Digestibility and palatability of isolated porcine protein in dogs

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ABSTRACT
The objective of this study was to evaluate the digestibility and palatability of an isolated porcine protein (IPP) for adult dogs. In the digestibility assay, eight adult Beagle dogs were distributed in a double Latin square (4 × 4) experimental design. Diets containing 0, 100, 200, or 300 g IPP/kg were offered. Diets (0–300 g IPP/kg) presented 229.6–265.3 g/kg crude protein (CP) and 17.59–18.73 MJ/kg metabolisable energy (ME). The apparent total tract digestibility (ATTD) of diets and of the IPP were evaluated by analysis of regression. For the palatability test, diets containing 0 and 300 g IPP/kg were compared using 16 adult dogs. Dry matter (DM) and CP ATTD and the ME content of the IPP were determined as 99.2%, 86.4% and 22.48 MJ/kg, respectively. Faecal DM (424–342 g/kg) and pH (6.86–5.98) were linearly reduced (p < .01) as dietary IPP increased. The other evaluated faecal characteristics were not influenced by the treatments (p > .05). Lower intake ratio was obtained with the diet with 300 g IPP/kg, compared with the diet with 0 g IPP/kg (p < .01). The inclusion of IPP in the diet increases the digestibility of dietary nutrients and ME content; however, it reduces food palatability and faecal DM. Isolated porcine protein presents high nutrient digestibility and ME content for dogs.

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Introduction
Proteins are essential nutrients in dog nutrition. Some factors, such as dietary protein content, digestibility and amino acid composition, determine the efficiency of dietary protein utilisation by dogs and cats (Case et al. 2011) and may greatly vary among protein sources.

The main protein sources included in dog diets are fish or meat meals, which are by-products derived from the rendering. The most frequently animal by-products used by pet food industry are poultry offal or bone meal or bovine meat. It should also be mentioned that the use of these by-products by the pet food industry contributes for the sustainability of animal production, as it allows the recycling of animal protein, reducing its environmental load (Meeker and Meisinger 2015).

Isolated porcine protein (IPP) is a by-product of pork processing obtained by cooking, pressing and grinding of pig skin. It has high protein (70 to 75%) and low ash (3%) contents and its chemical composition is less variable compared with other animal meals. Due to these characteristics, IPP may potentially be included in pet diets. However, its use is still limited due to the lack of information on its nutritional value and palatability for dogs.

The objective of this study was to evaluate the digestibility and palatability of IPP for dogs.

Material and methods
The experiment was approved by the Committee of Ethics on Animal Use of the sector of Agricultural Sciences of the Federal University of Paraná (UFPR), under protocol number no. 056/2015.

Animals and facilities
For the digestibility trial, eight Beagle dogs (four males and four females), with 1.4 ± 0.1 years of age and 9.47 ± 0.71 kg average body weight, were evaluated. Dogs were vaccinated and dewormed and were housed in concrete individual kennels (5 m long × 2 m wide), located at experimental facilities of Dog Nutrition Lab (LENUCAN), UFPR, Curitiba, Brazil.
**IPP production**

Pig skin obtained from a processing plant was received in stainless steel hoppers of a commercial rendering plant. Butylated hydroxytoluene (an antioxidant) was added to the pig skin, which was then transported by augers to the digesters. In the digesters, the skin was cooked using saturated steam (5 kgf/cm²) at 130°C for 20 min.

The digested product was percolated to separate the solid fraction from the fat, which was then pumped to a centrifuge for purification. The purified fat was stored in tanks. The solid fraction was pressed for the extraction of any remaining fat. The fat was transported to the centrifuge and the solid fraction was ground, sieved and transported to the meal hopper and were finally packed. The final product was the IPP evaluated in the present experiment. The amino acid profile and chemical composition of the IPP and poultry offal meal are shown in Table 1.

### Experimental diets

A reference diet (with inclusion of poultry offal meal) and three diets with increasing IPP inclusion levels (100, 200 or 300 g/kg), added at the expense of poultry offal meal, were evaluated. The reference diet was formulated to meet the nutritional requirements of adult dogs, according to the Fédération européenne de l'industrie des aliments pour animaux familiers (FEDIAF 2014). The ingredients and analysed chemical composition of the experimental diets are shown in Table 2.

