Effects of ascorbic acid supplementation on the performance of growing pullets

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Abstract

Two studies were conducted to evaluate the nutritional effects of supplementary ascorbic acid (AA) at levels of 0, 100, 200, and 300 mg/kg in the diets of growing pullets reared at different seasons (dry season and rainy season). 240 eight weeks-old Harco pullet chicks were used in each trial, they were randomly assigned to each of the four dietary treatments in three replications of twenty chicks per replicate. Each trial lasted 12 weeks (84 days) during which data were collected and a 2 X 4 factorial arrangement was employed in the analysis of data collected. Both ascorbic acid and season significantly affected ($P < 0.05$) growth rate with better growth rate reported in the dry season. Body weights at first lay exhibited a linear reduction with increasing concentration of ascorbic acid ($P < 0.05$). Seasonal variation significantly affected ($P < 0.05$) age and egg weight at first lay with higher values obtained in the rainy season. The cost- benefit analysis of supplementary ascorbic acid in the diet of experimental birds revealed that inclusion of the graded levels of ascorbic acid increased the cost of feed in a linear fashion across the dietary treatments. At the growing stage, cost of feed per kg weight gain was found to be lowest in birds fed 0 mg /kg AA. It was evident that at the growing stage, optimum response occurred with supplementation of 300 mg /kg AA.

Keywords: Ascorbic acid, supplementation, performance, pullets.

Introduction

Ascorbic acid is a simple six-carbon compound found in considerable amounts in citrus fruits and green vegetables, with feedstuff used in modern poultry diet formulation lacking the substance. Domestic fowls like most terrestrial vertebrates, possess the innate ability to synthesize ascorbic acid for normal growth and development. There is increasing evidence that a dietary requirement may exist under certain environmental and physiological stress conditions. Physiological stress is defined as the non - specific response to any external demand, which calls upon the bird to adapt to a new condition, (Selye, 1973). Under these conditions,

ascorbic acid is involved in the synthesis of the central stress hormones (epinephrine and corticosterone). Both hormones are responsible for the mobilization of energy for the so called essential functions such as blood flow, heat dissipation, maintenance of body temperature, respiration etc. In modern poultry management, there are several such factors which influence poultry productivity. These are heat, cold, humidity, pathogen, nutrient imbalance; others are molting, debeaking, high growth rate, frequent entry of personnel into poultry houses (Njoku *et al.*, 1992). It has been generally associated with decline in production and performance in poultry (Siegel, 1980). Studies

investigating the potential of ascorbic acid supplementation to stimulate growth in poultry have produced inconsistent results (Pardue, 1983; Njoku, 1984). Briggs *et al.* (1994) supplemented highly purified diets with 100mg AA/kg of diet and noted improved growth rates. However, addition of AA to corn/soy based ration had no effect on growth. This experiment was conducted to evaluate the role of dietary ascorbic acid in improving the performance of growing pullets reared under normal tropical conditions.

Materials and Methods

Experimental Location

The two trials were carried out at the University of Agriculture, Abeokuta Teaching and Research Farm, Alabata, Abeokuta. Alabata (7° 10' and 3° 2' E) is located in the tropical sub- savannah region with an average ambient temperature of 33°, a relative humidity of 80 % and a mean precipitation of 1100mm per annum.

Experimental Design

The study was designed to have two trials (I and II), which were carried out on the use of graded levels of ascorbic acid at different seasons. Trial I was carried out in the rainy season (May-August) while trial II was carried out in the dry season (November-January). Experimental birds in each trial were randomly allotted to the dietary treatments in three replications of twenty chicks per replicate.

Experimental Treatments

The feed ingredients used for the preparation of basal diet were purchased from UNAAB Consult feedmill, Kotopo, Abeokuta, while the feed grade ascorbic acid used was sourced from Nutrivitas Nigeria Limited, Lagos. There were four experimental treatments, made up of the basal diet which served as the control, while diets two,

three and four contained 100, 200 and 300 mg added ascorbic acid per kg of the basal diet (Table 1).

Experimental Birds

A total of two hundred and forty 8 weeks old Harco pullet chicks were used in the study. Sixty (60) chicks were randomly assigned to one of the four dietary treatments in three replications of twenty chicks per replicate. The birds were raised on deep litter pens with dry wood shavings as litter material. At 16 weeks of age the birds were transferred from the deep litter system to a 960 – bird capacity standard Petersime battery cage with automatic nipple drinkers. The cage as well as the house was thoroughly disinfected prior to transfer. The birds were vaccinated against the major poultry diseases endemic in the area. Feed and water were given *ad libitum* throughout the period. The birds were weighed at the beginning of the trials and weekly thereafter. Feed intake was measured daily with feed: gain determined by dividing it with average weight gain. Age at first egg was determined by the number of days after hatching when the first egg was laid and 5 birds per replicate randomly weighed and the body weight taken as the body weight at first egg.

Chemical and Statistical analyses

The proximate composition of the diet was determined by the AOAC (1995). The results of the parameters were subjected to a 2 X 4 factorial analysis. The analysis of variance was done according to the procedure of the Statistical Analysis System (SAS, 2001).

