# Stool Characteristics, Gastrointestinal Transit Time and Nutrient Digestibility in Dogs Fed Different Fiber Sources[1]

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## EXPANDED ABSTRACT

**Indexing Key Words:**

• *fiber* • *dogs* • *digestibility*

High fiber ingredients are frequently used in commercial pet foods to decrease their energy density and as an aid in treatment of patients with diseases such as diabetes mellitus, hyperlipidemia and colonic disorders (Blaxter et al. 1990, Dimski 1992, Dimski and Buffington 1991, Nelson 1989, Nelson et al. 1991). The nutritional adequacy of most high fiber commercial diets is usually confirmed using standard feeding trials. Only a few studies (Burrows et al. 1982, Fahey et al. 1990a, Fahey et al. 1990b) have evaluated the effect of different dietary fiber sources on nutrient digestibility, gastrointestinal motility and stool characteristics in healthy dogs eating practical diets. The purpose of this study was to evaluate the short-term effects of different fiber sources on these parameters in normal dogs.

***Materials and methods.*** Five healthy adult female beagle dogs were fed each of five diets in a randomized block design. The basal diet was a single batch of canned nutritionally balanced dog food, which contained either starch or four different fiber sources (finely ground cellulose, coarsely ground cellulose, corn fiber or pectin). Ingredients and proximate analysis of diets are listed in **Table 1.** The fiber diets contained 5.5–5.8 g total dietary fiber/100 g diet (as fed), the composition of which was primarily insoluble fiber in the fine and course cellulose diets and in the corn-fiber diet and primarily soluble fiber in the pectin diet. Dogs were fed once daily at a rate that maintained a constant body weight. The animals were acclimitized to each diet for 11 d, after which the total amount of feces passed during a 3-d period was collected and the following were determined: apparent nutrient digestibility, stool characteristics (weight, water content

**TABLE 1**

***Nutrient content of diets (% as fed)[1]***

| | Control starch | Fine cellulose[2] | Coarse cellulose[3] | Corn fiber[4] | Pectin[5] |
|---|---|---|---|---|---|
| Fiber-Crude | 0.4 | 2.6 | 3.8 | 2.6 | 0.5 |
| Total dietary | 2 | 5.8 | 5.7 | 5.5 | 5.7 |
| Insoluble | 1.65 | 5.6 | 5.6 | 5.4 | 1.65 |
| Soluble | 0.35 | 0.2 | 0.1 | 0.1 | 4.05 |
| Neutral detergent | 3.1 | 7.5 | 6.1 | | 6.6 |
| Moisture | 72.1 | 72.1 | 71.9 | 72.2 | 72 |
| Protein | 4.25 | 4.06 | 4.44 | 4.29 | 4.67 |
| Fat | 2.95 | 3.25 | 3.33 | 3.33 | 2.73 |
| Ash | 0.81 | 0.79 | 0.71 | 0.75 | 1.05 |
| Minerals[6] | | | | | |

[1] Ingredients common to all diets: water, corn, rice, liver, high-fat chicken, starch or fiber, soy oil, dried whole egg, nonfat dried milk, yeast, salt, choline chloride, mineral mix, vitamin mix.

[2] Fine ground Solka-Floc BW300, 4.4%, average fiber length = 20 μm.

[3] Coarse ground Solka-Floc BW40, 4.4%, average length = 120 μm.

[4] Corn fiber, 4.4%.

[5] Pectin, 4.8%

[6] All diets had the following per gram diet: calcium 1.3 mg, phosphorus 1.1 mg, sodium 0.7–1.7 mg, potassium 0.9 mg, magnesium 0.2 mg, iron 50–80 μg, copper 3.4–4.1 μg and zinc 50 μg.