### Manufacturing of the experimental diets

The dietary ingredients were mixed in a vertical mixer, ground to 1 mm particle size in a hammer mill, and mixed. The mash was added to the preconditioner digesters, the skin was cooked using saturated steam (5 kgf/cm²) at 130°C for 20 min.

The digested product was percolated to separate the solid fraction from the fat, which was then pumped to a centrifuge for purification. The purified fat was stored in tanks. The solid fraction was pressed for the extraction of any remaining fat. The fat was transported to the centrifuge and the solid fraction was ground, sieved and transported to the meal hopper and were finally packed. The final product was the IPP evaluated in the present experiment. The amino acid profile and chemical composition of the IPP and poultry offal meal are shown in Table 1.

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## Table 1. Chemical composition and amino acid profile (g/kg on dry matter basis) of the IPP and POM.

| Chemical composition | IPP | POM |
|----------------------|-----|-----|
| Dry matter           | 915.1 | 959.8 |
| Crude protein        | 742.2 | 615.6 |
| Ashes                | 10.1  | 188.4 |
| Calcium              | 7.3   | 53.1 |
| Phosphorus           | 30.1  | 26.1 |
| Ether extract in acid hydrolysis | 77.4 | 155.1 |
| Gross energy, MJ/kg  | 23.22 | 20.46 |
| Amino acids          |       |     |
| Aspartic acid        | 69.5  | 42.3 |
| Glutamic acid        | 103.4 | 89.3 |
| Alanine              | 54.9  | 46.2 |
| Arginine             | 51.4  | 39.6 |
| Cystine              | 9.4   | 8.2  |
| Phenylalanine        | 37.3  | 22.6 |
| Glycine              | 97.2  | 62.8 |
| Histidine            | 16.4  | 12.0 |
| Isoleucine           | 29.4  | 21.5 |
| Leucine              | 63.8  | 40.0 |
| Lysine               | 49.2  | 32.3 |
| Methionine           | 14.5  | 10.8 |
| Methionine + cystine | 24.0  | 18.6 |
| Proline              | 0.0   | 1.5  |
| Serine               | 35.5  | 22.7 |
| Tyrosine             | 29.2  | 14.2 |
| Threonine            | 31.3  | 21.8 |
| Tryptophan           | 0.0   | 5.2  |
| Valine               | 42.3  | 27.5 |

IPP: isolated porcine protein; POM: poultry offal meal.

## Table 2. Ingredients and analysed chemical composition of the experimental diets.

| Ingredients | 0 | 100 | 200 | 300 |
|-------------|---|-----|-----|-----|
| Corn        | 601.425 | 601.425 | 601.425 | 601.425 |
| Poultry offal meal | 300.000 | 200.000 | 100.000 | – |
| Isolated porcine protein | – | 100.000 | 200.000 | 300.000 |
| Poultry fat | 50.000 | 50.000 | 50.000 | 50.000 |
| Poultry liver hydrolysate | 30.000 | 30.000 | 30.000 | 30.000 |
| Potassium chloride | 6.000 | 6.000 | 6.000 | 6.000 |
| Sodium chloride | 5.000 | 5.000 | 5.000 | 5.000 |
| Mineral-vitamin supplement | 3.000 | 3.000 | 3.000 | 3.000 |
| Calcium propionate | 2.000 | 2.000 | 2.000 | 2.000 |
| Choline chloride | 2.000 | 2.000 | 2.000 | 2.000 |
| Citric acid | 0.350 | 0.350 | 0.350 | 0.350 |
| BHT | 0.150 | 0.150 | 0.150 | 0.150 |
| BHA | 0.075 | 0.075 | 0.075 | 0.075 |
| Chemical composition, g/kg (on dry matter basis) |
| Dry matter | 931.400 | 944.500 | 930.000 | 933.600 |
| Crude protein | 229.600 | 243.500 | 258.200 | 265.300 |
| Ether extract in acid hydrolysis | 126.400 | 122.600 | 124.000 | 136.900 |
| Ashes | 77.900 | 68.000 | 44.300 | 34.800 |
| Crude fibre | 29.500 | 12.800 | 16.600 | 18.300 |
| Calcium | 8.300 | 7.500 | 7.400 | 5.500 |
| Phosphorus | 11.600 | 8.500 | 6.200 | 4.000 |
| Gross energy, MJ/kg | 18.870 | 19.540 | 19.570 | 19.870 |

*Enrichment kg food⁻¹: Vitamin A: 20,000 U; Vitamin D₃: 2000 U; Vitamin E: 480 U; Vitamin K₃: 48 mg; Vitamin B₁: 4 mg; Vitamin B₂: 32 mg; Vitamin B₃: 0.2 mg; Pantothenic acid: 16 mg; Niacin: 56 mg; Choline: 800 mg – 800 mg; Zinc: 150 mg; Iron: 100 mg; Copper: 15 mg; Iodine: 1.5 mg; Manganese: 30 mg; Selenium: 0.2 mg and Antioxidant: 240 mg.

