INDICES OF RESPONSE OF YOUNG TURKEYS TO DIETS CONTAINING MANNAN-OLIGOSACCHARIDE OR INULIN

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Abstract. For 8 weeks, the birds were fed *ad libitum* with the mash feed mixtures containing 0.1% or 0.4% of two types of low-digestible carbohydrates: mannan-oligosaccharide (MOS) and long-chain polymer of fructose – inulin. All diets were without an antibiotic addition. Productivity and faecal parameters of birds were analysed. The supplementation of diets with MOS or inulin had no significant influence neither on the diet intake nor feed conversion of turkeys. In addition, in all groups comparable concentration of dry matter and faecal pH were observed. The lower dose of inulin (0.1%) decreased faecal ammonia concentration compared to the both MOS groups. Ingested supplements increased faecal activity of microbial α-glucosidase and α-galactosidase. In the experimental groups, higher concentrations of short-chain fatty acids (especially acetate) were observed compared to the control group (total SCFAs: 38.5-46.17 μmol/g vs. 20.58).

Keywords: mannan-oligosaccharide, inulin, feed utilization, faecal parameters, turkey.

RACIONO, TURINČIO MONOOLIGOSACHARIDŲ IR INULINO, POVEIKIS KALAKUČIUKŲ AUGINIMO RODIKLIAMS

Santrauka. 8 savaites paukščiai *ad libitum* buvo lesinami mišiniu, turinčiu 0,1% arba 0,4% iš dviejų tipų kompleksinių angliavandenių – monooligosacharido (MOS) ir inulino. Racionai neturėjo antibiotikų priedų. Buvo tiriamas paukščių produktyvumas bei išmatų rodikliai. Raciono papildymas MOS ir inulinu neturėjo didelės įtakos sulesto lesalo kiekiui ir virškinamumui. Visose grupėse buvo pastebėta panaši sausųjų medžiagų koncentracija ir bemaž toks pat išmatų pH. Mažesnė inulino dozė (0,1%) sumažino amoniako koncentraciją išmatose lyginant su abiem MOS grupėmis. Papildai suaktyvino fekalinę mikrobinių alfa gliukozidazės ir alfa galaktozidazės veiklą. Eksperimentinėse grupėse buvo nustatytos didesnės trumpų grandinių riebalų rūgščių koncentracijos (ypač acetato) negu kontrolinėje (bendras trumpų grandinių riebalų rūgščių kiekis – 38,5–46,17μmol/g palyginti su 20,58 μmol/g).

Raktažodžiai: monooligosacharidai, inulinas, lesalo virškinamumas, išmatų rodikliai, kalakutai.

Introduction. The first attempts of fructo-oligosaccharide application as a substitute for subtherapeutic level of antibiotics were tested with broilers over ten years ago (Ammerman et al., 1988). Bailey et al. (1991) suggested that feeding chickens with fructo-oligosaccharide-supplemented diet (0.375% and 0.75%) may lead to a shift in the intestinal gut microflora, and under some circumstances may result in reduced susceptibility to *Salmonella* colonization. In turn, Fukata et al. (1999) showed that low-dose feeding of fructo-oligosaccharide (0.1%) in the diet of chicks may cause a decrease in *Salmonella* colonization, but with few changes in the number of total bacteria, *Bifidobacterium, Bacteroides, Lactobacilli*, and *E. coli*. Results of numerous experiments suggested that mannan-oligosaccharide (MOS) can be an alternative for antibiotic growth promoters (Hooge, 2003) and even small doses of MOS (0.1-0.4%) added to a diet were effective in improving health and production of poultry (Savage and Zakrzewska, 1997). Results of other experiments indicate that small amount of MOS in the diet had no significant influence on SCFA production or pH level in broiler (Spring et al., 2000) and turkey poults (Fritts and Waldroup, 2003; Juśkiewicz et al., 2003). In the presented experiment, physiological responses of young turkeys to two types of low-digestible carbohydrates (mannan-oligosaccharide and long-chain polymer of fructose – inulin) were determined.

Material and Methods. The experiment was conducted on 40 eight-week-old BUT-9 turkeys randomly allocated to five groups. The basal mixture contained typical components, mainly corn and soybean meal, and nutrients (protein, energy, amino acids and minerals) according to the NRC (1994) requirements for turkeys (Table 1). For 8 weeks, the birds were fed ad libitum with the mash diets containing basal mixture supplemented with 0.1 or 0.4% two preparations: mannan-oligosaccharide (Bio-Mos, Alltech) or inulin (Frutafit-Inulin Tex, Holland). Feed consumption and body weight were recorded. At the age of 7 weeks, the birds were kept on the bedding in individual metabolic cages. The amount of feed consumed and excrements was registered for 4 successive days.

