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FOOD ALLERGIES IN DOGS AND CATS: A BRIEF REVIEW

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ABSTRACT

Food allergies (FA) in companion animals can affect pet health and cause concern for their caretakers. Pet owners maintain emotional bonds with their pets, therefore emphasizing the importance of well-being in their companions. However, successful diagnosis and treatment of FA remains inconsistent due to lack of consensus among scientifically based literature articles. Therefore, this work aims to improve general reader knowledge by reviewing various crucial aspects of FA, including terminology, clinical signs, risk factors, known allergens, treatment management, and prognosis. Use of proper terminology encourages accurate diagnoses by limiting confusion between various conditions, particularly given food intolerances (such as toxicity) can be misdiagnosed for immune-related reactions because clinical signs may appear similar at times. Symptoms of FA may be expressed as dermatological or gastrointestinal, ranging in afflicted area, severity and appearance. Diet composition, life stage, genetics, species (canine or feline), and the gut microbiome may contribute to FA prevalence. Food allergens provoke a physiological immune response, which can be activated acutely or chronically. Common pet diet ingredients associated with inducing FA symptoms include beef, dairy, chicken and fish. Although prognoses for FA are good when the offending dietary component is successfully removed from the pet food, care must be taken to address additional contributing factors, such as flea and mite prevention. Natural hyposensitization rarely occurs and future episodes of FA are possible after diet adaptation. Future work should seek to establish standardized diagnostic protocols for FA as well as to methodically investigate the links between risk factors and FA occurrence.

Keywords: *Food allergies, pet nutrition, hypersensitivity, atopic dermatitis.*

INTRODUCTION

The broad history of FA in pets lacks clear methods of reliable identification. This may be due to the vague nature of symptom appearance. A technical definition has been described as involving any immune-related response related to food intake (Verlinden et al., 2006). The intestinal mucosa provides a crucial function in defending the host system from pathogens. Normally, the immune system can identify and appropriately respond to antigens in the gastrointestinal (GI) tract by suppressing T-cell activation, which produces oral tolerance (no allergic reaction).

However, in the circumstance of a hypersensitive pet, the immune response is unable to properly distinguish between harmless and harmful compounds. This results in a targeted antigen-specific attack leading to the release of IgM, IgG, or IgE cells (Verlinden et al., 2006). Physiological immune response is further divided into four types (I, II, III, IV) with each type associated with response time, physiological effects, and severity. Often, symptoms of FA may be expressed via the GI and dermatological systems. However, studying FA in an applied situation (such as a case study) can be challenging as these symptoms may result from other conditions, such as lactose intolerance or toxicity (Jackson, 2023). Therefore, these knowledge gaps are currently being studied to improve the accurate identification and treatment of pet FA. The current prevalence in dogs and cats is unknown, however, estimated numbers suggest 0.2% of dogs and 0.1% of cats in the United States are affected (Banfield Pet Hospital, 2018). However, the same report states that environmental and flea allergies are on the rise. Dogs and cats with FA are, respectively, six and fifteen times more likely to clinically present with pyoderma (skin infections) than their non-allergic counterparts (Banfield Pet Hospital, 2018). According to American Veterinary Medical Association, it was estimated in 2020 that there were roughly 83.7 million dogs and 60 million cats in the United States (AVMA, 2021). Following these numbers, there is an estimated 167,400 dogs and 60,000 cats suffering from FA in the United States. These data may reflect underdiagnosis, with skin conditions in pets being otherwise stated as commonly caused by adverse food reactions (AFRs) (Biel et al., 2022). This work aims to enhance general reader knowledge by reviewing several important aspects of FA, including terminology, symptoms, risk factors, known allergens, and treatments.

TERMINOLOGY

Many terms and abbreviations are involved when encountering issues associated with FA in pets. As previously mentioned, AFRs cover both food hypersensitivities and food intolerances. Food intolerance reactions are collectively grouped as non-immunological responses, meaning there is no association with FA. Such responses include idiosyncrasies, toxicities, and metabolic effects (Verlinden et al., 2006). These are typically variable and dose-dependent reactions that may be hours or days after a dietary exposure (Craig et al., 2018). On the other hand, food hypersensitivities are considered to be immunologically related responses following food intake. This may be objectively verified by the presence of various immune defense cells in the plasma. However, there may be overlap between both groups (hypersensitivities and intolerances), which proves differentiation difficult at times (Verlinden et al., 2006). Other terms commonly utilized include descriptions of dermatological symptoms. These are cutaneous adverse food reactions (CAFRs) and atopic dermatitis (AD). CAFRs simply refer to acute dermatological problems associated with an ingested food (as opposed to an environmental or parasitic cause). Atopic dermatitis, also known as eczema, is a common skin issue associated with patches or “hot spots” of reddened, dry and inflamed epidermis that is typically chronic in nature. The term “pruritis” is usually a description of frequent scratching

behavior, usually affecting specific body areas. Alopecia refers to lost hair and bare patches. Although many of these terms are related, it is crucial to remember the differences to assist in accurate information portrayal.

