BAP -23

Effects of Phytase and Protease Supplementation on Growth Performance and Carcass Characteristics of Broiler Chickens Fed Sub-Optimal Levels of Crude Protein

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Abstract
The experiment was carried out to evaluate the effect of phytase and protease supplementation on performance of broiler chickens fed diets with sub-optimal levels of crude protein (CP). One day old unsexed Acre Arbor broiler chicks (n=270) were randomly divided into 27 replicates of 10 chicks each. Birds were fed enzyme-supplemented diets with phytase (PHY) or protease (PRO) and their combination at different crude protein levels. Nine experimental diets were fed during the starting phase which was; the control (23% CP) without enzyme (T1), 21% CP without enzyme (T2), 21% CP plus PHY (T3), 21% CP plus PRO (T4), 21% CP plus PHY and PRO (T5); and 19% CP without enzyme (T6), 19% CP plus PHY (T7), 19% CP plus PRO (T8), 19% CP plus PHY and PRO (T9). Phytase and protease supplementation followed the same pattern in all phases, but the crude protein was 23, 21 and 18% CP (in T1); 21, 18 and 16% CP (in T2, T3, T4 and T5) and 19, 16 and 14% CP (in T6, T7, T8 and T9) during starting, growing and finishing phase. Each of the diets was offered to three replicates of 10 birds each. Feed and water were given *ad libitum* and the birds were weighed weekly. At the starter phase, there was a synergistic effect of the combination of the two enzymes in birds on T5 which significantly ($p<0.05$) improved final body weight and daily weight gain compared to the control (T1) and other treatments. From 0 -56 days, PHY supplementation significantly ($p<0.05$) improved final body weight and daily weight gain in suboptimal CP diets (T3) compared to the non-supplemented normal protein diets (T1), but performance was similar to birds on PRO and PRO plus PHY supplementation. There was no significant effect of treatments on carcass parameters except for drumstick and T1 had the least value ($p<0.05$) compared to other treatments. It could be concluded that phytase, protease and the combination improved the performance of broiler chickens fed suboptimal crude protein diets and there was a synergistic effect of protease and phytase at the starter phase.

Keywords: Feed additives, enzymes, crude protein, performance

Introduction

Phytate is abundant in many feed ingredients of plant origin and it is a major anti-nutritional factor for non-ruminant animals (Iyayi *et al*., 2013). However, the limited ability of monogastric animals to use phytate-P poses a problem. This relates to the ability of phytate to form complexes with other dietary nutrients, such as minerals, proteins, free amino acid and starch (Selle *et al.,* 2000).

Phytase supplementation has been observed to increase the apparent ileal digestibility of crude protein and amino acid (AA) by a three-way interaction between phytate, proteolytic enzymes and protein-AA in the digestive contents (Cowieson and Adeola, 2005). However, Adeola and Sands (2003) pointed out that phytase supplementation does not consistently improve the digestibility of crude protein and amino acid. Freitas *et al*. (2011) and Ajayi (2015) observed that addition of protease to diets with sub-optimal crude protein levels improved daily weight gain and decreased daily feed intake and feed conversion ratio.

Therefore, the objective of this study was to evaluate the effect of phytase and protease and their combination on the growth performance and carcass characteristics of broiler chickens fed sub-optimal levels of dietary crude protein.

Materials and Methods

The experiment was carried out at the Teaching and Research Farm of Obafemi Awolowo University, Ile-Ife, Osun State.

Two hundred and seventy day old unsexed Acre Arbor broiler chicks were used for the study. The chicks were assigned to nine dietary treatments formulated in three phases with ten birds per replicate in a completely randomized design. Birds were fed enzyme-supplemented diets with phytase (PHY) or protease

(PRO) and their combination, and crude protein (CP) at different levels in three phases of starter, grower andfinisher. Nine experimental diets were fed during the starting phase which was: the control (23% CP) without enzyme, 21% CP without enzyme, 21% CP plus PHY, 21% CP plus PRO, 21% CP plus PHY and PRO; and 19% CP without enzyme, 19% CP plus PHY, 19% CP plus PRO, 19% CP plus PHY and PRO. During the growing phase birds fed the control (20% CP) without enzyme, 18% CP without enzyme, 18% CP plus PHY, 18% CP plus PRO, 18% CP plus PHY and PRO; and 16% CP without enzyme, 16% CP plus PHY, 16% CP plus PRO, 16% CP plus PHY and PRO. During the finishing phase birds were fed the control (18% CP) without enzyme, 16% CP without enzyme, 16% CP plus PHY, 16% CP plus PRO, 16% CP plus PHY and PRO; and 14% CP without enzyme, 14% CP plus PHY, 14% CP plus PRO, 14% CP plus PHY and PRO (table 1). The phytase and protease enzymes were supplemented at 0.1 g/kg and 0.05 g/kg diet, respectively. Diets in each phase were formulated to be isocaloric. The duration for starter, grower and finisher phases were 0-21 days, 21-42 days and 42-56 days respectively, making a total of 8 weeks of experimental period. Feed and water were provided unrestrictedly.

