

Intestinal viscosity and metabolizable energy in chickens and turkeys of different ages fed cereal-based diets with or without enzyme supplementation

S. Palander^{1}, M. Näsi² and P. Hägg², ¹Seinäjäski Polytechnic, Ilmajoki Institute of Agriculture, Ilmajoentie 525, FIN-61800 Ilmajoki, Finland, ²University of Helsinki, Department of Animal Science, P.O.B. 28, FIN-00014 University of Helsinki, Finland.
E-mail: samu.palander@seamk.fi*

Abstract

Two experiments were conducted to assay digesta viscosity and metabolizable energy values of different cereal-based diets with or without enzyme supplementation in growing turkeys and broiler chickens at 3 and 6 weeks of age and in laying hens. Age, feeding and poultry species had interacting effects on digesta viscosity and metabolizable energy. Viscosity was reduced with age in broilers, but energy metabolizability was improved with age more remarkably in turkeys. Growing turkeys gained slightly more energy from the diets as compared to hens.

Introduction

In poultry feed formulation, the same mean digestibility and energy values are usually applied for different poultry species and for birds of different ages. It is, however, known that nutrient digestibility and metabolizable energy content of a diet may vary according to age of the target birds. For fat digestibility and therefore for metabolizable energy an increasing trend in growing chickens and turkeys seems to be evident (Wallis and Balnave 1984, Plavnik et al. 2000, Palander et al. 2005). Viscosity-reducing hemicellulolytic enzyme supplementations have been widely applied in poultry feeding and widely investigated in broiler chickens. Regarding turkeys investigations have been carried out to a small extent, and comparative information on effects of enzymes in different types of poultry fed different diets is scarcely available. The objective of the present study was to assay digesta viscosity and metabolizable energy values of different cereal-based diets with or without enzyme supplementations in growing broiler chickens at two age periods and in laying hens.

Materials and methods

In Experiment 1, 252 growing turkeys (B.U.T. 8) and 162 growing broiler chickens (Ross 208) were used. 14 turkeys or 9 broilers were placed in each cage, thus forming 18 replicates for each species. The experimental feed mixtures consisted of ground cereals, soybean meal, vegetable oil and sufficient mineral and vitamin supplementations. 2 g of chromic oxide and 5 g of titanium oxide per 1 kg feed were added to the mixtures as markers. The feeding treatments were composed to form diets which according to general knowledge can be considered to represent sources of soluble (wheat and barley) and insoluble (oats) fibres:

1. a 1:1 mixture of wheat + dehulled barley (WB)
2. oats (O)
3. a 1:1:1 mixture of wheat + dehulled barley + oats (WBO)
4. as 1. + Avizyme 1200, 1.0 g / kg (WB+E)
5. as 2. + O Avizyme 1200, 1.0 g / kg (O+E)
6. as 3. + Avizyme 1200, 1.0 g / kg (WBO+E)

The trial periods at 3 and 6 weeks of age consisted of excreta collection of 24 h, an intervening time of one day, and finally a slaughtering day so that the slaughtering days took place at 21 and 42 of age. The diets and excreta was analysed for gross energy and nitrogen for nitrogen corrected metabolizable energy determination. At the slaughtering days, a part of the birds of each cage (7 turkeys and 5 broilers at 3 weeks of age, 4 turkeys and the remaining 4 broilers at 6 weeks of age) were taken for digestive tract sampling. The birds were stunned

mechanically, killed by neck dislocation, contents of *duodenum + jejunum* sampled and viscosity of centrifuged jejuno-duodenal digesta was measured. In Experiment 2, the remaining 54 turkeys from the Experiment 1 were used at 9 weeks of age with 90 laying 22-week-old Isabrown hens. In Exp. 2, the treatments and procedures were similar to those of Exp. 1, but the diets contained extra calcium carbonate to meet calcium requirements of laying hens.

Results and Discussion

Jejuno-duodenal digesta viscosity is shown in Table 1. In Experiment 1, the highest viscosities were observed in the WBO diet and the lowest in the OE diet. Viscosity was generally higher in turkeys than in broilers ($P < 0.001$), and this trend was more pronounced in 6-week-old than in 3-week-old birds ($P < 0.001$). Actually viscosity had increased with age in turkeys for most of the diets, a result which is not consistent with previous findings (*e.g.* Salih et al. 1991, Palander et al. 2005). In the WBO mixture the viscosity was higher than in WB only ($P < 0.001$) and on average higher in wheat-barley-containing diets than in pure oats diets ($P < 0.05$). Viscosity was lower in the enzyme-supplemented diets ($P < 0.001$) in both age groups. However, double and triple interactions of feeding and age occurred, thereby complicating interpretation of some of the results. In Experiment 2, no remarkable effects of the factors on intestinal viscosity were observed.

Table 1. Intestinal supernatant viscosity.

