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REDUCED PROTEIN DIETS CAN REDUCE PRODUCTION COST WHILE ENSURING OPTIMUM PERFORMANCE IN BROILER CHICKENS

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ABSTRACT

This study evaluated the growth performance, costs benefit, and gross margins of broiler chickens fed a reduced protein diet with amino acid supplementation from 14 to 42 days post-hatch. Two hundred one-day-old Cobb-500 broiler chicks were assigned to a Completely Randomized Design with four dietary treatments: a control diet and three reduced protein diets (-1% protein, -2% protein, -3% protein), each with five replicates of ten birds. The diets were supplemented with methionine, lysine, and threonine. The results showed that weight gain, feed intake, and feed conversion ratio (FCR) were significantly influenced by dietary protein levels ($P < 0.05$). Growth performance was similar with a protein reduction of up to 2%, but a further reduction to 3% resulted in significant decline. Cost analysis indicated that feed prices decreased with lower protein levels. Although overall expenses were not significantly impacted, gross margins were better among birds fed the 2% reduced protein diet compared to those fed the 3% reduction. In conclusion, reducing protein in broiler diets by up to 2% with the supplementation of only the three limiting amino acids (methionine, lysine and threonine) supports optimal growth performance while reducing production costs.

Keywords: Amino acids, broiler, profit, gross margin, low income, sustainability

INTRODUCTION

The need for environmental sustainability has birthed innovative feed formulations in broiler production. Reducing crude protein (CP) in broiler diets has been suggested to significantly enhance the sustainability of chicken meat production (Kidd et al., 2013, Liu et al., 2021), which has been confirmed (Chrystal et al., 2021, Maynard et al., 2021). By lowering protein levels and using synthetic amino acids, the poultry industry can cut feed costs and reduce nitrogen pollution (Greenhalgh et al., 2020; Liu et al., 2021). Conventional diets typically maintain a recommended CP level using ingredients like soybean meal, canola meal, etc. To meet the amino acid needs, feeds are supplemented with amino acids such as methionine, lysine, and threonine (Kidd et al., 2013). When using reduced CP diets, higher inclusion of non-bound (crystalline and synthetic) amino acids that are not usually supplemented is usually required. However, these uncommon amino acids are expensive at the moment and thus, may not be suitable to be implemented in developing economies. This study therefore aims to determine the level of protein reduction that could be achieved if only the three limiting amino acids are supplemented in broilers' diets.

MATERIALS AND METHODS

Experimental site

This research was carried out at the Federal University of Agriculture Abeokuta. The procedures and methodologies implemented during this study were approved by the Project Review Committee of the College of Animal Science and Livestock Production, Federal University of Agriculture, Abeokuta.

Experimental birds, management, diets and design

A total of 200 one-day-old Cobb-500 broiler chicks were obtained from a commercial hatchery was used for the experiment. On d 14 post-hatch, the birds were randomly allotted to four isocaloric (AME; kcal/kg) experimental diets. The feeds were formulated to contain four protein levels (Control; 1% [control minus 1 percentage point CP reduction]; 2% [control minus 2 percentage point CP reduction]; 3% [control minus 3 percentage point CP reduction]). All other nutrients in the experimental feeds meet or exceed the Cobb-Vantress (2018) nutrient specification guide. A two-phase feeding strategy was employed so that the treatments would have varying protein contents but similar other nutrient profiles at the grower (14 – 28 d) and finisher (28 – 42 d) phases. The control, 1%, 2% and 3% diets were formulated with targeted levels of 21, 20, 19, and 18% CP during the grower phase and 19.5, 18.5, 17.5, and 16.5% CP during the finisher phase, respectively. The experiment lasted from week 2 – 8, after a 2-week brooding period. The experimental diets are presented in Table 1. The experiment was laid in a Completely Randomized Design (CRD) with four dietary protein levels to make a total of four dietary treatments. Each treatment has five replicates, with each replicate having ten birds.

Data collection

Initial body weight, weekly feed intake, and average weight gain were recorded during the trial. The data obtained from the experiment was used to calculate the total feed intake (g/b), daily feed intake (g/b*d), total weight gain (g/b), daily weight gain (g/b*d), and feed conversion ratio (FCR). Feed price per kg (FP/kg), feeding cost per bird (FC/b), and feed cost per kg weight gain (FC/kgWG) of the birds was calculated following the procedure adopted from Kareem et al. (2022).

FP/kg = Total cost of feed * Quantity of feed

FC/kgBW = FI * FP/kg

Where, BW – Body weight; FI – Feed intake; FP/kg – Feed price per kg; FC/kgBW – Feed cost per kg body weight

The selling price per kg of processed chicken of whole chicken was obtained from the market during the experimental period (February 2024) for calculation of the economic return. The gross margin per bird was calculated as income minus total expenses. The total expense was obtained based on the report that feeding cost (FC/b) = 70% of total expense (Oladokun and Johnson, 2012).

