ISSN 1682-8356
ansinet.org/ijps

INTERNATIONAL JOURNAL OF

POULTRY SCIENCE

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

International Journal of Poultry Science 6 (11): 814-817, 2007
ISSN 1682-8356

Effects of Replacing Maize with Enzyme - Supplemented Bovine Rumen Content in the Diets of Pullet Chicks

A.A. Adeniji and A. Jimoh
Department of Animal Production, Faculty of Agriculture, University of Ilorin, Ilorin, Nigeria

Abstract: A total of 240 day old pullet chicks were employed in a feeding trial to determine the optimum inclusion level of enzyme-supplemented rumen content that pullet chicks will tolerate in their diet. Rumen content (RC) was included at levels of 10, 15, 20 and 25% and two types of enzymes (Nutrase xyla and Roxazyme – G) were fed. A 4 x 2 factorial experiment (four levels of rumen content and two types of enzymes) was adopted. There was significant effect ($P<0.05$) of the levels of rumen content on the observed feed intake. There was no significant difference between the effects of the two enzymes on feed intake. Effects of Roxazyme-G on weight gain was significantly ($P<0.05$) better than that of nutrase xyla. The 15% rumen content fed chicks had the best ($P<0.05$) feed-to-gain ratio of 3.82; while the enzyme type had no effect ($P>0.05$) on obtained feed-to-gain. Results of this study shows that pullet chicks can tolerate up to 15% enzyme-supplemented rumen content in their diets. Roxazyme-G (a multipurpose enzyme) is better than nutrase xyla (a single purpose enzyme). It is evident that enzyme-supplemented rumen can replace up to 37.5% maize in the diets of pullet chicks.

Key words: Pullet chicks, maize, rumen content, nutrase xyla, roxazyme-G, enzyme

Introduction

A major problem facing the development of animal production is the availability and high cost of feedstuffs. Feed accounts for 55 – 70% of the cost of poultry production (Atteh, 2003). High cost of feedstuffs has contributed to the poor performance or productivity on many poultry farms and this has led to a shortage in the availability of protein to the citizenry. There is also competition between man and poultry for conventional feedstuffs like maize. There is therefore the need for alternative and non-conventional feedstuffs to be used. Biobaku *et al.* (1999) reported that activated sewage sludge can be included in the diets of broilers and better weight gains were obtained compared to the control.

Poultry, like other monogastric animals, have little or no ability to digest high fibrous materials and this is one of the major problems in their utilization of agricultural wastes. Chickens do not posses enzymes like cellulose, hemicellulose, xylanase and phytase to digest components of cell wall of plant. It is therefore difficult and uneconomical to substitute completely very cheap high fibrous ingredients like rice bran and wheat offal for the conventional and costly maize.

To enhance the degradation and better utilization of non-starch polysaccharides by monogastrics, synthetic enzymes are added as feed additives. This is an attempt to help the chicken to extract more nutrients from feedstuffs (Atteh, 2003). Atteh (2000) reported that increase in dietary levels of nutrase xyla increased the retention of both protein and crude fiber in layers. There was an increase in egg production and reduced feed/dozen eggs when dietary level of nutrase xyla increased from 50ppm to 100ppm. Ojewole *et al.* (2003) also reported that Roxazyme-G significantly ($P<0.05$) influenced the mean daily weight gain and feed-to-gain ratio of poults fed palm kernel-based feed.

This study was conducted to determine the effects of replacing maize with enzyme-supplemented rumen content in the diets of pullet chicks. Maize is expensive and highly competed for by both man and his livestock. Rumen content is a waste with disposal problems only that it is high in crude fibre ; hence the feeding of enzyme for degradation of the high fibre level of rumen content. Two enzymes were compared in this study and they were nutrase xyla and Roxazyme-G. Nutrase xyla is a single purpose enzyme containing xylanase while roxazyme-G is a multipurpose enzyme containing β-glucanase, xylanase and cellulose and some traces of α-amylase, hemicellulases, pectinases and protease. The study also evaluated which of the two enzymes would give the better result.

