DIETARY FIBRE IN DOGS AND CATS – ITS THERAPEUTIC IMPORTANCE

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Marge Chandler looks at the many types of dietary fibre and how it can be used in a number of disorders, including diabetes mellitus and diarrhoea

IN the years after the Second World War, surgeon Denis Burkitt and physician Hugh Trowell noted the people of Uganda, who ate a diet high in vegetable fibre, had different diseases and increased faecal bulk compared to the population of Britain, who were eating a lower fibre diet.

Burkitt and Trowell developed the "fibre hypothesis", which suggested eating highfibre foods helped protect against many diseases, including colonic cancer, constipation, diabetes mellitus, heart disease and obesity.

Fibre is a carbohydrate macronutrient with diverse and sometimes confusing definitions. Fibre differs from starches and sugars in that it resists enzymatic digestion in the mammalian small intestine. Fibre sources include cellulose, hemicellulose, pectins, gums, and lignin. Resistant starches are sometimes classified with fibre, as they are resistant to digestion in the small intestine.

Cellulose forms the structure on plant cell walls. Hemicelluloses contain sugars such as glucose or galactose and are closely associated with cellulose in the cell walls. Pectins are found in many fruits and vegetables, such as apples and potatoes. Gums are a diverse group of viscous, sticky polysaccharides in seeds and plant exudates. They are often used as thickening agents, water binders, gelling agents and stabilising agents in human and pet foods.

Lignin is chemically not a carbohydrate, but is classified with fibre, as it is part of the plant cell wall. It is not digestible by either mammalian or bacterial enzymes. Resistant starches include a variety of different types. Some are formed when starchy foods (for example, potatoes) are cooked and then chilled, some are starches that occur in a form inaccessible to digestive enzymes (for example, encased in a hard hull), some are granular (green potatoes, some types of corn), and there are those chemically modified to resist digestion.

Crude fibre, the term used on petfood labels, is largely cellulose and pectin, and omits many soluble fibres. Dietary fibre includes most all plant polysaccharides (and lignin) resistant to hydrolysis by mammalian digestive enzymes, and is a more encompassing term, which includes more of the soluble or gel-forming polysaccharides. Different fibre sources vary in fermentability, solubility, effects on gastrointestinal (GI) transit, water-holding capacity, viscosity, free radical scavenging and cationic exchange properties ([Figures 1] and [2]; [Table 1]). Because of the differences in these properties, fibre should not be considered a single entity.

Different fibres are fermented to varying degrees by microbes in the colon. Rapidly fermentable fibres, such as pectins and most gums, produce more short-chain fatty acids (SCFAs) and gases than those that ferment, such as cellulose and hemicelluloses. Most rapidly or highly fermentable fibres are considered to be “soluble”, meaning they will disperse in water.

Conversely, less fermentable fibres, such as cellulose, are usually relatively “insoluble” ([Table 1]). Fibres are, therefore, often categorised as soluble versus insoluble.

Insoluble fibres generally have more of a “bulking” effect on stools, especially if they have good water holding capacity. Soluble fibres are more likely to increase GI transit time (that is, ingesta moves more slowly through the GI tract).

The more viscous a fibre, the more it will slow nutrient absorption, a feature that can be used beneficially in diabetes mellitus, but also can be detrimental in some cases. Insoluble fibre usually comes from the grains in the diet or added as cellulose. Many dietary fibre sources are “mixed” fibres with mostly soluble fibre characteristics – for example, psyllium is a mixed fibre with excellent water-holding capacity ([Figure 1]).

Some fibres are termed prebiotics, which “feed” beneficial bacteria. One of these often added to pet foods is fructooligosaccharids (FOS). Like other fermentable fibres, FOS are complex carbohydrates that are fermented by colonic microbes to produce SCFAs. Adding FOS to the diet seems to increase the normal colonic beneficial flora, and FOS have been helpful in treating secretory diarrhoea in pigs and humans.

One study found FOS had no effect on bacterial numbers or species in the duodenum, but did alter the faecal microbiota in healthy cats by increasing lactobacilla and *Bacterioides* species and decreasing *Escherichia coli* and *Clostridia* species.

Disorders in dogs and cats in which dietary fibre has shown to be therapeutically important include obesity, large intestinal diarrhoea, constipation and diabetes mellitus.