IPP: isolated porcine protein; BHT: butylated hydroxytoluene; BHA: butylated hydroxyanisol.
at a feeding rate of 1200 kg/h and with the addition of 207 L of water/h and extruded in a double-screw extruder (model E-96-D, Ferraz Ltda, Ribeirão Preto, Brazil). After extrusion, kibbles were dried in a horizontal dryer at 100–110°C for 20 min. After drying, kibbles were coated with poultry fat, cooled and sprayed with a palatant (chicken liver hydrolysate).

**Digestibility assay**

The digestibility trial was conducted using the method of total faecal collection. The experimental diets were offered for five days of adaptation to the diets and to the facilities, followed by five days of total faecal collection, according to the Association of American Feed Control Officials (AAFCO 2004). During the adaptation period, food was offered twice daily, at 8:30 am and 4:30 pm, in sufficient quantity to satisfy dog requirements of metabolisable energy (ME) \[130 \text{kcal/kg}^{0.75}\] (NRC 2006). Water was supplied ad libitum.

During the collection period, faeces were collected twice daily, weighed and stored in previously identified individual lidded plastic pots and stored in a freezer (−15°C) until further analysis. At the end of the collection period, faeces were thawed at room temperature, pooled per replicate, homogenised and dried in a forced ventilation oven at 55°C for 72 h. After drying, faeces were ground to 1 mm particle size and subjected to chemical analyses.

**Faecal parameters**

The following faecal parameters were determined: total dry matter (DM) content, faecal output (g faeces/g DM intake/d), pH, ammonia content, sialic acid content, faecal score and faecal odour.

Faecal pH was measured using a digital pH meter (331, Politeste Instrumentos de Teste LTDA, São Paulo, SP, Brazil) in 2 g of fresh faeces within 15 min after deposition and diluted in 20 mL of distilled water. Faecal ammonia content was determined according to Felix et al. (2013). Faeces were freeze-dried (Alpha 1-4 LO plus, Christ, Osterodeam Hans, Germany) to determine sialic acid content, according to Jourdian et al. (1971).

Faecal score was given according to 1 to 5 scale: 1 = watery faeces (can be poured from the container); 2 = unshaped stools (take the shape of the container); 3 = soft, shaped and moist stools; 4 = shaped, firm and soft stools and 5 = hard and dry stools (Carciofi et al. 2009).

Faecal odour was evaluated by 11 volunteers who compared fresh faeces from dogs fed with the diet containing 0 g IPP/kg (standard) to the diet containing 300 g IPP/kg (test). Only two diets were evaluated because the evaluation of more diets would have confused the volunteers and interfered with results. Five grams of fresh faeces from three dogs per diet were weighed and homogenised in plastic jars. The top opening of the jars was immediately sealed with PVC film, symmetrically perforated with 36 holes and were given to the volunteers for evaluation. All volunteers evaluated all samples. The faecal odour of the diet with 300 IPP/kg was compared to the diet with 100 g IPP/kg scored according to a 1–3 scale: 1: less unpleasant, 2: not different and 3: more unpleasant (Maia et al. 2010). Each sample was evaluated by all volunteers.

**Chemical analyses**

The chemical analyses of the IPP, experimental diets and faeces were performed at the Animal Nutrition Laboratory of the Federal University of Paraná (Curitiba, Paraná, Brazil).

Isolated porcine protein, diets and faeces were analysed for crude protein (CP), ether extract in acid hydrolysis (AHEE), ash (A) and dry matter (DM) contents according to the AOAC (1995) and for gross energy (GE) in a bomb calorimeter. Isolated porcine protein and diets were analysed for calcium and phosphorus levels and only diets for crude fibre (CF) according to the AOAC (1995). Organic matter (OM) content was calculated as 100 ash content.

