Editorial

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In the United States today, antibiotics are commonly used in food animals to promote growth and prevent disease, as well as to treat sick animals. The U.S. Food and Drug Administration (FDA) estimates that 14.6million kg of antibiotics were sold for use in animals in 2012 (FDA, 2014), more than four times the 3.29million kg of antibiotics sold for human use in 2011 (FDA, 2012).[1–3] Antibiotics are used primarily in intensive swine, poultry, and feedlot cattle systems, with limited use in dairy cows, sheep, and companion animals.[1] Therefore, the increasing antibiotic resistance of pathogens led to bans on antibiotics for growth promotion (AGPs) in the European Union in 2006.[3] In the United States, AGPs are not banned, but the FDA recently issued guidelines for the industry to voluntarily withdraw medically important antibiotics from growth promotion (FDA, 2013a).[1,4] To eliminate the use of AGPs in poultry industry in Denmark farmers have been using different approaches like incorporation of live microbial feed supplement which beneficially affects the host animal by improving its intestinal microbial balance and management changes to maintain animal productivity.[1,4] Benefits from probiotic microorganisms have been recognized for over 100years, and as being useful in poultry for 50years.[4–10] The strains most frequently used as probiotics include lactic acid bacteria (LAB) like *Lactobacillus* spp., *Bifidobacterium* spp. and *Saccharomyces boulardii* which are isolated from traditional fermented products, fruits, gut, feces and breast milk of human subjects.[11–14] However, some the major challenges of the industry producing probiotics with *Lactobacillus* spp. and *Bifidobacterium* spp. are the following:

i. These microorganisms are microaerophilic or strict anaerobic, therefore their production is complex and could be a challenge the handling and production of this microorganisms;[15]

ii. Their growth is slow requiring expensive and elaborate culture medium as the *Lactobacillus* MRS medium based on the formulations of deMan, Rogosa and Sharpe (MRS) medium that supports luxuriant growth of *Lactobacilli* spp. and *Bifidobacterium* ssp.[16,17] In addition, both microorganism are slow growers;

iii. Their shelf-life in general is short and the product must be maintained at low temperatures, increasing the cost of production.[18] To resolve the shelf-life problem several approaches have been used from lyophilization or freeze drying to the most recently techniques involving the microencapsulation of *Lactobacillus*.[19–21] Spray drying is one of the oldest encapsulation methods adapted to many industrial areas including probiotics to make powders and capture bioactive components. However, high heat treatment during the spray-drying method cause cellular injuries and dead in *Lactobacillus* and *Bifidobacterium* species;[22]

iv. Many of *Lactobacillus* and *Bifidobacterium* are damage by the gastric juice when they go through the Gastrointestinal (GI)-track. Both genus are temperature-sensitive microorganisms.[22,23]

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Bacillus is a genus of Gram positive, rod-shaped member of the phylum Firmicutes.[24] *Bacillus* species can be strict aerobes or facultative anaerobes. Under stressful environmental conditions, the bacteria can produce spores which remain in a dormant state for long periods.[24] The genetics and physiology of the large bacterial genus *Bacillus* is remarkable.[25] On the other hand, though, where these Gram-positive bacteria live and grow is far from clear. The soil, once considered their habitat, may simply serve as a reservoir.[25] Several studies have showed that *Bacillus* spores can be found in the intestinal tracts of animals where they live and multiply actively, raising the question of whether this could be where they live and grow.[25–30] For instance, has been reported that soil carries approximately 10^6 spores/g of soil while human feces present an average of up to 10^4 spores/g. The numbers of spores found in human feces, is too high to be accounted for principally by ingestion of food contaminated with spores from soil.[25] This provides further evidence that *Bacillus* spore formers may have adapted to survival within the intestinal tract of insects and other animals that ingest them, multiply in the GI-track and sporulate at the colon being excreted in the feces, this has been demonstrated in pigs and other animals utilizing molecular biology tools. These results suggested that *Bacillus* ssp. is commensal bacteria of the GI-track.[26,27,31,32] Other major advantages of spores over vegetative (LAB) cells are their thermostability to high temperatures spores can survive at 235°F (113°C) for 8minutes.[28,33,34] This thermostability property allow incorporate the spores into the feed the during the milling and pelletizing of the feed and other applications as production of vaccines incorporate as adjuvants.[28,35,36] Spores also can be spray-dried. In addition, spores are resistant to desiccation and other stress factors like bile and low pHs both present in the gastric juice.[26,27,32] *Bacillus* spores have different mode of action in the GI-track per se are able to adsorb toxins, induce the innate immunological response through interaction with the Toll-like receptors of the host cells (TLR2 and TLR4),[37] stimulating of NF-bk pathway increasing the levels of NK cells, induction of cytokines (IFN-g),[38,39] improve intestinal integrity and stabilize the microflora, enhance the Daily weight gain (DWG) of the chickens and the Feed Conversion Ratio (FCR).[26,40] Other important characteristic of *Bacillus* ssp. is their genetic potential, fully sequenced *Bacillus* ssp. have 3000 to 6000 genes (Big tool box) NCBI *Bacillus* genomes, whereas *Lactobacillus* ssp. have from 1800 genes to 3000 genes.[41,42]

Conclusion

Bacillus species are superior probiotic feed-additives for poultry and pigs due to their big genomes with relevant features; they are spore producers which make the product stable for long time and enhancing the bird's intestinal integrity and growth performance.

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Conflict of interest

The author declares no conflict of interest.

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