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EFFECTS OF FEED RESTRICTION AND ASCORBIC ACID SUPPLEMENTATION ON CARCASS CHARACTERISTICS, BREAST MEAT CHOLESTEROL AND TRIGLYCERIDES OF MARSHALL BROILER CHICKENS

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ABSTRACT

To determine the effects of feed restriction and ascorbic acid supplementation on carcass characteristics, breast meat cholesterol and triglycerides of broiler chickens, 252 two-week old Marshall broiler chickens were used in a 4 x 3 factorial experiment. The birds were weighed and randomly distributed into 12 treatments with 3 replicates of 7 birds each, subjected to four 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 days 15 to 35 and three levels of ascorbic acid supplementation (0, 150, 300 mg/kg feed). Feed was provided *ad libitum* to all the birds from days 36 to 56. Birds on full feeding regime containing 0 mg/kg ascorbic acid had the highest ($P<0.05$) live weight, dressing percentage, plucked weight, eviscerated weight, thigh, back, wings and heart. Breast was highest ($P<0.05$) in birds on full feeding regime containing 150 mg/kg ascorbic acid. Birds on skip two days feeding regime containing 300 mg/kg had the lowest breast meat cholesterol and triglycerides though not statistically ($p>0.05$) different from other treatments. In conclusion, feed restriction regimes and ascorbic acid supplementation did not improve carcass characteristics in the feed-restricted birds; however, 150 mg/kg ascorbic supplementation improved the breast weight of the fully fed Marshall broiler chickens.

Keywords: feed restriction, ascorbic acid, carcass characteristics, meat cholesterol, triglycerides, broiler chickens.

INTRODUCTION

Broilers are fast growing special chickens reared for meat and reach between 1.4-2.2 kg from 6-8 weeks (Asaniyan *et al.*, 2007). Broiler production plays a major role in food security for the ever increasing human population. Feeding strategy in growing broiler chickens should be to produce animals with improved growth performance and maximum lean body carcass. Allowing birds an unlimited supply of food results in consumption in excess of the bird's requirements for maintenance and production and the excess energy is converted into fat (Cuddington, 2004). Improved meat quality attracts more attention from consumers and excess fat deposition is one of the important factors of poor meat quality of broilers. The excess fat reduces carcass yield and often causes rejection of the meat by consumers (Kessler *et al.*, 2000) and causes difficulties in processing (Chambers, 1990). Feed restriction regimes have been used to tackle a number of problems that accompany early-life fast growth rate in broiler chickens such as high body fat deposition, high incidence of metabolic disorders, high mortality, and high incidence of skeletal diseases (Rezaei *et al.*, 2006). Feed restriction could decrease fat content and increase protein deposition in carcasses, thus resulting in improved carcass composition (Nielsen *et al.*, 2003). Ascorbic acid plays a major role in gluconeogenesis to enhance energy supply during nutritional stress (Bains, 1996). Ascorbic acid supplementation was reported to improve carcass traits of broilers (Lohakare *et al*., 2005). However, information on the combined effects of feed restriction and ascorbic acid supplementation in broiler production are scarce. Therefore, this study was conducted to determine the effects of feed restriction and ascorbic acid supplementation on carcass characteristics, breast meat cholesterol and triglycerides of Marshall 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 and altitude 76 metres above sea level (Google Earth, 2006). The climate is humid and located in the rainforest vegetation zone of western Nigeria.

Experimental birds and design

Two hundred and fifty two (Marshall) unsexed day-old broiler chicks were sourced and raised on ascorbic acid free diet for two weeks (adaptation period) in deep litter pens of an open-sided poultry house. The birds were fed with a conventional corn soybean meal diet (2942.46 kcal ME/kg, 20.75% CP). All the pens were located in one house to have identical environment. Each pen was provided with a feeder and drinker. Normal prophylactic medication and vaccination were administered as and when due. At the 14th day, the chicks were randomly distributed into 12 treatments with 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 (S2D) feeding and skip three days (S3D) feeding every week for 24 hours from 15th to 35th day (restriction phase) and 3 ascorbic acid supplementation levels (0, 150, 300 mg/kg feed). Feed was provided *ad libitum* to all the birds from days 36 to 56 (realimentation phase). The experiment lasted for 56 days.