**Palatability assay**

In addition to the eight dogs evaluated in the digestibility assay, other eight adult Beagles of similar age and body weight were used. Palatability was determined by the pairwise comparison of the reference diet (0 g IPP/kg) with the diet containing 300 g IPP/kg, according to Griffin (2003). The reference diet (0 g IPP/kg) and the diet containing 300 g IPP/kg were offered for two consecutive days at 8:00 am in two different bowls for 30 min or until one of the diets was completely consumed. The position of the bowls was daily switched in order to prevent dogs from being conditioned to feeding at the same location.

Diet allowance was calculated to supply 130% of the dogs energy requirements recommended by the NRC (2006). Water was supplied ad libitum. Food offer and food residues in the bowls were weighed to calculate food preference. Food preference was calculated as the intake ratio between the two diets, according
to the equation: Intake ratio (%) = \([g\, of\, diet\, A\, or\, B\, intake/g\, of\, total\, food\, offer\, (A + B)] \times 100\).

The first bowl to which the dog approached when the two test foods were simultaneously offered was recorded as first choice. Palatability was determined by associating the results of the food preference and the first-choice test results.

Calculations and statistical analyses

Based on the laboratory results, the apparent total tract digestibility (ATTD) of the experimental diets was determined according to the equation:

\[
\text{ATTD} = \left[\frac{(\text{nutrient intake} - \text{nutrient excretion})/\text{nutrient intake}}{\text{C}2}\right] \times 100. 
\]

Dietary ME content was determined with no urine collection, according to the equation proposed by the AAFCO (2004) as ME (MJ/kg) = \(\left\{\frac{(g\, of\, DM\, intake \times \text{dietary GE}) - [(g\, faecal\, DM \times \text{faecal GE}) + (5.23 \times \text{digestible protein intake})]}{g\, of\, food\, intake}\right\}\).

Data normality was analysed by the test of Shapiro-Wilk at 5% probability level. Digestibility and faecal characteristics data were analysed according to a double (4 \times 4) Latin square experimental design, totalling eight replicates in time. The experimental unit was the individual dog. For data analysis, a linear mixed model by the Statistical Analysis System, version 9.1.3 (SAS 2004, Statistical Analysis System – SAS Online Doc. Cary: SAS Institute.) was utilised. Sums of squares of analysis of variance (ANOVA) of the model were separated into animal, period and treatment effects. As ANOVA did not detect effect of period and animal, when significant, the effects of IPP levels on the evaluated parameters were submitted to regression analysis.

The following equation was applied to determine the digestibility of individual nutrients in the IPP, according to Fan and Sauer (1995):

\[
\text{ATTD}_{\text{TDI}} = \text{ATTD}_{\text{IPP}} + \left(\text{ATTD}_{\text{BD}} - \text{ATTD}_{\text{IPP}}\right) \times \text{CONT}_{\text{BD}},
\]

where \(\text{ATTD}_{\text{TDI}}\) = apparent total tract digestibility of the nutrient in the test diet \(i\); \(\text{ATTD}_{\text{BD}}\) = apparent total tract digestibility of the nutrient in the basal diet; \(\text{ATTD}_{\text{IPP}}\) = apparent total tract digestibility of the nutrient in IPP; \(\text{CONT}_{\text{BD}}\) = contribution (%/100) of the nutrient of the basal diet in the test diet.

Faecal score and odour were analysed by the Kruskal-Wallis test \(p < .05\). Palatability first-choice results were submitted to the Chi-square test and the intake ratio to the Student’s \(t\)-test, both at 5% probability level \((n = 32)\).

Results

Digestibility assay

Table 3 shows the obtained food intake (on DM basis) values, the ATTD of nutrients and the ME content of the evaluated IPP and of the experimental diets.

No episodes of food rejection, vomiting or diarrhoea were observed. Food intake was not different among diets \((p > .05)\). The dietary inclusion of IPP linearly increased the ATTD of DM, CP and AHEE \((p < .05)\), as well as dietary ME content \((p < .01)\). Regression equations obtained were:

- ATTD of DM (%): \(\text{ATTD}_{\text{DM}} = 0.200x + 80.667\) \((R^2 = 0.463)\);
- ATTD of CP (%): \(\text{ATTD}_{\text{CP}} = 0.115x + 81.983\) \((R^2 = 0.169)\);
- ATTD of AHEE (%): \(\text{ATTD}_{\text{AHEE}} = 0.081x + 87.900\) \((R^2 = 0.812)\); and
- ME (MJ/kg): \(\text{ME} = 9.508x + 17.67\) \((R^2 = 0.492)\).