Results

The results of the main effects of dietary ascorbic acid levels and season on average final weight (AFW), average weight gain (AWG), feed intake (F: I), feed: gain ratio (F: G), % mortality and cost

Table 1 Percentage compositions of experimental basal diets (growers mash)

Ingredient	Level of Ascorbic Acid (mg/kg) supplementation			
	0	100	200	300
Maize	35.00	35.00	35.00	35.00
Soya bean Meal	5.30	5.30	5.30	5.30
Groundnut Cake	6.00	6.00	6.00	6.00
Wheat Offal	24.00	24.00	24.00	24.00
Brewers Dried Grain	25.00	25.00	25.00	25.00
Bone Meal	2.00	2.00	2.00	2.00
Oyster Shell	2.00	2.00	2.00	2.00
*Vit/Trace Min. Premix	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Methionine	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10
Vitamin C	-	+	++	+++
	100.00	100.00	100.00	100.00
Calculated Analyses				
Crude Protein (%)	16.23	16.23	16.23	16.23
Ether Extract (%)	4.26	4.26	4.26	4.26
Crude Fibre (%)	6.31	6.31	6.31	6.31
Calcium (%)	1.36	1.36	1.36	1.36
Phosphorus (%)	0.45	0.45	0.45	0.45
M.E (Kca/kg ⁻¹)	2411.00	2411.00	2411.00	2411.00
Determined Analyses				
Crude Protein (%)	14.03	14.03	14.03	14.03
Crude Fibre (%)	7.79	7.79	7.79	7.79
Ether Extract (%)	3.25	3.25	3.25	3.25

* Provided the following per kg of feed:

**** Grower Premix**

Vit. A = 4,000,000 iu; Vit. D₃ = 800,000 iu; Vit. E = 10,000mg; Vit. K₃ = 1,200mg; Vit. B₁ = 1,000mg; Vit. B₂ = 1,500mg; Vit. B₆ = 500mg; Niacin = 10,000mg; Panthothenate = 4,500mg; Biotin = 15mg; Vit B₁₂ = 10mg; Folic Acid = 200mg; Chlorine chloride=120,000; Manganese = 60,000mg; Iron = 15,000mg; Zinc = 15,000mg; Copper = 800mg; Iodine = 400mg; Cobalt = 80mg; Selenium = 40mg.

benefit analysis of growing pullets are presented in Table 2. Significant differences ($P < 0.05$) were shown in weight gain and feed: gain ratio due to varying levels of ascorbic acid (AA). The highest average final weight of 1059.24g was observed in 300mg AA/kg, which had the highest daily feed intake of 80.61g. Percent mortality was found to increase steadily across the dietary treatments with increasing levels of AA with the highest value of 6.04% recorded in birds fed 300mg AA/kg. General comparison of the dietary treatments across the season they were fed revealed significant differences ($P < 0.05$) in all the parameters measured. Birds fed graded levels of ascorbic acid during the hotter period gave better AFW, AWG, ADG and F: G ratio than birds in the rainy season. Nevertheless, higher feed intake was observed in the rainy compared to the dry period. Interaction effects of different levels of AA X season indicated significant differences ($P < 0.05$) for average weight gain and average daily weight gain as presented in Table 3. Lower values of average weight gain (AWG) were obtained in the rainy season when graded levels of AA were fed compared to the dry season where 300 mg/kg AA gave the highest weight gain value of 826.67g. The interaction of AA X season revealed a value of 10.41% mortality when 300 mg of the substance per kg was fed in the dry as compared to 1.67% recorded in the rain. At this stage of birds' growth, birds fed 0 mg AA/kg gave the lowest feed cost per kg weight gain, with the highest value of N213.02 recorded in 200 mg AA/kg. The cost of feed per kg, however, ranged between N20.68 and N21.22. Effects of ascorbic acid levels and season and their interaction on age, body and egg weights at first lay are presented in Table 4 and Table 5 respectively. Analysis of variance indicated significant differences ($P < 0.05$) in body weight due to graded levels of AA and the season had significant effect on age at first egg and egg

weight. Birds fed 200mg/kg added AA were the first to come into lay with an average egg weight of 42.05g. Body weights of bird at first lay, however, decreased across the dietary treatments from 1450.7g in 0 mg AA/kg to 1323.80g in 300 mg AA/kg. Furthermore, age and egg weights at first lay indicated slightly lower values in the dry season compared to rainy season. Mean egg weight ranged from 42.05 - 44.05g among the dietary treatments with the highest value of egg weight occurring in birds fed 100mg AA/kg. Interaction effects of different AA levels and season generated no significant difference ($P > 0.05$) in the parameters measured. However, values of age and egg weight at first lay were found to be higher in the rainy season with graded levels of AA fed.

