
Digestive Characteristics of Dogs Fed a Dry Food Enhanced with Additional Beet Pulp

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Abstract

Beet pulp has found favor in commercial dog foods as promoter of gut health, which means that beet-pulp content claims are considered relevant. The question addressed was whether inclusion of beet pulp beyond 5% of the diet can be done in practice. In a cross-over digestibility trial, six adult dogs were fed an extruded dry food containing 5 or 10% beet pulp, the additional beet pulp being incorporated at the expense of a grain mixture. The 10% versus 5% diet did not affect the percentage of apparent total digestive tract digestibility of protein, while fecal output of dry matter and water were raised by 6 and 19%. It is concluded that increasing beet pulp from 5 to 10% in a dry food is feasible if it involves an exchange with grains, and provided that the associated increase in fecal volume is acceptable.

Keywords: Dog, Diet, Beet pulp, Digestion and Feces

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ความสามารถในการย่อยได้ของสุนัขที่ได้รับอาหารที่เสริมด้วยเศษเหลือจาก หัวผักกาดหวานในปริมาณสูง

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บทคัดย่อ

เศษเหลือจากหัวผักกาดหวานนิยมใช้ในการผลิตอาหารสุนัขในเชิงการค้าเนื่องจากส่งผลดีต่อระบบทางเดินอาหารของสุนัข สามารถเสริมเศษเหลือจากหัวผักกาดหวานลงในอาหารสุนัขได้มากกว่าร้อยละ 5 ในการทดสอบครั้งนี้ทำการศึกษาการย่อยได้แบบ cross-over ใช้สุนัขจำนวน 6 ตัว ที่ได้รับอาหารที่ประกอบด้วยเศษเหลือจากหัวผักกาดหวานร้อยละ 5 และ 10 โดยค่าใช้จ่ายของ เศษเหลือจากหัวผักกาดหวานอยู่ในส่วนของค่าใช้จ่ายเมล็ดธัญพืช จากการศึกษาพบว่า อาหารสุนัขที่ผสมด้วยเศษเหลือจากหัว ผักกาดหวานร้อยละ 5 และ 10 ไม่มีผลต่อร้อยละของความสามารถในการย่อยได้ของโปรตีน ส่วนมูลที่ถูกขับออกมามีสิ่งแห้งและ น้ำเพิ่มขึ้นร้อยละ 6 และ 19 สรุปได้ว่าการเสริมเศษเหลือจากหัวผักกาดหวานร้อยละ 5 และ 10 ในอาหารสุนัขสามารถทำได้ อีกทั้งสามารถใช้ทดแทนเมล็ดธัญพืชและทำให้มูลสุนัขมีปริมาณเพิ่มมากขึ้นด้วย

คำสำคัญ: สุนัข, อาหาร, หัวผักกาดหวาน, การย่อยได้ และมูล

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Introduction

Beet pulp is the dried residue of sliced sugar beets after the sugar constituent has been extracted by hot water. It roughly contains 70% of total dietary fiber which breaks up in 50% insoluble and 20% soluble fiber (De Godoy *et al.*, 2013). The soluble fiber mainly includes pectins (polymers of galacturonic acid). Beet pulp is widely used as ingredient of commercial dog foods. It is believed to support intestinal health as promoter of bowel regularity through its insoluble fiber, while its soluble fiber is regarded as a prebiotic that stimulates growth of beneficial intestinal bacteria.

Regular dry dog foods contain up to 5% sugar-beet pulp. It has been reported that higher inclusion levels depress protein digestion and enlarge stool volume in dogs. Replacement of corn starch by 7.5% beet pulp in extruded diets decreased apparent fecal protein digestibility, or the proportion of protein intake which is not excreted in the feces, by 2.5% units (Fahey *et al.*, 1990a, 1990b, 1992). In those studies, beet pulp feeding raised feces volume, frequency of defecation and fecal moisture content. Similar effects were seen when 7% beet pulp was mixed into a corn-meat diet (Diez *et al.*, 1998).

Depression of apparent protein digestibility in dogs, due to high beet-pulp intake, can be explained by two mechanisms that operate simultaneously and relate to the pulp's soluble fiber which is indigestible, viscous and fermentable (De Godoy *et al.*, 2013). Ingestion of beet pulp may increase the viscosity of small intestinal contents, which interferes with digestion of proteins by a reduction of the diffusion rate of digestive enzymes and by less mixing of chyme.

The soluble fiber component of beet pulp reaches the hindgut where it serves as energy source for the colonic bacteria. Thus, more bacterial protein is excreted with the feces, which by itself lowers apparent overall digestive tract digestibility for protein.