CLINICAL SIGNS

When comparing the expression of clinical signs of FA in dogs and cats, it must be remembered that there is a lack of evidence-based diagnostic procedures due to the elusive nature of dietary allergy symptoms. In both species, there is manifestation of both dermatological and GI symptoms. As previously reported, there is not consistent data for symptom occurrence rates, with researchers providing contrasting results, including the type and prevalence of GI symptoms observed (Mueller et al., 2018; Wernimont et al., 2020). Muller and coworkers (Muller et al., 1989) generously stated that FA occurs in dogs as approximately 10% of all allergic skin diseases. Food allergy cases in cats have been far less common in comparison.

Dermatological signs include evidence of pruritis (licking, scratching, alopecia, compulsive chewing), poor hair quality (i.e., brittleness), and AD. Skin symptom presentation often involves the face, feet, and genital regions. Additional symptoms in dogs include GI signs (such as frequent defecation with loose stool and increased flatulence), conjunctivitis, sneezing, and anaphylaxis (Mueller and Olivry, 2018). Cats often present in a slightly different fashion, expressing vomiting, diarrhea, respiratory signs, conjunctivitis, and hyperactive behavior (Mueller and Olivry, 2018). A bibliometric study reported that AD in cats is more frequently reported in females than males, with some study participants demonstrating severe dermatological compromise as characterized by subjective appearance based on lesion size, type, exudate and physiological location (Santoro et al., 2021). However, a limitation is the poor ability to discern the differences between specific causes amongst cases of feline atopic syndrome (FAS). A previous review suggests additional symptoms may also be exhibited, but lack statistical correlation (Verlinden et al., 2006). Effects of FA are generally considered non-seasonal. Symptom expression is assumed to be based on continuous consumption of the antigen-containing ingredient unless weather conditions were to influence the ingredient profile. Incidences of FA can occur at any age but may be prevented by early encouragement of oral tolerance immediately after the first 9 weeks of life as shown by the partial introduction of ovalbumin dissolved in cow milk (Zemann et al., 2003). The 28-day treatment enabled allergy-prone puppies to immunologically overcome and adapt to a new food without provoking a dietary allergic reaction as opposed to the control group (Zemann et al., 2003).

RISK FACTORS

Potential determinants for FA have been identified with life stage, breed, genetics, diet, gut microflora, and other elements (Jackson, 2023; Marsella, 2009; Olivry & Bexley, 2018; Tawfik et al., 2020). A study sought to find the prevalence of allergic skin reactions in various breeds and ages of dogs (Tawfik et al., 2020). In this study, twenty-nine dogs were utilized ranging from 1.5 months to 2.5 years old. The main

methods of sample collection were via skin scraping, skin biopsies and histological examination while biopsies were attained from body pinnae, nasal plenum, footpads, and small lesions via surgical resection (4 and 6 mm insert size). Results showed 13.79% of the dogs had FA-associated dermatitis based on elevated infiltration of lymphocytes, macrophages and neutrophils noted in biopsy cores related to immune responses. Infectious skin issues were more common than miscellaneous dermatitis. Flea allergy dermatitis was most common for infectious, while primary contact dermatitis was most often exhibited in miscellaneously caused cases. Food allergies were the second most common cause in miscellaneous cases (Tawfik et al., 2020). Although breeds were recorded, they varied greatly. However, another study found German Shepherds, Irish Setters, and Shar-Peis to be more commonly affected by GI symptoms accompanying FA (Roudebush et al., 2000). Ingredients have been reported to influence food acceptance, pruritic behaviors, hair quality and fecal score in dogs expressing AFR (Weemhoff et al., 2021). Further factors include the storage conditions of dry kibble. *Tyrophagus* storage mites can be found in contaminated commercial dry foods and may cause a false positive when testing dogs for FA. A study found that these mites were more likely to achieve high numbers in commercial stored dry foods when initial mite numbers were high and the kibble was crushed (Olivry and Mueller, 2019). Another cofactor for high mite proliferation rates includes storage of foods in ideal mold-proliferation conditions such as higher humidity and increased ambient temperatures. While cereal-rich foods are more commonly reported to sustain mite reproduction, *Tyrophagus putrescentiae* reproduces quickly in fat- and protein-rich diets (Olivry and Mueller, 2019). Mite multiplication is mitigated when foods are purchased fresh, utilized in shorter time periods, and stored in low humidity in addition to cooler temperatures. Existing microbial presence and diversity may influence susceptibility to increased FA-induced inflammatory responses. It is suggested that when FA manifests as GI disturbance, such as enteritis and diarrhea, alterations occur to the resident microbiome, with the most literature studying the colonic region (Wernimont et al., 2020). Gut barrier functionality may be improved by specific postbiotics, such as 10-hydroxy-cis-12-octadecenoic acid released during microbial fatty acid metabolism (Yamada et al., 2018). Exposure to probiotics (*Lactobacillus rhamnosus*) in the first 6 months of life for puppies significantly decreased allergen-specific IgE levels to ragweed, timothy and Dermatophagoides farinae as well as prevented partial AD after comparison with baseline challenge data (Marsella, 2009). Few studies have been conducted in pets evaluating microbiome differences between allergic and non-allergic individuals. However, one study compared two groups of adult humans, a non-allergic group and a group allergic to peanuts and tree nuts, exhibited that those with an allergy expressed lower numbers of intestinal *Clostridiales*, *Prevotella*, and *Ruminococcaceae* as well as higher numbers of *Bacteroides* as discerned by fecal analysis (Hua et al., 2016). Identified microbiological differences may be a dysfunctional causative cofactor, a result of chronic allergen response, or likely, a complex mixture of both.