Materials and methods

Rumen content was collected fresh from the abattoir slab immediately the visceral of the cattle was opened. It was boiled for about two hours with constant stirring to prevent burning. After boiling, it was sun-dried to reduce the moisture content to about 12%. The sun-dried material was subjected to particle size reduction followed by proximate analysis according to A.O.A.C (1980). On analysis, the rumen content contained 11.16% crude protein, 20.01% crude fiber and ether extract and total ash of 1.83 and 12.14% respectively. The analyzed rumen content was then used in the

formulation and compounding of the experimental diets. Two hundred and forty day old black pullets were randomly allocated to eight experimental diets. Each diet was replicated thrice and each replicate had ten pullet chicks. The eight experimental diets (Table 1) had graded levels of rumen content (10%, 15%, 20% and 25%) and each of the diets was supplemented with either nutrase xyla or Roxayzme-G to form a 4 X 2 factorial experiment. All the diets were formulated to be isonitrogenous.

The pullets were housed in a broader cage throughout the experiment period of fifty six days where feed and water were supplied *ad libitum*. The birds were vaccinated against Newcastle disease at 10th day while Gumboro vaccine was given at about two weeks.

Records of initial body weight, weekly feed intake, weekly weight gain and mortality were kept. At the sixth week of age, nutrient retention trial was carried out for protein, crude fiber and ether extract using the procedure of total feacal collection.

At the end of the feeding trial, feed-to-gain ratio, percentage nutrient retention for protein, crude fiber and ether extract were analysed while percentage mortality was calculated. The were subjected to statistical analysis of variance suitable for a 4 X 2 factorial design as described by Steel and Torrie (1980). Significant difference between treatment means was also determined at 5% significance level using the Duncan Multiple Range Test (Duncan, 1955).

Results

The effect of the dietary treatments on growth performance characteristics of pullets chicks is as shown in Table 2. There was no significance difference between the effects of the two enzymes on feed intake even though birds on roxazyme-G tended to have consumed more feed than chicks fed the nutrase xyla. There was a gradual decrease in feed intake with the increase in the percentage of rumen content in diets. On 10% RC had the highest ($P<0.05$) feed intake of 33.14g and this is significantly different from the value obtained for birds fed 15% RC (26.83g) and 20% RC (26.95g) while the feed consumed by chicks on the 15, 20 and 25% RC diets were comparable ($P>0.05$) with feed intake value of 26.83, 26.95 and 27.99g respectively.

The weight gain decreased with increase in the inclusion level of RC in the diet. Diet with 10% RC gave the highest weight gain of 7.49g which is significantly higher than weight gained by chicks on the other RC diets. The chicks fed the 15% RC diet had comparable ($P>0.05$) weight gain value with the 10% RC fed chicks. The roxazyme-G fed chicks had significantly ($P<0.05$) higher body weight gain value of 7.06g than the nutrase xyla fed chicks that gained 6.03g. The effect of the rumen content on feed-to-gain ratio showed that diet with 15% RC gave the best feed-to-gain ratio of 3.82 which is comparable ($P>0.05$) to the feed-to-gain ratio obtained on the chicks fed 10 and 20% RC diets with value of 4.49 and 4.28 respectively. Chicks fed the 25% RC had the highest feed-to-gain ratio of 4.91. There was no significant difference between the effects of the two enzymes on feed-to-gain ratio although roxazyme-G seems to have a numerically better effect than nutrase xyla (4.15 Vs 4.59).

There were savings in the cost of feed as the level of RC increased in the diets. The cost of feed dropped from N38.45/kg of feed in the 10% RC diet. There was also high comparison in the effect of the two enzymes on cost of feed. Cost of nutrase xyla-supplemented feed was N36.70/kg of feed while cost of Rozaxyme-G supplemented feed was N36.85/kg of feed. Diets with 15% RC gave the best cost of feed per kilogram weight gain of N140/kg body weight. Roxazyme-G supplemented feed had the lower and economical cost of feed per kilogram body weight of gain of N156.57 compared to N167.36 for nutrase xyla-supplemented feed.

Effect of the dietary factors on nutrient retention is as shown in Table 3. There was no significant difference between the levels of RC on crude fiber, protein and ether extract retention. There was also no significance difference ($P<0.05$) between the effects of the enzymes on nutrient retention. However, nutrase xyla gave a numerically better retention for the analyzed nutrients (crude fiber, protein and ether extract) compared to roxazyme-G. No significant interaction ($P<0.05$) was obtained between the dietary factors on nutrient retention.

