

The influence of enzyme supplementation on wheat and inedible pasta utilization in broiler diets

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This study was performed to investigate the effect of xylanase supplementation on wheat and inedible pasta substitution for corn in broiler diets. Prior to study, the xylanase and beta-glucanase activities of crude enzyme preparation were determined to be 1260 and 390 units/g, respectively. Three levels of either wheat or inedible pasta (20, 40 and 60% of diet) were included in a corn-soybean meal control diet supplemented with one of the three xylanase levels (0, 500 and 1000 units/g). A total of 1008 broiler chicks of 7 days-old were used to test these 21 experimental diets in a 7×3 factorial arrangement with 3 replicates of 16 birds. The type of basal diet (control vs. wheat or inedible pasta containing diets) had highly significant effect ($P < 0.01$) on FI in all stages, but the enzyme influence depended to growth stage. The average daily gains were affected ($P < 0.01$) by type of basal diet, enzyme level and interaction between them. Dietary treatments had significant effect on feed conversion ratios in the grower stage, with the best ratios assigned to birds fed on diets containing inedible pasta. Unlike the total mortality, periodical mortalities were not affected by given treatments. In summary, the present results show that the bird' response to feed enzyme dependent on age and dietary inclusion level of wheat and inedible pasta.

Keywords: broiler chick; performance; wheat; inedible pasta; enzyme supplementation

Introduction

Wheat is an important feed ingredient in poultry diets, accounting for up to 70% of the metabolizable energy and 40% of the protein requirements of broilers. Compared with other cereal grains, however, the nutrient composition and nutritive quality of wheat vary widely (Hew et al., 1998). Wheat contains arabinoxylans (AX) at levels of 50-80 g/kg dry matter (Annison, 1990). Choct and Annison (1992) established that addition of both water-extractable and alkali-extractable wheat AX to a sorghum-based diet depressed ileal digestibility of starch, protein, and lipid in broiler chickens. A significant decrease in the dietary AME value was also found to be highly correlated to the arabinoxylan content in diet. One of the strategies has recently been shown to improve nutritive value of wheat-based diets for broiler chickens, is dietary supplementation with appropriate enzymes. Studies have demonstrated that the negative effects of the soluble arabinoxylans can be ameliorated by partial hydrolysis of the fiber in the presence of crude enzyme preparation having high xylanase activity (Classen and Bedford, 1991).

The by-products from food processing industries are considered as the good sources of energy and protein in poultry diets. One of them is pasta wastes which includes product spills, line changes, off-specification materials, etc. (Williams et al. 1998). The heat processing during the pasta production is associated with positive effects in bird performance, including increased feed utilization and better growth rate. Processing heat, however, can also be associated with negative effect, especially when the mixture is overheated (Silversides and Bedford, 1999). There is conflicting data regarding the efficacy of heat processing in improving nutritive value of feed ingredients, therefore the present study was designed to investigate the effect of heat processing on improving feeding value of pasta wastes and

evaluate whether dietary inclusion of enzyme preparation with predominant xylanase activity can increase the utilization of this by-product and wheat in broiler diets.

Materials and methods

A total of 1008 female broiler chickens (Ross × Ross) which had been identically brooded to 7 days of age were used in this study. The experimental design was completely randomized in 7×3 factorial arrangement of treatments (7 various basal diets, and 3 levels of xylanase supplementation) with 3 replicates of 16 birds. To preparing various basal diets, three levels of either wheat or pasta wastes (20, 40, and 60% of diet) were included in a corn-soybean meal control diet. The basal diets (7 diets) were supplemented with one of the three xylanase levels (0, 500, or 1000 units/kg of diet). The AME_n values of ingredients used were determined by tube-feeding of adult cockerels in our station (Jahanian et al., under publication). The experimental diets were formulated to be isocaloric and isonitrogenous and to meet or exceed NRC (1994) nutrient recommendations. The xylanase and beta-glucanase activities of crude enzyme preparation (Endo Feed W, Canada) were determined according to Cosson et al. (1999) procedure and were 1260 and 390 units/g, respectively. Residual feed and pen weights were recorded on Days 21, 42 and 49. Data were analyzed as a completely randomized design by using the General Linear Models procedures of SAS software (SAS Institute, 1999).