Faecal pH was measured using a microelectrode and a pH/ION meter (model 301, Hanna Instruments). Dry matter was determined by the difference between wet weight and dry weight on aliquots of the excrements. The ammonia extracted and trapped in a solution of boric acid was determined by direct titration with sulfuric acid (according to the standard Conway's method).

The glycolytic activity in faeces was measured by the rate of p- or o- nitrophenol release from their p- or o-

nitrophenylglucosides (Juśkiewicz et al., 2002a). The reaction mixture contained 0.3 mL of substrate solution (5 mM) and 0.2 mL of a faecal sample diluted (1:10 v/v) in a phosphate buffer (pH 7.0, 0.1 Mol/L). Incubation was carried out at 37°C and the p-nitrophenol concentration was measured as the optical absorbance at 400 nm and 420 nm (o-nitrophenol concentration) after the addition of 2.5 mL of 0.25 M sodium carbonate. The glycolytic activity was expressed as μmol of a product formed per min (IU) per g of faecal digesta.

Table 1. **Composition and nutritive value of basal diet**

Components	Feeding period, weeks	
	1-4	5-8
Wheat, %	10.00	15.00
Maize	35.04	31.67
Soybean meal, %	43.50	41.00
Fish meal, %	3.00	3.00
Soybean oil, %	2.30	3.50
Monocalcium phosphate	3.00	2.80
Limestone	0.95	0.95
NaCl -	0.30	0.27
DL-methionine 99	0.25	0.29
L-lysine 99 MonohydroCl	0.54	0.41
L-Threonine	0.12	0.11
Mineral and vitamin premix[1]	1.00	1.00
Calculated chemical composition:		
ME, MJ/kg	11.79	11.87
Crude protein, %	26.54	25.63
Crude fibre, %	3.37	3.29
Lys, g/kg	18.1	16.5
Met + Cys, g/kg	10.6	10.7
Ca, g/kg	12.8	12.3
P available, g/kg	7.21	6.89

[1] in 1 kg of diet: vitamin A - 15,000 IU; vitamin D_3 - 4,500 IU; vitamin E - 50 mg; vitamin K_3 - 2.5 mg; vitamin B_1 - 3.5 mg; vitamin. B_2 - 10 mg; vitamin B_6 - 6 mg; vitamin B_{12} - 0.03 mg; folic acid - 2 mg; biotin - 0.36 mg; niacin - 75 mg; panthotenic acid - 21 mg; choline - 600 mg; Mn - 150 mg; Zn - 90 mg; Fe - 60 mg; Cu - 15 mg; J - 1 mg; Se - 0.3 mg.

The concentration of short-chain fatty acids (SCFA) in the faecal digesta was measured 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). The faeces were weighed, mixed with 0.2 mL formic acid, diluted with deionised water and centrifuged at 10000×g for 5 min. Supernatant was decanted for injection in the gas chromatograph.

The results were analyzed using the one-way ANOVA test, and significant differences between groups were determined by the Duncan's multiple range test. Differences were considered significant at $P \leq 0.05$ and $P \leq 0.01$.

Results and Discussion. The supplementation of diets with MOS and inulin at the both levels (0.1 and 0.4% of a diet) had no significant influence on the feed intake of turkeys over the experimental feeding (Table 2). There were no differences in live body weight of birds at the age of 8 weeks. Feed conversion index was also at a similar level in all groups. In the short-term experiment of Juśkiewicz et al. (2002b), diet intake by young turkeys fed a diet with a 0.4% dose of inulin was lower than that of birds fed MOS- or FOS-supplemented diets. The lack of differences in birds' growth was noted also in our previous study (Juśkiewicz et al. 2003), where turkey chickens were fed for 4 weeks with starter diets containing 0.1, 0.2 and 0.4% mannan-oligosaccharide. On the other hand, it has also been reported that a small content of MOS in a diet (0.1%) can improve the performance of turkeys (Savage and Zakrzewska, 1997; Fairchild et al., 2001). In the study on broilers by Waldroup et al. (2003a, 2003b), the addition of Bio-Mos (1 g/kg from 0 to day 42 followed by 0.75 g/kg to day 63) had no significant effect on the growth, but improved the feed conversion of birds. The authors found it possible that the level of mannan used in the study was not sufficient to elicit a positive response. In other study conducted on turkeys by Fritts and Waldroup (2003), the supplementation of a diet with mannan-oligosaccharide (0.05 and 0.10%) did not influence the body weight of turkeys, but the feed conversion from 0 to 20 weeks of age was significantly improved by both antibiotic (bacitracin methylene disalicylate) and 0.10% MOS.

