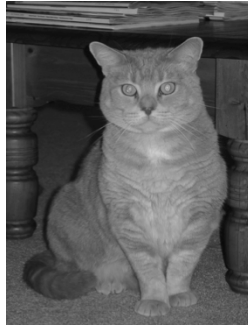


Dietary Fiber - What is it and how do we use it?



Lecture Outline

- **What is dietary fiber?**
- **What does dietary fiber do?**
- **How is dietary fiber used in the management of disease?**
- **How do we compare and categorize dietary fiber?**
- **Why does understanding how fiber is reported matter?**

What is fiber?



- **Fiber**
 - **Non-starch polysaccharides**
 - **Varied group of compounds not digestible by mammalian enzymes**
 - **Cellulose, waxes, gums, pectins, chitin, inulin, phytates, resistant starch**
 - **Not considered nutritionally essential in dogs and cats**
 - **Categorized based on solubility and/or fermentability**

Fiber

- **Soluble Fiber**
 - **high water holding capacity**
 - **delays gastric emptying**
 - **slows nutrient absorption**
 - **highly fermentable**



Fiber

- **Soluble Fiber**
 - Pectins
 - Gums
 - Oligosaccharides



Fiber

- **Insoluble fiber**
 - less water holding capacity
 - decrease gi transit time
 - less fermentable



Fiber

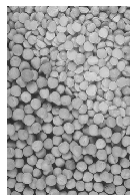
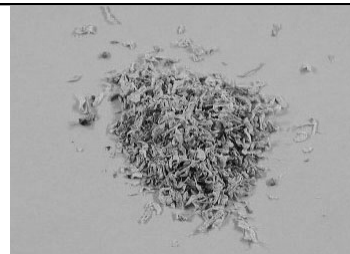
- **Insoluble fiber**

- Cellulose
- Oat Fiber
- Peanut Hulls



Fiber

- **Mixed fiber**
- **Provides characteristics of both soluble and insoluble fiber**
 - Beet pulp
 - Soybean hulls/soy fiber
 - Pea fiber



What does fiber do?

- **Assist with satiety and helps to decrease the energy density of food**
- **Modifies stool quality and consistency**
- **Modulation of gastric emptying and gastrointestinal transit**
- **Modulation of nutrient absorption**
- **Fermentation of fiber produces short chain fatty acids**

What conditions might respond to dietary fiber?

- **Obesity**
- **Gastrointestinal Disease**
- **Diabetes Mellitus**



How is dietary fiber used to manage obesity?

- Integrated into the dietary matrix to reduce the caloric density of a food
- Secondary increase in volume of food fed may assist with owner and pet perception of energy restriction and compliance
- May assist with satiety
 - Gastric distention (direct & via water absorption)
 - Slowing glucose absorption and gastrointestinal transit time
 - Delaying gastric emptying

What does other research say on the use of fiber to manage obesity in dogs?

- Dogs fed restricted amounts of high vs. low fiber diets had the same degree of weight change despite no apparent impact on satiety (Butterwick & Markwell 1997)
- Dogs fed without restriction showed reductions in voluntary intake with high fiber diet (Jewell & Toll 1999; Jackson et al. 1997)

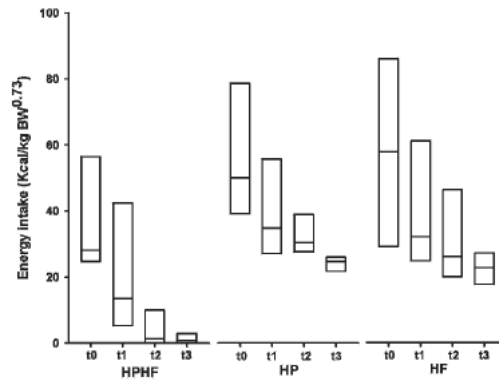


Figure 1. Box plot of sequential energy intake on 3 diets (high protein high fiber [HPHF], high protein [HP], and high fiber [HF]) during 4 meals, each of 15-minute duration, offered at hourly intervals (t = 0, t = 1, t = 2, and t = 3). The boxes depict median (horizontal line) and interquartile range (top and bottom of box). Energy intake decreased over the 4 meals for all diets, ($P < .05$), with the HPHF diet having the greatest proportional decrease.