Carcass characteristics

At the 56th day, two birds per replicate whose weights were close to the mean of each replicate were fasted for 12 hours, slaughtered via neck slit and eviscerated. Scalding was done at 60ºC following standard commercial procedures (Jensen, 1984). The carcass yield was recorded by weighing the cut-up parts (neck, wings, breast, back, drumstick and thighs), organs (heart, liver and gizzard), abdominal fat and expressed as percentage of the live weight.

Cholesterol analysis

Twenty four samples (two per treatment) of breast meat weighing 20 g each were used for cholesterol analysis. Composite paste of breast tissues was prepared by blending with a mixture of chloroform/methanol mixture 1:1 (v/v) in a mortar and pestle. The resulting paste-solvent mixture will be filtered and rinsed with an additional volume of the combined homogenate and allowed to stand for 5 minutes. The filtered homogenate was equilibrated to remove non-lipid material and 2% (0.32M) w/v KCL solution was added to the aqueous layer. The filtrate was centrifuged and lipid extract were decanted. The extracts were made up to a final volume by adding chloroform so that the proportion of chloroform to methanol is (2:1 v/v). The supernatant decanted were re-extracted were re-extracted before cholesterol analysis (Gary, 1993). The total meat cholesterol was estimated by one-step method of Wybenga *et al.* (1970).

Statistical analysis

Data obtained 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 DISCUSSIONS

The effects of interaction of feed restriction and ascorbic acid supplementation on carcass characteristics of Marshall broiler chickens are shown on Table-1. There were significant differences ($P<0.05$) in the carcass characteristics of the birds among the treatments. Birds on full feeding fed diets containing 0 mg/kg ascorbic acid had significantly higher live weight, plucked weight, eviscerated weight, thigh, back, wings and heart than other treatments. This agrees with the findings of Bolu *et al.* (2004) that ascorbic acid has no significant effect on the carcass characteristics of birds. Sahin *et al*. (2003) reported that dietary ascorbic acid supplementation decreased abdominal fat pad and increased carcass, liver, heart, spleen and empty gizzard weight. Onbasilar *et al.* (2009) also reported a significantly lower heart weight in feed restricted broilers when compared to the unrestricted control. However, McGovern *et al.* (1999) concluded that heart weight as a percentage of body weight was significantly higher in feed-restricted broilers. This contrast in results may be attributed to the feed restriction programme applied and slaughter age of the birds. Birds on full feeding fed diets containing 0 and 150 mg/kg ascorbic acid had the highest ($P<0.05$) breast and dressing percentage. This does not agree with findings of De Silva and Kalubowila (2012) that birds on restricted feeding had higher eviscerated weight and dressing percentage than the fully fed birds. A severe feed restriction has made a more pronounced live weight and breast meat yield losses (Balog *et al*., 2000). Supplementation of ascorbic acid through feed or water increased breast meat, dressing yield as well as total meat yield (Mbajiorgu *et al.*, 2007). Birds on S3D fed diets containing 0 mg/kg ascorbic acid had the lowest ($P<0.05$) live weight, plucked weight and eviscerated weight. The depressed live weight of the birds on skip three days fed diets containing 0 mg/kg ascorbic acid suggests high level of nutritional stress and insufficient endogenous synthesis of ascorbic acid by the birds to meet the birds requirement. Gizzard was heaviest ($P<0.05$) in birds on S3D fed diets containing 0 mg/kg ascorbic acid. The increased gizzard could be attributed to the stimulatory effect of particle size of the feed on the gizzard (Svihus *et al*., 2010). Large particle size and hardness of feed explains why birds consuming such diets develop heavy gizzards and a muscular adaptation to meet greater demand for grinding. This result agrees with the findings of Onwurah and Okejim (2012) who reported that birds with the least access time to feed had heavier gizzard and liver weights. The birds on skip two days feeding every week fed diets containing 150 mg/kg ascorbic acid had the lowest abdominal fat though not statistically different from other treatments. In previous studies, Nielsen *et al.* (2003) cited a decreasing trend in fat deposition, whereas opposite results was obtained by Lanhui *et al.* (2011). The discrepancies may be due to the metabolic programming, whereby, early malnutrition leads to adult life obesity. The metabolic programming is induced by nutritional experience during the critical period in development with consequences during adulthood (Patel and Srinivasan, 2002). This result agrees with the findings of Santoso (2002) who reported that the severity of early restriction affects fat accumulation in broiler chickens. Celik and Ozturkcan (2003) found that ascorbic acid supplementation had no effect on abdominal fat. Similarly, Sahin *et al*. (2003) reported that dietary ascorbic acid supplementation decreased abdominal fat pad and increased carcass, liver, heart, spleen and empty gizzard weight. No significant difference was observed in the liver of the broiler chickens. This agrees with the findings of Onbasilar *et al.* (2009) who reported no significant differences in liver weight of restricted and unrestricted broiler chickens. Konca *et al*. (2009) reported that dietary ascorbic supplementation had no significant effect on carcass and parts, liver, gizzard, heart, kidney and abdominal fat yields of broiler chickens. Table-2 shows the effects of interaction of feed restriction and ascorbic acid supplementation on breast meat cholesterol and triglycerides of Marshall broiler chickens. The birds on