Allen *et al.* (1981) used a diet consisting of 54.5% extruded corn, 30% extruded soybean meal, 10% tallow, 0.5% vitamin mix and 5% mineral mix. Dogs were fed on the ingredient mixture moistened with an equal part of water. Amounts of 6 and 12% beet pulp were substituted for the same percentages of extruded corn. Apparent fecal crude protein digestibilities were found to be 73.2% for the basal diet and 74.9 and 73.1% for the beet-pulp diets. The lack of effect of beet pulp on protein digestion might be explained by extruded corn having similar quantitative effects on ileal fluid viscosity and colonic fermentation.

The observations by Allen *et al.* (1981) suggest that increasing beet pulp levels in dry dog food, at the expense of grains, may not have negative effects on digestion and feces characteristics. As a consequence, it could be possible to incorporate higher levels of beet pulp into dry, grain-based dog food so that beet-pulp content claims are reasonable. In other words, such foods could be advertised as high in beet pulp supporting gut health. The present digestibility trial with dogs tested the feasibility of raising beet pulp, in place of grains, from 5 to 10% in an extruded food.

Materials and Methods

Three Beagles and three Schnauzers were enrolled in a cross-over study with feeding periods

of three weeks. The six male dogs were aged 4-12 years and weighed 13-16 kg. The ingredient and analysed composition of the extruded diets is given in Table 1. The amount of non-structural carbohydrates (nitrogen-free extract) was calculated as residual fraction. The diets contained either 5 or 10% beet pulp. The 5% diet was a commercial dry dog food (Allco Primus Adult, Vobra Special Petfoods). The 10% diet was the commercial diet to which 5% additional beet pulp was added at the expense of grains. In the two diets, the grain component was a mixture consisting of 46% rice, 31% corn and 23% barley. The dogs were housed individually in kennels with outdoor pens for 14 days, followed by 7 days in metabolism cages. Food was provided once daily (9 am) at a plane of 90% of the assumed dog's maintenance requirement (0.52 MJ metabolizable energy per kg^{0.75}). The calculated energy content of the diets was 1.7 MJ/100 g. The dogs had free access to tap water and demineralized water while housed in the kennels and in the metabolism cages, respectively. During the last five days of each period, feces and urine were collected separately and quantitatively. On the last day, dogs were walked to collect fresh feces for bacterial enumeration and identification.

Feed, feces and urine were processed and analysed as described earlier (Beynen *et al.*, 2002). The following microbe groups were quantified as log₁₀/g wet weight of feces: anaerobic bacteria, aerobic bacteria, Enterobacteriaceae, Staphylococci, Lactobacilli, Streptococci, Clostridia, Bacteroidaceae, Bifidobacteria, Salmonella and yeasts plus molds. The measure differences between the diets containing 5 or 10% beet pulp were checked for statistical significance with the use of the paired Student's t test as dictated by

the cross-over design. For the microbe counts, the Wilcoxon test was applied. The level of statistical significance was pre-set at P<0.05.

Results and Discussion

Results

Table 2 shows that increasing the dietary level of beet pulp from 5 to 10% significantly raised the amount of fresh feces and diminished fecal dry matter content. The apparent digestibilities of dry matter, crude protein, crude fat and non-structural carbohydrates were not significantly influenced by higher beet pulp intake. However, fat and carbohydrate digestion tended to be increased and decreased, respectively.

The nitrogen balance elements, intake, fecal and urinary excretion, were unaffected by the level of dietary beet pulp (Table 3). High intake of beet pulp produced an increase in fecal ammonia and a decrease in group-mean fecal pH.

The counts for 10 bacterial groups and yeasts plus molds in feces did not change when the dogs were fed the diet with 10% beet pulp when compared to 5% (results not shown). Table 4 shows that the higher beet pulp level had no significant impact on apparent mineral absorption, but it tended to make phosphorus more available.

Discussion

This study indicates that raising the beet pulp level of an extruded food from 5 to 10%, at the expense of a grain mixture, does not reduce apparent fecal protein digestibility in dogs. Similar results were published earlier by Allen *et al.* (1981), who used a corn-soybean diet and increased the beet pulp content from 6 to 12% beet pulp while lowering the corn fraction by 6% units. Seemingly, equal amounts of beet pulp and

corn have comparable effects on protein digestion in the small intestine and on microbial protein synthesis in the large intestine. This reasoning might extend to grains other than corn as in this study beet pulp was substituted for a grain mixture with corn.

In one study, beet pulp was simply added to a complete dog food (Diez *et al.*, 1998), thus replacing part of the food. In other studies, beet pulp was substituted for corn starch (Fahey *et al.*, 1990a, 1990b, 1992), extruded corn (Allen *et al.*, 1981) or another fiber source such as cellulose (Sunvold *et al.*, 1995; Muir *et al.*, 1996). The impact of beet pulp should be considered in terms of the exchange of diet components: the observed effect is the net effect of the addition of beet pulp and the omission of the counterpart. In this light, it is easy to see that replacement of the insoluble, non-fermentable cellulose fiber by beet pulp caused a decrease in both apparent ileal (Muir *et al.*, 1996) and fecal protein digestibility (Sunvold *et al.*, 1995; Muir *et al.*, 1996).