Weber et al. JVIM 2007

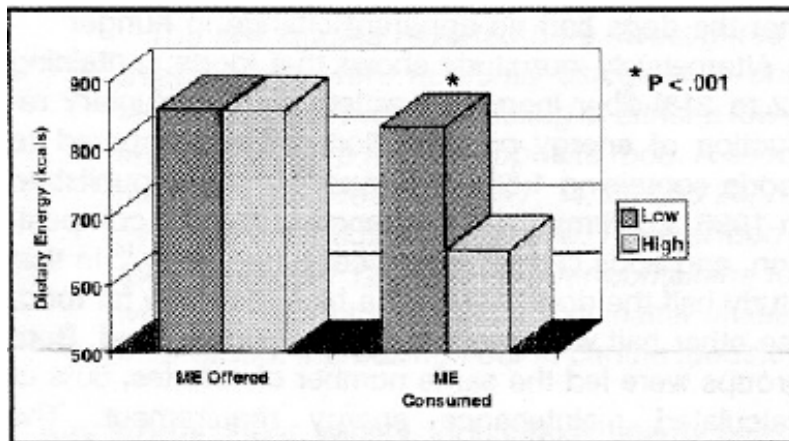


FIG. 4 — Study 2: The effect of foods containing 1.5% or 21% fiber on daily energy intake. Dogs eating the low fiber food consumed significantly more metabolizable energy (ME) ($p < 0.001$).

Jewell et al. Vet Clin Nutr 1996

What does other studies report on fiber use to manage obesity in cats?

- Cats fed high fiber diets reduce energy intake whether energy restricted or not (Hand 1988)
- Cats fed 24% cellulose (DM) had a reduction in food intake (Prola et al. 2006)
 - Significant water dilution of fiber may have created volume limitations in the cats in this study, thus explaining the reduced intake
- Cats fed 10 & 20% sugar cane fiber and 20% cellulose (all AF) increased food intake to meet energy needs (Loureiro et al. 2016)

TABLE 2

Dry matter and energy intake (mean of 4 d) in relation to cellulose level in the diet (Experiment 1)¹

Cellulose added	Dry matter intake	Energy intake	Energy intake
	<i>g/kg body weight</i>	<i>MJ ME/kg body weight</i>	<i>% maintenance requirements</i>
Control/ 0%	15.5 ± 3.4	0.265 ± 0.053	101.2 ± 18.6
2%	14.6 ± 5.4	0.234 ± 0.073	88.9 ± 27.7
4%	16.9 ± 4.6	0.245 ± 0.075	92.5 ± 25.2
6%	16.5 ± 5.1	0.192 ± 0.062*	73.5 ± 23.4*

¹ Values are means ± SD, n = 6. *Different from control, *P* < 0.05.

Prola et al. 2006

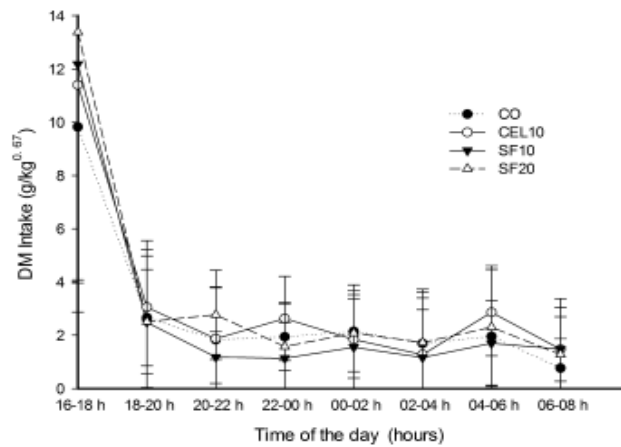


Fig. 1 Pattern of food intake of experimental diets for cats with different insoluble fiber sources. Mean intake of each 2-h interval recorded. CO, control without fiber supplementation; SF10, with 10% sugar cane fiber addition; SF20, with 20% sugar cane fiber addition; CEL10, with 10% cellulose addition. Mean of the observations of days 21 and 37 ($n = 8$ cats per diet).