Results and discussion

Feed consumption and weight gain data are presented in *Table 1*. As noted, the type of basal diet had a highly significant ($P < 0.01$) effect on feed consumption in all experimental periods.

Table 1 Effects of enzyme supplementation of various basal diets on feed consumption and body weight gain of broiler chicks during entire experimental period

Main effects	Daily feed consumption (g/bird)			Total FI (g/bird)	Daily body weight gain (g/bird)			Total BWG (g/bird)
	7-21 d	21-42 d	42-49 d		7-21 d	21-42 d	42-49 d	
Type of basal diet								
Control diet ¹	58.72 ^a	96.59 ^{cd}	151.46 ^b	3911 ^b	36.67 ^b	44.82 ^a	55.14 ^c	1853 ^c
20% wheat diet	56.77 ^b	109.76 ^a	159.69 ^a	4218 ^a	34.69 ^c	48.65 ^a	60.37 ^a	1930 ^b
40% wheat diet	54.68 ^c	92.27 ^e	147.01 ^b	3732 ^c	36.06 ^b	44.29 ^{bc}	57.27 ^b	1836 ^{cd}
60% wheat diet	49.59 ^e	104.68 ^b	142.01 ^c	3887 ^b	31.12 ^d	42.71 ^d	55.84 ^{bc}	1723 ^f
20% pasta diet	56.94 ^b	91.70 ^e	149.62 ^b	3770 ^c	36.21 ^b	43.18 ^{cd}	56.70 ^{bc}	1811 ^{de}
40% pasta diet	56.61 ^b	99.59 ^c	150.91 ^b	3940 ^b	37.83 ^a	47.96 ^a	61.67 ^a	1969 ^a
60% pasta diet	51.79 ^d	94.77 ^{de}	147.73 ^b	3749 ^c	34.87 ^c	41.98 ^d	61.89 ^a	1803 ^e
Enzyme level (U/kg)								
0	54.38	100.08 ^a	144.36 ^b	3874	34.36 ^b	42.94 ^b	54.48 ^c	1764 ^c
500	55.35	98.51 ^{ab}	151.74 ^a	3906	35.85 ^a	45.47 ^a	59.61 ^b	1874 ^b
1000	55.32	96.86 ^b	153.23 ^a	3881	35.84 ^a	45.99 ^a	61.13 ^a	1901 ^a
Probability								
Basal diet type	***	***	***	***	***	***	***	***
Enzyme level	NS	*	***	NS	***	***	***	***
Diet × Enzyme	NS	NS	***	**	***	***	***	***
SE	0.98	2.04	2.87	52.26	0.68	0.85	1.08	15.99

^{a-f}Means with no common superscript within a column of each classification (type of basal diet, or enzyme level) are significantly different ($P < 0.05$); ¹Corn-soybean meal diet; * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

The chicks fed on 60% wheat diet consumed minimum feed in the starter phase. Enzyme addition caused to numerical increase in feed intake (FI) in the starter period. In the grower stage, however, the birds fed on 60% wheat diets increased their FI as compared with other groups. Enzyme addition resulted to significant decrease in chicks' feed intake in this period. The lower feed intake in groups fed on greater levels of wheat and inedible pasta may be due to increasing digesta viscosity. In agreement with present observations, White et al. (1983) and Almirall et al. (1995) demonstrated that the increasing intestinal viscosity was the main reason for decline in FI and impairment of performance observed in chicks fed barley diets. However, in their study, Garcia et al. (2003) observed that the heat processing of barley improved feed intake and daily gain from 0 to 8 d of age in spite of the increase observed in intestinal viscosity. It is possible that at early ages, the beneficial effects of heat processing on nutrient retention overwhelmed the negative effects of the higher viscosity.

