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Gastrointestinal responses of turkeys to the addition of exogenous xylanase and glucanase to diets

J. Juśkiewicz[1,3], D. Mikulski[2], J. Jankowski[2] and Z. Zduńczyk[1]

[1]Institute of Animal Reproduction and Food Research, Polish Academy of Sciences
Tuwima 10, 10-747 Olsztyn, Poland
[2]Warmia and Mazury University in Olsztyn, Department of Poultry Science
Oczapowskiego 2, 10-957 Olsztyn, Poland

ABSTRACT

Changes in digesta parameters were examined in turkeys fed for 8 weeks on diets with and without the addition of an enzymatic preparation, Kemzyme®W Liquid, in doses of 50, 100 and 150 mg/kg. The preparation contained a specified mixture of xylanase and glucanases. The diet with the highest addition of exogenous enzymes decreased ileal viscosity (1.21 vs 1.33 mPa• s) and weight of ileal tissue (10.6 vs 13.4 g/kg BW) compared with the control group. Dietary enzymes did not influence either hydration or pH of caecal digesta, but decreased the activity of bacterial enzymes as well and tended to increase short-chain fatty acid contents in the caeca. The highest dietary addition of an enzymatic preparation decreased caecal viscosity (3.04 mPa•s) compared with the control (3.79 mPa• s) and other experimental groups (3.50-3.51 mPa•s).

KEY WORDS: non-starch polysaccharides, microbial enzymes, xylanase, caecal fermentation, turkey

INTRODUCTION

Non-starch polysaccharides (NSP), the main ingredients of the endosperm of cereals, are generally undigested in the upper part of the gastrointestinal tract of poultry but can be hydrolysed to a small extent by caecal microflora. It was shown that the addition of xylanase (Choct et al., 1999) or a complex of enzymes (Józefiak et al., 2004), improved the digestibility of NSP of wheat- and barley-based diets in chickens. The aim of the study was to investigate the enzymes added (three doses of a β-xylanase and β-glucanase mixture) to wheat and barley-based diets in turkeys.

[3] Corresponding author: e-mail: glebczo@pan.olsztyn.pl

MATERIAL AND METHODS

A total of 420 BIG-6 female turkeys divided into four groups (four replications with 21 birds each) were fed a control diet containing 10% barley and 37 or 40% wheat in the period of 1-4 and 5-8 weeks, respectively. Experimental diets were supplemented with the Kemzyme®W Liquid preparation (Kemin Industries, Inc.) at doses of: 50, 100 and 150 mg/kg (group K_{50}, K_{100} and K_{150}, respectively). The preparation contained 1,4-β-xylanase (210000 U/g), 1,3(4)-β-glucanase (10000 U/g), 1,4-β-glucanase (120000 U/g), and α-amylase (400 U/g). After 8 weeks of feeding, 8 turkeys from each group were killed, the small intestine and caeca with contents were removed and emptied. The pH of the ileal and caecal digesta was measured using a microelectrode and pH/ION meter (model 301, Hanna Instruments). Empty ileum and caeca were flushed clean, blotted and weighed. Samples of fresh caecal digesta were used for determining dry matter, microbial enzyme activity and short-chain fatty acid (SCFA) concentrations.

The viscosity of intestinal and caecal digesta was determined using a Brookfield cone-plate viscometer Model LVDV-II (Brookfield Engineering Laboratories Inc., Stoughton, MA). Samples of ileal and caecal digesta were diluted with water at a 1:1 or 1:2 ratio, respectively. The caecal digesta was analysed for VFA concentration by gas chromatography (Shimadzu GC-14A with a glass column 2.5 m × 2.6 mm, containing 10% SP-1200/1% H_3PO_4 on 80/100 Chromosorb W AW, column temperature 110°C, detector FID temperature 180°C, injector temperature 195°C). Microbial enzyme activity in the caecal digesta was measured by the rate of p- or o-nitrophenol release from their nitrophenylglucosides according to the modified method of Djouzi and Andrieux described by Juśkiewicz et al. (2002). The results were analysed using one-way ANOVA and the Duncan's multiple range test.

RESULTS

As shown in Table 1, the supplementation of diets with carbohydrases significantly decreased the viscosity of intestinal digesta and mass of ileal wall. The pH of intestinal and caecal digesta was also numerically lowered. Supplementation of the diet with the enzyme preparation had no significant effect on the mass of empty caeca, DM content and pH of digesta. A lower activity of microbial enzymes was found in turkeys fed diets with the addition of the enzymatic preparation. The content of acetic acid in the caecal digesta of group K_{100} was higher, while the content of propionic acid in groups K_{100} and K_{150} was lower than in the control group. Due to a larger amount of caecal digesta, the SCFA pool was numerically the highest in group K_{150}.

The acetic acid content in the caecal digesta of group K_{100} was significantly higher than in the control and K_{150} groups, the latter with the highest addition

of enzymes. Experimental groups were characterized by a higher propionic acid content compared with the control. Due to a larger amount of caecal digesta, the total ceacal SCFA production (SCFA pool) appeared to be the highest in group K_{150} turkeys.