Statistical analysis

All the data obtained from this study were checked for normality (Shapiro-Wilk test) and homoscedasticity of error at 5% level of probability. Outliers were removed after checking for plausibility. Data were then subjected to one-way Analysis of variance (ANOVA) using SPSS 28 statistical package. Significant ($P < 0.05$) means among variables were compared using the Tukey Test contained in the statistical package. The means were plotted into graphs using Microsoft Office 365 Excel software.

RESULTS AND DISCUSSION

Figures 1 and 2 shows reduced protein diets can reduce production cost while ensuring optimum performance in broiler chickens. The varying levels of protein reduction affected ($P <0.05$) weight gain, feed intake, feed conversion ratio (FCR), feed price, feeding cost per bird and gross margin of the broiler chickens. The broiler chickens had similar ($P < 0.05$) and better values of weight gain, FCR, feeding cost per kgBW and gross margin up to 2% reduced CP diets compared with the birds fed 3% reduced protein. The feed price/kg of the birds was observed to increase ($P < 0.05$) as the level of dietary protein reduced, while the feeding cost/kgBW increased. The similar feeding cost/kgBW recorded for the birds fed control diets up to 2% reduced CP diet suggests the suitability of utilizing diets of up to 2% CP reduction in broilers when only methionine, lysine and threonine are supplemented.

The similar body weight, weight gain, and FCR observed for the birds up to 2% CP reduction is in line with previous results (Chrystal et al., 2021; Maynard et al., 2021; Kareem, 2023) despite supplementing on the first three amino acids. This suggests that despite that the extra amino acid supplementation may further improve the birds' performance, it comes at a cost, and this may not be affordable to farmers in developing economies. There is a dearth of literature on the economics of broiler chickens fed reduced protein diets. In the current study, the feed price/kg, although little, was observed to increase as the dietary CP reduced. This could be due to the increased dietary AA (methionine, lysine, and threonine) supplementation. While birds on diets up to 3% reduced CP had comparable feeding costs per kgBW, those on 2% CP reduction were numerically better compared to those on a 3% reduced CP diet. This suggests the suitability for up to 2% CP reduction in broiler diets even if only methionine, lysine and threonine are supplemented. Profitability (gross margin) decreased as dietary CP levels were reduced, with higher and more favorable values observed for birds fed diets with up to 2% reduced CP. While reducing CP by up to 3% led to a significant decline in gross margin, the reduced expenses could benefit farmers in developing economies in terms of environmental sustainability.

Table 1: Gross composition of diets

	Starter	Grower				Finisher			
Ingredients (%)		**Control**	**1%[2]**	**2%**	**3%**	**Control**	**1%**	**2%**	**3%**
Maize, grain	51.79	52.28	52.52	54.07	55.62	56.78	58.33	59.89	61.47
Palm Kernel Oil	3.74	4.66	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Wheat offals	0.00	2.71	5.43	7.03	8.63	1.80	3.40	4.94	6.46
Fish meal	1.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Soybean meal	39.94	37.23	33.73	30.39	27.05	33.47	30.14	26.81	23.50
Bone meal	1.29	1.20	1.19	1.17	1.15	1.05	1.03	1.02	1.00
Limestone	0.64	0.69	0.73	0.77	0.82	0.73	0.77	0.82	0.86
Salt (NaCl)	0.31	0.24	0.21	0.18	0.15	0.24	0.21	0.14	0.05
Premix[1]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
DL-Methionine	0.33	0.31	0.34	0.36	0.38	0.28	0.31	0.33	0.35
L-Lysine HCl (78%)	0.12	0.11	0.20	0.29	0.38	0.09	0.19	0.28	0.37
L-Threonine (98.5%)	0.00	0.04	0.07	0.11	0.15	0.00	0.04	0.08	0.12
Choline chloride (60%)	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Sodium bicarbonate	0.12	0.19	0.24	0.28	0.33	0.19	0.24	0.34	0.47
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total NBAA	0.42	0.44	0.57	0.70	0.83	0.35	0.50	0.63	0.76
Calculated nutrient composition (%, unless otherwise stated)									
Crude Protein	22.50	21.00	20.00	19.00	18.00	19.50	18.50	17.50	16.50
AME (kcal/kg)	2975	3000	3000	3000	3000	3050	3050	3050	3050
Crude Fibre	3.75	3.82	3.87	3.87	3.87	3.67	3.67	3.67	3.67
Neutral Detergent Fibre	11.61	12.73	13.72	14.31	14.90	12.33	12.92	13.48	14.04
Ether Extract	7.69	8.50	8.79	8.76	8.72	8.82	8.79	8.76	8.72
Ash	3.67	3.52	3.72	3.77	3.82	3.18	3.23	3.27	3.32
Calcium	0.90	0.80	0.80	0.80	0.80	0.75	0.75	0.75	0.75
Available Phosphorus	0.45	0.40	0.40	0.40	0.40	0.38	0.38	0.38	0.38
Sodium	0.18	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Chlorine	0.29	0.23	0.23	0.23	0.23	0.23	0.23	0.21	0.17
Potassium	0.91	0.88	0.85	0.81	0.77	0.81	0.78	0.74	0.70
Digestible Lysine	1.26	1.16	1.16	1.16	1.16	1.06	1.06	1.06	1.06
Digestible Methionine	0.64	0.60	0.61	0.62	0.63	0.55	0.56	0.57	0.58
Digestible Met+Cys	0.94	0.88	0.88	0.88	0.88	0.82	0.82	0.82	0.82
Digestible Cysteine	0.30	0.28	0.27	0.26	0.25	0.27	0.26	0.25	0.24
Digestible Threonine	0.80	0.78	0.78	0.78	0.78	0.70	0.70	0.70	0.70
Digestible Glycine	0.86	0.77	0.73	0.69	0.64	0.72	0.67	0.63	0.59
Digestible Serine	1.07	1.00	0.94	0.88	0.82	0.93	0.87	0.82	0.76
Digestible Gly+Ser	1.62	1.48	1.40	1.32	1.23	1.38	1.30	1.21	1.13
DEB (mEq/kg)	230	230	221	212	202	214	204	200	200