	WB	WB+E	O	O+E	WBO	WBO+E
Exp. 1, turkeys, 3 weeks	4.99	5.72	4.92	4.35	7.30	4.70
Exp. 1, broilers, 3 weeks	3.68	3.85	4.29	4.32	6.31	4.30
Exp. 1, turkeys, 6 weeks	6.38	5.40	6.53	5.56	6.49	6.60
Exp. 1, broilers, 6 weeks	2.83	2.78	3.89	2.62	4.09	2.47
Exp. 2, turkeys, 9 weeks	4.24	4.47	4.04	3.55	4.13	4.02
Exp. 2, hens	3.78	3.73	4.56	4.06	4.13	3.90
	Statistics for Exp. 1			Statistics for Exp. 2		
SEM (3 weeks)	0.30	SEM (6 weeks)	0.42	SEM	0.30	
	Probabilities			Probabilities		
Overall C1	0.0003	Age*C1	0.7699	C1	0.2902	
Overall C2	0.0101	Age*C2	0.0451	C2	0.9899	
Overall C3	0.0002	Age*C3	0.1642	C3	0.9440	
Overall C4	0.0001	Age*C4	0.0001	C4	0.7849	
Overall C5	0.1615	Age*C5	0.0819	C5	0.2470	
Overall C6	0.0001	Age*C6	0.0022	C6	0.5410	
Overall C7	0.6437	Age*C7	0.3441	C7	0.6980	
Overall C8	0.1049	Age*C8	0.4884	C8	0.0360	
Overall C9	0.1446	Age*C9	0.1528	C9	0.2129	
Overall C10	0.7400	Age*C10	0.6950	C10	0.8086	
Overall C11	0.0579	Age*C11	0.0158	C11	0.8565	
Age effect	0.0924					

C1 = enzyme effect, C2 = pure oats diets vs. other diets, C3 = wheat-barley-oats mixture vs. wheat-barley only, C4 = turkey vs. chicken effect, C5 = interaction C1*C2, C6 = interaction C1*C3, C7 = interaction C1*C4, C8 = interaction C2*C4, C9 = interaction C3*C4, C10 = interaction C1*C2*C4, C11 = interaction C1*C3*C4

Apparent nitrogen-corrected metabolizable energy of the diets is shown in Table 2. In Exp. 1, energy metabolizability increased with age of the birds ($P < 0.001$), which is in accordance with previous findings. This effect, however, was much more pronounced in turkeys than in broilers ($P < 0.001$), and 6-week-old turkeys gained more energy from the diets than 6-week-

old broilers. Enzyme supplementation had interacting effects with age and improved metabolizable energy of the diets in younger birds only ($P < 0.01$). In Exp. 2, growing 9-week-old turkeys gained slightly more energy from the diets as compared to hens ($P < 0.01$), and ME content of O diets was lower than that of the other diets, but no effects of enzyme supplementation was observed. In these experiments, highest ME values were observed in WBO mixture diets and lowest in O diets, although intestinal viscosity was highest in WBO diets as well. In the present experiments, differences in intestinal viscosity were moderate and did not clearly explain differences in ME of the diets, although enzyme supplementation generally both reduced viscosity and increased ME value. In a previous experiment with turkeys (Palander et al. 2005), ME content of oats had been similar to that of wheat without enzyme supplementations, and intestinal viscosity had been strongly correlated with ME.

Table 2. Apparent nitrogen-corrected metabolizable energy of the diets.

	WB	WB+E	O	O+E	WBO	WBO+E
Exp. 1, turkeys, 3 weeks	12.12	12.43	11.17	12.06	12.37	12.37
Exp. 1, broilers, 3 weeks	12.05	12.61	12.03	12.45	12.54	12.91
Exp. 1, turkeys, 6 weeks	13.25	13.64	12.79	12.35	13.42	13.38
Exp. 1, broilers, 6 weeks	12.70	12.64	12.52	12.31	13.01	13.15
Exp. 2, turkeys, 9 weeks	12.62	12.67	11.67	11.82	12.53	12.39
Exp. 2, hens	12.26	12.15	11.50	11.70	12.38	12.23
	Statistics for Exp. 1			Statistics for Exp. 2		
	Pooled SEM		0.13	Pooled SEM		0.14
	Probabilities			Probabilities		
Overall C1	0.007	Age*C1	0.001	C1	NS	
Overall C2	< 0.001	Age*cereal	0.002	C2	< 0.001	
Overall C3	0.002			C3	NS	
Overall C4	NS	Age*C4	< 0.001	C4	0.004	
Overall C5	NS	Age*C5	0.070	C5	NS	
Overall C6	NS	Age*C6	NS	C6	NS	
Overall C7	NS	Age*C7	NS	C7	NS	
Age effect	< 0.001					
C1 = enzyme effect, C2 = pure oats diets vs. other diets, C3 = wheat-barley-oats mixture vs. wheat-barley only, C4 = turkey vs. chicken effect, C5 = interaction C1*cereal, C6 = interaction C1*C4, C7 = interaction C1*C4*cereal						

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