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THE IMPACT OF THE INCLUSION OF GRAINS IN A CANINE DIET ON THE ANIMAL'S
OVERALL HEALTH

An Undergraduate Honors Thesis
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Abstract

The objective of this senior project was to examine the impacts that grains in a canine diet have on the overall health of the animal. Specifically, there was a focus on the nutritional attributes of grains, potential concerns regarding their inclusion in foods, misconceptions from consumers about grains in pet food, and alternatives to grains used in some diet formulations. The method of research for this project was a literature review. Scholarly articles focused on the various subtopics which helped to answer the research question were reviewed and included throughout the following discussion. Ultimately, the review of various literature resulted in the conclusion that grains are a useful source of nutrients in canine diets. They provide sources of macronutrients, namely carbohydrates, proteins, and essential fats, as well as vitamins and minerals. There are many consumer misconceptions that grains cause allergies in pets or are used as fillers in a recipe, but multiple studies by various authors have proven these misconceptions to be partly or entirely false. This is an ongoing field of research and conclusions about the usefulness of grains are ever-changing.

Key Words: grains, animal nutrition, animal health, grain digestibility

Introduction

In recent years, there have been many studies focused on the inclusion of grains, or rather the exclusion thereof, in a companion animal diet. More specifically, the impact of grains in the diet on the species *Canis familiaris* has been of particular focus. This is in part due to the ever-changing findings released about the nature of the food we are feeding our pets. Many pet owners began to get the perception that grains in commercially produced dog foods were unhealthy and causing allergic reactions their pets may have been developing, leading consumers to prefer diets for their animals that are “grain-free”. Alternatively, after the proposed increased incidence of cardiovascular disease in pets fed grain-free foods for an extended period of time, owners began to re-consider their choice of grain-free foods and new studies were released concerning the benefits of grains in a companion animal diet. Due to the back-and-forth nature of this topic, this review aims to present facts concerning the impact of grains on the overall health of dogs.

Background Information

It is important when analyzing nutrition to have a reference for the health of a dog and define the standard of longevity. Many reports have been published concerning the lifespan of dogs, all presenting similar findings with slight variations based on the specific variables included/not included in the statistical calculations. Based on one study performed by Urfer, Kaeberlein, Promislow, and Creevy, they found the median survival time of dogs to be 15.4 years¹. This study was unique in that it also considered dogs who were still known to be alive and included them in calculations, which removed potential underestimation of the lifespan. These researchers determined that there are some variables that are statistically significant in their contribution to variances in lifespan, those being size, presence or lack of sexual organs,

and genetic diversity. In general, small dogs live about two to three years longer than large or giant breed dogs (16.2 years versus 13.4 years) ¹. Dogs who are still intact tend to live about 6 months to a year less than dogs who have been gonadectomized, but this variance was more prevalent in females than males (15 vs 15.2 years in males and 14.1 vs 15.8 years in females) ¹. Additionally, the study found that breeds with less genetic diversity, especially the mountain ancestral group, live a much shorter life ¹. Based on these statistics, it is safe to say that a “long-lived” life by a dog would be one around the median survival time, and it will be important to consider how the diet of a dog contributes to its health and longevity of life.

There is a wide variation in nutrient requirements between dogs based on life stage or overall health but the general categories of nutrients necessary are the same. To get energy, dogs must consume proteins and fats in their daily diet ². Carbohydrates are often a source of supplemental energy, though they are not necessary for survival. There are a few different classifications of carbohydrates based on where they get absorbed or broken down in the body. Absorbable carbohydrates are readily absorbed in the lumen of the small intestines and do not need to be metabolized, digestible carbohydrates enter the intestinal tract but must be metabolized by enzymes prior to their absorption, and fermentable carbohydrates make it all the way through the small intestinal tract before they are broken down by microbes in the large intestine or excreted in the stool ². All of these types of carbohydrates are necessary and valuable in their own way in the diet. They provide a readily available source of glucose that is used for sustainable energy. Protein is necessary in the diet as a source of essential amino acids: those which cannot be synthesized by the body ². Amino acids are the building blocks of all proteins that are essential to body function. Fats are a vital source of energy in the diet and can be important to maintaining qualities such as a healthy coat and immune function ². Beyond

macronutrients, vitamins and minerals are also necessary in the diet, though they are required at much lower concentrations. If these vitamins and minerals are not properly provided, there can be long-term adverse effects ². Grains can be utilized in pet foods to provide nutrients and this review will examine how they fit these nutritional requirements.

It is important to define the term “grain” and the scope of their inclusion in a diet. According to the Grain Foods Foundation, grains are “edible seeds of certain grasses” ³. Grains can include many crops grown throughout the United States and are not limited to corn, wheat, oats, rice, and barley, among others ⁴. Oftentimes, these grains are processed in various ways prior to their inclusion in any sort of food, but they can also be included as a whole grain. To be considered a whole grain within the diet, they must have the entire kernel intact, which includes the bran, germ, and endosperm. They can alternatively be included as refined grains which only consist of the endosperm. Each part of the kernel has unique nutritional attributes. The bran provides a source of fiber along with vitamins and minerals. The germ contains more vitamins, namely vitamin E, along with fats and antioxidants. The endosperm is mainly a source of starch and protein ³. There are advantages and disadvantages to refined grains, as their shelf life is greatly increased but at the cost of the nutritional quality from the bran and germ. In order to make up for the decreased nutritional quality, producers will add vitamins and minerals to the final product to ensure they are enriched with necessary nutrients ⁴.