The IPP inclusion did not change the ATTD of OM and GE of diets \((p > .05)\). The IPP presented higher digestibility and ME values than the poultry offal meal.

Faecal characteristics

The faecal characteristic results are shown in Table 4.

The increasing dietary inclusion of IPP resulted in a linear reduction of faecal DM content and pH \((p < .01)\). Other faecal characteristics, such as faecal output,
score, ammonia nitrogen content, odour, and sialic acid content were not different ($p > 0.05$) among treatments.

### Palatability assay

The results of the palatability assay are presented in Table 5. No differences in first choice ($p > 0.05$) were observed between the diets with 0 or 300 g IPP/kg. However, the reference diet (0 g IPP/kg) was preferred over the diet with 300 g IPP/kg, as determined by its higher intake ratio ($p < 0.01$).

### Discussion

No studies evaluating the digestibility of IPP individual nutrients for dogs or other species were found in literature. However, comparing the results obtained in the present study with the digestibility of other animal meals reported in literature, IPP presented ATTD of CP similar or greater than poultry offal meal or bovine meat or bone meal. Kawauchi et al. (2014) and Sa Fortes (2005) reported values for CP digestibility of poultry offal meal between 80.4 and 89.1% and for bovine meat and bone meal between 72.3 to 80.1% for dogs. In the present study, IPP presented greater ATTD of CP (86.4%) than poultry offal meal, considering that dietary CP digestibility increased from 81.5% in reference diet, containing 300 g of poultry offal meal to 85.0% in diet with 300 g IPP/kg. According to Johnson et al. (1998), the nutrient utilisation of rendering products by dogs is influenced by the livestock species from which they are derived, bodyparts included and their processing methods.

The ATTD values of DM and AHEE of almost 100% obtained for IPP demonstrate a limitation of the regression method to estimate the digestibility of food ingredients. According to Kawauchi et al. (2011), the extrapolation of the inclusion level of an ingredient to 1000 g/kg may increase the determination errors of its digestibility, because results may exceed the physiological digestive capacity of the animal. Other limitation of the regression method is that the substitution of one ingredient for another alters the nutritional and energetic composition of the diets. Considering that, it is important that more studies are conducted in the future to evaluate the effects of IPP in nutritional equalised diets for dogs.

Isolated porcine protein evaluated in this study presented greater ME (22.48 MJ/kg) content than other animal meals related in literature, as bovine meat, bone meal and poultry offal meal (11.22 and 14.71 MJ/kg; Sa Fortes 2005). This better energy utilisation may be related to the high digestibility of the IPP nutrients and to its low ash content. The high ash content of some animal by-product meals negatively affects the quality of their protein as essential amino acid levels per unit of protein are reduced (Johnson et al. 1998), limiting their inclusion in feed formulations. Therefore, the low ash content of IPP represents an advantage over other animal protein meals, which generally have high mineral content.

Despite the linear reduction in faecal DM as dietary IPP inclusion level increased, faecal score was not affected. The faecal score remained within the interval considered optimal for dogs (3 to 4). The reduction in

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**Table 4.** Faecal characteristics of dogs fed diets containing increasing inclusion levels of isolated porcine protein (IPP).

| Item       | 0  | 100 | 200 | 300 | SEM | L  | Q  |
|------------|----|-----|-----|-----|-----|----|----|
| DM         | 424| 411 | 388 | 342 | 0.922| <0.001 | 0.389 |
| Score *    | 4  | 4   | 4   | 4   | 0.103| <0.010 | 0.790 |
| pH         | 6.860| 7.040| 6.550| 6.590| 0.013| 0.983 | 0.999 |
| Ammonia a  | 0.090| 0.100| 0.080| 0.090| 0.013| 0.199 | 0.277 |
| Output b   | 0.110| 0.100| 0.080| 0.100| 0.006| 0.199 | 0.277 |
| Odour c    | 2  | 2   | 2   | 2   | 0.006| 0.199 | 0.277 |
| Sialic acid b | 1.100| 1.200| 1.230| 1.240| 0.358| 0.613 | 0.954 |

IPP: isolated porcine protein; SEM: standard error of the mean; DM: faecal dry matter, g/kg.