Loureiro et al. 2016

How is dietary fiber used to manage diabetes mellitus?

- Integrated into the dietary matrix to reduce the caloric density of a food
- May assist with satiety
 - Gastric distention (direct & via water absorption)
 - Slowing glucose absorption and gastrointestinal transit time
 - Delaying gastric emptying

Nelson et al. AJVR 1991

- Experimentally induced diabetes in dogs
- Dogs w/ induced DM fed high insoluble (cellulose; 70 g TDF/Mcal), high soluble (pectin; 55 g TDF/Mcal), or low fiber (24 g TDF/Mcal) experimental diets
- High fiber diets resulted in lower blood glucose

Nelson et al. AJVR 1991

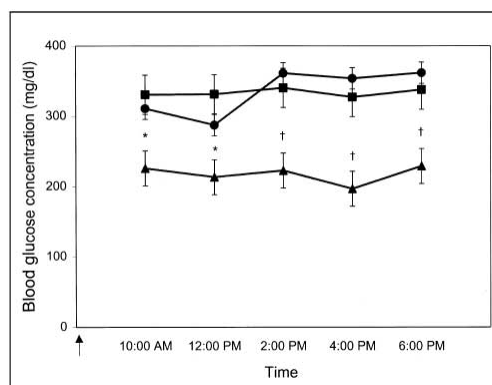
- Significant reductions in 24 hr blood glucose fluctuations compared to control
- Dogs consuming high fiber diets consumed fewer calories than control dogs
- Was better glycemic control secondary to fiber, reduced calorie intake or both?

Effects of insoluble and soluble dietary fiber on glycemic control in dogs with naturally occurring insulin-dependent diabetes mellitus

J Am Vet Med Assoc 2000;216:1076-1081

Susan E. Kimmel, DVM; Kathryn E. Michel, DVM, MS, DACVN; Rebecka S. Hess, DVM, DACVIM; Cynthia R. Ward, VMD, PhD, DACVIM

- **Effects of insoluble and soluble fiber in 7 dogs with IDDM**
- **Cross-over design, 3 dry diets, similar caloric composition, fed for 1 month**
- **HIF (5%, AF); HSF (5%, AF); LF (2%, AF)**
Dogs consuming high amounts of insoluble fiber had better glycemic control
- **Dogs experienced diarrhea on high soluble fiber**



▲ = High insoluble fiber

■ = High soluble fiber

● = Low fiber

Effects of insoluble and soluble dietary fiber on glycemic control in dogs with naturally occurring insulin-dependent diabetes mellitus

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Susan E. Kimmel, DVM; Kathryn E. Michel, DVM, MS, DACVN; Rebecka S. Hess, DVM, DACVIM; Cynthia R. Ward, VMD, PhD, DACVIM

•Differences in diets with respect to CHO source

- Rice and corn in the low fiber and high, soluble fiber diets
- High insoluble fiber diet contained only corn
- In healthy Beagles, rice induced a significantly higher postprandial glucose response compared to corn

What about other studies on dietary fiber use to manage diabetes mellitus?

- Graham et al. 94
 - Dogs fed high in insoluble fiber (14 g TDF/Mcal) had reduced post meal variation in blood glucose vs baseline
 - No difference in glucose AUC or mean increase overall
- Fleeman et al. 09
 - Diets with 18-20 g TDF/Mcal had no advantage vs. diet with 14 g TDF/Mcal (all mostly insoluble)

Are high protein, high fiber or low carbohydrate diets useful for treating diabetes mellitus in cats?

- **Limited research data available**
- **Carbohydrate level not the only dietary factor influencing DM**
- **Which factor is the most important for any given patient?**
- **Effects of dietary fiber, protein, digestibility, etc.**



Dietary intervention studies

- **Of the interventional studies, only three compared two or more diets**



Summary: Controlled interventional dietary studies

- All three reported remission or improvement for cats in both dietary groups
- Nelson et al. 2000 reported higher rates in the high fiber diet group
- Bennett et al. 2006 reported higher rates in the lower fiber & CHO, higher fat diet group
- Hall et al. 2009 reported no difference in rates between groups fed low CHO vs. maintenance diets

What dietary component is to blame or credit for change or lack of change?