Generally, both basal diet type and enzyme supplementation had a highly significant ($P < 0.01$) effects on average daily gain in all experimental periods. Signifying the interaction between diet type and enzyme level may be due to unsuitability of corn-soybean meal diets for enzyme action as well as different effect of enzyme levels across the various basal diets. Although the chicks fed on 60% pasta diet had low feed intake, but their weight gains did not decrease to extent observed in 60% wheat group, which indicate that the heat processing during the pasta production improved its nutritive value for broilers (Garcia et al., 2003).

In the present study, enzyme supplementation of 1000 U/kg of 60% wheat diets resulted to 11.5% increase in body weight gain in starter period, which was maximum effect of dietary enzyme among the all experimental groups. This observation demonstrate that wheat containing diets are more responsive to dietary enzyme supplementation than pasta diets, probably due to already positive effect of heat processing on nutritive value of latter.

Table 2 Effects of enzyme supplementation of various basal diets on feed conversion ratio and mortality rate of broiler chicks from 7 to 49 days of age

Main effects	Feed conversion ratio (feed:gain)				Total mortality
	7-21 d	21-42 d	42-49 d	Entire period	
Type of basal diet					
Control diet ¹	1.60 ^a	2.16 ^c	2.75 ^a	2.11 ^{bc}	4.17 ^{ab}
20% wheat diet	1.64 ^a	2.26 ^b	2.65 ^{ab}	2.19 ^{ab}	0.69 ^b
40% wheat diet	1.52 ^{bc}	2.08 ^c	2.57 ^{bc}	2.03 ^{cd}	2.78 ^{ab}
60% wheat diet	1.59 ^a	2.48 ^a	2.55 ^{bc}	2.27 ^a	3.47 ^{ab}
20% pasta diet	1.58 ^{ab}	2.12 ^c	2.64 ^{ab}	2.08 ^{cd}	3.47 ^{ab}
40% pasta diet	1.50 ^c	2.08 ^c	2.45 ^{cd}	2.00 ^d	2.78 ^{ab}
60% pasta diet	1.49 ^c	2.27 ^b	2.40 ^d	2.08 ^{cd}	7.64 ^a
Enzyme level (U/kg)					
0	1.58	2.34 ^a	2.65 ^a	2.20 ^a	5.05 ^a
500	1.54	2.17 ^b	2.55 ^b	2.09 ^b	2.30 ^b
1000	1.55	2.11 ^c	2.52 ^b	2.04 ^b	3.37 ^{ab}
Probability					
Basal diet type	***	***	***	***	*
Enzyme level	NS	***	*	***	*
Diet × Enzyme	NS	***	NS	NS	NS
SE	0.04	0.05	0.08	0.07	2.32

^{a-d}Means with no common superscript within a column of each classification (type of basal diet, or enzyme level) are significantly different ($P < 0.05$); ¹Corn-soybean meal diet; * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

As noted in *Table 2*, the type of basal diet had a significant effect on feed conversion ratio (FCR). With the exception of starter phase, the FCR values were affected by enzyme supplementation. The enzyme supplementation improved overall FCR by 5.26 to 7.84%. In all, the best FCR values were related to chicks fed on pasta diets.

Unlike the periodical mortalities (data not shown), overall mortality was affected by type of basal diet as well as enzyme level (*Table 2*). Enzyme supplementation resulted to significant decrease in mortality rate. In agreement with our results, Engberg et al. (2004) reported that the mortality of whole wheat-fed birds supplemented with xylanase tended to be lower than non-supplemented ones.

In conclusion, the present results demonstrate the beneficial effects of enzyme supplementation and heat processing on feeding value of diets which mainly consisted of high NSP ingredients. Dietary enzyme addition allows utilizing more wheat and pasta wastes in broiler diets; however, utilizing the high amounts of this by-product should be precautious.

