Food Safety Symposium: Potential Impact of Reduced Antibiotic Use and the Roles of Prebiotics, Probiotics, and Other Alternatives in Antibiotic-Free Broiler Production

89 Probiotics and direct-fed microbials: Practical applications and real-world needs. J. T. Barton*, *The Poultry Federation Lab*.

It seems likely that antibiotic treatments of food animals will end, despite the strong support of antibiotic use by agricultural advocates as well as scientific evidence that the use of antibiotics in food animals is not the major cause of pathogen resistance in the human population. If the post-antibiotic farm comes to pass, farmers will still depend on veterinarians and scientists to deliver effective therapies that relieve animal suffering and protect against financial losses. Probiotics, direct-fed microbials, and perhaps other types of beneficial bacteria appear to be the most likely successors to the functional role of antibiotics in meat and poultry farming. The perception of farmers regarding beneficial bacterial applications in food animal husbandry has evolved from skepticism to curiosity to guarded acknowledgment of positive attributes. These views have changed due, in part, to publications in scientific journals and well as hands-on experience applying beneficial bacterial products. It is certain that the natural diminution of ineffective, yogurt-sourced *Lactobacillus* sp. and the development of species-targeted probiotics and direct-fed microbials have caused a major shift in the use of beneficial bacteria in food animal farming. Future advancement in beneficial bacteria application will depend upon increased knowledge of their mechanism(s) of action as well a continued discovery of novel microbial species for development.

Key Words: probiotic, direct-fed microbial, beneficial bacteria

90 Probiotics: Current limitations and future potential in commercial poultry. B. M. Hargis*[1], G. Tellez[1], R. E. Wolfenden[1], S. Shivaramaiah[1], A. D. Wolfenden[1], S. E. Higgins[2], and T. E. Porter[2], [1]*University of Arkansas*, *Fayetteville*, [2]*University of Maryland*, *College Park*.

During the last 2 decades, we and many colleagues have worked toward development of commercially applicable probiotics (DFM) that could consistently replace or ameliorate removal of antibiotic growth promoters from poultry rations. There have been many educational failures along with some striking successes during this odyssey. In several published manuscripts, we have shown that a highly selected group of compatible lactic acid bacteria could reduce enteric *Salmonella* in laboratory and commercial field studies, improve performance in large broiler and turkey field trials, effectively treat idiopathic diarrhea in commercial turkeys, and prevent necrotic enteritis in challenge studies. The effects of treating *Salmonella*-infected broilers is observed very quickly, between 12 and 24 h, leaving the conventional explanation for mechanism of action, that of competitive exclusion, in doubt. Very recently we have observed very rapid changes in host gene expression through microarray analysis that could explain the rapidity of these observations suggesting that elicitation of a host innate immune response may be partially responsible for the beneficial action of this probiotic. Because lactic acid bacteria are not stable or thermotolerant, we have also worked toward selection of effective spore-forming *Bacillus*-based probiotics using intense in vitro selection criteria, and ultimately, in vivo testing. During this more recent experience, we have concluded that in vitro biological activity of *Bacillus* is not highly predictive of isolates with potential to improve performance or to reduce necrotic enteritis or *Salmonella* infections in vivo. Interestingly, a select subset of *Bacillus* isolates appear to be capable of complete spore-to-spore life cycle completion within the chicken gut, which may be important for selection. Our studies indicate that for effective administration of useful spore-formers in feed, very high concentrations of spores are required (~1×10^6 cfu/g finished feed). Therefore, selection of highly efficient thermotolerant spore-formers is necessary for cost-effective development of feed-additive probiotics (DFM).

Key Words: *Bacillus*, DFM, probiotic

1087 Alternatives to antibiotic treatment for necrotic enteritis. C. L. Hofacre*[1], M. Lee[1], and G. Mathis[2], [1]*The University of Georgia*, *Athens*, [2]*Southern Poultry Research*, *Athens, GA*.

Necrotic enteritis (NE) is the reason poultry producers use growth promoting antibiotics. Our research has shown that it is the subclinical form of NE that affects the birds' small intestines to result in the reduced growth rate and poorer feed efficiency that is seen when antibiotics are not used. The disease-causing agent is the obligate anaerobic bacteria *Clostridium perfringens* and more specifically a strain that produces an exotoxin. These are ubiquitous bacteria; therefore, just presence of *C. perfringens* in the birds' intestines is not enough to cause disease either clinical or subclinical in most cases. There must also be a change in the bacterial normal flora of especially the small intestine to allow the *C. perfringens* to grow and elaborate the toxin. In the past, we have used antibiotics to keep the flora in balance and the *C. perfringens* in check. One of the major causes for shifts in the normal intestinal flora is coccidian infection of the duodenum, jejunum and ileum. When the birds' intestine responds by producing mucus, this provides the mucolytic bacteria, *C. perfringens*, a ready nutrient source which results in rapid growth and elaboration of the toxin(s). This results in further intestinal damage and production of additional mucus and a cycle begins that would be prevented by antibiotics. The presence of the ubiquitous bacteria *C. perfringens* in the birds' intestines does not necessarily mean N.E. will occur. As long as the normal flora of the small intestine stays in balance, the *C. perfringens* level will stay low; however if the intestinal epithelium becomes damaged or the birds experience an extreme level of stress, *C. perfringens* can grow rapidly and produce its toxin resulting in most often slower growth, lower body weights and poorer utilization of feed. In the extreme form of N.E., we see necrosis of the intestinal epithelium and death. Managing the normal intestinal flora of the bird can be a highly effective method of preventing both clinical and subclinical necrotic enteritis.

Key Words: necrotic enteritis, antibiotics

88 Historical perspective: Prebiotics, probiotics, and other alternatives to antibiotics. M. E. Hume*, *USDA, ARS, Food and Feed Safety Research Unit*, *College Station, TX*.

European Union food animal producers have moved away from the use of selected antibiotic growth promoters. Some poultry producers in the United States have opted to reduce or remove antibiotic growth promoters from their production schedules. Additionally, there is increasing public sentiment in the US toward the complete removal in this country of antibiotic growth promoters from poultry and other food animal production. The symposium will examine a history of prebiotic,

probiotic, and other antibiotic alternatives; current needs and expectations of antibiotic replacements; current limitations of probiotic and future potential; current experiences with antibiotic-free poultry production; and bacteriocins as potential replacements for antibiotic growth promoters. The concept of a prebiotic was launched in 1995 by Glenn Gibson and Marcel Roberfroid. An updated definition of a prebiotic was proposed in 2007 by Marcel Roberfroid as "a selectively fermented ingredient that allows specific changes, both in the composition and/or activity in the gastrointestinal microflora, that confers benefits upon the host well-being and health." The notion of a probiotic began at the end of the nineteenth and early twentieth century with the observations of Eli Metchnikoff, who put forth the idea that aging was affected by certain putrefying toxins created by microbes in the large intestine. He went on to state that villagers in eastern Europe who consumed milk fermented by lactic-acid bacteria characteristically lived long lives. A probiotic as redefined in 1989 by Roy Fuller is "A live microbial feed supplement which beneficially affects the host animal by improving its intestinal microbial balance." Fuller stressed the need for the probiotic organism to be viable. Both concepts recognize the importance of developing, supporting, supplementing, and maintaining a healthy digestive microflora. The 2 concepts have been the focus of considerable research and cover a range of materials and formulations in the livestock and human arenas.

Key Words: prebiotic, probiotic, antibiotic growth promoter