Beet pulp is often described as moderately fermentable. Canine fecal microflora, which reflects the colonic bacterial population, ferments beet pulp better than cellulose, but not as fast as citrus pectin (Sunvold *et al.*, 1995). This study clearly indicates that additional beet pulp instead of grains stimulated bacterial fermentation in the hindgut, yielding more short-chain fatty acids: the diet high in beet pulp reduced fecal pH and increased fecal water content. These beet-pulp effects were accompanied by unchanged numbers of fecal anaerobic and aerobic bacteria. In an earlier study using the same methods as in this study, total anaerobic and aerobic counts in canine feces were significantly elevated by feeding

a diet with 1% of oligofructose (Beynen *et al.*, 2002).

When the dogs were on the diet with extra beet pulp, the amounts of fecal excretion of water and dry matter were higher. The increase in fecal water loss can be explained by excretion of more short-chain fatty acids and their osmotic effect. One third of the greater dry matter excretion was accounted for by the lower group-mean digestibility of carbohydrates. Possibly, the pectin component of beet pulp had impaired starch digestion in the small intestine (Silvio *et al.*, 2000). Additional beet pulp enhanced fermentation which likely was accompanied by an increase in fecal bacterial dry matter. However, this inference is without backing as protein digestibility was not depressed while anaerobic and aerobic bacterial counts were not increased.

Increasing the beet pulp content of the diet from 5 to 10% raised the amount of fresh feces by 15% and fecal water excretion by 19%. Unfortunately, feces quality was not assessed by visual inspection against a grading system. The percentage of fecal dry matter was higher compared with that for dogs fed a dry commercial diet mixed with 30% dried tomato pomace (Yuangklang *et al.*, 2015). Those dogs had well-formed stools with a slightly moist surface. The feces produced by the dogs in this study probably had acceptable shape and consistency because the care taker did not report aberrant feces quality.

Table 1 Ingredient and analysed diet compositions

Items	Dietary sugar-beet pulp (g/100 g diet as fed)	
	5%	10%
Ingredients		
Sugar-beet pulp	5	10
Grain mixture	29	24
Constant	66	66
components		
Chemical analysis		
Crude protein	28.1	28.3
Crude fat	16.3	17.0
Crude fiber	2.8	3.2
Crude ash	6.6	7.0
Moisture	4.9	5.5
Carbohydrates	41.3	39.0
Calcium	1.24	1.32
Magnesium	0.10	0.10
Phosphorus	0.76	0.78

¹Grain mixture: 46% rice, 31% corn and 23% barley

²Constant components: proprietary information

Table 2 Feces production and apparent macronutrient digestibility

Items	Dietary sugar-beet pulp		P value
	5%	10%	
Feces production, g/day			
Fresh feces	117 ± 15.8	134 ± 12.4	0.004
Dry matter	39.3 ± 4.4	41.5 ± 3.0	0.060
Fecal dry matter, %	33.6 ± 1.7	31.0 ± 1.5	0.007
Apparent digestibility, % of intake			
Dry matter	79.9 ± 1.4	79.2 ± 0.7	0.405
Crude protein	77.2 ± 2.5	77.4 ± 1.3	0.879
Crude fat	92.1 ± 1.0	93.7 ± 1.0	0.068
Carbohydrates	89.9 ± 1.0	88.5 ± 1.5	0.088

Results are means ± SD for 6 dogs

Table 3 Nitrogen excretion and fecal pH

Items	Dietary sugar-beet pulp		P value
	5%	10%	
Nitrogen intake, g/day	10.6	10.6	
Fecal nitrogen, g/day	2.4 ± 0.4	2.4 ± 0.2	0.874
Urinary nitrogen, g/day	7.7 ± 0.8	7.6 ± 0.6	0.591
Fecal ammonia, mmol/day	1.8 ± 0.9	2.3 ± 0.9	0.029
Urinary urea, mol/day	0.23 ± 0.04	0.23 ± 0.03	0.977
Fecal pH	6.24 ± 0.20	6.05 ± 0.28	0.092

Results are means ± SD for 6 dogs

Table 4 Apparent mineral absorption

Items	Dietary sugar-beet pulp		P value
	5%	10%	
Mineral absorption, % of intake			
Calcium	4.4 ± 5.0	10.1 ± 7.2	0.110
Magnesium	22.8 ± 5.6	25.8 ± 8.7	0.198
Phosphorus	23.7 ± 3.2	29.6 ± 5.1	0.064

Results are means ± SD for 6 dogs

Conclusion

This study shows that increasing the beet pulp content of an extruded food from 5 to 10%, at the expense of a grain mixture, raised fecal volume moderately without negative effects on digestive characteristics in terms of macronutrient digestibility and fecal moisture content. This information may be relevant to petfood manufacturers who wish to meet a high level beet pulp claim.

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