Role of probiotics, prebiotics and synbiotics in poultry nutrition

In recent years, probiotics, prebiotics and synbiotics have gained significant attention in the poultry sector for their ability to promote healthy intestinal function, improve performance and keep pathogens in check.

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This article looks at microbiota-regulating products and research applications in modern poultry production.

What are probiotics?

Probiotics were first used in animal feed in the 1970s. The FAO and WHO definition from 2001 is the most widely accepted: 'Live microorganisms, which when administered in adequate amounts confer a health benefit on the host.'

This definition implies a direct relationship between the probiotic and the health of the person or animal that receives it. Probiotics registered for poultry feed fall into two main groups: sporulated probiotics (Bacillus and Clostridium genera) and various lactic-acid-producing bacteria belonging to the genera Lactobacillus, Enterococcus, Pediococcus and Bifidobacterium.

Probiotics have varied modes of action, including:

- Deactivating certain toxins.
- Reducing oxygen concentration.
- Promoting gastrointestinal function.
- Competitive exclusion for nutrients.
- Regulating the permeability and development of the intestinal epithelium.
- Synthesising bacteriocins and other metabolites that inhibit pathogen growth.
- Several enzyme activities, inducing digestion and absorption of nutrients.
- Various immunomodulatory effects.

Prebiotics and synbiotics

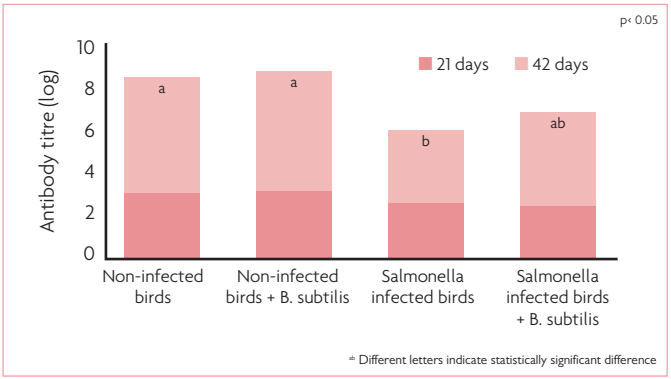
Prebiotics have been defined as 'non-digestible food ingredients that beneficially affect the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon.'

For a substance to be classified as a prebiotic, it must:

- Not be hydrolysed or absorbed in the stomach or small intestine.
- Select for beneficial commensal bacteria in the large intestine.
- Induce beneficial luminal/systemic effects within the host during fermentation.

Finally, synbiotics are defined as a mixture of probiotics and prebiotics that improve the survival and implantation of live microbial dietary supplements in the gastrointestinal tract.

Fig. 1. Effect of B. subtilis (DSM 17299) on Newcastle disease vaccine response in chickens (Sadeghi et al, 2015).



Pathogen control

Probiotics can be used to control pathogen excretion on poultry farms and maintain a microbiome that is beneficial to bird health. Of interest is the demonstrated efficacy of Bacillus subtilis in broilers, layers and more recently, chicks.

A recent statistical meta-analysis of 14 studies confirmed the positive effect of one strain of B. subtilis (DSM17299) on broiler performance.

A commercial probiotic feed supplement based on the same strain of Bacillus subtilis (DSM 17299) was also found to have a positive effect on antibody titres against Newcastle virus and infectious bursal disease.

In broilers challenged with Salmonella enterica serotype enteritidis, which decreases antibody titres against infectious bursal disease and Newcastle virus, probiotic feed supplementation was associated with significant improvements in antibody titres.

In healthy chickens, however, probiotic supplementation had no significant effect on the immune parameters, and thus did not generate additional energy expenditure.

The same probiotic is also associated with significantly enhanced humoral immune response when birds are immunosuppressed by salmonella (Fig. 1).

These results confirm the results of S. enteritidis and Clostridium perfringens challenge studies showing that B. subtilis, when administered prior to disease challenge, helped reduce the persistence and colonisation of both pathogens.

Improved health and production performance

Several recent studies have demonstrated the efficacy of B. subtilis in promoting broiler health and performance.

In studies in which broilers were fed diets containing different levels of metabolisable energy, investigators concluded that at 62kcal/kg of feed, B. subtilis supplementation was associated with reduced feed costs and significantly improved growth and health status.

Other studies have shown that Bacillus licheniformis, another Bacillus species widely used in poultry production, has the capacity to mitigate the effects of major intestinal diseases, such as coccidiosis and necrotic enteritis.

