Research Articles

Digestibility of sundried tomato pomace in dogs

C. Yuangklang[1,2] K. Vasupen[1,2*] C. Wongnen[2] S. Wongsuthavas[1,2] A.C. Beynen[2,3]

[1]Department of Agricultural Technology and Environment, Faculty of Sciences and Liberal Arts, Rajamangala University of Technology-Isan, Nakhon Ratchasima Campus, Nakhon Ratchasima 30000 Thailand
[2]Department of Animal Science, Faculty of Natural Resources, Rajamangala University of Technology-Isan, Phang Khon Campus, Sakon Nakhon 47160, Thailand
[3]Vobra Special Petfoods, Veghel, The Netherlands

[*]Corresponding author, E-mail address: ks_vasupen@yahoo.com

Abstract

Tomato pomace is increasingly used as ingredient for petfood production. In this study with dogs, the apparent digestibility of sundried tomato pomace has been measured by the difference method. In a 3x3 Latin square-design, 12 healthy dogs were fed a commercial dry food or the same food mixed with either 10 or 30 % tomato pomace. The average digestibilities for sundried tomato pomace were calculated to be as follows: crude protein, 46.5 %; crude fat, 48.7 %; non-structural carbohydrates, 63.1 %. For the commercial diet, the observed digestibilities were 81.1 % for crude protein, 89.2 % for crude fat and 85.3 % for non-structural carbohydrates. Contrary to the outcome, the digestibilities of the protein, fat and non-structural carbohydrate fractions in sundried tomato pomace may not be lower than those of the commercial diet. The sundried tomato pomace contained 31.6 % of crude fiber while high dietary crude fiber levels are known to depress digestibility. Thus, the high fiber content of the diets with tomato pomace may have biased the calculated digestibility of this ingredient towards low values. It is concluded that 10% of sundried tomato pomace can be a useful ingredient of dry dog foods. High levels of tomato pomace in the diet are well accepted with no negative effect on feces consistency. The high crude fiber content of tomato pomace limits its inclusion level in commercial petfoods.

Keywords: dog, diet, tomato pomace, digestibility

Introduction

The processing of whole tomatoes into juice, sauce or paste yields the byproduct tomato pomace consisting of pulp, seeds and skins. After drying, the residue may be ground or pulverized into a powder. There is a growing number of dry dog foods for which tomato pomace appears on the ingredient list. It is commonly incorporated with inclusion levels of 3-7% (Aldrich, 2009). Typically, dried tomato pomace contains about 20% protein, 12% fat, 4% ash and 30% crude fiber. The levels of neutral-detergent and acid-detergent fiber are around 60 and 45 %. For the production of dry petfoods, the fiber component should be considered. Dry dog foods generally contain about 3-4% of crude fiber, this target limiting abundant addition of tomato pomace to the ingredient mixture.

Weanling rats have been fed on diets with one protein source, containing either 10% protein in the form of dried tomato pomace or 9% protein as casein (Drouliscos, 1976). The rats fed tomato pomace showed a decrease in body weight gain by 7%. The lower weight gain cannot be explained by an insufficient intake of essential amino acids. Probably, lower digestibility of the protein moiety of tomato pomace had caused lower weight gain. This idea is supported by digestibility trials in dogs. The addition of 8% tomato pomace to a diet at the expense of extruded corn produced a decrease in apparent digestibility of whole-diet crude protein from 82.3 to 78.2% (Allen et al., 1981). Replacement of dietary corn starch by 8.7% tomato pomace lowered the digestibility of whole-diet protein from 85.1 to 80.7% (Fahey et al., 1990). The data presented in the two papers (Allen et al., 1981; Fahey et al., 1990) do not allow calculation of the digestibility of the protein component of tomato pomace. However, it appears that the digestibility of the protein itself is low or is reduced by the fiber constituent of tomato pomace. There is a negative correlation between the dietary concentration of crude fiber and apparent protein digestibility in dogs (Castrillo et al., 2001).