Birds were weighed at the beginning of the experiment and on weekly basis till the end of the experiment. Weekly voluntary feed intakes (FI) were monitored while daily weight gain and feed conversion ratio (FCR) were calculated. Routine management procedures were observed. At the end of the experiment, three birds per treatment were weighed, slaughtered, de-feathered, eviscerated and cut into parts to determine some carcass characteristics.

Data generated were subjected to one-way analysis of variance (ANOVA) using the General Linear Models procedure of SAS (2002). Significant differences among treatments were separated at 5% significance level by Duncan's Multiple Range Test.

Results and Discussion

The performance of the broiler chickens fed sub-optimal levels of crude protein with or without enzyme supplementation for the three phases and carcass characteristics are presented in tables 2 and 3 respectively. There was a significant ($p<0.05$) effect of the enzyme supplementation on final body weight (FB), daily weight gain (DW) and daily feed intake (DF) during the starting phase. Birds fed diet supplemented with PHY and PRO (T5) had the highest ($p<0.05$) FB and DW compared to T1, but this was comparable to PHY supplemented T3, PRO supplemented T4 and non-supplemented 19% CP T6. Treatments with enzyme supplementation at 21% CP had improved FB and DW. This is in agreement with the report of Ajayi (2015), who reported an improved body weight gain (BW) and DW when broilers were fed reduced crude protein diets supplemented with protease. The increased FI observed in this study was in accordance with the report of Ghazi (2003), who reported that protease supplementation resulted in increased BW and feed intake. The response of broilers to supplemental feed additives followed a similar pattern to the overall performance (0 – 56 days) during the growing and finishing periods.

From 0 - 56 days, PHY supplementation significantly ($p<0.05$) improved final body weight and daily weight gain in suboptimal CP diets (T3) compared to the non-supplemented normal protein diets (T1), but performance was similar to birds on PRO and PRO plus PHY supplementation. The observation in the present study in which phytase, protease or their combination resulted in improved performance of birds fed suboptimal levels of crude protein is in consonance with the report of Cowieson and Adeola (2005). Cowies on and Adeola (2005) fed diets that were nutritionally marginal in energy, calcium and phosphorus and observed that phytase and protease, individually or in combination improved the growth performance of broiler chicks fed these diets from day old to 28 days. There was no significant effect of treatments on carcass parameters except for drumstick and T1 had the least value ($p<0.05$) compared to other treatments.

Conclusion

It was concluded that phytase, protease and combination improved the performance of broiler chickens fed suboptimal crude protein diets and there was a synergistic effect of protease and phytase at the starter phase.

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Table 1: Gross composition of experimental diets for the three phases (%; 0-8weeks)[1]

	Starter (0 - 3 weeks)			Grower (3 - 6 weeks)			Finisher (6 - 8 weeks)		
	23% CP	21% CP	19% CP	21% CP	19% CP	16% CP	18% CP	16% CP	14% CP
Ingredients	T1	T2	T6	T1	T2	T6	T1	T2	T6
Maize	52.26	56.00	59.00	57.39	59.83	62.10	59.83	62.66	64.36
SBM[2]	37.30	30.04	24.58	27.92	23.33	17.00	24.45	19.08	12.08
Wheat Offal	4.75	7.00	8.38	8.90	8.40	10.07	8.40	9.30	11.41
HQCP[3]	1.10	2.10	3.4	2.20	4.73	6.86	4.85	6.38	9.33
Bone meal	1.10	1.40	1.4	0.80	0.80	0.96	0.75	0.77	0.80
Limestone	1.10	0.60	0.60	0.92	0.92	0.92	0.92	0.92	0.92
Fish meal	1.50	1.50	1.50	1.00	1.00	1.00	-	-	-
DL-meth.	0.19	0.19	0.19	0.10	0.12	0.14	0.07	0.09	0.12
L-lysine	0.20	0.31	0.45	0.27	0.37	0.45	0.21	0.33	0.48
Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100	100	100	100
Calculated analysis (%)									
ME (kcal/kg)	2961.98	2968.69	2971.99	2966.23	2977.41	2963.32	2974.54	2979.70	2981.68
Crude protein (%)	23.01	21.04	19.27	20.01	18.43	16.44	18.07	16.43	13.28
CF (%)	3.98	3.88	3.79	3.91	3.83	3.78	3.90	3.81	3.45

[1]During the starting, growing and finishing phases, phytase and protease were added to diet T2 (T2 plus PHY = T3; T2 plus PRO =T4; T2 plus PHY and PRO =T5) and T6 (T6 plus PHY = T7; T6 plus PRO =T8; T2 plus PHY and PRO =T9) at the expense of maize. TI was the non-supplemented control of 23, 21 and 18% CP at starting, growing and finishing phases respectively. T2 was a non-supplemented diet of 21, 18 and 16% CP at starting, growing and finishing phases respectively, while T6 was another non-supplemented diet of 19, 16 and 14% CP at starting, growing and finishing phases respectively.

