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Effects of dietary inclusion of high- and low-tannin faba bean (*Vicia faba* L.) seeds on microbiota, histology and fermentation processes of the gastrointestinal tract in finisher turkeys

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ABSTRACT

This study evaluated the effects of dietary replacement of soybean meal (SBM) with graded levels of faba bean (FB) seeds with high or low tannin content (HT or LT) on the gastrointestinal function and growth performance of turkeys at 13–18 weeks of age. Hybrid Converter turkeys were distributed into 7 treatments corresponding to 7 different finisher diets: a control wheat-soybean meal-based (FB_0) diet and experimental diets where SBM was partially replaced with HT or LT seeds at 100, 200 and 300 g/kg. Each treatment comprised 210 turkeys, with seven replicate pens and 30 birds per pen. The LT treatment decreased jejunal crypt depth (*vs.* FB_0; $P = 0.049$) and the experimental factors had no significant effect on the analysed caecal histological parameters. In comparison with the FB_0 diet, diets containing HT and LT FB contributed to an increase in the total bacterial counts ($P = 0.001$ and $P = 0.033$) and *Bacteria* domain ($P = 0.001$ and $P = 0.060$), and a decrease in the counts of *Bacteroides* ($P = 0.002$ and $P = 0.013$). Diets containing LT FB reduced the abundance of *Salmonella* bacteria, relative to the FB_0 diet ($P = 0.011$) and diets with HT FB ($P = 0.023$). The LT treatment decreased the counts of total bacteria and *Bacteria* domain ($P = 0.005$), in comparison with the HT treatment. The highest ileal short-chain fatty acid (SCFA) concentrations were observed in response to the LT_{200} diet. LT diets stimulated increased SCFA production in the caeca, relative to the FB_0 diet ($P = 0.022$), and the opposite effect was noted when HT and SBM dietary treatments were compared. In comparison with HT diets, LT diets led to a desirable increase in the concentrations of all major fatty acids (acetic, propionic and butyric) in the caecal contents. It can be concluded that FB seeds enhanced fermentation processes in the gastrointestinal tract of turkeys. In comparison with HT FB, LT seeds improved selected parameters of intestinal function, including a decrease in the counts of *Salmonella* bacteria ($P = 0.023$), increased SCFA production (including butyrate; $P = 0.001$), and a decrease in the pH of intestinal digesta ($P = 0.105$). In conclusion,

Abbreviations: DAPI, 4,6-diamidino-2-phenyl-indol; DM, dry matter; FB, faba bean; HT, high-tannin; FB_0, 0 g/kg FB seed content of diet; HT_{100}, 100 g/kg HT FB seed content of diet; HT_{200}, 200 g/kg HT FB seed content of diet; HT_{300}, 300 g/kg HT FB seed content of diet; LT, low-tannin; NSP, non-starch-polysaccharide; RFO, raffinose family oligosaccharide; SBM, soybean meal; SCFA, short-chain fatty acid; SEM, standard error of the mean

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both LT and HT FB seeds, the latter containing up to 7.1 g/kg tannins, can be included in finisher turkey diets at up to 300 g/kg as a safe and effective substitute for SBM.

1. Introduction

The major factor limiting the feed value of seeds of coloured-flower faba been (*Vicia faba* L., **FB**) varieties is their high tannin content (Duc et al., 1999). Many experiments have shown a negative effect of tannins on feed intake (Iji et al., 2004), in particular on protein digestibility and energy utilization (Vilariño et al., 2009). The removal of tannin-rich hulls produces high-tannin (**HT**) and low-tannin (**LT**) FB seeds with similar nutritional value (Flis et al., 1999), but this type of treatment is not commonly used. Instead, selective breeding for improvements in yield potential and disease resistance of white-flowering FB varieties is receiving increasing interest (Crépon et al., 2010). In recent years, LT FB seeds have been successfully used in diets for pigs (Zijlstra et al., 2008) and broiler chickens (Vilariño et al., 2009). However, only moderate amounts of seeds of conventional FB varieties, i.e. 150–200 g/kg feed, have been found to be well tolerated by broilers (Nalle et al., 2010). Therefore, it was a surprising that both LT and HT FB seeds added to turkey finisher diets at up to 300 g/kg were an effective substitute for SBM without compromising the key variables of performance and with no negative effects on carcass traits and breast meat quality parameters (Przywitowski et al., 2016). However, there is a scarcity of research on the influence of tannins on turkeys, which are characterised by a longer rearing period and considerably higher feed consumption than broiler chickens.

