BREAKING IT DOWN – MEASURING FOOD QUALITY AND DIGESTIBILITY

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Categories : Vets

Date : February 28, 2011

Tim Watson examines the significance of dog food digestibility, looking at nutritional value and the differences between wet and dry pet foods

Summary

Digestibility, which describes the relative amount of nutrients that are available to the body following digestion, is often cited as a measure of a pet food's quality. The digestibility of dry matter in dog foods should be more than 80 per cent and values for energy, protein, fat and carbohydrate between 80 and 90 per cent. Digestibility is largely determined by the source and quality of ingredients, as well as processing and amount fed. Meat, eggs and dairy products are highly digestible, whereas cereal grains are more poorly digestible unless cooked and extruded.

Excessive dietary fibre can substantially suppress digestibility and increase faecal bulk and frequency of defecation. Wet and dry commercial dog foods, despite contrasting ingredient and nutrient profiles, do not differ in their digestibility and are associated with similar faecal volume and appearance. Nutrient digestibility is unaffected by breed size, but is lower in young puppies, reaching adult values around six months of age, and also tends to drop off in old age. Products with low digestibility can cause increased faecal quantity with loose consistency, whereas foods with exceptionally high digestibility result in small amounts of dry faeces with risk of constipation and straining. Any changes in faecal characteristics when foods of optimal digestibility are fed are related to other effects on gastrointestinal function.

Key words

dog, diet, digestibility, faeces, pet food

THE term digestibility is often used as the measure of a pet food's quality, with manufacturers citing high digestibility as a key attribute.

This has been underpinned by substantial research into how digestibility is affected by dietary and animal-related factors, leading to significant improvements in the nutritional value and feeding performance of pet foods.

For the majority of owners, however, it is what comes out of their dog's rear end that determines how they view the quality of the dog food. Despite the considerable advances in health and longevity that are afforded by the science of pet nutrition, many owners consider the "rear end performance" of a pet food as important as its price or veterinary credentials. (Figure 1.)

The significance of pet food digestibility, particularly in relation to nutritional value and stool characteristics, and its influences are examined in this article. The sometimes-held belief that there are differences in digestibility between wet and dry dog foods is also reviewed.

What does the term "digestibility" mean?

Digestibility describes the relative amount of nutrients within a food that become available to the body following the processes of digestion and absorption. The digestibility of pet foods is determined in feeding studies and, for a specific nutrient, is calculated from the daily amount consumed minus the amount excreted in faeces. This figure is divided by the total consumed to give a coefficient or percentage.

Digestibility values are typically reported for dry matter, organic matter, protein, fat and energy. For dry pet foods, the digestibility of carbohydrate – sometimes referred to as nitrogen-free extract – may also be recorded.

The design of pet food digestibility trials is described by expert bodies such as the Association of American Feed Control Officials (AAFCO). They typically involve a five-day period during which a minimum of eight dogs are acclimatised to the diet being tested, followed by five days where food intake is monitored and all faeces collected for analysis. The European Pet Food Industry Federation (FEDIAF) also bases its guidelines on this approach.

Results should strictly be termed as "apparent digestibility" because the measurement protocols do not take into account absorbed nutrients that are subsequently returned to the gut. Digestive enzymes and secretions, sloughed epithelial cells, and bacteria are present in faeces and their nutrient content contributes to the amount calculated as undigested. Protein is perhaps the nutrient

most influenced in this respect, with non-dietary sources, particularly those arising from microbial nitrogen metabolism, increasing faecal nitrogen content and hence reducing apparent digestibility of protein consumed.

Sources of error inherent in these apparent values are accepted because eliminating them would involve studies to measure baseline faecal output, when dogs are either fasted or fed a diet devoid of the nutrient in question. Alternatively, true small intestinal digestion can be quantified using dogs with surgically constructed ileal cannulae. These options are not only questionable for ethical reasons, but are impractical and assume, with no certainty, that endogenous metabolism remains unaltered in the face of food withdrawal, nutrient deficiency or surgical modification.

How digestible are dog foods?