References

- Adeola, O. and Bedford, M.R. (2004) Exogenous dietary xylanase ameliorates viscosity-induced anti-nutritional effects in wheat-based diets for White Pekin ducks (*Anas platyrinchos domesticus*). *Br. J. Nutr.* 92: 87-94.
- Almirall, M., Francesch, M., Perez-Vendrell, A.M., Brufau J. and Esteve-Garcia, E. (1995) The differences in intestinal viscosity produced by barley and β -glucanase alter digesta enzyme activities and ileal nutrient digestibilities more in broiler chicks than in cooks. *J. Nutr.* 125: 947- 955.
- Annisson, G. (1990) Polysaccharide composition of Australian wheats and the digestibility of their starches in broiler chicken diets. *Aus. J. Exp. Agric.* 30: 183-186.
- Association of Official Analytical Chemists (2002) *Official Methods of Analysis*. 16th ed., AOAC. Washington, DC., USA.
- Choct, M. and Annisson, G. (1992) The inhibition of nutrient digestion by wheat pentosans. *Br. J. Nutr.* 67: 123-132.
- Classen, H.L. and Bedford, M.R. (1991) The use of enzymes to improve the nutritive value of poultry feeds. in: *Recent Advances in Animal Nutrition*, pp. 95-116. Butterworth-Heinemann Ltd., Oxford, UK.
- Cosson, T., Perez-Vendrell, A.M., Gonzalez-Teresa, B., Rene, D., Taillade, P. and Brufau, J. (1999) Enzymatic assays for xylanase and β -glucanase feed enzymes. *Anim. Feed Sci. Technol.* 77: 345-353.
- Engberg, R.M., Hedeman, M.S., Steinfeldt, S. and Jensen, B.B. (2004) Influence of whole wheat and xylanase on broiler performance and microbial composition and activity in the digestion tract. *Poult. Sci.* 83: 925-938.
- Garcia, M.I., Latorre, M.A., Garcia, M., Lazaro, R. and Mateos, G.G. (2003) Heat processing of barley and enzyme supplementation of diets for broilers. *Poult. Sci.* 82: 1281-1291.
- Hew, L.I., Ravindran, V., Mollah, Y. and Bryden, W.L. (1998) Influence of exogenous xylanase supplementation on apparent metabolisable energy and amino acid digestibility in wheat for broiler chickens. *Anim. Feed Sci. Technol.* 75: 83-92.
- National Research Council (1994) *Nutrient Requirements of Poultry*. 8th rev. ed., National Academy Press, Washington, DC., USA.
- Pickford, J.R. (1992) Effects of processing on the stability of heat labile nutrients in animal feeds. in: *Recent Advances in Animal Nutrition* (Garnsworthy, P.C., Haresign, W. and Cole, D.J.A., Eds.), pp. 117-192. Butterworth-Heinemann, Oxford, UK.
- SAS Institute (1999) *SAS Statistics User's Guide*. Statistical Analysis System. 5th rev. edition. Cary, NC., SAS Institute Inc.
- Silversides, F.G. and Bedford, M.R. (1999) Effect of pelleting temperature on the recovery and efficacy of a xylanase enzyme in wheat-based diets. *Poult. Sci.* 78: 1184-1190.
- White, W.B., Bird, H.R., Sunde, M.L. and Martlett, J.A. (1983) Viscosity of β -D-glucan as a factor in the enzymatic improvement of barley for chicks. *Poult. Sci.* 62: 853-862.
- Williams, J.E., Belyea, R.L., Hsieh, F.H. and Firman, J.D. (1998) Responses of growing turkeys to the dietary inclusion of inedible pasta and unextruded and extruded biosolids from milk processing. *Anim. Feed Sci. Technol.* 70: 123-136.