The questions addressed in the present experiment with dogs were as follows. What is the apparent digestibility of the protein, fat and non-structural carbohydrates in dried tomato pomace? To answer these questions, the apparent digestibility of macronutrients in dried tomato pomace was determined by the difference method at two inclusion levels, namely 10 and 30%. A further objective of this study was to determine whether the intake of high amounts of tomato pomace affects feed intake, body weight and feces quality in dogs.

Materials and methods

The procedures of housing and caring of dogs followed the guidelines of Use of Experimental Animals for Scientific Research of Rajamangala University of Technology Isan.

Dogs and housing

Twelve Golden Retrievers, aged 20 months, were used. There were 8 intact males and 4 spayed females. The dogs were housed as a group in a confinement (10 x 10 m) located under a roof, but otherwise with open air. Within the confinement there were 12 cages (1.0 x 0.5 x 0.6 m) with plastic grated

floor. The animals could move freely within the confinement, including the open cages. However, during feeding and feces collection intervals, the dogs were locked up in their own cage.

Experimental design

The dogs were subjected to a 3x3 Latin square design with three experimental diets and three periods of three weeks each. Per diet order there were 4 dogs. Initial body weights were 26.0 ± 0.7 kg (mean ± SEM) for the males and 21.8 ± 0.2 kg for the females. The final body weights were 25.4 ± 0.6 and 20.9 ± 0.7 kg. Table 1 shows the ingredient and analyzed composition of the three experimental diets. The control diet was a commercial diet (Bok Dök, Nutrix Company Ltd, Muang, Chachoengsao, Thailand) of one production batch. The extruded, commercial diet was homogenized, water was added and the mixture was put through a pelleting machine. The pellets were sundried. The test diets were made in the same manner, but after homogenizing either 10 or 30% of sundried tomato pomace was added. The analyzed composition of the dried tomato pomace was 9.4% moisture, 17.0% crude protein, 10.8% crude fat, 4.6% ash and 31.6% crude fiber. The calculated amount of non-structural carbohydrates was 26.6%.

A restricted amount of each diet was fed in two equal portions per day. During feeding, the dogs were confined in their own cage for a period of 15 min. The daily amount of food provided was equivalent to 5181 kJ and 4540 kJ of metabolizable energy for the males and females, respectively. The amounts of energy were equivalent to 90% of the assumed requirement for maintenance (500 kJ per kg body weight^0.75). To calculate the energy content of the experimental diets, the energy values for protein, fat and carbohydrates were taken to be 17, 37 and 16 kJ metabolizable energy per gram. The calculated energy content of the control diet was 1415 kJ/100 g. For the test diets with 10 or 30% dried tomato pomace the calculated energy densities were 1385 and 1325 kJ/100 g. The energy density of the control diet was based on the guaranteed analysis panel on the packaging: crude protein, 20%; crude fat, 7%; crude fiber, 6%; ash, 6%; moisture, 10%.

During the last 5 days of each period, the dogs were penned up in their own cage. From each dog the feces were collected quantitatively.

Measurements

At the beginning of each period, body weights of the dogs were determined. Throughout the experiment, the feces quality was scored on a 1-5 scale (Waltham Faecal Grading System). Feed and feces samples were processed for the proximate analysis of dry matter, crude fat, crude protein, crude fiber and ash as described (Vasupen et al., 2011). The amount of non-structural carbohydrates (nitrogen-free extract) was calculated as residual fraction.

Statistical analysis

The data were evaluated for diet effects with the use of ANOVA. If there were statistically significant diet effects, the three diet groups were compared with the Tukey test. The paired Student's t test was used to evaluate the digestibilities for the two inclusion levels of tomato pomace. $P < 0.05$ was taken as a criterion of statistical significance.

Results

At the end of experiment, dogs were healthy as before. On a regular basis, they were walked and allowed running loose.

Table 1 shows the analysed composition of the experimental diets. As would be expected, mixing of dried tomato pomace into the commercial diet raised the amount of crude fiber and fat in the diet and lowered that of crude protein.