Faecal odour and score medians analysed by the Kruskal-Wallis test ($p > 0.05$).

aAmmonia nitrogen, g/kg DM.

bSialic acid, mg/g.

*1: watery stools to 5: hard and dry stools.

**Faecal output on fresh matter basis, g/dry matter intake, g/per day.

***1: less unpleasant, 2: no difference, 3: more unpleasant relative to the diet with 0 g IPP/kg.

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**Table 5.** First choice (%) and intake ratio (preference) of the reference diet (0 g IPP/kg) compared to the diet with inclusion of isolated porcine protein (300 g IPP/kg).

| Item       | 0  | 300 | SEM | Probability |
|------------|----|-----|-----|-------------|
| First choice | 46.880| 53.120| 0.080| 0.125       |
| Intake ratio | 68.400| 31.600| 0.050| <0.001      |

IPP: isolated porcine protein; SEM: standard error of the mean; first choice analysed by the Chi-squared test; intake ratio analysed by the Student’s t-test ($p < 0.05$); n = 32 animals.
the faecal DM content of the dogs is probably due to the lower ash content of diets with IPP (3.48 and 7.79% ash in diets with 300 and 0 g IPP/kg, respectively). According to Butolo (2002), bovine meat and bone meals with high bone content present high ash, respectively). Carciofi (2008) also reported that dogs presented higher faecal DM values when fed diets containing poultry by-product meal, with greater ash content, compared with micronized soybeans and soybean meal.

The linear reduction of the faecal pH of dogs fed diets containing increasing IPP levels suggests reduced fermentation of nitrogen compounds in the colon of the dogs as a result of the linear increase in dietary CP digestibility as IPP levels increased. When ingredients with low protein digestibility are fed to dogs, the fermentation of non-digested protein produces nitrogen compounds, such as ammonia and branched chain fatty acids (iso-butirate and iso-valerate; Musco et al. 2016), increasing intestinal pH. Felix et al. (2013), compared the effects of different protein sources on the faecal characteristics of growing and adult dogs and observed the greatest faecal pH in dogs fed with the least digestible protein source. In addition, the putrefactive compounds generated by protein fermentation, such as ammonia and biogenic amines, may harm intestinal health and cause unpleasant faecal odour (Hesta et al. 2003). However, in the present study, no differences in faecal ammonia nitrogen or faecal odour were observed. Hesta et al. (2003) also observed that the increase in ammonia levels in faeces of dogs fed diets containing 50% meat, bone and pig meal did not influence faecal odour. According to Hesta et al. (2003), faecal odour is influenced by several factors, such as the volatility of the faecal compounds and faecal moisture content and pH, as well as environmental temperature and relative humidity; however, those authors did not evaluate diet digestibility.

The lack of differences in faecal sialic acid production observed in the present study indicates that IPP did not affect intestinal mucus production, which suggests that IPP is not potentially aggressive to the intestinal mucosa of dogs.

No first-choice difference was observed between the reference diet and that containing 300 g IPP/kg. However, the intake ratio of the food containing 300 g IPP/kg was lower than that with no IPP. This preference for the lower protein diet does not agree with the findings of Carvalho (2006), who evaluated the palatability of dog foods containing different levels of poultry by-product meal and observed that the dogs preferred the food with highest protein content. No studies were found in literature evaluating the palatability of IPP in dogs. However, the results of the present study indicate that, although the diet with 300 g IPP/kg was not rejected, the dogs preferred the diet with 300 g/kg of poultry offal meal, as demonstrated by its greater intake ratio. The perception of food palatability by dogs is complex and influenced by several factors, such as the interaction between dietary ingredients, palatant type and food texture, among others (Zanatta et al. 2016).

**Conclusions**

Isolated porcine protein presents high nutrient digestibility and ME content for dogs, and therefore, when included in dog foods in replacement for poultry offal meal, dietary nutrient digestibility and ME content are increased. However, the inclusion of up to 300 g IPP/kg of diet reduces faecal DM content and pH, as well as the palatability of dog foods.

**Disclosure statement**

No potential conflict of interest was reported by the authors.

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