

Performance and Some Digesta Parameters of Broiler Chickens Given Low or High Viscosity Wheat-Based Diets with or without Enzyme Supplementation*

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Abstract: The influence of 2 enzyme supplements for diets based on wheat with high or low viscosity on performance and some intestinal parameters of male broiler chickens were investigated. The experiment was of 2 x 3 factorial design, with 2 types of wheat (high or low viscosity) and 3 enzyme treatments (none, Avizyme 1300-xylanase or Avizyme 1500-amylase). Ileal digesta viscosity was significantly ($P < 0.029$) higher in birds fed with high viscous wheat than with low viscous wheat.

Ileal digesta viscosity ($P < 0.001$) and dry matter content ($P < 0.002$) were significantly reduced by both enzyme preparations. Body weight gain, feed intake, dry matter intake, feed conversion ratio, DM retention and wet or dry excreta output were not significantly ($P > 0.05$) affected by all treatments. There were no significant interactions ($P > 0.05$) between the effects of wheat type and enzyme supplementation. In conclusion, the supplementation of high or low viscous wheat-based diets with the enzyme preparations of amylase or xylanase activity led to significant reductions in ileal digesta viscosity whereas no significant alterations were observed in the performance parameters.

Key Words: Broiler, wheat, enzyme, viscosity, performance

Etlik Piliçlerde Yüksek yada Düşük Viskositeli Buğdaya Dayalı Rasyonlara Enzim İlavésinin Performans ve Bazı Sindirim Sistemi Parametreleri Üzerine Etkileri

Özet: Bu araştırmada, yüksek yada düşük viskositeli buğdaya dayalı broyler rasyonlarına iki farklı enzim preparatının broyler performansı ve bazı sindirim sistemi kriterleri üzerine etkileri araştırılmıştır. Deneme iki buğday çeşidi (yüksek yada düşük viskositeli) ve üç enzim muamelesi (kontrol, Avizyme 1300-ksilanaz yada Avizyme 1500-amilaz) olmak üzere 2 x 3 faktörlü olarak planlanmıştır. Deneme sonuçlarına göre; yüksek viskositeli buğday rasyonu ile beslenen piliçlerin ileum içeriğinin viskositesi, düşük viskositeli buğday rasyonu ile beslenen piliçlerden önemli derecede ($P < 0,029$) yüksek bulunmuştur. Buna karşın, rasyonlara her iki enzim ilavesi ile ileum kuru madde içeriği ($P < 0,002$) ve viskositesi ($P < 0,001$) önemli derecede azalmıştır. Ayrıca deneme hayvanlarının canlı ağırlık kazançları, yem tüketimleri, kuru madde tüketimleri, yemden yararlanma oranları, kuru maddenin sindirilebilirlikleri ve ıslak yada kuru gübre miktarları deneme muamelelerinden önemli derecede etkilenmemiştir ($P > 0,05$). Diğer taraftan kullanılan buğday çeşidi ile rasyonlara katılan enzim preparatları arasında önemli bir interaksyon saptanmamıştır. Sonuç olarak, yüksek yada düşük viskositeli buğdaya dayalı broyler rasyonlarına amilaz yada ksilanaz aktiviteli enzim ilavesinin sindirim sistemi içeriğinin viskositesini düşürdüğü, buna karşın performans kriterleri üzerine etkili olmadığı söylenebilir.

Anahtar Sözcükler: Broyler, buğday, enzim, viskosite, performans

Introduction

It has been reported that soluble and gelling fibres, such as arabinoxylans and β -glucans of wheat, barley and rye grains, inhibit the extent of digestion and absorption of nutrients from the intestine in broiler chickens since the non-starch polysaccharides of these types comprise

the bulk of the endosperm cell walls whilst a proportion of the soluble arabinoxylans contribute to viscosity (1,2). The increased viscosity interferes with the activity of digestive enzymes and with the subsequent movement of nutrients before their absorption; this was shown to depress growth rate and feed conversion efficiency (3,4).

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Classen and Scott (5) suggested that in vitro viscosity is a useful indicator of wheat quality, but large differences in viscosity were not always reported to result in performance differences (6,7).

Exogenous enzymes have been shown to alleviate the adverse effects of high viscosity of digesta in the small intestine and to improve digestion (2,8) and to reduce the variability between birds induced by antinutritive factors in cereal grains (9). Recent studies have shown that the inclusion of enzyme preparations in wheat-based diets caused significant reductions in digesta viscosity, crypt cell proliferation and total volatile fatty acid production in the caecum of chickens but had no significant effects on bird performance (10). Thus, apparent improvements in the digestive tract are not always followed by improvements in growth efficiency.

This study was conducted to determine the effects of 2 different enzymes (Avizyme 1300 and Avizyme 1500) on performance and some digesta parameters of birds given low or high viscous wheat-based diets. The former

enzyme preparation has mainly xylanase activity, with some protease, while the latter is designed for maize-based diets with predominantly protease and amylase activity with some xylanase.