Nutritional Attributes of Grains

In general, most grains have a similar nutritional composition, only with slight variances in the amount of a particular nutrient present. This review is going to focus on the attributes of corn and sorghum, but it is important to note the greater scope of the discussion of grains and more information should be gathered to gain a collective understanding of the topic.

Corn is one of the most versatile and important crops in the world today. It is utilized for human consumption, animal consumption, and ethanol production, among many other uses. The main nutritional component of corn, and most grains for that matter, is starch. More specifically, amylose and amylopectin are the most prevalent starches in corn ⁵. These compounds can be broken down by enzymes in the body to provide a readily available source of glucose and thus energy to the animal. They are also a vital component of a dry dog food recipe, as they ensure the dough maintains its structure throughout processing ⁵. The method that is used to process the corn prior to its addition to the food contributes significantly to the digestibility of the nutrients thereof. One of the most common forms of corn found in the pet food industry is corn starch which is a co-product of the wet milling process. This product is highly digestible, as about 70% of the nutrients are absorbed in the small intestinal tract prior to entrance into the cecum ⁵. Something that must be monitored when including a highly digestible starch such as corn in a diet is the overall digestibility of the product. For example, the inclusion of too much corn in a feed can lead to the development of diabetes due to the rapid increase in plasma glucose and insulin levels after eating ⁵. As long as the amount of corn and other highly digestible starches included in the diet is regulated, they provide a great source of energy for the dog. Beyond providing energy, corn in the diet can also support immune function by fostering a beneficial microbiota population in the colon, and also has antioxidant qualities, though it is typically not included in large enough quantities in the diet for this quality to contribute to overall health ⁵.

Sorghum is another grain found in pet foods, though it is less popular than corn, wheat, barley, and rice ⁶. Typically, it is included as whole sorghum, but there are studies that have been performed to determine if sorghum fractions from dry milling, namely sorghum flour and sorghum mill feed, would be suitable and beneficial to include in pet food. Ultimately, it was

determined that the fractions could be advantageous in a diet where calories must be limited, but there would need to be other sources of protein supplements in the diet ⁷. Regardless of which form of sorghum is included, the grain provides a number of health benefits to the animal. There is a high amount of antioxidant activity present when sorghum is included in a diet ⁸. This activity prevents chronic diseases that are exacerbated by long-term oxidative stress.

Additionally, this antioxidant activity can have anti-inflammatory benefits and help to prevent the formation of cancerous cells. These latter two benefits are attributed also to the activity of phenolic compounds in the grain, namely gallic acid, ferulic acid, and 3-deoxyanthocyanidins ⁸. Condensed tannins found in the grain help to prevent both diabetes and obesity, as they inhibit digestive enzymes released by the pancreas ⁸. All of these attributes support the longevity of a dog's life and support the notion that grains have benefits in the diet.

Beyond the use of grains as a source of protein and carbohydrates, it has been found that they can be useful as an alternative fiber source in pet foods. The most common sources of fiber found in companion animal diets are products from vegetables such as beet pulp, and other supplemental sources such as microcrystalline cellulose ⁹. These sources vary in their fermentability and viscosity, but both are a source of pectin, cellulose, and hemicellulose. De Godoy, Kerr, and Fahey looked into which grains available could provide an alternative source of fiber in the diet. They found that corn fiber, rice bran, and a balanced source of whole grains can be a source of nutrients similar to those found in typical vegetables. Corn fiber is a product of the wet milling process and is beneficial due to its antioxidant properties and ability to potentially reduce the risk of colon cancer ⁹. Rice bran is a beneficial source of fiber in the diet and can also be beneficial as an antioxidant, anti-inflammatory, or chemo-preventive supplement ⁹. Lastly, whole grains are an important component of a well-balanced diet. Not only are they a

rich fiber source, but they also provide essential vitamins and minerals to the animal ⁹. They can help to prevent many diseases, both chronic and others, such as diabetes and obesity ⁹. Grains as a fiber source also increase satiety in the diet which helps the animal feel full and not over-eat ⁹. These sources of grain can be an incredibly beneficial component of the diet that can contribute to the increased overall health of the animal.

Consumer Misconceptions

As previously mentioned, there were many events that led to the formation of a negative stigma surrounding grains in pet food. There was contamination that occurred in 2007 which involved industrial chemicals in China being added to ingredients to appear as wheat gluten included in commercial dog food and give inaccurate protein-level readings. This contamination induced kidney damage, but rather than the general public having the knowledge that the damage was caused by chemicals, they assumed the issue was associated with any form of wheat in their pet food ¹⁰.