- Comparison studies have used commercial diets that differ in many respects
 - Protein type and level
 - Fat type and level
 - Carbohydrate type and level
 - 'low' not consistently defined
 - Fiber type and level
 - Digestibility



Role of adiposity and dietary fat

- **Overall, higher remission rates appear more likely in obese cats that lose body fat, regardless of diet**
- **Obesity**
 - **insulin resistance**
 - **abnormal glucose tolerance**
 - **abnormal lipid metabolism**



How is dietary fiber useful in managing gastrointestinal disease?

- **Little research data, mostly clinical use**
- **Trial and error (amount and type)**
- **Useful for both diarrhea and constipation**
 - **Maintenance of normal stool quality**
 - **Effects on motility**
 - **Water absorption/adsorption**
 - **Microbiota effect**
- **Fermentable fiber (typically oligosaccharides)**
 - **Prebiotic effect: selective fermentation by GI bacteria produces short-chain fatty acids (SCFAs) which are food source for enterocytes**

How do we categorize and measure dietary fiber?

- Diets vary in the amount and type of fiber they provide
- No standardized test
- Crude fiber (CF)
 - Used almost exclusively for pet food
- Total dietary fiber (TDF)
 - Used in human food

Guaranteed Analysis:

Crude Protein (min)	13%
Crude Fat (min)	6%
Crude Fiber (max)	0.5%
Moisture (max)	77%
Ash (max)	2%

How do we categorize and measure dietary fiber?

- Crude fiber (CF)
 - Refers to the laboratory method used to measure
 - Represents only part of the insoluble fraction and NONE of the soluble fiber
 - Cellulose, lignin and some hemicellulose
- Total dietary fiber (TDF)
 - Represents the insoluble and most soluble fiber

Evaluation of fiber concentration in dry and canned commercial diets formulated for adult maintenance or all life stages of dogs by use of crude fiber and total dietary fiber methods

JAVMA, Vol 242, No. 7, April 1, 2013

Amy K. Farcas, DVM, DACVN; Jennifer A. Larsen, DVM, PhD, DACVN; Andrea J. Fascetti, VMD, PhD, DACVN, DACVIM

- **Study Design:**
- **20 canned and 20 dry dog foods formulated for maintenance or all life stages.**
- **Parameters measured:**
- **CF and TDF (without oligosaccharides)**
- **Label information reviewed and compared**

Evaluation of fiber concentration in dry and canned commercial diets formulated for adult maintenance or all life stages of dogs by use of crude fiber and total dietary fiber methods

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Amy K. Farcas, DVM, DACVN; Jennifer A. Larsen, DVM, PhD, DACVN; Andrea J. Fascetti, VMD, PhD, DACVN, DACVIM

- **Measured CF < measured TDF for all diets ($p < 0.001$)**

	Median TDF	Median CF
Dry diets	10.3% DM	2.9% DM
Canned diets	6.5% DM	1.1% DM

- **For dry diets, CF captured ~28% of the TDF**
- **For canned diets, CF captured ~17% of the TDF**

Evaluation of fiber concentration in dry and canned commercial diets formulated for adult maintenance or all life stages of dogs by use of crude fiber and total dietary fiber methods

JAVMA, Vol 242, No. 7, April 1, 2013

Amy K. Farcas, DVM, DACVN; Jennifer A. Larsen, DVM, PhD, DACVN; Andrea J. Fascetti, VMD, PhD, DACVN, DACVIM

- **Over 6 fold difference in TDF and over 31 fold difference in CF among diets**
- **Energy density was not well correlated with TDF for either dry or canned diets ($r^2 \leq 0.4$).**

What is the relevance of this study?