Throughout the experiment there were no food refusals: each dog ate its ration within 15 min after administration. Within the feeding periods, there were no significant changes in body weight.

The inclusion of tomato pomace in the diet significantly elevated the amount of fecal dry matter in a dose-dependent fashion (Table 2). The percentage of dry matter in feces was not systematically influenced by the intake of tomato pomace. There was no diet effect on feces score. A feces score of 2.5 is equivalent to well formed stools with a slightly moist surface.

The apparent digestibilities of dry matter, organic matter, crude protein, non-structural carbohydrates and crude fat were all lowered by mixing tomato pomace with the commercial diet (Table 3). The lowering effect of tomato pomace showed a dose dependency. For the 30 %-inclusion level, the decrease in digestibility ranged from 7.4 percentage units for dry matter to 10.1 percentage units for crude fat. The percentage of apparent fiber digestibility was not systematically influenced by tomato pomace in the diet (Table 3). Likewise, there was no diet effect on the apparent digestibility of ash.

Table 1. Ingredient and analysed composition of the experimental diets

	Control	10% DTP	30% DTP
Ingredient, g			
Commercial diet	1000	900	700
Tomato pomace	-	100	300
Chemical analysis, % of dry matter			
Dry matter*	93.4	92.7	93.4
Crude protein	19.5	18.6	17.3
Crude fat	8.4	8.6	9.5
Crude fiber	7.3	9.5	13.0
Ash	9.7	9.0	8.1
Nitrogen-free extract	55.1	54.3	52.1

DTP = dried tomato pomace

*Expressed on product basis.

Table 2. Feces production and score for dogs fed the experimental diets

	Control	10% DTP	30% DTP	SEM	P value
Feces					
g dry matter/day	92[a]	107[a,b]	120[b]	4.2	0.02
g dry matter/100 g	28	29	26	0.7	0.06
Score	2.6	2.6	2.6	0.09	0.87

DTP = dried tomato pomace

Means (n = 12) within the same row not sharing the same superscript letter are significantly different (P < 0.05)

Table 3. Apparent digestibility of nutrients in dogs fed the experimental diets

	Control	10% DTP	30% DTP	SEM	P value
Apparent digestibility, % of intake					
Dry matter	75.4[b]	71.1[a,b]	68.0[a]	1.14	0.02
Organic matter	80.0[b]	74.5[a]	71.1[a]	1.09	0.00
Crude protein	81.1[b]	77.6[a]	71.1[a]	1.10	0.00
Crude fat	89.2[c]	84.5[b]	79.1[a]	0.92	0.00
Crude fiber	25.9	22.1	28.4	2.63	0.64
Nitrogen-free extract	85.3[b]	82.0[a,b]	80.3[a]	0.71	0.01
Ash	32.9	30.3	32.4	2.38	0.90

DTP = dried tomato pomace

Means (n = 12) within the same row not sharing the same superscript letter are significantly different (P < 0.05)

Table 4. Apparent digestibility of tomato-pomace components for the two inclusion levels as calculated according to the difference method

	10% DTP level	30% DTP level	SEM	P value
Apparent digestibility, % of intake				
Dry matter	42.4	43.1	4.17	0.95
Organic matter	48.6	50.4	6.58	0.91
Crude protein	45.0	47.9	6.42	0.85
Crude fat	46.8	50.6	2.57	0.53
Crude fiber	21.7	25.8	7.37	0.82
Nitrogen-free extract	63.4	62.7	2.48	0.91
Ash	34.4	29.6	7.30	0.78

DTP = dried tomato pomace

Means (n = 12) within the same row are not significantly different.

The apparent digestibilities of the various components of tomato pomace were calculated by the difference method. The calculations were made separately for the 10 and 30 % inclusion levels. The digestibilities for the low and high inclusion levels of tomato pomace were not significantly different (Table 4). Except for ash and non-structural carbohydrates, the group mean digestibilities of tomato pomace components were higher for the high inclusion level. The digestibility values of the high inclusion level were 4.8 percentage units lower for ash and 3.8 percentage units higher for crude fat.