While wheat can be associated with a higher number of allergies in dogs versus most other grains (about 15% of food allergies total) ¹¹, it is not nearly the leading source of food allergies and should not be reason enough to avoid the ingredient overall. Beef and dairy have been found to be the leading cause of food allergies in pets, contributing to about 60% of all allergies ¹². One reason why this misconception regarding allergies has come about is due to the marketing of most commercial pet food products. These diets which are grain-free have been marketed as having “no fillers” or “no by-products” and thus give the perception that they include more natural sources and thus will not cause as many allergies ¹².

Additionally, there have been reports that consumers lean toward diets without grains due to a concern about the quality of grain products included in the food. There seems to be a lack of education about where the grains included in pet food come from and the high nutritional content that products such as corn gluten feed, corn starch, or wheat gluten feed actually possess. These products provide a highly digestible source of all macronutrients which are necessary for a balanced diet ¹⁰. Additionally, the United States Department of Agriculture has a quality control system in place for the inspection of grains prior to their inclusion in both human and pet foods. This system rates the grains on a scale from one to five, one being the best and five the worst, and almost always the only grains sent forward to processing for consumption score in the top two categories ¹¹. Unfortunately, systems such as this for quality control are not the focus of marketing efforts and thus the consumer is not aware of the care and attention that goes into ensuring quality ingredients are included in the food.

Beyond the quality, some consumers believe that grains are present in the diet as fillers and provide no true digestible nutrients, especially with regard to their level of processing prior to inclusion in the diet. A literature review performed by Corsato Alvarenga, Dainton, & Aldrich sought to examine the effect of the processing of corn on apparent total tract digestibility to answer the question regarding variable nutrition attributes from the same ingredient. Their review found that the apparent total tract digestibility of starches in corn did not vary between whole corn versus processed corn starch ⁷. Additionally, they found that the apparent total tract digestibility of dry matter between different sources of grains was relatively equal, which supports the notion that many variable grains can be beneficial, and one is not more of a filler than the other ⁷. Though there are some instances where grains are added into the diet to provide additional calories, their use as a filler does not imply a lack of nutritional benefits. In total, these

misconceptions about grains in the diet have brought about a wave of products that are targeted at individuals wishing to exclude grains from their pet's diet.

Concern for Mycotoxins

When storing grains prior to processing, there is a potential for the product to be contaminated with mycotoxins. If stored improperly, mycotoxins are a secondary result of fungi growing on the grain ¹³. There have been studies performed that assayed a variety of commercial dry dog foods which contained grains that identified the presence of mycotoxin contamination. Though the levels detected were not potent enough to be toxic, animals eating these foods over a long period of time were subject to chronic exposure. The effects of this exposure can include but are not limited to acute hepatic injury, chronic disease in the liver or kidney, cancer, or even death ¹³. In order to combat the potential for long-term exposure to mycotoxins, pet food companies must ensure they are purchasing high-quality grains to include in their food. It is recommended that they use only the highest quality grains per the USDA quality control scale, grade one, so that contamination is reduced ¹³. Beyond mycotoxin poisoning, there have been no other major issues found with the inclusion of grains in a commercial dog food diet.

Grain Alternatives

To replace the nutritional value that is provided by grains in the diet, many companies have had to find alternative sources of protein, fatty acids, and carbohydrates. Often, this is found in vegetables and other starch-containing ingredients. The alternative ingredients must contain starches to withstand the processing of the food. Some examples of these alternatives include but are not limited to: "pumpkin, sweet potato, tapioca, peas, butternut squash, parsnips, carrots, spinach greens, and various fruits" ¹⁰. These ingredients provide the necessary

carbohydrates and protein in the diet at a relatively similar digestibility rate, but it has been found that they provide less energy than grain alternatives ¹⁴. Despite the similarity in nutritional quality, there are other difficulties that can be faced when choosing this option. These grain-free diets that are commercially produced are often more expensive than those which include grains on the market, as products such as vegetable flours are not nearly as mass-produced as grain cereals and thus drive the price up ¹⁴. There are also many more exotic ingredients included in these diets which are hard to obtain and cost more ¹⁴. This is not to say that these grain-free diets cannot be beneficial in some cases. When recommended by a veterinarian in the case of a true grain allergy or other special circumstance, grain-free diets can be a great alternative, though care must be taken if they are to be fed long-term. Ultimately, it comes down to what is best for the dog based on its medical history.

Conclusion

When considering the data presented in this review as a whole, it is reasonable to say that grains are a healthy and arguably essential part of a canine diet. Not only do they provide a rich source of highly digestible carbohydrates, proteins, and fatty acids, but they also can be supplemented as a fiber source within the diet. They contain essential vitamins and minerals and have strong antioxidant and anti-inflammatory characteristics. Many studies have proven that these nutrient sources also can contribute to the reduction of risk for chronic diseases and combat conditions such as diabetes and obesity. In some cases, it is necessary to feed a grain-free diet, especially when a grain allergy has been diagnosed, but the idea that removing grains from the diet will make it healthier is nothing more than a misconception. Pet food companies must do a better job of marketing the truth about grains in their products so that consumers can choose the

diet which is best suited for their animal's needs. With some more education and research, grains can continue to be a major source of nutrition for companion animals.

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