Popular brands of dog food have average digestibility percentages for protein, fat and carbohydrate of 81 per cent, 85 per cent and 79 per cent respectively.[1] Although nutrient digestibility may be higher in premium brands and lower in economy products, the majority of dog foods from reputable manufacturers will deliver apparent digestibility values within a range of 80 per cent to 90 per cent.

Pet food regulatory bodies, notably AAFCO in the United States and FEDIAF in Europe, do not specify minima and maxima for digestibility values, but they do regulate how data is used on pack labels and in advertising materials. They also base the minimum nutrient requirements on an assumed digestibility of at least 70 per cent for dry matter and 80 per cent for protein. Canine nutritionists generally accept that an appropriate minimum target for digestibility is 80 per cent, with ideal values for nutrients of between 80 and 90 per cent.

The biggest single determinant of a pet food’s digestibility is its ingredients and, specifically, their source and quantity. Other influences include how the food is processed, any adaptation to a previously fed diet, and the amount fed. Animal factors can also contribute, with breed and age being most relevant in healthy dogs.

The importance of ingredients

The digestibility of raw, unprocessed ingredients commonly used in the manufacture of dog foods can vary from more than 40 per cent to almost 100 per cent. Highly digestible ingredients include egg whites, muscle and organ or offal meats, and dairy products. Cereal grains, such as wheat, corn and oats, are of relatively low digestibility in their unprocessed state, but this is increased by cooking and extruding. Digestibility is improved by processes that reduce the particle size of ingredients, as well as heat and pressure, which modify the chemical structure, notably of starch.

Overcooking or excessive processing of food can have the opposite effect and lead to a deterioration in digestibility of one or more nutrients – such as creating protein complexes that mammalian enzymes cannot break down. There have also been suggestions that the inclusion of

soya bean products, cereal and plant by-products, and certain animal by-products, which are widely used in pet food manufacture, might be detrimental to digestibility. These would appear to be unfounded, with studies showing rendered meat and bone meal, poultry by-product meal and defatted soy flour have organic matter digestibility coefficients similar to fresh beef and fresh poultry (Figure 2).

The digestibility of cereal products, including whole ground wheat, barley and oat meals, sugar beet pulp and other bean and nut meals, is variable, ranging from around 40 per cent to 90 per cent.[2]

The low apparent digestibility of many of these materials is explained by their relatively high fibre content and this has been the source of substantial investigation. Initial studies were conducted using cellulose[3] and have subsequently encompassed a range of fibres, including sugar beet pulp, guar gum, inulin, tomato pomace, soybean hulls, selected corn fibres and other carbohydrate sources.[4-9]

It has consistently been shown that adding dietary fibre reduces the apparent digestibility of dry matter, organic matter, energy and crude protein by between two and 20 per cent (Table 1). The effects are similar in wet and dry diets and are dose-related. The consensus is that added fibre levels up to 7.5 per cent on a dry matter basis are tolerated well by dogs without adverse effects on digestion. Studies do, however, report a consistent linear increase in both the frequency of defecation and the total weight of faeces produced with incremental inclusion of dietary fibre.

What impact does food type have?

Given that wet and dry foods have very different ingredient and macronutrient profiles, it might be expected that differences are found in digestibility between canned, pouched and dry pet foods. Wet dog foods are typically meat-based and are high in protein and fat, and low in carbohydrate. Dry foods, on the other hand, contain much more carbohydrate (about 50 per cent on a dry matter basis) and fibre, but are lower in protein and fat.

Despite these contrasts, particularly in relation to their meat, carbohydrate and dietary fibre contents, the digestibility of wet and dry diets does not differ significantly (Figure 3). Both formats typically deliver apparent digestibility values in the desired range of 80 to 90 per cent. It is only when ingredients, such as fibre, are included at high levels that any substantial decline in apparent digestibility is observed.

The similarity in digestibility of wet and dry dog foods is mirrored by their impact on stool volume and quality. The faecal output for a medium-sized dog when fed solely wet foods is 52 to 78g/100g of dry matter consumed, compared with 44 to 75g/100g dry matter when solely dry food is eaten (Figure 4).

Breed size and nutrient digestibility

There are intriguing differences in digestive anatomy and efficiency between dog breeds. For instance, the gastrointestinal tract accounts for three to four per cent of bodyweight in giant breeds compared with six to seven per cent in small breeds.[10] Potential disparity in digestive capacity has been suggested as the reason why large dog breeds often produce faeces with a higher moisture content and less acceptable appearance than smaller dogs.