Table 1. The effect of enzyme addition on ileal and caecal parameters of turkeys

	Control	K_{50}	K_{100}	K_{150}	SEM
Ileal viscosity, mPa•s	1.33 [a]	1.29 [ab]	1.27 [ab]	1.21 [b]	0.02
pH of ileal digesta	6.04	5.78	5.61	5.62	0.08
Intestinal wall, g/kg BW	13.4[a]	11.6[ab]	11.7[ab]	10.6[b]	0.17
Caecal wall, g/kg BW	3.59	3.45	3.50	3.67	0.07
Caecal digesta, g/kg BW	3.60	3.97	3.80	4.17	0.22
Dry matter of caecal digesta, %	16.9	16.3	16.2	16.3	0.33
pH of caecal digesta	5.47	5.69	5.61	5.74	0.05
Viscosity of caecal digesta, mPa.s	3.79[a]	3.50[a]	3.51[a]	3.04[b]	0.15
α-glucosidase, U/g digesta	1.98[a]	1.25[b]	1.88[ab]	1.86[ab]	0.12
β-glucosidase, U/g digesta	0.66[ab]	0.48[b]	0.92[a]	0.79[ab]	0.06
α-galactosidase, U/g digesta	3.54	3.08	2.38	2.13	0.24
β-galactosidase, U/g digesta	6.87[a]	5.29[ab]	2.79[b]	3.68[b]	0.48
β-glucuronidase, U/g digesta	2.90[a]	1.45[b]	1.54[b]	1.44[b]	0.20
SCFA concentration, μmol/g					
acetic	48.1[b]	51.4[ab]	56.6[a]	46.1[ab]	1.50
propionic	28.1[a]	22.4[ab]	21.2[b]	19.1[b]	1.16
isobutyric	0.65	1.07	0.85	1.08	0.10
butyric	17.8	17.5	19.8	17.5	0.60
isovaleric	0.79	1.03	0.98	1.01	0.06
valeric	2.21	2.29	2.32	2.11	0.08
total	97.7	95.7	102	86.9	2.46
SCFA pool, μmol/kg BW					
acetic	178	204	215	210	13.37
propionic	106	89.2	80.6	83.9	6.92
total	363	379	386	393	24.2

[a,b] different superscripts within a row indicate significant differences, $P<0.05$

DISCUSSION

Supplementation of diets with exogenous enzymes, especially at a high dose of 150 mg/t, lowered intestinal viscosity. This is consistent with the results obtained by Choct et al. (1999) and Józefiak et al. (2004). The lower activity of microbial enzymes observed in the present study may indicate that enzymatic preparations decreased the amount of easily fermentable carbohydrates in caecal digesta. This refers to the soluble fraction of NSP (i.e. soluble arabinoxylans and/or β-glucans),

which plays an important role in the formation of viscosity in ileal digesta (Lázaro et al., 2003). The addition of exogenous enzymes increased the concentration of SCFA, mainly of acetic acid, in caecal digesta. In the experiment of Józefiak et al. (2004), the increase in SCFA concentration was more distinct: almost two times higher in broilers fed barley- or oat-diets supplemented with xylanase and protease. In other studies, enzymatic preparations added to rye diets did not increase the SCFA concentration in caecal digesta (Lázaro et al., 2003).

CONCLUSIONS

Supplementing diets with a mixture of exogenous xylanase and β-glucanase lowered the viscosity in intestinal and caecal digesta, the activity of bacterial enzymes and enhanced the production of some SCFA. This effect points to a change of bacterial populations in the caeca; it was more distinct at the highest dose of the enzymatic preparation administered to the diet.

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STRESZCZENIE

Reakcja przewodu pokarmowego indyków na zawartość w mieszance ezgogennej ksylanazy i glukanazy

Analizowano zmiany w składzie i właściwościach treści pokarmowej indyków żywionych przez 8 tygodni mieszankami bez lub z dodatkiem 50, 100 lub 150 mg/kg preparatu enzymatycznego zawierającego mieszaninę ksylanazy oraz glukanaz. Największy dodatek enzymów obniżył lepkość treści (1,21 vs 1,33 mPa · s) i masę tkanki jelita cienkiego (10,6 vs 13,4 g/kg m.c.) w porównaniu z grupą kontrolną. Dodatek enzymów nie wpłynął na uwodnienie i pH treści jelita ślepego, natomiast obniżył aktywność enzymów glikolitycznych mikroflory jelitowej; stwierdzono też tendencję zwiększenia produkcji lotnych kwasów tłuszczowych. Największy dodatek preparatu do diety obniżył lepkość treści jelit ślepych (3,04 mPa · s) w porównaniu z grupą kontrolną (3,79 mPa · s) i pozostałymi grupami doświadczalnym (3,50-3,51 mPa · s).