Throughout the experimental period, eight birds died resulting in a mortality of 3.3%.

Discussion

The percentage mortality obtained in the experiment is an indication that the test ingredient is not toxic. It also confirms that the processing method was adequate.

The gradual decrease in feed intake with increase in the level of rumen content in the diets may be attributed to an increase in the fiber content of the feed. Fiber creates bulkiness of the feed in the gut and this reduces the feed consumption of the birds. However, birds consume to satisfy their energy requirements and the presence of synthetic enzymes resulting in the breakdown of fiber may be responsible for the decrease in feed intake observed in this study. Values of feed intake obtained in this study were lower than 31g/b recommended by Oluyemi and Roberts (1985) except for birds on 10%RC which consumed 33.14g. Also, only birds on diet with 10% RC consumed more than 28.25g obtained by Adeniji (2001) where bovine blood rumen content mixture was included in pullets' diet at 10% level. This difference in feed intake may be attributed to the improvement in the value of rumen content by the

Table 1: Composition of Experimental Diets (Kg/100kg)

	Diets							
Ingredients	1	2	3	4	5	6	7	8
Rumen content	10.00	10.00	15.00	15.00	20.00	20.00	25.00	25
Maize	30.00	30.00	25.00	25.00	20.00	20.00	15.00	15
Wheat bran	12.00	12.00	9.00	9.00	7.00	7.00	5.50	5.5
Corn bran	16.50	16.50	19.70	19.70	21.70	21.70	23.20	23.2
Blood meal	0.70	0.70	0.70	0.70	0.50	0.50	0.50	0.5
Soyabean meal	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.5
Groundnut cake	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17
Fish meal	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.0
Oyster Shell	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.0
Bone meal	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.5
Methionine	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.1
Vit-Min Premix*	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Nutrase Xyla (ppm)**	100.00	----	100.00	-----	100.00	-----	100	-----
Roxazyme-G (ppm)***	-----	150.00	-----	150.00	------	150.00	------	150
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100	100
Analysed values								
Crude protein (%)	20.08	20.08	19.99	19.99	20.00	20.00	20.04	20.04
Crude fiber (%)	6.96	6.96	8.00	8.00	8.50	8.50	9.91	9.91
Calculated values								
Metabolizable energy (Kcal/kg)	2395.20	2395.20	2241.80	2241.80	2082.70	2082.70	1920.45	1920.45
Lysine (%)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.0
Methionine (%)	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Calcium (%)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.0
Available Phosphorus (%)	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45

X Contains: Vitamin A, Vitamin D_3, Vitamin E, Vitamin K, Vitamin B, Vitamin B_2, Niacin, Calcium panthothenate, Vitamin B_6, Vitamin B_{12}, Choline chloride, Folic acid, Biotin, Managanesse, Iron, Zinc, Copper, Iodine, Cobalt, Selenium and Antioxidant.XX: A bacteria endoxylanase enzyme manufactured by Nutrex NV of Belgium. It contains mainly Xylanase enzyme.XXX: A multipurpose enzyme containing mainly β-glucanase and Xylanase with activities (as determined by the manufacturer) of 8000 and 11000 units per gram respectively. It was manufactured from Trichoderma viride by Hoffman-La Roche Limited, Missiauga ON Canada L5N 627

addition of blood meal which increases the protein content of the mixture to about 30% and reduces the fiber content to 15%.