Materials and methods

Diets

Experimental diets are presented in Table 1. Diet 1 was based on wheat containing 16.25 cps Consort variety. Diet 2 supplemented with a commercial xylanase (Avizyme 1300) and Diet 3 supplemented with a commercial maize enzyme (Avizyme 1500) were the same as Diet 1. Avizyme 1300 and Avizyme 1500 contain 2500 U/g xylanase and 800 U/g protease, and 800 U/g xylanase, 6000 U/g protease and 2000 U/g amylase, respectively. Diet 4 was based on wheat containing 30.75 cps Savannah variety. Diet 5 and Diet 6 were similar to Diet 4, just differing in containing Avizyme 1300 and Avizyme 1500, respectively.

Table 1. The composition of the experimental diets (g/kg).

Ingredients	D I E T S					
	LV + Without enzyme	LV + Avizyme 1300	LV + Avizyme 1500	HV + Without enzyme	HV + Avizyme 1300	HV + Avizyme 1500
Wheat	809.50	808.50	808.50	809.50	808.50	808.50
Casein	150.00	150.00	150.00	150.00	150.00	150.00
CaCO ₃	20.00	20.00	20.00	20.00	20.00	20.00
Vegetable Oil	10.00	10.00	10.00	10.00	10.00	10.00
Salt	3.50	3.50	3.50	3.50	3.50	3.50
Vit + Min Prem. ¹	4.00	4.00	4.00	4.00	4.00	4.00
Enzyme	0.00	1.00	1.00	0.00	1.00	1.00
Titanium Oxide	3.00	3.00	3.00	3.00	3.00	3.00
TOTAL	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
Analysed Extract Viscosity, cps	11.2	11.2	11.2	20.2	20.1	20.2
Calculated Analysis DM, %	90.69	90.60	90.60	90.69	90.60	90.60
Crude Protein, %	22.55	22.53	22.53	22.55	22.53	22.53
ME, MJ/kg	13.36	13.35	13.35	13.36	13.35	13.35
Methionin, %	0.76	0.76	0.76	0.76	0.76	0.76
Lisin, %	1.19	1.19	1.19	1.19	1.19	1.19
Ca, %	0.93	0.93	0.93	0.93	0.93	0.93
Total P, %	0.44	0.44	0.44	0.44	0.44	0.44

¹Vit + min premix per kg 2400000 IU vit. A, 800000 IU vit. D₃, 14000 mg vit. E, 4000 mg copper from cupric sulphate, 100 mg molybdenum from sodium molybdate, 40 mg selenium from sodium selenite, Ca 26.49% and sodium 1.56%.

Animals and management

One-day-old male broiler chickens were fed in a group on a standard starter crumb for 20 days. Forty-eight birds were then allocated at random to individual cages, designed to allow quantitative collection of excreta. Illumination was provided for 23 h per day and temperature was controlled at 23 °C. The diets were offered ad libitum. Feed intakes were recorded daily and body weights weekly. Excreta output was collected between days 28 and 32. The chickens were killed on day 37 using a rising concentration of carbon dioxide followed by cervical dislocation. Digesta samples included the contents from Meckel's diverticulum to the ileo-caecal junction. The dry matter (DM) contents of the diets, the digesta and the excreta were determined by drying at 100 °C for 48 h. All excreta from each 4-day collection every week were thawed, mixed homogeneously and dried at 105 °C for measurement of the apparent retention of dry matter that was calculated as follows:

$$\text{DM retention (g/kg)} = \frac{\text{DM Intake, g} - (\text{DM Faeces} + \text{Urine}), \text{ g}}{\text{DM Intake, g}} \times 100$$

Viscosity of digesta was measured by centrifuging approximately 2.0 g of digesta at 13,000 g for 10 min; 0.5 ml of supernatant was measured in a Brookfield Digital Viscometer (Model LDVI+CP, Brookfield

Engineering Laboratories, Stoughton, MA) at 40 °C and 30 rpm. Acid extract viscosities of diets and wheat were determined (11): a 1 g sample was suspended in 15 ml of 0.2 M HCl-KCl acidic buffer (pH 1.5), placed in an agitating water bath at 37 °C for 3 h at 200 strokes per min and centrifuged at 900 g for 10 min. Viscosity of supernatants was measured at 25 °C and 50 rpm.

The experiment was of 2 (wheat varieties) x 3 (enzymes) factorial design. All data were subjected to analysis of variance using the general linear models (GLM) procedure (Minitab).

Results

The main effects of enzyme treatments are presented in Table 2 and of wheat type in Table 3. Final body weight, body weight gain, feed intake, dry matter intake, feed conversion ratio, retention and wet or dry excreta were not significantly affected by treatments ($P > 0.05$). Digesta viscosity ($P < 0.001$) and dry matter proportion ($P < 0.002$) were significantly reduced by both enzyme preparations. The excreta dry matter of Avizyme 1500 was significantly less than Avizyme 1300 ($P < 0.05$). Digesta viscosity was significantly higher in birds fed HV rather than LV ($P < 0.029$) (Table 3). There were no significant interactions ($P > 0.05$) between the effects of wheat variety and enzyme type.