Fibre, satiety and obesity

Dietary fibre has been reported to reduce hunger and decrease food intake. Increased satiety with increased dietary fibre is at least partially attributed to delayed gastric emptying and subsequent feeling of fullness. In humans, the more viscous fibres are reported to aid satiety, while in pets it has been stated that less fermentable fibres, such as cellulose, may improve the sensation of fullness by increasing bulk in the stomach and intestines. Mixed fibres can also promote gastric distension, delayed gastric emptying time and a longer ileal transit time.

Gastric distension stimulates release of cholecystokinin (a satiety hormone that decreases hunger). The SCFA produced by fermentation of fibre may also act in the production and secretion of GI satiety hormones. Infusion of SCFAs into rats' colons increased peripheral peptide tyrosine-tyrosine (PYY) concentration. PYY acts on the arcuate nucleus of the hypothalamus to stimulate satiety and decrease food intake, similar to the action of dirlotapide. In one study, inclusion of fermentable fibre in canine diets increased the production of glucagon-like peptide-1 (GLP-1), a hormone that also slows gastric emptying and prolongs intestinal transit time. Fermentable fibre has also been found in rats to decrease plasma ghrelin, a hormone that stimulates appetite. Despite these theoretical functions, a paper looking at the effects of highly fermentable fibre (sugar beet pulp combined with inulin) versus a fibre of low fermentability (cellulose) did not show any treatment effects for PYY, GLP-1 or ghrelin.

In humans, consuming fibre as part of a weight-reducing diet assists in weight loss, and dietary fibre intake is associated with a lower incidence of obesity and a lower body mass index. Fibre has fewer calories per gram than other nutrients, ranging from 0kcal/g to 2kcal/g compared to protein and carbohydrates, which have 3.5kcal/g and fat at 8.5kcal/g. Increasing the fibre content of the food results in "calorie dilution" (the calories/100g of diet are decreased).

Increased fibre in the diets of dogs and cats has a role in weight loss and obesity prevention ([Figure 3]). An epidemiological study of obesity in dogs showed crude fibre was positively associated with protein intake and negatively associated with body fat, regardless of the dogs' weight. Lean dogs received significantly more crude fibre than overweight dogs. Another study showed that combining high fibre (mixed cellulose, beet pulp, FOS, psyllium husk and cereals) and high protein in a weight loss programme for dogs was more successful in reducing food intake at three hours post-feeding than either diets with high fibre or high protein alone. Another canine study looking at a high-protein, high-fibre diet for weight loss showed the percentage and rate of weight loss and the percentage of fat loss were greater compared to feeding a highprotein, medium-fibre diet.

In cats on a weight loss programme, those on a higher fibre diet (5g/100kcal, fibre type not noted) versus a lower fibre (0.6g/100kcal) and lower carbohydrate diet were less likely to pace or beg at the feeding bowl, and less likely to forage or steal food.

Owners of the cats on the high-fibre diet were more satisfied with their cats' weight loss programmes than those with cats on the low-fibre diet. Another study showed reduced calorie intake in cats on a diet with increased cellulose, but it was unclear whether this was due to satiety or poor palatability.

Effects of fibre on the intestine

While the focus of the effects of fibre are on the large intestine, some types of fibre may increase the number of goblet cells and mucus in the small intestine; some gel-forming fibres slow gastric emptying and small intestinal transit time; and some insoluble fibres hasten gastric emptying and small intestinal transit time. In some dogs a "normalisation" of GI transit time occurs on a cellulose containing diet, in that slow transit times become faster and rapid transit is slowed.

When fibre is fermented by colonic bacteria, SCFAs are formed. The SCFAs, especially butyrate, provide more than 70 per cent of the energy for colonocytes, which is important for cell renewal and repair. Butyrate also appears to directly inhibit tumour formation in the large intestine.

Increased SCFAs increase colonic absorption of sodium, chloride and water, which may improve some types of diarrhoea. Increased SCFA also increases colonic ammonia absorption by decreasing the pH and trapping the ammonium ions (ionised particles are less able to cross cell membranes). The decreased pH also discourages the growth of some pathogenic bacteria, such as *Clostridium perfringens*, *Salmonella* and pathogenic *Escherichia coli*. A study has shown the faecal microbiota of dogs with chronic diarrhoea became more similar to that of normal dogs after the addition of a fibre blend containing banana flakes, rice bran and a yeast product.

