SHORT COMMUNICATION

Zero-tannin faba bean as a replacement for soybean meal in diets for starter pigs

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Beltranena, E., Hooda, S. and Zijlstra, R. T. 2009. **Zero-tannin faba bean as a replacement for soybean meal in diets for starter pigs**. Can. J. Anim. Sci. **89**: 489–492. The nutritional value of zero-tannin (ZT) faba bean for starter pigs is poorly characterized. Five mash diets containing 0, 10, 20, 30 or 40% ZT faba bean in substitution for soybean meal were fed to 75 pens of 5-wk-old pigs for 21 d. Increasing the dietary level of ZT faba bean did not affect average daily weight gain, feed intake or feed efficiency ($P > 0.05$) for each weekly period and the entire study (days 0 to 21). Increasing the dietary level of ZT faba bean linearly increased apparent total tract digestibility of crude protein and P ($P < 0.05$), but not of dry matter, gross energy and Ca ($P > 0.05$). In conclusion, young pigs can be fed up to 40% raw, ground ZT faba bean (var. Snowbird) in full substitution for soybean meal in the starter diet.

Key words: Digestibility, faba bean, growth performance, soybean meal, starter pig

Beltranena, E., Hooda, S. et Zijlstra, R. T. 2009. **Substitution du tourteau de soja par de la fèverole sans tanins dans la ration de démarrage des porcelets**. Can. J. Anim. Sci. **89**: 489–492. On connaît mal la valeur nutritive de la fèverole sans tanins (ST) pour les porcelets. Cinq pâtées dans lesquelles on avait respectivement remplacé 0, 10, 20, 30 ou 40 % du tourteau de soja par de la fèverole ont été servies pendant 21 jours à des porcelets de cinq semaines répartis dans 75 enclos. Augmenter la teneur de la ration en fèverole ST n'affecte pas le gain quotidien moyen, l'ingestion d'aliments ni l'indice de consommation ($P > 0{,}05$), ni hebdomadairement ni durant la totalité de l'étude (du 1er au 21e jour). La hausse de la concentration de fèverole ST dans la ration accroît de manière linéaire la digestibilité apparente des protéines brutes et du P dans l'ensemble du tractus digestif ($P < 0{,}05$), mais pas celle de la matière sèche, de l'énergie brute et du Ca ($P > 0{,}05$). En conclusion, on peut donner jusqu'à 40 % de fèverole (var. Snowbird) ST brute moulue aux porcelets à la place du tourteau de soja dans les rations de démarrage.

Mots clés: Digestibilité, fèverole, croissance, tourteau de soja, porcelet

Soybean meal is the worldwide standard supplemental protein source in swine diets. Little soybean is cultivated in western Canada due to the cool and short growing season; instead pulses (non-oilseed legumes) and canola are grown. Field pea has become the local pulse standard for feeding swine and zero-tannin (ZT) faba bean is an emerging pulse crop. With adequate rainfall, seed yield and atmospheric N fixation of ZT faba bean is higher than for field pea (Strydhorst et al. 2008). Faba bean (ZT) also has a higher crude protein (28 vs. 23%) than field pea. Tannins limited the dietary inclusion of traditional colour-flowered faba bean varieties in swine diets. Modern zero-tannin ($<1\%$), white-flowered varieties may be an alternative feedstuff to locally grown field pea or imported soybean meal. We recently reported that feeding ZT faba bean did not alter average daily feed intake (ADFI) or average daily gain (ADG) of grower-finisher pigs at inclusion rates up to 30% in substitution for soybean meal (Zijlstra et al. 2008). However, information if younger pigs can tolerate high levels of ZT faba bean in the diet is lacking. Tannin content has been reduced, but other anti-nutritional factors (ANF) or non-starch polysaccharides may still hinder utilization of energy and nutrients in ZT faba bean by starter pigs.