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full feeding fed diets containing 150 mg/kg ascorbic acid had the highest breast meat cholesterol while the least was observed in birds on skip two days feeding fed diets containing 300 mg/kg ascorbic acid though not statistically (P>0.05) different from other treatments. The lower breast meat cholesterol could be attributed to the level of blood supply to these parts of the body. This indicates that the level of cholesterol in breast muscles is dependent on the level of serum cholesterol (Suchy *et al*., 1995). Practically as based on this study, meat of birds on skip two days feeding every week fed diets containing 300 mg/kg ascorbic acid being low in cholesterol content is important from public health point of view. Triglycerides was also lowest in birds on S2D fed diets containing 150 and 300 mg/kg ascorbic acid though not statistically (P>0.05) different from other treatments. Idowu *et al*. (2011) reported that ascorbic acid is hypolipolemic and is capable of influencing lipid metabolism.

Table-1. Effects of interaction of feed restriction and ascorbic acid supplementation on carcass characteristics of Marshall broiler chickens at day 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													
Live weight (g)	2300.00^{a}	2100.00^{abc}	2033.33^{abc}	2243.33^{ab}	2086.67^{abc}	2256.67^{ab}	2100.00^{abc}	2036.67^{abc}	2036.67^{abc}	1890.00^{c}	1930.00^{bc}	2083.33^{abc}	31.20
Carcass yield													
Plucked weight (g)	2160.00^{a}	1903.33^{abc}	1803.33^{abc}	1970.00^{abc}	1930.00^{abc}	2043.33^{ab}	1866.67^{abc}	1826.67^{abc}	1753.33^{bc}	1613.33^{c}	1626.67^{c}	1900.00^{abc}	36.22
Dressing percentage (%)	81.17^{a}	81.03^{a}	80.19^{b}	80.09^{bc}	79.73^{bcd}	79.39^{cd}	79.66^{bcd}	79.83^{bcd}	79.23^{d}	79.56^{bcd}	79.73^{bcd}	79.41^{cd}	0.11
Eviscerated weight (g)	1593.20^{a}	1421.20^{ab}	1278.90^{bc}	1415.60^{ab}	1363.00^{abc}	1447.10^{ab}	1276.00^{bc}	1218.60^{bc}	1292.30^{bc}	1113.00^{c}	1229.10^{bc}	1307.00^{bc}	81.43
Cut-up parts[1]													
Thigh	10.80^{a}	10.34^{ab}	9.89^{ab}	9.37^{ab}	9.10^{b}	10.16^{ab}	9.48^{ab}	9.03^{b}	9.47^{ab}	8.91^{b}	9.32^{ab}	10.05^{ab}	0.15