Insoluble fibres dilute colonic content by their bulking activity, adsorb colonic bile acids and other mucosal irritants, and often improve faecal consistency. In humans, there is also a role for increased dietary fibre in irritable bowel syndrome (IBS), and it may help in some dogs with clinical signs consistent with IBS.

A study in dogs with chronic idiopathic large intestinal diarrhoea showed a good to excellent response to the addition of psyllium in 96 per cent of the dogs. However, some authors recommend first trying a novel protein or hydrolysed protein diet, and then adding a fibre source if the response is inadequate. The type of fibre to choose varies among animals and the initial choice is empiric. A source of mixed soluble and/or fermentable (such as psyllium or some vegetable fibres) and less soluble fibre (for example, cellulose) may be beneficial in many cases. The crude fibre information on the label is misleading, as it does not include all fibre sources. Where provided, the total dietary fibre is more useful.

The response of constipation to fibre is variable and can depend on the underlying cause.

Increased non-soluble, less fermentable fibres increase faecal bulk, which may stimulate colonic and rectal contractions and increase frequency of defecation, but may worsen constipation in an animal with colonic dysmotility.

Fibre producing viscous gels, such as psyllium, will increase the faecal water and faecal bulk, and the SCFA produced may stimulate colonic smooth muscle contractions. However, some individuals produce methane from fermentation, which may slow contractions.

In two studies in cats with constipation, 82 per cent to 93 per cent showed improvement on a psyllium-enriched diet. Many of the cats required less or no cisapride and lactulose. However, diets with increased fibre should not be used in cats with severe obstipation.

Interestingly, in cat studies the addition of pectin has been shown to have some protection against formation of small intestinal ulcers induced by the NSAIDs indometacin or flunixin. Conversely, addition of cellulose increased the intestinal lesions induced by indometacin.

Fibre and diabetes mellitus

• Dogs

While dogs nearly always have type-1 diabetes mellitus and require insulin injections, glycaemic control can sometimes be improved with weight loss and/or increased dietary fibre.

Increased fibre may help glycaemic control by slowing gastric emptying, slowing carbohydrate absorption from the intestinal tract and improved glycaemic control. Several studies have indicated high fibre diets (often insoluble fibre), improve glycaemic control compared to low fibre diets. One study comparing high fibre to moderate fibre diets showed no significant improvement with the higher amounts of fibre. Fibre sources used were a blend of soluble (guar and pea fibre) and insoluble fibre (arbocell fibre).

As dogs on the higher fibre diets lost weight compared to the more moderate fibre diets, the choice of diet may reflect whether the dog's weight should be decreased or not. Thin diabetic dogs should usually not be fed a high-fibre diet.

• Cats

Diet and pharmacological management of type-2 diabetes results in remission (the resolution of the requirement for insulin) for up to 50 per cent to 70 per cent of diabetic cats. Remission is aided by weight loss in overweight cats and control of blood glucose concentrations with insulin to eliminate glucose toxicity.

Two types of food are recommended for diabetic cats – high fibre/high complex carbohydrate or high protein/low carbohydrate. Diabetic cats on either type of diet have shown improvement.

As in dogs, the recommendation for increased dietary fibre content is due to the effects (depending on the type of fibre) of slowing gastric emptying, slowing small intestinal carbohydrate absorption, altering GI transit times, and improving insulin sensitivity.

Cats regulate food intake by volume, and foods high in insoluble fibre reduce calorie intake and may, therefore, aid in weight control or weight loss. As with dogs, the use of increased fibre in normal weight or thin cats should be avoided or used cautiously. Recommendations for dietary management now often include the use of the high-protein, low-carbohydrate diets, which have shown very good evidence for improved control and good rates of remission.

Side effects of fibre

While fibre is beneficial in many conditions, there are potential side effects. As it is low in calories, a high-fibre diet can result in unintentional weight loss.

Other potential side effects may include decreased absorption of nutrients, poor palatability, flatulence and increased faecal volume.

Summary

There are many types of dietary fibre, with differing attributes. Often they are loosely categorised as soluble or insoluble, which may reflect the fermentability, gel-forming tendencies or other characteristics. The crude fibre listed on labels does not reflect the total dietary fibre, as it omits many of the more soluble fibre types.

Disorders that may benefit from increased fibre in the diet include obesity treatment or prevention, some types of diarrhoea and constipation, and some animals with diabetes mellitus. Therapy for each animal must be considered on an individual basis, and some cases may require trial and error with different fibre types.

• Please note not all medications listed may be licensed for use in cats and dogs.

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