}	1.95^{bc}	1.99^{ab}	0.01

[abc]Means in the same row with different superscripts differ significantly (P<0.05)

FCR: Feed conversion ratio SEM: Standard error of mean g/b- gram per bird g/b/d- gram per bird per day
AD- Full feeding S1D- Skip a day feeding S2D- Skip 2 days feeding S3D- Skip 3 days feeding

Table 2. Effect of interaction of feed restriction and ascorbic acid supplementation on growth performance of broiler chickens during realimentation (days 36-56)

Restriction levels	AD			S1D			S2D			S3D			SEM
Ascorbic acid levels	0mg/ kg	150mg/ kg	300mg/ kg	0mg/ kg	150mg/ kg	300mg/ kg	0mg/ kg	150mg/ kg	300mg/ kg	0mg/ kg	150mg/ kg	300mg/ kg	
Parameters													
Final weight (g/b)	2320.00^{a}	2133.80^{c}	2058.13^{de}	2261.20^{b}	2085.67^{cd}	2272.43^{ab}	2100.00^{cd}	2050.83^{de}	2060.97^{de}	1930.20^{g}	1980.50^{fg}	2023.73^{ef}	20.01
Weight gain (g/b/d)	50.47^{c}	42.53^{d}	39.43^{e}	50.43^{c}	41.60^{de}	49.83^{c}	55.00^{a}	51.63^{bc}	51.10^{bc}	53.33^{ab}	54.70^{a}	55.61^{a}	0.91
Feed intake (g/b/d)	144.27^{a}	131.57^{e}	133.40^{d}	134.27^{d}	138.30^{c}	142.33^{b}	113.57^{g}	113.53^{g}	115.50^{f}	88.20^{j}	94.50^{i}	100.93^{h}	3.11
FCR	2.86^{c}	3.10^{b}	3.38^{a}	2.67^{d}	3.33^{a}	2.86^{c}	2.06^{f}	2.20^{ef}	2.26^{e}	1.66^{h}	1.73^{gh}	1.81^{g}	0.10

[abc]Means in the same row with different superscripts differ significantly (P<0.05)

FCR: Feed conversion ratio SEM: Standard error of mean g/b- gram per bird g/b/d- gram per bird per day
AD- Full feeding S1D- Skip a day feeding S2D- Skip 2 days feeding S3D- Skip 3 days feeding

Table 3. Effect of interaction of feed restriction and ascorbic acid supplementation on growth performance of broiler chickens during entire experimental period (days 15-56)

Restriction levels	AD			S1D			S2D			S3D			SEM
Ascorbic acid levels	0mg/ kg	150mg/ kg	300mg/ kg	0mg/ kg	150mg/ kg	300mg/ kg	0mg/ kg	150mg/ kg	300mg/ kg	0mg/ kg	150mg/ kg	300mg/ kg	
Parameters													
Initial weight (g/b)	307.30	307.20	307.17	307.20	307.20	307.30	307.17	307.20	307.23	307.17	307.30	307.23	0.02
Final weight (g/b)	2320.00^{a}	2133.00^{c}	2058.13^{de}	2261.20^{b}	2085.67^{cd}	2272.43^{ab}	2100.00^{cd}	2050.83^{de}	2060.97^{de}	1930.20^{g}	1980.50^{fg}	2023.73^{ef}	20.01
Weight gain (g/b/d)	47.93^{a}	43.50^{b}	41.70^{de}	46.50^{b}	42.37^{cd}	46.77^{ab}	42.70^{cd}	41.50^{de}	41.77^{de}	38.63^{g}	39.83^{fg}	40.87^{ef}	0.48
Feed intake (g/b/d)	117.43^{a}	108.50^{d}	107.43^{d}	107.93^{d}	111.50^{c}	115.40^{b}	84.47^{g}	86.30^{f}	89.10^{e}	66.17^{j}	71.63^{i}	76.47^{h}	2.94
FCR	2.45^{b}	2.49^{b}	2.58^{a}	2.32^{c}	2.63^{a}	2.47^{b}	1.98^{e}	2.08^{d}	2.13^{d}	1.71^{h}	1.80^{g}	1.87^{f}	0.05

^{abc}Means in the same row with different superscripts differ significantly ($P<0.05$)

FCR: Feed conversion ratio; SEM: Standard error of mean; g/b- gram per bird; g/b/d- gram per bird per day
AD- Full feeding; S1D- Skip a day feeding; S2D- Skip 2 days feeding; S3D- Skip 3 days feeding

Table 4. Effect of interaction of feed restriction and ascorbic acid supplementation on rectal temperature and respiratory rate of broiler chickens

Restriction levels		AD			S1D			S2D			S3D			SEM
Ascorbic acid levels		0mg/ kg	150mg/ kg	300mg/ kg	0mg/ kg	150mg/ kg	300mg/ kg	0mg/ kg	150mg/ kg	300mg/ kg	0mg/ kg	150mg / kg	300mg/ kg	
Phases	PT													
End of feed restriction	RT	41.30^{a}	41.07^{b}	41.03^{b}	41.23^{a}	41.27^{a}	41.27^{a}	40.73^{c}	40.87^{c}	40.83^{c}	40.87^{c}	40.83^{c}	40.80^{c}	0.04
	RR	43.67	42.33	43.33	44.00	43.33	43.00	44.33	44.33	45.00	43.00	42.67	45.00	0.24
End of realimentation	RT	40.97	40.97	40.93	40.83	40.97	40.97	41.03	41.00	40.97	40.97	40.93	40.83	0.03
	RR	42.67^{abc}	42.33^{abc}	42.33^{abc}	42.00^{bc}	43.33^{ab}	42.33^{abc}	43.67^{a}	42.67^{abc}	42.67^{abc}	42.00^{bc}	41.67^{c}	42.00^{bc}	0.14

^{abc}Means in the same row with different superscripts differ significantly ($P<0.05$)

PT: Physiological traits; RT: Rectal temperature (^{o}C); RR: Respiratory rate (breaths/mins); SEM: Standard error of mean

Conclusion: The results of this study suggest that ascorbic acid supplementation at 150 mg/kg feed improved weight gain, rectal temperature and respiratory rate of broiler chickens on skip three days feeding every week. It may be concluded that milder forms of feed restriction and longer realimentation period may be necessary to achieve full compensatory growth in broiler chickens.

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