Breast	18.63^{a}	18.97^{a}	15.73^{bcd}	17.64^{abc}	17.96^{ab}	16.72^{abcd}	15.72^{bcd}	15.66^{bcd}	17.81^{ab}	15.02^{cd}	15.92^{bcd}	14.86^{d}	0.30
Back	16.65^{a}	15.62^{ab}	15.33^{ab}	13.60^{b}	15.70^{ab}	16.12^{ab}	13.83^{b}	14.28^{ab}	15.39^{ab}	13.54^{b}	15.99^{ab}	13.50^{b}	0.27
Wings	9.10^{a}	8.34^{ab}	7.75^{bc}	7.88^{bc}	8.38^{ab}	7.45^{bc}	7.35^{bc}	6.94^{c}	7.54^{bc}	7.44^{bc}	8.03^{abc}	7.94^{bc}	0.13
Neck	4.60^{b}	5.00^{ab}	5.49^{ab}	5.06^{ab}	4.39^{b}	4.31^{b}	5.07^{ab}	4.93^{ab}	4.62^{b}	5.07^{ab}	5.26^{ab}	7.13^{a}	0.20
Drumsticks	9.47	9.29	8.77	9.44	9.77	9.14	9.10	8.86	8.54	8.94	9.09	9.18	0.13
Organs and abdominal fat[2]													
Heart	0.57^{a}	0.43^{ab}	0.39^{b}	0.42^{ab}	0.42^{ab}	0.38^{b}	0.46^{ab}	0.40^{b}	0.43^{ab}	0.47^{ab}	0.50^{ab}	0.39^{b}	0.01
Liver	1.90	2.56	2.39	2.22	2.01	2.73	2.38	2.50	2.34	2.36	2.21	2.46	0.09
Gizzard	1.61^{ab}	1.74^{ab}	1.63^{ab}	1.62^{ab}	1.54^{ab}	1.55^{ab}	1.69^{ab}	1.68^{ab}	1.68^{ab}	1.94^{a}	1.47^{b}	1.76^{ab}	0.04
Abdominal fat	2.16	2.34	1.58	1.33	1.76	1.62	1.28	1.27	1.69	1.37	1.93	2.17	0.10

$^{a-d}$Means in the same row having different superscripts are significantly different (P<0.05)
[1, 2] Percentages of the live weight SEM: Standard error of mean
AD- Full feeding S1D- Skip a day feeding S2D- Skip 2 days feeding S3D- Skip 3 days feeding

Table-2. Effects of interaction of feed restriction and ascorbic acid supplementation on breast meat cholesterol and triglycerides of Marshall 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	
Parameters													
Cholesterol (mg/dl)	69.50	69.65	69.47	69.46	69.51	69.50	69.49	69.40	69.37	69.47	69.50	69.51	0.06
Triglyceride (mg/dl)	90.42	90.44	90.37	90.34	90.40	90.40	90.38	90.33	90.33	90.36	90.36	90.45	0.04

Means in the same row with different superscripts differ significantly ($P<0.05$)
SEM: Standard error of mean AD- Full feeding S1D- Skip a day feeding S2D- Skip 2 days feeding S3D- Skip 3 days feeding

CONCLUSIONS

In conclusion, feed restriction reduced the carcass characteristics of feed-restricted birds though supplemented with ascorbic acid in their diets. Dietary ascorbic supplementation up to 150 mg/kg elicited positive effects on the breast and dressing percentage of the fully fed Marshall broiler chickens.

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