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The effect of soy oligosaccharide extraction on diet digestibility, faecal characteristics, and intestinal gas production in dogs

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ABSTRACT

This study aimed at evaluating the coefficients of total tract apparent digestibility (CTTAD) and metabolisable energy (ME) content of dog foods containing different soybean protein products, as well as the faecal characteristics and intestinal gas production of dogs consuming these diets. The following soybean products were added at 300 g/kg of diet: soybean meal (SBM), soy protein concentrate (SPC) with 600 g crude protein (CP)/kg (SPC600), SPC with 700 g CP/kg (SPC700), hydrolysed SPC700 (HSPC), and soy protein isolate (SPI). The CTTAD and faecal characteristics were determined in six dogs according to a 6 × 6 Latin square design. Intestinal gas production was evaluated by radiography of 16 dogs fed the reference diet and diets containing 300 g SBM, SPC700, or SPI/kg. Crude protein digestibility of SBM, SPC600, SPC700, HSPC, and SPI was 0.898, 0.839, 0.852, 0.906, and 0.988, respectively. Soy protein isolate presented the highest ME content (21.26 MJ/kg, P<0.001) and SPC600, the lowest ME (14.15 MJ/kg, P<0.001). Dogs fed the reference and the SPI diets presented harder faeces and higher faecal pH (P<0.001). Soybean meal produced the highest intestinal gas volume (P<0.05), while there was no difference among the other treatments (P>0.05). The removal of soybean oligosaccharides reduces intestinal gas production in dogs. However, soybean ethanol-insoluble fibres must be removed to increase protein digestibility and ME content, as well as to improve the faecal texture of dogs.

1. Introduction

The combination of soybeans and animal products in feed formulation has allowed balancing protein and macro-mineral levels in dog foods. However, soybean contains anti-nutritional factors, such as protease inhibitors, lectins, oligosaccharides, and soluble non-starch polysaccharides (NSP) that may affect the utilisation of soybean products in animal diets (Dierick, 1989; Zuo et al., 1996).

Indigestible soybean oligosaccharides are carbohydrates with polymerisation degree of two or higher, are soluble in ethanol at 80%, and cannot be digested by pancreatic or intestinal enzymes (Quigley et al., 1999). The main soybean

Abbreviations: ADF, acid detergent fibre; CF, crude fibre; CP, crude protein; CTTAD, coefficient of total tract apparent digestibility; DM, dry matter; DPI, dispersible protein index; EE, acid-hydrolysable ether extract; GE, gross energy; HSPC, hydrolysed soy protein concentrate with 700 g CP/kg; ME, metabolisable energy; KOHSP, soluble protein in 0.2% potassium hydroxide; NDF, neutral detergent fibre; NSP, non-starch polysaccharides; OM, organic matter; SCFA, short chain fat acids; SBM, soybean meal; SPC600, soy protein concentrate with 600 g CP/kg; SPC700, soy protein concentrate with 700 g CP/kg; SPI, soy protein isolate.

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Table 1
Ingredient composition (g/kg, as fed) and analysed and calculated chemical composition of the reference diet (g/kg, on dry matter, unless otherwise stated).

Item	
Ingredient	
Maize	590.8
Poultry offal meal (55)	261.4
Maize gluten (60)	57.1
Beef tallow	50.0
Poultry hydrolysate	18.6
Calcium propionate	1.7
Potassium sorbate	0.3
Trace mineral and vitamin premix[a]	13.0
Salt	7.1
Analysed chemical composition	
Dry matter	909.7
Crude protein	246.2
Acid-hydrolysable ether extract	110.1
Crude fibre	13.5
Crude ash	70.0
Calcium	14.3
Total phosphorus	10.2
Calculated chemical composition	
Metabolisable energy (MJ/kg)[b]	16.82

[a] Contained 20,000 IU vit. A, 2000 IU vit. D, 48 mg vit. E, 48 mg vit. K, 4 mg vit. B1, 32 mg vit. B2, 16 mg pantothenic acid, 56 mg niacin, 800 mg chlorine, 150 mg zinc, 100 mg iron, 15 mg copper, 1.5 mg iodine, 30 mg manganese, 0.2 mg selenium and 240 mg antioxidant per kg supplement.
[b] Estimated according to the NRC (2006).

oligosaccharides are the α-galactosides stachyose, typically present at 32–52 g/kg, and raffinose, present at 6–14 g/kg (Coon et al., 1990). Moreover, soybean contains NSP, whose average content is 60.3 g/kg (Bach Knudsen, 2001). These indigestible carbohydrates may increase digest viscosity, impairing the interaction between endogenous enzymes and nutrients, as well as nutrient absorption by the intestinal mucosa, negatively affecting diet digestibility (Oakenfull, 1993). Moreover, they may be fermented in the large intestine, producing gas, lactate and short-chain fatty acids (SCFA). Excessive SCFA and lactate levels increase intraluminal osmotic pressure and passage rate in the large intestine of dogs, resulting in the production of softer faeces and flatulence (Coon et al., 1990; Roberfroid, 1993; Silvio et al., 2000).

The presence of these heat-stable compounds in soybeans is the main limitation to the inclusion of soybean products in dog foods, and their removal requires special processing methods. The products resulting from these processes are soy protein concentrate (SPC), with more than 650 g crude protein (CP)/kg, or soy protein isolate (SPI), with more than 900 g CP/kg (Lusas and Riaz, 1995). Considering the factors discussed, this study aimed at evaluating total tract digestibility, metabolisable energy (ME), intestinal gas production, and faecal characteristics of dogs fed soybean products with different oligosaccharide levels.

2. Materials and methods

2.1. Animals and facilities

In the digestibility assay, six adult Beagles (three males and three females), between 6.1 and 6.3 years old and with 11.2 ± 1.4 kg body weight, were used. Sixteen adult Beagles (eight males and eight females) between 6.1 and 6.3 years old and with 12.1 ± 1.6 kg body weight were used to evaluate intestinal gas production.

During the digestibility trial, dogs were housed in metabolic cages made of stainless steel and measuring 0.7 m × 0.6 m × 0.5 m. The dogs used for intestinal gas evaluation were kept in concrete kennels, with solarium, measuring 5 m × 2 m. The experiments were approved by the Committee of Ethics of Animal Use of the sector of Agrarian Sciences of Federal University of Paraná.

2.2. Food ingredients and diets

The ingredients and the chemical composition of the reference diet are presented in Table 1. The five test diets were formulated according to the substitution method proposed by Matterson et al. (1965) and included 700 g of the ingredients/kg of the reference diet and 300 g either of soybean meal (SBM), SPC containing 600 g CP/kg (SPC600), SPC containing 700 g CP/kg (SPC700), hydrolysed SPC700 (HSPC), or SPI/kg of the test diets. The digestibility of these six diets was determined. Intestinal gas production of dogs fed the reference diet and those containing 300 g SBM, SPC700, and SPI/kg of diet were evaluated.

The nutritional profile of the reference diet exceeded the recommendations of the Association of American Feed Control Officials (2004) for adult dogs. The chemical composition and the qualitative parameters of the soybean protein products included in the diets are shown in Table 2.