Studies into how anatomical variation related to breed size might affect the digestibility of pet foods have provided conflicting data. On the one hand, Meyer et al[11] found no inter-breed differences when comparing digestibility across 10 breeds of dog varying in average weight from 4.2kg to 52.5kg. Conversely, Weber et al[12] showed digestibility was actually significantly higher in great Danes and giant schnauzers when compared with miniature poodles and medium schnauzers.

These studies do indicate that differences in faecal output and stool quality between large and small dog breeds are not related to nutrient digestibility (Figure 5). Instead, it is likely that more rapid transit of material through the alimentary canal,[13] increased intestinal permeability and reduced mineral absorption,[14],[15] and greater fermentative activity[16] explain why faecal characteristics can be less favourable in larger dogs. Products formulated for large breeds take this into account, using carefully selected sources of protein and dietary fibre to help ensure healthy gastrointestinal function and acceptable stool quality.

Impact of age

Nutrient digestibility is lower in young puppies – by as much as five per cent for protein – and increases with age to attain adult values by around six months old.[12],[17] This is believed to reflect maturation of the process involved in digestive enzyme production and secretion, and the mechanisms of nutrient absorption. As an example, pancreatic amylase levels have been shown to remain low in puppies until around 10 months of age. This knowledge is used in puppy foods, which are formulated to be more digestible than those designed for adults and contain increased nutrient levels to compensate for any reduced availability.

There have been concerns that digestive function deteriorates in old age. In the only study to date in dogs, there was no change up to around age 10, but a drop in digestibility at 15 to 17. While the consequences of this for feeding the geriatric dog, as well as its impact on stool quality, remain uncertain, there may be benefits in ensuring foods for senior dogs are also formulated with good digestibility.

How does digestibility relate to stool quality?

It has been estimated that nearly 75 per cent (Figure 6) of owners pay regular attention to the nature

of their dog's stools.[18] While owners tend not to worry if their dog is simply producing more faeces of a firm form, they develop concerns when the stools become loose and, hence, much more difficult to clean up.

In healthy animals, faecal output correlates with the amount of food fed and its overall dry matter digestibility. Low digestibility (less than 70 per cent) results in the transfer of ingredients other than fibre into the large intestine that, in turn, are partially or completely fermented by colonic bacteria. Large amounts of undito gested food may disrupt colonic function, leading to altered motility, water retention, excessive gas production and the increased passage of relatively loose stools.

Feeding foods of a low digestibility also necessitates larger meal sizes and, as the quantity of food consumed increases, its rate of passage through the alimentary tract quickens. This further contributes to poor digestion, greater gas production and an increased output of wet faeces.

Conversely, feeding diets with exceptionally high digestibility can also be problematic. The canine large intestine is well developed and adapted to expect some undigested food components, including low digestible proteins such as cartilaginous materials and plant fibres. Depriving the colon of these substrates may not only influence colonic health, but result in low faecal bulk and reduced frequency of defecation. This can cause dogs to become constipated or strain to pass very dry faecal matter.

Owners are not alone in their fascination with "rear end performance"; there is evidence that more than 70 per cent of veterinarians view faecal firmness as the primary indicator of how well a pet food is digested.[18] This requires clarification since, when diets with acceptable dry matter digestibility in the region of 80 to 90 per cent are fed, it is unlikely any deterioration in stool consistency is related to the food's digestibility. Instead the faecal characteristics are more a reflection of the food's impact on other aspects of gastrointestinal motility, permeability and colonic function.

For this reason, manufacturers pay close attention to the impact of their products on stool quality and incorporate assessments into digestibility and in-home testing protocols. There is usually a target for "optimal" stool quality where they are neither too soft or runny nor too dry and crumbly.

One of the most common causes of poor stool quality is the sudden introduction of a new food. For this reason a transition period of at least five days is usually recommended when switching between diets. This is especially important if a dog has been maintained on a single food long-term; switching to a new diet – even one that has a higher apparent digestibility – requires the gastrointestinal system to adapt to novel ingredients and different nutrient levels.

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