KNOWN FOOD ALLERGENS

The focus here will remain with commercial pet foods. Although it may not be possible to discuss every potential allergen, common ones involve glycoproteins (animal or plant). Typically insoluble during digestive absorption, usual food allergens are reviewed varying from 15 to 40 kDa in size (Jackson, 2023). Review of various antigen suspects commonly encountered in canine and feline diets summarize that there is more data provided for dogs, showing that beef and dairy present the most allergic reactions in hypersensitive dogs (Verlinden et al., 2006). The same work suggested wheat, chicken, egg, lamb, soy, pork and fish also provoked a smaller number of allergic cases. Cats exhibit lesser reactivity with antigenic challenges from beef, chicken and fish associated with most cases while fewer cats also negatively responding to grains and dairy (Mueller et al., 2016). A separate work recruited 179 atopic dogs, which included 27 dogs with cod allergy (Imanishi et al., 2020). All dogs were collected for serological immune responses to crude cod oil. Thirty-nine of the 179 (20%) atopic dogs possessed specific IgE for crude cod oil and 12 of the 27 (44%) allergic dogs had the same verified via ELISA analysis. The dogs which tested positive for specific IgE, 25%, 39%, and 50% of this population also tested positive for specific IgE to, respectively, parvalbumin, collagen, and tropomyosin (proteins found in crude cod oil). This suggests that it may be beneficial to isolate specific proteins in ingredients to provide an ideal fit for individual dietary needs of pets based on clinical diagnosis. A study performed by North Carolina State University retrieved sera from 40 dogs and 40 cats with undetectable, low, medium and high corn-specific IgE reactivity (Olivry and Bexley, 2018). Extracts (except the derived corn kernel extract) were subjected to phosphate-based buffer twice with centrifugation to remove allergens. Findings via ELISA analysis concluded no detectable IgE action in two cornstarch extracts as opposed to a heightened response against allergens found in corn flour. This further shows that differences in ingredient processing can alter allergic responses in pets (Olivry and Bexley, 2018).

TREATMENT, MANAGEMENT AND PROGNOSIS

Once one or more specific allergens have been identified, treatment involves diet manipulation to accommodate for allergens present. It has been found that extensive hydrolyzation of poultry-derived protein resulted in the absence of clinical symptoms in poultry-allergic dogs and cats (Olivry et al., 2017). However, partial hydrolysis did not achieve the same positive outcome. Protein hydrolysate diets, protein/ingredient replacement, homemade diets, and commercial hypoallergenic diets are available. Selection of a new diet relies on numerous factors, including severity of symptoms, budget, availability, preparation time, and more. Objective methods, such as individual IgE levels and scoring scales based on lesion appearance, for quantifying FA severity have proven to be variable and conflicting, with varying types of dermatitis being documented in multiple articles (Cucerzan et al., 2020; Santoro et al., 2021; Tawfik et al., 2020; Weemhoff et al., 2021). Cucerzan and coworkers found that 10 out of 10 food-allergic dogs showed significantly

reduced clinical AD signs after consuming a hydrolyzed protein diet for 3 months (Cucerzan et al., 2020). In individual pets in which there are numerous allergies or a lack of antigen identification, it may be necessary to administer glucocorticoids (Santoro et al., 2021; Verlinden et al., 2006). As it relates to dermal conditions, prevention of fleas and other causes of pruritis should not be ignored. Although prognosis is typically good after the offending antigen has been identified and manipulated out of the diet, relapse is possible (Olivry and Mueller, 2020). Natural hyposensitization to the existing allergens is rare (Muller et al., 1989).

CONCLUSION

Pet FA prevalence appears to be under-represented in the literature. However, this could be confirmed with improved diagnostic methods and protocols. Understanding the risk factors, pathways, GI components, and symptoms are crucial to initiate administered aid. Methodology that differentiates food intolerance (non-immune reaction) from food hypersensitivity (immune overreaction) is needed. Overall, further investigation of FA in pets is encouraged for not only the health of the pet but also the owners who struggle to ensure the comfort of the animal.

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