- **CF did not reflect TDF content and is likely not a reliable indicator of effects on intestinal health, fecal quality, satiety, etc.**
- **Wide variability in crude fiber content of diets and lack of information for proportions of insoluble and soluble types means this cannot be used for comparisons among diets**

Total dietary fiber composition of diets used for management of obesity and diabetes mellitus in cats

JAVMA, Vol 245, No. 1, July 1, 2014

Tammy J. Owens, DVM; Jennifer A. Larsen, DVM, PhD; Amy K. Farcas, DVM, MS; Richard W. Nelson, DVM; Philip H. Kass, DVM, MPVM, PhD; Andrea J. Fascetti, VMD, PhD

Evaluation of total dietary fiber concentration and composition of commercial diets used for management of diabetes mellitus, obesity, and dietary fat-responsive disease in dogs

JAVMA, Vol 247, No. 5, September 1, 2015

Amy K. Farcas, DVM, MS; Jennifer A. Larsen, DVM, PhD; Tammy J. Owens, DVM; Richard W. Nelson, DVM; Philip H. Kass, DVM, MPVM, PhD; Andrea J. Fascetti, VMD, PhD

What is the relevance of the 3 studies combined?

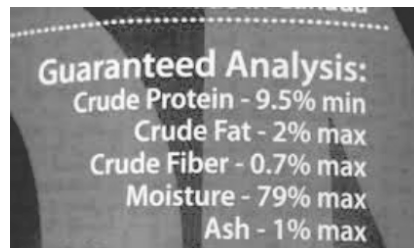
- **Together, these findings reinforce that there are marked differences among diets, and even between different versions of the same diet**
 - **Considerations for clinical trial planning and when making recommendations for individual animals**
- **More complete information for diets would also enable more accurate estimates of energy and of carbohydrate content**

What is the impact of fiber when we compare diets?

- **How does inaccurate information about fiber content affect estimates of energy and carbohydrate?**
- **Dry matter**
 - **Controls for moisture content only**
- **Calorie basis**
 - **Controls for moisture, fiber, and ash (components that don't provide energy)**

What is the impact of fiber when we compare diets?

- **Guaranteed analysis used to calculate energy coming from protein, fat and CHO**
- **Because label provides minimums and maximums, there are assumptions being made with respect to nutrient content**



What is the impact of fiber when we compare diets?

- **Carbohydrate content is determined by mathematical difference – not laboratory analysis!**
- **As a result – all errors in assumptions show up in the determination of carbohydrate content**
 - **Laboratory analysis**
 - **Rounding**
 - **Assumptions described previously**

What is the outcome of these assumptions?

- **This results in:**
 - **Overestimation of carbohydrate content**
 - **Overestimation of energy content of a diet**

Calculation Example

GUARANTEED ANALYSIS

CRUDE PROTEIN MIN8.0%
CRUDE FIBER MAX3.0%
CRUDE FAT MIN 3.0%
MOISTURE MAX76.0%

- $100 - (8+3+3+76) = 10$
- This 10% represents ash and carb
- Estimate ash or ask manufacturer: 3% in this case
- Difference is 7, so diet is 7% carb as fed

Calculation Example

	grams per 100 g food		kcal per gram		total kcal per 100 g food
--	-------------------------	--	------------------	--	------------------------------

Protein	8	x	3.5	=	28
Fat	3	x	8.5	=	25.5
Carb	7	x	3.5	=	<u>24.5</u>
					78

78 kcal per 100 g food

GUARANTEED ANALYSIS

CRUDE PROTEIN MIN8.0%
CRUDE FIBER MAX3.0%
CRUDE FAT MIN 3.0%
MOISTURE MAX76.0%

So I am overestimating the energy density and the contribution from CHO – does it matter?

- **Impact in our study of feline diets**
 - Low carbohydrate diets often recommended for feline diabetics
- **Using CF instead of TDF overestimated carb by up to 93% (median 21% higher when using CF)**
- **Results in inaccurate categorizations of diets based on carb content**
- **Many appropriate options may be unnecessarily omitted**

Can I give too much fiber?

- **Unintended calorie dilution/weight loss**
- **Increase in stool volume**
- **Decrease the the digestibility of a diet**
- **Diarrhea**
- **Flatulence**
- **Constipation**



Summary

- **Benefits**
 - **Obesity**
 - **Diabetes Mellitus**
 - **Gastrointestinal Disease**
- **Crude fiber**
 - **Most commonly reported form of fiber in pet foods**
 - **Does not reflect total dietary fiber content**
 - **Using crude fiber to determine CHO content and energy density will often lead to an overestimation**

Questions?

