ASSESSING COMMONLY USED COMMERCIAL PROBIOTICS AND THEIR RELEVANCE TO ZOO ANIMAL GUT MICROBIOMES

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Abstract

Commercial probiotics contain live microbes that are purported to have beneficial functions such as disease prevention, anti-inflammatory effects, and microbiome stabilization. While research on probiotic use in humans is burgeoning, the study of probiotic treatment in exotic animals is extremely limited. The specific microbial strains contained in commercial, animal probiotics are selected based on research in humans, rodent models, or agricultural animals. Whether these probiotics are beneficial to zoo animals remains largely untested.

The objectives of this project are threefold: (1) Identify the microbes in probiotics used to treat zoo animals and determine whether they match the product label, (2) compare the probiotic microbes to the gut microbiomes of zoo animals, and (3) provide a resource for zoo professionals on probiotic treatments and microbial therapies in zoo animals. To fulfill these objectives, we first surveyed professionals at 14 U.S. zoos about their probiotic use and collated a list of 11 commonly used probiotics. We used 16S rRNA sequencing to identify the microbial communities in each probiotic and compared them to data on the gut microbiomes of over 400 animal species under human care worldwide.

We found that the probiotic sequence data largely matched the label-reported strains, indicating minimal to no contamination and accurate labeling. Across the 11 probiotics, we identified 24 strains, all lactic acid bacteria. Bacterial membership of the probiotics ranged from a single strain (in probiotics labeled respectively for domestic dogs, domestic cats, and children) to 20 strains (labeled for humans). Although the probiotics were individually labeled for use in specific species (e.g., domestic dogs) or animal groups (e.g., "wildlife and exotic animals"), the microbial strains were nearly identical across all probiotics. For example, five probiotics respectively labeled for domestic dogs, domestic cats, equines, ruminants, and "multi-species" all had identical microbial membership. The majority of strains were members of *Lactobacillus* (12 strains), *Bifidobacterium* (6 strains), and *Enterococcus* (1 strain). The most common strain was *Enterococcus faecium*, present in 8 of the 11 probiotics, including those labeled for use in domestic dogs and cats, equines, ruminants, and "wildlife and exotic animals." We found that the probiotic strains were either completely absent or rare in most animal gut microbiomes. However, closely related bacteria, such as other lactic acid bacteria, were abundant in many animal microbiomes.

Overall, we find that the microbial components of commercial probiotics are generally not tailored to the microbiomes of zoo animals. The concept that lactic acid bacteria are inherently beneficial is largely untested in exotic and zoo animals, indicating that commercial probiotics may have unknown impacts on their microbiomes. Akin to any other health-related treatment, microbial therapies should be tailored to the recipient's physiological and microbial needs. Although there are benefits to using commercial probiotics (availability, cost, standardization), we suggest that zoo professionals also consider approaches such as fecal microbiota transplants, which provide relevant gut microbes, prebiotics, and metabolites, and may better serve to provide microbial benefits to ailing animals.