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**TABLE 2**

***Dietary fiber effects on stools and gastrointestinal transit time*[1]**

| Stool characteristics | Control starch | Fine cellulose | Coarse cellulose | Corn fiber | Pectin |
|---|---|---|---|---|---|
| Moisture, % | $74.3^{c}$ (72–77) | $61.5^{a}$ (55–65) | $63.9^{a}$ (58–70) | $66.8^{b}$ (63–70) | $74.6^{c}$ (72–79) |
| Rating[2] | $5.0^{a}$ (4.8–5.0) | $5.0^{a}$ (5) | $3.7^{b}$ (2.6–4.5) | $5.0^{a}$ (5) | $5.0^{a}$ (5) |
| Quantity, ($g \cdot kg\ BW^{-1} \cdot d^{-1}$) | | | | | |
| As excreted | $12.3^{b}$ (9.4–14.4) | $12.6^{b}$ (9.7–15.7 | $14.6^{b}$ (12.1–15.4) | $14.6^{b}$ (11.4–17.2) | $21.6^{a}$ (17.2–23.6) |
| Dry matter | $3.1^{a}$ (2.8–3.8) | $4.8^{b}$ (3.8–5.4) | $5.2^{b}$ (4.9–5.9) | $4.8^{b}$ (4.2–5.3) | $5.5^{b}$ (4.8–6.2) |
| Ingestion to excretion time,[3] *h* | $8.4^{a}$ (7.0–9.0) | $7.5^{ab}$ (5.5–11) | $8.0^{ab}$ (7.0–9.0) | $6.8^{ab}$ (5.0–8.0) | $5.4^{b}$ (4.5–6) |

[1] Values are means with ranges in parentheses. Means followed by different letters are significantly different ($P < 0.0002$, except time $P < 0.05$).

[2] Stool rating: 1, water, 2, runny with formed pieces; 3, soft unformed; 4, soft formed; 5, firm.

[3] Total daily diet fed once with 0.04 g of FD&C Blue #2 dye; time to first appearance of dye.

and subjective ratings) and minimum ingestion to excretion time.

***Results.*** The dietary fiber effects on stool characteristics and ingestion to excretion time are shown in **Table 2.** There was no difference in the weight of feces excreted from fine cellulose, coarse cellulose and corn-fiber-fed dogs, but the moisture content of feces was lower than when they were fed the starch diet. There was no difference in the moisture content of feces excreted from pectin fed dogs, but stool weight was greater than when fed the starch diet. Time from ingestion of the diet to first excretion of feces was not changed by dietary cellulose (7.5–8.0 h) or corn fiber (6.8 h) but was significantly shortened by pectin (5.4 h), as compared with the starch control diet (8.4 h).

Dry matter digestibility was not different among the high fiber diets (69–73%) but was lower than when fed the starch diet (81.8%) (**Table 3**). Cellulose and corn fiber, however, had no effect on the apparent digestibility of protein, fat, nonfiber carbohydrate, energy, calcium, magnesium, sodium, potassium, copper or zinc. The apparent digestibility of phosphorus and iron was lower on the coarsely ground cellulose diet than on the starch control diet. The apparent digestibility of nonfiber carbohydrate and energy was lower on the pectin diet than on the control starch diet, whereas the apparent digestibility of protein, fat and all minerals except sodium was similar on these two diets.

***Discussion.*** Mean retention time or gastrointestinal transit time are quite variable in healthy dogs eating various fiber diets compared with control diets with no fiber (Burrows et al. 1982, Fahey et al. 1990a, Fahey et al. 1990b). In this study, the minimum time