We hypothesized that starter pigs fed increasing levels of ZT faba bean would not perform differently from those fed soybean meal in the late nursery stage. During this period, the inclusion of specialty, highly digestible ingredients is reduced due to cost, and the level of soybean meal is increased considerably. The objective of this study was to test the dietary inclusion of 0, 10, 20,

Abbreviations: **ADFI**, average daily feed intake; **ADG**, average daily weight gain; **ANF**, anti-nutritional factors; **ATTD**, apparent total tract digestibility; **G:F**, feed efficiency; **NE**, net energy; **ZT**, zero-tannin

30 and 40% ZT faba bean in substitution for soybean meal on ADG, ADFI, feed efficiency (G:F) and the apparent total tract energy and nutrient digestibility (ATTD) of diets in starter pigs.

The ZT faba bean sample selected for the study (var. Snowbird) had the average nutrient profile (26.9% crude protein, 44.8% starch, 9.2% ADF, 14.3% NDF, 0.10% Ca, and 0.41% P, on as-is basis of four samples grown in Fort Saskatchewan, Alberta. The net energy (NE) and standardized ileal digestible amino acid coefficients for ZT faba bean were derived from Zijlstra et al. (2008). The test diets were formulated to provide 2.35 Mcal NE kg^{-1}, 5.0 g standardized ileal digestible lysine $Mcal^{-1}$ NE, and other amino acids as a ratio to lysine [National Research Council (NRC) 1998]. The ZT faba bean, including hull, was ground through a 2.8-mm screen using a hammer mill and substituted stock soybean meal in mash diets (Table 1). A premix was added to meet or exceed mineral and vitamin requirements (NRC 1998) and acid-insoluble ash (Celite 281, World Minerals Co., Lompoc, CA) was added as a digestibility marker.

The animal protocol for the study was approved by the University of Alberta Faculty Animal Policy and Welfare Committee, and followed principles established by the Canadian Council on Animal Care (1993). The experiment was conducted at the Swine Research and Technology Centre at the University of Alberta (Edmonton, AB). In total, 300 crossbred pigs (Duroc sire $\times$ Large White/Landrace F_1; Hypor, Regina, SK) weaned at 19 ± 1 d of age were selected based on acceptable weight gain during the first 10 d post weaning. Heavy and light barrows and gilts were then randomized within gender so that two barrows and two gilts were housed in each of 75 pens. After weaning, pigs were fed commercial Phase 1 and 2 diets (Unifeed, Edmonton, AB) for 14 d. Pigs (9.07 ± 1.99 kg) were then fed the experimental diets for 21 d.

Pigs were housed in floor pens (1.1×1.5 m) equipped with a nipple drinker, a four-space feeder, and slatted plastic flooring. They had free access to feed and water. Freshly voided faeces were collected by grab sampling from 0800 to 1600 during the last 3 d on trial and pooled by pen. Faeces were frozen at $-20^{\circ}C$ and freeze-dried. Subsequently, ingredients, diets, and faeces were ground through a 1-mm screen using a centrifugal mill (ZM 200; Retsch Model, Haan, Germany).

Ingredient, diet, and faeces were analyzed for moisture [method 930.15; Association of Official Analytical Chemists (AOAC) 2006], crude protein ($N \times 6.25$; method 988.05; AOAC 2006), Ca, and P (method 985.01; AOAC 2006). Diet and faeces were analyzed for acid-insoluble ash (McCarthy et al. 1974) and gross energy by bomb calorimetry. Based on results of chemical analyses, ATTD of nutrients was calculated using the acid-insoluble ash concentration of faeces

Table 1. Ingredient composition and nutrient content of the experimental diets fed to starter pigs[z]