Discussion

It can be argued that formulation of the experimental diets in this study was not appropriate. Rather than adjusting the ingredient composition to keep constant the amount of crude fiber, dried tomato pomace was simply mixed with the commercial diet. As a result, the addition of tomato pomace raised the concentration of crude fiber in the diet. This has affected the outcome for the digestibility of tomato pomace. There is a negative correlation between the dietary concentration of crude fiber and apparent organic matter digestibility in dogs (Castrillo et al., 2001). The objective of this study justifies the chosen approach to diet formulation. It was the objective to use the difference method to calculate the apparent digestibility of tomato pomace.

The diets containing 10 or 30% tomato pomace were well accepted by the dogs. Tomato pomace in the diet raised the amount of feces in a dose-dependent fashion. This is explained by the lower apparent digestibility of dry matter after incorporation of tomato pomace into the diet. Feces consistency and moisture content were not influenced by the ingestion of tomato pomace. Replacement of dietary corn starch by 8.7% tomato pomace raised feces production and frequency of defecation, but did not significantly change fecal dry matter content (Fahey et al., 1990).

The data in Table 3 indicate that crude protein, crude fat and non-structural carbohydrates in dried tomato pomace were less digestibile than these macronutrients in the commercial diet and/or that the fiber in tomato pomace had a reducing effect. Mixing tomato pomace into the commercial diet markedly lowered the whole-diet apparent digestibilities of crude protein, crude fat and non-structural carbohydrates. In this study, the apparent digestibility of the macronutrients as such and the impact of the accompanying crude fiber cannot be distinguished. The difference method only allows calculation of the overall digestibility of tomato pomace. Any attempt to correct the overall digestibility for the lowering effect of fiber is fraught with uncertainty.

The analysed concentration of crude fiber in the dry matter fraction of the commercial diet and the diets with tomato pomace was 7.3, 9.5 and 13.0%, respectively. These are relatively high values as a dietary level of about 4.0 % crude fiber in the dry matter is common for dry foods on the market. An increase in crude fiber will depress the apparent digestibility of crude protein, crude fat and non-structural carbohydrates (Castrillo et al., 2000). Thus, the digestibilities measured in this study are suppressed by the high dietary fiber levels.

Application of the difference method will yield biased values because the digestibilities for the commercial diet were measured at lower fiber levels than those for the diets containing tomato pomace. Castrillo et al. (2001) have shown that a decrease in 1% crude fiber (on a dry matter basis) will raise the apparent digestibility of crude protein, crude fat and non-structural carbohydrates by 4.13, 3.22 and 2.26 percentage units, respectively. When adjusting the observed digestibilities for the diets containing tomato pomace to a crude fiber level of 7.3%, the values are higher than those for the commercial diet. This indicates that the digestibility of the proteins, fats and non-structural carbohydrates tomato pomace is not less than that of the commercial diet and might even be higher. This idea should be tested by using the difference method for diets that have been balanced for the amount of crude fiber.

The sundried tomato pomace used had a crude fiber level of 31.6%. The diets containing tomato pomace did not show a higher apparent digestibility of fiber. This indicates that the fiber in tomato pomace cannot be considered highly fermentable and/or that ingestion of tomato pomace does not stimulate the capacity of fermentation in the hindgut. In-vitro studies with fecal flora from dogs have demonstrated that tomato pomace has appreciable fermentability, but is less fermentable than citrus pectin as assessed by disappearance of organic matter (Swanson et al., 2001).

In conclusion, sundried tomato pomace appears to be a useful ingredient for dry dog diets. High inclusion levels are well accepted with no negative effect on feces consistency. For the production of dry dog foods with regular amounts of crude fiber, inclusion levels higher than 10% are not feasible because of the high fiber content of tomato pomace. The proteins, fats and non-structural carbohydrates in sundried tomato pomace appear to have acceptable digestibilities.

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