Although there is no evidence to suggest that synthetic enzymes improve palatability of diets, the improvement in feed intake due to roxazyme-G over nutrase xyla may be due to a reduction in bukiness and intestinal viscousity. With the presence of fiber degrading enzymes, intestinal viscousity occasioned by the presence of soluble arabinoxylans is reduced. Roxyzyme-G, been a multipurpose enzyme is better in this regard than nutrase xyla, a single purpose enzyme. The gradual decrease in weight gain with the increase in dietary level of rumen content shows that fiber depresses utilization of feed energy and essential nutrients. This energy deficit would in turn affect other biological parameters as well as nutrient retention. The decreasing weight is also similar to those obtained by Adeniji (2001) with bovine blood-rumen content mixture in pullet chicks and Atteh (2000) with Brewers' Dried Grains in diets of broilers. Birds fed on Roxazyme-G, a multipurpose enzyme, has exhibited a better body weight gain which implies that the multipurpose nature of the enzyme had a better impact. Roxazyme-G also gave a numerically better feed-to-gain ratio and this may be attributed to its multipurpose nature. Two main factors that affect the efficiency of synthetic enzymes in monogastric nutrition are spectrum of enzymatic activity and presence of respective substrates. According to Van Soest (1982) different dietary fiber sources are known to be compositionally (physical and chemical properties) different from each other. This study has shown that an increase in level of rumen content did not result in a corresponding increase in daily weight gain with the addition of the enzymes at recommended dose. Previous studies with barley and a commercial glucanase (Hesselman *et al.*, 1982) suggested that the response per unit of enzyme supplementation followed a logarithmic curve. This also explains the gradual decrease in weight gain with an increase in fiber content of the feed at a constant inclusion level of the two enzymes.

Although an increase in inclusion level of rumen content resulted in a substantial decrease in cost of feed, the economic sense of such a reduction will depend on the utilization of the feed and the weight gain. Roxazyme-G and nutrase xyla have the same unit price of N3000 per kilogram but the recommended inclusion level of roxazyme-G (150ppm) makes it more costly than nutrase xyla (100ppm). However, roxazyme-G gave the lowest cost per kilogram body weight gain of N150 per kilogram compared to N160 for nutrase xyla. Therefore roxazyme-G is economically better than nutrase xyla.

Table 2: Growth Performance Characteristics of Pullet Chicks Fed Different Levels of Rumen Content and Two Types of Enzymes

Levels of RC (%)	Feed Intake (g/b/d)	Weight gain (g/b/d)	Feed-to-gain ratio	Feed cost (N/kg)*	Cost of feed per kg Wt gain (N)
10	33.14[a]	7.49[a]	4.49[a,b]	83.45	160
15	26.83[b]	6.62[a, b]	3.82[a]	37.08	140
20	26.95[b]	6.27[b]	4.28[a, b]	35.41	152
25	27.99[a, b]	5.80[b]	4.91[b]	34.94	169
SEM	2.68	0.54	0.37		
Types of Enzyme					
Nutrase Xyla	27.52	6.03[a]	4.59	36.70	167.36
Roxazyme-G	29.93	7.06[b]	4.15	36.85	156.57
SEM	NS	2.68	0.54	NS	0.37
Interaction					
RCX E	N S	N S	N S		

a,b: means in the same column followed by same superscript are not significantly different (p<0.05),
NS: Not significant (p>0.05), SEM: Standard error of mean, *1$ = N130

Table 3: Effect of Rc and Enzymes on Nutrient Retention

	Retention %		
Dietary treatment	Protein	Ether extract	Crude fiber
Levels of R C			
10	58.87[NS]	54.19[NS]	32.44[NS]
15	52.15[NS]	70.05[NS]	42.87[NS]
20	49.12[NS]	67.49[NS]	38.85[NS]
25	69.15[NS]	69.93[NS]	29.30[NS]
SEM	11.66	14.89	15.59
Enzymes			
nutrase Xyla	62.53[NS]	73.18[NS]	42.46[NS]
Roxazyme-G	54.20[NS]	57.05[NS]	29.27[NS]
SEM	11.66	14.89	15.59
Interaction			
R C X E	N S	N S	N S

NS: Not Significant, SEM: Standard error of mean

There was no significant difference between the levels of RC on nutrient retention (protein, crude fiber and ether extract). However, contrary to reports by Bedford (1996) and Marsmen *et al*. (1997) that multipurpose enzyme supports protein digestibility better than single purpose enzyme, nutrase resulted in a numerically better protein retention compared to roxazyme-G. This fact is also applicable to other nutrients (crude fiber and ether extract). Generally, fiber sources have negative influence on protein and amino acids digestibility. When dietary fiber sources contribute a significant amount of dietary protein, the effect on nutrient digestibility is high.

In conclusion, considering the effects of the dietary factors (levels of rumen content and two types of enzymes) on feed intake, weight gain and feed-to-gain ratio, it is obvious that 15% inclusion level of rumen content in combination with roxazyme-G gave the best result. The study showed that 37.5% maize can be replaced by enzyme supplemented rumen content.

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