Table 2. Main effects of enzyme treatments.

Parameters	Without enzyme	Avizyme 1300	Avizyme 1500	SEM	P
Initial bw, g/bird	432.6	431.6	430.0	12.48	NS
Final bw, g/bird	1086	1109	1089	43.09	NS
20-37 d weight gain, g/bird	653.8	676.9	659.0	40.67	NS
20-37 d feed intake, g/bird	1302	1318	1278	54.81	NS
DM intake, g/bird	1178	1194	1157	49.62	NS
20-37 FCE, g gain /g feed	0.49	0.51	0.51	0.01	NS
Fresh excreta output, g/bird	126.6	108.8	121.6	7.49	NS
Dry excreta output, g/bird	58.03	62.29	53.47	3.88	NS
Excreta DM, g/kg	498 ab	587 a	453 b	37.4	0.05
Digesta DM, g/kg	275 a	206 b	204 b	8.7	0.002
DM retention, g/kg	596	649	607	20.1	NS
Digesta viscosity, cps	32.8 a	19.8 b	21.4 b	1.9	0.001

Values with the same superscript in the same row are not significantly different ($P < 0.05$)

Table 3. Main effects of wheat type.

Parameters	Low viscosity	High viscosity	SEM	P
Initial bw, g/bird	432.1	430.7	10.19	NS
Final bw, g/bird	1106	1083	35.18	NS
20-37 Weight gain, g/bird	674.3	652.1	33.21	NS
20-37 Feed intake, g/bird	1324	1275	44.75	NS
DM intake, g/bird	1200	1152	40.51	NS
20-37 FCE, g gain /g feed	0.50	0.50	0.01	NS
Fresh excreta output, g/bird	117.5	120.5	6.11	NS
Dry excreta output, g/bird	58.03	57.83	3.17	NS
Excreta DM, g/kg	524	500	30.5	NS
Digesta DM, g/kg	230	227	7.1	NS
DM retention, g/kg	612	623	16.4	NS
Digesta viscosity, cps	21.5 a	27.8 b	1.6	0.029

Values with the same superscript in the same row are not significantly different ($P < 0.05$)

Discussion

The present study was undertaken to determine whether an enzyme preparation designed for use in maize-based diets would be more effective than one designed for wheat-based diets in alleviating the effects of a high viscosity wheat-based diet. Neither enzyme type nor wheat type had significant effects on final body weight, body weight gain, feed intake, dry matter intake, feed conversion ratio or DM retention, nor were wet or dry excreta output significantly affected by treatments, even though the enzymes reduced the viscosity and DM content of digesta. There were no interactions between effects of wheat variety and enzyme type.

The HV diet increased digesta viscosity. This result was similar to the previous reports by Choct and Annison (2), showing that digesta viscosity was affected by the amount of gelling and soluble fibres of feed. However, Veldman and Vahl (12) observed that differences in the viscosity of wheat grains were not reflected in broiler digesta viscosity. A recent study from Yasar and Forbes (10) also confirmed that supplementing wheat-based diets with enzymes did not result in a significant improvement in bird performance, whereas enzyme supplementation markedly reduced digesta viscosity, similar to the present results. Digesta viscosity was decreased by enzyme supplementation and this was presumably responsible for the effects on digesta and excreta dry matter.

Feed enzymes may indirectly alter the bacterial population in different regions of the intestinal tract by digesting the long chain carbohydrate molecules utilised by some bacteria to colonise the tract (3). Avizyme 1300 enzyme was numerically better than Avizyme 1500 enzyme in reducing digesta viscosity in the present experiment. Avizyme 1300 includes more xylanase than Avizyme 1500, and Steinfeldt et al. (7) reported that xylanase preparations are more efficient than other types of enzyme in reducing digesta viscosity.

The excreta dry matter of birds on LV was numerically higher than that of those fed on HV. In general, gelling fibre maintains its water-holding capacity during passage through the intestinal tract. Izydorczyk and Biliaderis (13) determined that the higher molecular weight arabinoxylans had a much greater potential to form cross-linked hydrogels with a very large water holding capacity than their smaller molecular weight counterparts. Although Avizyme 1300 significantly increased excreta DM content, unexpectedly Avizyme 1500 numerically reduced excreta dry matter, in comparison with the control group, which received the diet without added enzyme. The reduction in water content is important in improving litter quality. Dry matter retention was increased numerically by Avizyme 1300, compared with Avizyme 1500 and without enzyme; this was also reflected by similar trends in performance parameters in the present study.

The results of the present study confirm that the viscosity of wheat in diets for broiler chickens affects digesta viscosity in parallel but without significant effects on growth or efficiency. Supplementation of high-wheat diets with enzyme preparations decreased the viscosity and dry matter of digesta, though again without significant effects on bird performance.

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