Discussion

Studies investigating the potential of ascorbic acid supplementation to stimulate growth in poultry have produced inconsistent results (Pardue, 1983). Although, there were significant effects in the AWG and ADG, birds on 0 mg AA/kg gave better growth. This result agrees with earlier work of Pardue (1983) in which he reported an absence of growth stimulation in birds fed 250, 500 or 1000 mg/kg supplemental AA. Also, consistent with this finding was the failure of dietary AA in stimulating improved growth in birds fed practical diet (Fratzer *et al.*, 1996) but there was a response with a purified diet and perhaps, the birds on this diet could be considered to be under some form of nutritional stress. Feed intake was not significantly affected by dietary treatments. However; significantly lower feed intake value was exhibited at the dry period of this phase. Furthermore, the significant effect of dietary AA on feed: gain ratio agrees with the earlier finding of Njoku (1986) who reported significant effects in feed conversion efficiency following ascorbic acid

Table 2 Main effects of ascorbic acid levels and season on performance of growing pullets.

Parameters	Ascorbic acid level (mg/kg)						Season				
	0	100	200	300	SEM	Rain	Dry	SEM			
Ave. Initial Weight (g)	379.75	396.66	396.68	390.50	6.94	394.29	377.50	7.04			
Ave. Final Weight (g)	1034.79	990.70	966.14	1059.24	27.97	959.60 ^b	1085.83 ^a	22.69			
Ave. Weight Gain (g)	638.37 ^{ab}	590.70 ^a	569.47 ^b	688.74 ^a	27.64	555.30 ^b	688.33 ^a	24.15			
Ave. Daily Wt gain (g)	7.95 ^b	7.17 ^b	6.92 ^b	8.52 ^a	1.04	5.45 ^b	9.83 ^a	0.35			
Ave. daily Feed Intake (g)	78.62	77.95	80.45	80.61	1.71	82.36 ^a	76.45 ^b	0.76			
Feed: Gain Ratio	8.68 ^b	9.32 ^{ab}	10.10 ^a	8.71 ^b	0.67	10.48 ^a	7.92 ^b	0.33			
Mortality (%)	3.63	3.74	4.29	6.04	1.73	2.58 ^b	6.84 ^a	1.08			
Cost of feed (N/kg diet)	20.68	20.86	21.04	21.22	0.30	18.14	23.75	2.81			
Cost of feed (N/kg wt. gain)	177.59	191.71	213.02	179.03	9.12	192.77	187.91	2.43			

^{ab}Means within the same row for each main effect with differing superscript are significantly different ($P < 0.05$).

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^{abc}Mean within the same row with differing superscripts are significantly different ($P < 0.05$)

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Table 4 Main effects of ascorbic acid levels and season on age, body & egg weights at first lay

Parameters	Ascorbic acid level (mg/kg)					Season		
	0	100	200	300	SEM	Rain	Dry	SEM
Age (day)	152.16	149.20	147.97	149.46	3.97	156.82 ^a	142.57 ^b	1.70
Body Weight (g)	1450.74 ^a	1342.76 ^b	1330.23 ^b	1323.80 ^b	27.45	1358	1364.87	23.89
Egg Weight (g)	42.47	44.23	42.05	42.61	2.51	47.02 ^a	38.65 ^b	1.23

^{ab}Means within the same row for each main effect with differing superscripts are significantly different ($P < 0.05$).

Table 5 Interaction effects of ascorbic acid levels X season on age, body & egg weights at first lay

Parameters	Ascorbic acid level (mg/kg)							
	0		100		200		300	
	Dry	Rain	Dry	Rain	Dry	Rain	Dry	Rain
Age (days)	159.13	145.18	154.07	144.33	152.60	143.33	161.47	137.45
Body Weight (g)	1471.93	1429.55	1313.16	1372.36	1297.69	1362.78	1352.81	1294.79
								2.83
								35.13

supplementation. At this stage of birds' development, the graded levels of AA supplementation did not significantly affect percent mortality and in fact, birds fed graded levels of supplemental AA/kg exhibited higher % mortality compared to the control group. This result is, however, in agreement with the previous work of Kassab *et al.* (1990). The significant greater improvement in performance parameter shown in the dry period of the grower phase might be as a result of higher environmental conditions characteristic of the late dry season with an average temperature of 24.5 C and a linear relationship has been established between ascorbic acid and high environmental temperature. Thus, the result agrees with the earlier work of Kazzim and Norziha (1995). The workers reported that addition of AA to diets improved body weight and feed efficiency in birds reared under hot (20 – 35 C) and humid conditions in Malaysia. The pattern of cost of feed per kilogram weight gain at the grower stage recorded in the study might be due to the fact that quantifying the cost of feed in relation to weight gain may not be economically justified as cost differential among the dietary treatments was not all that pronounced. There were no significant advantages obtained in age at first lay and egg weight due to dietary treatments. Nevertheless, birds with supplemental AA came into lay earlier than those on 0 mg AA/kg. Body weights at first lay were found to be significantly different and birds on 0 mg/kg AA, however, gave higher body weight of 8.17% over AA treated birds at first lay. Seasonal significant effects were noticed in age and egg weight at first lay. Birds reared during the dry period were the first to come into lay. The reason might have been due to the higher sunlight intensity (lightning) associated with the period, which has been found to affect the development of the ovary, and the lower egg weight of the dry period might be attributed to

lower feed intake with resultant lower nutrient ingestion which is found to affect egg size.

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