	Zero-tannin faba bean (%)				
Ingredient (%)	0	10	20	30	40
Wheat	62.68	57.55	52.63	47.84	42.95
Zero-tannin faba bean	–	10.00	20.00	30.0	40.00
Soybean meal	22.10	16.60	11.10	5.50	–
Menhaden fish meal	6.00	6.00	6.00	6.00	6.00
Whey permeate	5.00	5.00	5.00	5.00	5.00
Canola oil	1.10	1.80	2.10	2.40	2.70
Acid-insoluble ash	0.80	0.80	0.80	0.80	0.80
Limestone	0.78	0.63	0.65	0.65	0.65
Mono-dicalcium phosphate	0.60	0.63	0.65	0.68	0.70
Salt	0.50	0.50	0.50	0.50	0.50
L-Lysine HCl 78%	0.15	0.15	0.15	0.15	0.15
Vitamin premix[y]	0.10	0.10	0.10	0.10	0.10
Mineral premix[x]	0.10	0.10	0.10	0.10	0.10
L-Threonine	0.03	0.06	0.09	0.12	0.14
Choline chloride 60%	0.05	0.05	0.05	0.05	0.05
DL-Methionine	–	0.02	0.04	0.06	0.09
L-Tryptophan	0.02	0.03	0.05	0.06	0.07
Analyzed nutrient content					
Dry matter (%)	90.75	90.80	90.85	90.85	90.85
Crude protein (%)	23.87	22.61	21.99	21.40	21.40
Calcium (%)	1.15	1.15	1.05	1.07	1.14
Phosphorus (%)	0.86	0.80	0.79	0.84	0.82
Gross energy (kcal g^{-1})	3606	3606	3658	3670	3645

[z]As-fed basis.
[y]Provided per kilogram of diet: vitamin A, 15 000 IU; vitamin D, 1500 IU; vitamin E, 40 IU; niacin, 47.5 mg; pantothenic acid, 31.25 mg; folacin 1.0 mg, riboflavin, 8.75 mg; pyridoxine, 3.3 mg; vitamin K, 2.06 mg; biotin, 0.12 mg; vitamin B_{12}, 0.04 mg.
[x]Provided per kilogram of diet: Zn, 150 mg; Cu, 100 mg; Fe, 85 mg; Mn, 40 mg; I, 0.36 mg; Se, 0.3 mg.

Table 2. Growth performance of starter pigs fed increasing levels of zero-tannin faba bean in substitution for soybean meal from 14 to 35 d post-weaning[z, y]

	Zero-tannin faba bean (%)						*P* value	
Variable	0	10	20	30	40	SEM	Linear	Quadratic
ADFI (g)								
Days 0 to 7	670	638	637	614	621	37	0.223	0.632
Days 7 to 14	890	859	870	868	849	25	0.208	0.854
Days 14 to 21	1079	1025	1024	1020	1056	21	0.447	0.030
Days 0 to 21	879	841	844	835	842	19	0.139	0.215
ADG (g)								
Days 0 to 7	487	455	458	463	455	27	0.453	0.575
Days 7 to 14	581	569	575	580	554	24	0.466	0.691
Days 14 to 21	666	677	657	664	692	17	0.448	0.330
Days 0 to 21	579	572	560	556	569	11	0.308	0.262
Feed efficiency								
Days 0 to 7	0.73	0.72	0.72	0.75	0.73	0.02	0.632	0.948
Days 7 to 14	0.66	0.67	0.66	0.67	0.66	0.02	0.950	0.534
Days 14 to 21	0.62	0.67	0.65	0.65	0.66	0.01	0.134	0.284
Days 0 to 21	0.67	0.68	0.68	0.70	0.68	0.01	0.122	0.243

[z]Least-square means were based on 15 pens of four pigs per diet.
[y]Final weight 20.7±3.6 kg.

relative to feed using the indicator method (Adeola 2001). To calculate pen ADG, individual pigs were weighed every 7 d. To calculate pen ADFI, feed added and orts were weighed every 7 d. Feed efficiency was calculated as ADG/ADFI.

Pen was considered the experimental unit. Performance and digestibility values were analyzed using the MIXED procedure of SAS software (SAS Institute, Inc. 1996) with ZT faba bean inclusion level as the main factor in the model. Performance values were analyzed as repeated measures for time using initial weight as covariate. Two orthogonal contrasts tested for linear and quadratic effects of ZT faba bean inclusion. A probability value of $P < 0.05$ was defined as a significant difference. Data are reported as least-square means.