When a higher amount of fermentable oligosaccharides was used in animal feeding, the increased digesta weight was considered a physiological

response of no toxicological significance (WHO, 1987) and often associated with some beneficial changes in the hind gut (lower pH, ammonia reduction and increased amount of SCFA). In this study, similar faecal pH as well as percentage of dry matter in faeces were observed in all experimental groups. The lowest ammonia concentration (mg/g faeces) was observed in the birds fed 0.1%-inulin diet, while the highest in both MOS groups (P≤0.05). The faecal ammonia concentration in the control and 0.4%-inulin groups were intermediate between them. The production of ammonia is closely related to bacterial activity and is associated with certain toxic events in the gastrointestinal tract, hence ammonia is considered to be a potential tumor promoter in the hind gut (Salminen et al., 1998). In the above-cited study of Juśkiewicz et al., (2002b), a 0.4% addition of MOS or inulin to the mixture for young turkeys beneficially lowered the ammonia concentration in their caecal digesta, without decreasing the pH of digesta as compared to the control group.

Table 2. **Feeding results and faecal parameters of turkeys**

Parameter	Control	MOS		INULIN		SEM
		0.1	0.4	0.1	0.4	
Feeding results:						
- body weight at 8 week, kg	3.65	3.71	3.67	3.60	3.67	0.052
- diet intake, kg/8 weeks	7.27	7.40	7.39	7.47	7.57	0.450
- feed conversion, kg/kg BWG	2.03	2.03	2.05	2.11	2.10	0.181
Faecal parameters:						
- dry mater, %	19.41	19.52	20.40	20.45	19.83	0.318
- pH	5.65	5.68	5.83	5.56	5.71	0.058
- ammonia, mg/g	1.56^{ab}	1.63^{a}	1.61^{a}	1.36^{b}	1.53^{ab}	0.036
Enzyme activity, U/g						
- α-glucosidase	0.302^{Bb}	0.403^{ABa}	0.415^{ABa}	0.456^{Aa}	0.420^{ABa}	0.017
- β-glucosidase	0.083	0.072	0.081	0.087	0.065	0.006
- α-galactosidase	1.371^{b}	1.394^{ab}	1.408^{ab}	1.824^{a}	1.897^{a}	0.080
- β- galactosidase	1.359	1.360	1.292	1.628	1.824	0.095
- β-glucuronidase	0.439	0.744	0.657	0.715	0.786	0.059
SCFAs concentration, μmol/g:						
- total SCFAs	20.58^{B}	39.52^{A}	38.50^{A}	46.17^{A}	44.48^{A}	2.288
- acetate	11.21^{B}	29.12^{A}	27.94^{A}	34.43^{A}	33.98^{A}	1.967
- propionate	4.51	4.31	3.75	5.00	4.72	0.226
- isobutyrate	0.99	1.16	0.93	1.00	0.96	0.048
- butyrate	3.87	4.93	5.88	5.74	4.81	0.343

a, b, c - P≤0.05 A, B, C -P≤0.01

The supplementation of a diet with both carbohydrates significantly enhanced the bacterial α-glucosidase in the faeces, compared to the control group. Inulin addition (both levels) caused a higher α- galactosidase activity than in control turkeys. Elevated enzymatic activity of microflora in the hind gut of birds from MOS and inulin groups, was confirmed by higher short-chain fatty acids, especially acetate, compared to the control birds. Propionate and butyrate concentrations did not differ among all groups. In birds, fermentation proceeds mainly in caeca, and SCFAs produced are actively and quickly absorbed trough the caecal wall or used by caecal cells (Terada et al., 1994). Therefore, the concentration of SCFAs in the faeces was rather low.

Conclusions. The experimental 8-week feeding of turkeys with diets supplemented with different levels of mannan and inulin (0.1 and 0.4%) had no influence on the productivity of the birds. The faecal parameters were affected by dietary treatments to some extent. The lower dose of inulin effectively reduced ammonia concentration, compared to 0.1 and 0.4% mannan groups. Both carbohydrate preparations enhanced the activity of bacterial α-glucosidase and caused a higher concentration of faecal SCFAs (especially acetate). Because of a relatively small amount of carbohydrates supplemented to a diet and a lack of productive effects, further studies are needed to establish the relationship between the turkeys and the low-digestible carbohydrate treatments.

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