[1]Provided per kg of vitamin/mineral premix: Folic Acid (min) 1600 mg; Vitamin B5 - Pantothenic acid (min) 24.96 g; Biotin (min) 80 mg; Vitamin B5 - Pantothenic acid (min) 24.96 g; Biotin (min) 80 mg; Butyl hydroxide toluene 100 mg; Niacin (min) 67.20 g; Selenium (min) 600 mg; Vitamin A (min) 13440000 UI; Vitamin B1 (min) 3492 mg; Vitamin B12 (min) 19200 mcg; Vitamin B2 (min) 9600 mg; Vitamin B6 (min) 4992 mg; Vitamin D3 (min) 3200000 UI; Vitamin K3 (min) 2880 mg. Provided per kg of mineral premix: Copper (min) 15 g; Iron (min) 90 g; Iodine (min) 1500 mg; Manganese (min) 150 g; Zinc (min) 140 g.

[2]% CP Reduction

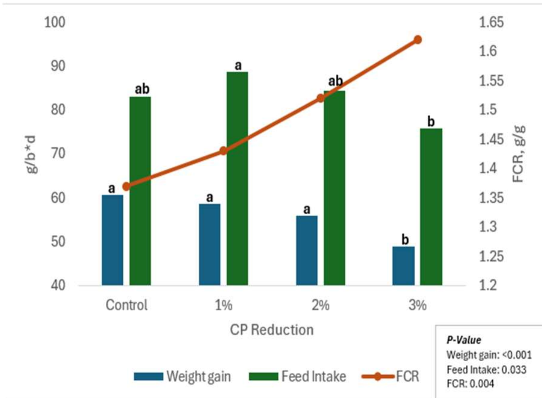

Fig 1. Growth performance of broiler chickens fed reduced protein diets
[ab]Means with different superscripts across the same row are significantly (P < 0.05) different
FCR - Feed Conversion Ratio

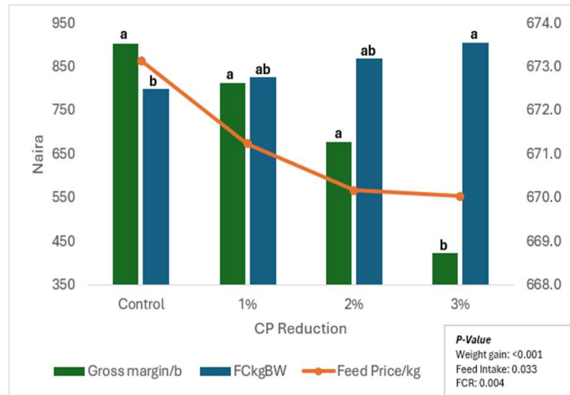

Fig 2. Cost benefit and gross margin of broiler chickens fed reduced protein diets
[ab]Means with different superscripts across the same row are significantly (P < 0.05) different
Gross margin/b – Gross margin per bird; FCkgBW – Feeding cost per kg body weight; Feed price/kg – Feed price per kg diet

CONCLUSION

Broiler chickens can be fed reduced protein diets up to 2% reduction level with the supplementation of only the three limiting amino acids (methionine, threonine and lysine) without compromising productivity and profitability.

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