Further research has shown that one strain of B. licheniformis (17236) provides an excellent complement to coccidiostats, even in cases of severe coccidiosis, which makes this bacterium the probiotic of choice for the prevention of side effects of coccidiosis vaccines in poultry.

Lactic-acid bacteria

Another group of micro-organisms frequently used as probiotics in poultry are several species of lactic-acid-producing bacteria.

Enterococcus faecium has generated considerable interest, particularly in application to drinking water and mash feed. Studies have revealed significant reductions in intestinal populations of the Enterobacteriaceae family and E. coli, Staphylococcus aureus and Enterococcus faecalis when adding an E. faecium-based probiotic (M74) in drinking water ($15x10^9$ cfu/100l).

The addition of the same E. faecium strain to water has been associated with reduced blood triglycerides. The total plasma antioxidant status of the birds was also significantly improved.

The improvement in the antioxidant status of birds is important because low antioxidant status could cause subclinical inflammation, which can compromise production performance.

The antioxidant effect of the probiotic can have an anti-inflammatory action, making it a valuable tool during stressful phases of the production cycle.

More recent findings have shown that in ovo inoculation by this E. faecium strain at the end of the

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incubation period increases the viability of chicks during the first week of life (Fig. 2).

Egg and turkey production

Studies of probiotics in egg production have also yielded positive results, including significant improvements in laying rate and egg weight of hens fed B. subtilis (DSM 17299).

Several studies have indicated that use of a mixed culture of different lactic-acid bacteria in laying hens improved egg size.

Recent research also confirms performance and health benefits of probiotics in turkey production.

Performance improvements in turkeys fed a probiotic supplement containing B. subtilis and B. licheniformis suggest a synergistic effect of combining the two probiotic strains.

Prebiotics

Field trials to evaluate the effect of prebiotics on the production performance, intestinal health and pathogen spread in chickens have been increasing.

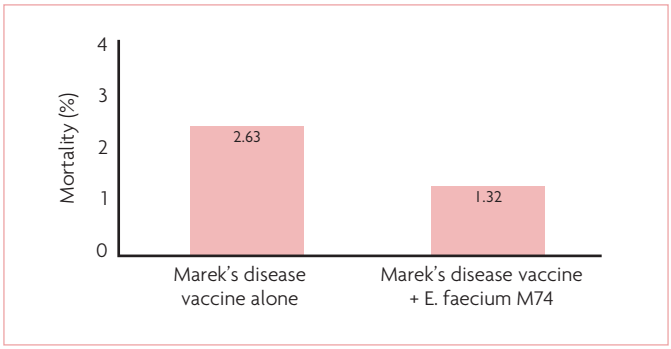

Fig. 2. Effect of E. faecium (M74) in ovo inoculation on hatched chick mortality (Day 0-7) (Beck et al, 2016).

Fructo-oligosaccharides (FOS) have been shown to have a dose-dependent effect on average daily weight gain (ADG).

The addition of 0.25% (FOS) and 0.05% mannan-oligosaccharide seems to be comparable to avilamycin in improving productivity in broilers up to 28 days of age.

The supplementation of dietary fructo-oligosaccharides-inulin has been found to modulate the innate immune system, enhancing killing of Salmonella enteritidis and decreasing inflammatory activation in chickens.

Another study with broilers fed galacto-oligosaccharides (GOS) at two different concentrations revealed a significant increase of bifidobacteria in the intestine.

Prebiotics also appear to selectively improve populations of bifidobacteria and lactobacilli, while reducing colonisation by pathogenic bacteria.

Synbiotics

There is currently little information available on the use of synbiotics in poultry. Studies have shown that a synbiotic product was potentially comparable to antibiotics in improving broiler performance.

The addition of GOS and B. subtilis to broiler diets was shown to improve ADG and FCR, while reducing the incidence of diarrhoea and mortality.

In other broiler studies, a synbiotic containing a combination of E. faecium and a prebiotic derived from chicory and sea algae significantly improved live weight, ADG, carcase yield and FCR.

Using combinations of probiotics and prebiotics could represent a synergistic strategy to improve poultry intestinal health and reduce the spread of pathogens in the environment.

Conclusions

Probiotics, prebiotics and synbiotics employ multiple modes of action to promote intestinal function and health, while preventing gastrointestinal infections.

Unlike antibiotics, this type of additive does not exclusively attack pathogens; it also comprehensively modulates the gastrointestinal environment, thereby reducing the risk of enteric disorders. ■

References are available from the author on request