[2]SBM – Soya been meal

[3]HQCP – High-quality cassava fine mash

Table 2. Performance of broiler chicken fed sub-optimal levels of crude protein with or without enzymes in three phases

Parameter	T1	T2	T3	T4	T5	T6	T7	T8	T9	SE	P
0 – 21 days											
Initial body weight (g/bird)	47.92	47.78	47.85	47.58	48.18	47.58	47.88	47.82	45.85	0.25	0.605
Daily weight gain (g/bird)	21.68^{c}	22.47^{bc}	23.69^{ab}	23.46^{abc}	25.22^{a}	23.76^{ab}	22.99^{bc}	22.38^{bc}	22.69^{bc}	0.24	0.013
Daily feed intake (g/bird)	45.41^{b}	49.51^{a}	51.25^{a}	51.75^{a}	51.29^{a}	50.58^{a}	50.69^{a}	49.62^{a}	49.57^{a}	0.41	0.000
Feed conversion ratio	1.90	1.99	1.96	2.00	1.84	1.93	2.00	2.01	1.98	0.02	0.140
21- 42 days											
Initial body weight (g/bird)	503.29^{c}	519.61^{bc}	545.30^{a}	540.29^{bc}	577.73^{a}	546.44^{ab}	530.63^{b}	517.87^{bc}	522.24^{bc}	5.16	0.013
Daily weight gain (g/bird)	42.08^{abc}	40.61^{bc}	46.74^{a}	44.65^{ab}	41.64^{abc}	36.87^{c}	36.37^{c}	39.97^{bc}	39.08^{bc}	0.81	0.016
Daily feed intake (g/bird)	124.07^{a}	122.82^{ab}	129.42^{a}	122.32^{ab}	120.84^{ab}	119.12^{ab}	119.33^{a}	112.79^{bc}	107.19^{c}	1.48	0.005
Feed conversion ratio	2.97	3.02	2.78	2.75	2.93	3.23	3.29	2.82	2.75	0.05	0.095
42 – 56 days											
Initial body weight (g/bird)	1387.06^{b}	1372.51^{b}	1526.9	1477.94	1452.12^{a}	1320.67	1294.31	1357.21^{b}	1342.87^{b}	18.7	0.020
Daily weight gain (g/bird)	56.12^{abc}	53.66^{abc}	64.49^{a}	62.14^{a}	57.25^{ab}	40.77^{c}	44.85^{bc}	43.03^{bc}	46.35^{bc}	2.08	0.018
Daily feed intake (g/bird)	185.48^{abc}	186.62^{abc}	198.66^{a}	193.68^{a}	191.99^{ab}	177.59^{bc}	196.51^{a}	175.91^{c}	177.19^{bc}	2.07	0.014
Feed conversion ratio	3.47	3.48	3.11	3.20	3.43	4.41	4.51	4.09	3.84	0.14	0.123
0 – 56 days											
Initial body weight (g/bird)	47.92	47.78	47.85	47.58	48.18	47.58	47.88	47.82	45.85	0.25	0.605
Final body weight (g/bird)	2172.75^{b}	2123.76^{c}	2429.7	2347.91	2253.64^{a}	1891.45	1922.18	1959.67^{e}	1991.73^{d}	40.3	<.000
Daily weight gain (g/bird)	37.94^{bcd}	37.07^{cde}	42.53^{a}	41.08^{ab}	39.39^{abc}	32.93^{f}	33.47^{ef}	34.14^{ef}	34.75^{def}	0.72	<.000
Daily feed intake (g/bird)	112.33^{abc}	113.61^{abc}	119.92^{a}	116.07^{ab}	114.91^{abc}	110.27^{bc}	115.32^{a}	107.07^{cd}	105.23^{d}	1.08	0.010
Feed conversion ratio	2.86^{c}	2.95^{bc}	2.72^{c}	2.73^{c}	2.84^{c}	3.23^{ab}	3.33^{a}	3.03^{abc}	2.92^{bc}	0.05	0.010

^{abc}Means within the same row with different superscripts are significantly different ($p<0.05$)

Table 3. Carcass Characteristics of broiler chickens fed enzyme-supplemented diets (%)

Parameter	TI	T2	T3	T4	T5	T6	T7	T8	T9	Pooled SEM	P value
Dressing percentage	77.89	72.55	71.37	72.07	70.57	74.94	71.35	70.45	69.08	0.79	0.2609
Drumstick	12.85^{c}	14.68^{ab}	15.05^{ab}	16.21^{a}	15.28^{ab}	14.58^{b}	15.04^{ab}	16.25^{a}	15.67^{ab}	0.23	0.0034
Thigh	16.91	16.82	16.06	16.98	17.82	16.10	15.73	16.53	15.94	0.18	0.1228
Wings	10.80	11.17	9.92	11.03	10.58	10.20	10.31	11.29	12.56	0.24	0.2737
Breast	34.07	30.74	32.80	33.44	30.52	32.03	32.17	26.25	26.40	0.78	0.1280

Abdominal fat	1.70	1.73	2.05	2.19	3.05	2.38	2.69	3.05	3.07	0.16	0.2147

[abc]Means within the same row with different superscripts are significantly different ($p<0.05$)