**TABLE 3**

***Dietary fiber effect on apparent nutrient digestibility (%)***

| | Control starch | Fine cellulose | Coarse cellulose | Corn fiber | Pectin |
|---|---|---|---|---|---|
| Proximates | | | | | |
| Dry matter | $81.8 \pm 3.4^{a**}$ | $73.1 \pm 3.4^{b}$ | $70.9 \pm 1.8^{b}$ | $73.5 \pm 1.8^{b}$ | $69.3 \pm 2.4^{b}$ |
| Protein | $69.5 \pm 4.1^{a}$ | $73.3 \pm 4.9^{a}$ | $73.9 \pm 1.8^{a}$ | $73.9 \pm 3.5^{a}$ | $71.8 \pm 4.0^{a}$ |
| Fat | $93.3 \pm 2.0^{a}$ | $93.7 \pm 1.0^{a}$ | $93.7 \pm 1.3^{a}$ | $94.2 \pm 0.3^{a}$ | $93.5 \pm 1.5^{a}$ |
| Crude fiber | $15.6 \pm 16.2$ | $1.9 \pm 13.1$ | $-0.2 \pm 2.8$ | $-9.7 \pm 4.8$ | $42.8 \pm 10.6$ |
| Nonfiber carbohydrate | $85.8 \pm 4.0^{a}$ | $81.1 \pm 2.1^{a}$ | $84.2 \pm 1.8^{a}$ | $83.5 \pm 2.7^{a}$ | $67.6 \pm 2.9^{b}$ |
| Energy | $84.4 \pm 2.8^{a}$ | $82.8 \pm 2.2^{a}$ | $84.5 \pm 1.3^{a}$ | $84.4 \pm 1.8^{a}$ | $73.5 \pm 2.2^{b}$ |
| Minerals | | | | | |
| Calcium | $-2.0 \pm 11.8^{a}$ | $10.7 \pm 11.3^{a}$ | $-5.9 \pm 5.0^{a}$ | $4.3 \pm 4.4^{a}$ | $2.4 \pm 8.5^{a}$ |
| Phosphorus | $45.2 \pm 11.5^{a}$ | $42.1 \pm 3.6^{a}$ | $26.2 \pm 5.4^{b}$ | $44.1 \pm 5.1^{a}$ | $60.8 \pm 3.8^{a}$ |
| Magnesium | $38.6 \pm 10.4^{a}$ | $36.4 \pm 7.1^{a}$ | $24.9 \pm 4.5^{a}$ | $34.5 \pm 4.7^{a}$ | $35.8 \pm 7.3^{a}$ |
| Sodium | $67.8 \pm 12^{a}$ | $70.2 \pm 12.7^{a}$ | $60.0 \pm 7.1^{a}$ | $61.8 \pm 13.6^{a}$ | $42.8 \pm 13.8^{b}$ |
| Potassium | $74.7 \pm 9.2^{ab}$ | $84.8 \pm 3.7^{a}$ | $79.1 \pm 2.8^{ab}$ | $78.9 \pm 2.4^{ab}$ | $69.7 \pm 8.3^{b}$ |
| Trace Minerals | | | | | |
| Iron | $22.5 \pm 10.2^{ab}$ | $14.2 \pm 7.7^{bc}$ | $3.3 \pm 6.9^{c}$ | $31.5 \pm 7.8^{a}$ | $16.0 \pm 8.6^{bc}$ |
| Copper | $3.6 \pm 8.3^{a}$ | $-9.8 \pm 12.1^{a}$ | $0.5 \pm 5.4^{a}$ | $3.7 \pm 5.9^{a}$ | $7.7 \pm 11.6^{a}$ |
| Zinc | $8.2 \pm 9.3^{a}$ | $4.6 \pm 9.9^{a}$ | $3.3 \pm 4.7^{a}$ | $10.7 \pm 3.4^{a}$ | $10.7 \pm 7.3^{a}$ |

[1] Values are means ± SD for 5 dogs.

[a,b] Values followed by different letters are significantly different ($P < 0.004$, except potassium $P < 0.04$).

from diet ingestion to feces excretion was not affected by cellulose or corn fiber but was shortened by pectin. Results of this study confirm previous reports that showed that dietary fiber has a significant effect on fecal weight, fecal dry matter, fecal moisture and fecal water output (Burrows et al. 1982, Fahey et al. 1990a, Fahey et al. 1990b). The lower dry matter digestibility observed in healthy dogs eating these fiber diets rather than a starch control diet is similar to that reported in previous studies (Burrows et al. 1982, Fahey et al. 1990a, Fahey et al. 1990b). The decreased sodium digestibility with pectin has been observed by other researchers (Mercurio and Behm 1981) and is attributed to greater cation-exchange occurring with the soluble fiber component of pectin.

There are methodological problems with short-term balance techniques that often result in large standard deviations. The negative digestibility coefficients noted in our studies are not significantly different from 0, thus indicating mineral balance. This is not unusual in a healthy adult animal. A longer adaptation and study period may have resulted in smaller standard error and more accurate digestibilities.

In conclusion, the results of this study suggest that finely ground cellulose, corn fiber or pectin can be used in commercial pet foods without adversely affecting nutrient digestibility or gastrointestinal function. Pectin at the levels used in this study decreased energy and sodium digestibility and shortened the minimum ingestion to excretion time.

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