In view of the above, the aim of this study was to investigate how different dietary inclusion levels of HT or LT FB seeds (100, 200 and 300 g/kg) affect gastrointestinal tract (**GIT**) function and fermentation processes mediated by the activity of intestinal microbiota in turkeys.

Table 1
Ingredient composition and nutrient content of experimental diets (g/kg, as-fed basis) fed to turkeys from 13 to 18 weeks of age.

Item	Dietary treatment[a]						
	FB_0	HT_{100}	HT_{200}	HT_{300}	LT_{100}	LT_{200}	LT_{300}
Ingredient composition							
Wheat grain	719.5	645.8	571.7	498.0	648.2	576.6	505.3
Soybean meal (483 g CP/kg)	143.6	109.9	76.2	42.4	107.6	71.7	35.7
Faba bean seed	–	100.0	200.0	300.0	100.0	200.0	300.0
Full-fat rapeseed	80.0	80.0	80.0	80.0	80.0	80.0	80.0
Lard	27.7	35.4	43.1	50.8	35.0	42.4	49.8
Sodium bicarbonate	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Sodium chloride	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Limestone	11.0	11.0	11.1	11.1	11.0	11.1	11.1
Monocalcium phosphate	5.2	5.3	5.5	5.6	5.3	5.5	5.6
Choline chloride (750 g/kg)	0.7	0.7	0.7	0.7	0.7	0.7	0.7
DL-Methionine (990 g/kg)	1.1	1.4	1.7	2.0	1.4	1.8	2.1
L-Lysine HCL (780 g/kg)	3.9	3.3	2.8	2.2	3.4	2.9	2.4
L-Threonine (985 g/kg)	0.6	0.5	0.5	0.5	0.6	0.6	0.6
OptiPhos phytase	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Vitamin-mineral premix[b]	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Analysed nutrients							
Crude protein	178.2	177.8	180.2	174.0	172.3	176.7	176.5
Crude fat	75.8	80.2	83.6	86.2	75.5	78.8	82.2
Calculated nutrients							
AME (MJ/kg)	13.2	13.2	13.2	13.2	13.2	13.2	13.2
Lysine	10.5	10.5	10.5	10.5	10.5	10.5	10.5
Methionine and cysteine	7.3	7.3	7.3	7.3	7.3	7.3	7.3
Threonine	6.5	6.5	6.5	6.5	6.5	6.5	6.5
Calcium	6.5	6.5	6.5	6.5	6.5	6.5	6.5
Available phosphorus	3.0	3.0	3.0	3.0	3.0	3.0	3.0

[a] Diets FB_0, HT_{100}, HT_{200}, HT_{300}, LT_{100}, LT_{200}, LT_{300} contained 0, 100, 200, 300 g/kg of high-tannin (HT) and low-tannin (LT) faba beans, respectively.

[b] Provided per kilogram of diet: retinol 2.52 mg, cholecalciferol 0.09 mg, DL-α-tocopheryl acetate 70 mg, K_3 4.2 mg, thiamine 3.5 mg, riboflavin 5.6 mg, pyridoxine 4.2 mg, cobalamin 0.021 mg, biotin 0.21 mg, pantothenic acid 18 mg, nicotinic acid 56 mg, folic acid 2.1 mg, Fe (ferrous sulfate monohydrate) 42 mg, Mn (manganese oxide) 84 mg, Zn (zinc oxide) 77 mg, Cu (copper sulfate) 14 mg, I (potassium iodide) 2.1 mg, Se (sodium selenite) 0.21 mg.

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