Increasing dietary ZT faba bean level in substitution for soybean meal did not affect ADFI, ADG or G:F ($P > 0.05$; Table 2) for the entire study period (days 0 to 21) or for days 0 to 7 and days 7 to 14. For days 14 to 21, increasing dietary ZT faba bean level quadratically reduced ADFI ($P < 0.05$), but did not affect ADG or G:F ($P > 0.05$). Increasing dietary ZT faba bean linearly increased the ATTD of crude protein and P ($P < 0.05$; Table 3), and did not affect ATTD of dry matter, gross energy, and Ca ($P > 0.05$).

These results indicate that starter pigs can be fed up to 40% raw, ground ZT faba bean in full substitution for soybean meal in the late nursery stage. Pigs fed ZT faba bean performed similar to controls since the first week on trial starting two weeks post weaning and, thus, did not require a period of adaptation to ZT faba bean inclusion. Linear increases in the ATTD of crude protein and P were due to ingredient changes (Table 1).

Pulse seeds contain ANF including tannins, protease inhibitors, and lectins (Van der Poel et al. 1992). We fed a low tannin (<1%), white-flowered cultivar (Snowbird), so we anticipated that tannins would not be a problem. A concern to us was that high inclusions of ZT faba bean would contribute protease inhibitors, primarily anti-tryptic and anti-chymotryptic (Gatel 1994), that could complex with pancreatic digestive enzymes (de Lange et al. 2000), rendering them inactive, increasing endogenous losses. Likewise, inclusion of ZT faba bean may contribute lectins that could bind to the epithelium, disintegrating intestinal epithelial brush border glycocalyx, impairing absorption and triggering immunological

Table 3. Apparent total tract digestibility of diets with increasing level of zero-tannin faba bean in substitution for soybean meal fed to starter pigs[z]

	Zero-tannin faba bean (%)						*P* value	
Digestibility (%)	0	10	20	30	40	SEM[z]	Linear	Quadratic
Dry matter	82.9	82.9	83.7	83.1	82.4	0.4	0.560	0.066
Crude protein	79.6	80.7	81.7	82.4	82.1	0.7	0.003	0.231
Gross energy	82.3	82.4	83.2	83.1	82.0	0.5	0.956	0.085
Calcium	58.1	60.3	63.0	56.4	64.5	1.9	0.152	0.735
Phosphorus	51.8	49.1	54.6	52.9	55.8	1.2	0.005	0.391

[z]Least-square means were based on 15 pens of four pigs per diet.

reactions. Finally, ZT faba bean may shorten duodenal villi height and thereby reduce absorptive capacity compared with soybean meal (Salgado et al. 2002). The present study with starter pigs indicates that these ANF did not likely reduce digestion of nutrients, growth, feed efficiency, or animal health.

Carbohydrates in pulse seeds may also pose a concern. Pulse starch is mainly Type C, a combination of Type A and B, which is more slowly digested by bacterial and porcine pancreatic α-amylase than corn or tapioca starch (Hoover and Zhou 2003). Fermentation of pulse oligosaccharides, hemicellulose, cellulose, glucans, and pentosans may cause flatulence and abdominal distress in humans (Fleming et al. 1988). High levels of ZT faba bean inclusion thus contributed slowly digestible starch and fermentable non-starch polysaccharides to the starter diets. However, these factors did not induce diarrhoea or a transient check on pig growth early in the present study.

We recently reported that feeding ZT faba bean did not alter ADFI or ADG of grower-finisher pigs at inclusion rates up to 30% in substitution for soybean meal (Zijlstra et al. 2008). The results of the present study further pushed inclusion levels up to 40% in younger pigs with the same outcome. The results of the present study also confirm that the digestible nutrient profile previously established with grower pigs (Zijlstra et al. 2008) is applicable to diet formulation for starter pigs. Thus, the combined results of these two studies indicate that pigs can be fed ZT faba bean (var. Snowbird) in full substitution for soybean meal from 2 wk post-weaning to market weight.

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