Use of bacillus spores as growth promoters in broiler chickens

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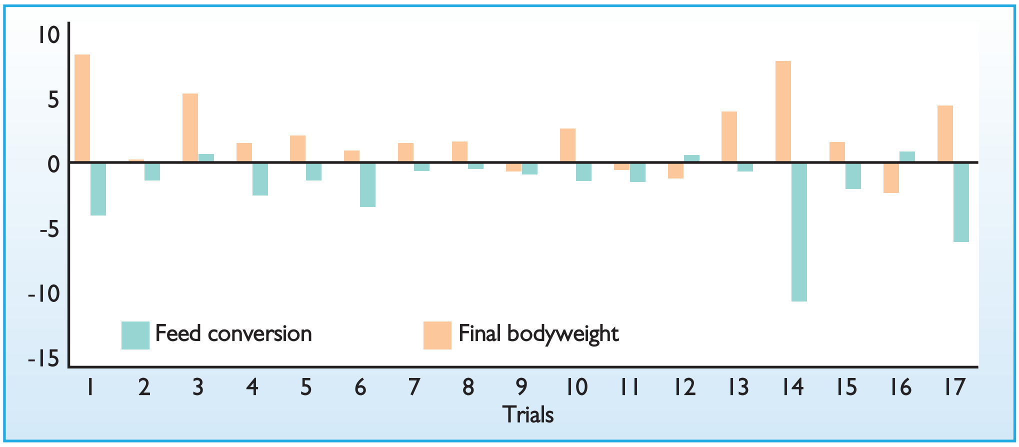

Fig. 1. Result of 17 chicken production trials with addition of GalliPro (Bacillus subtilis) performed at different trial locations (Europe, USA and South America).

Today, science leaves no doubt about the critical importance of a balanced gut microflora in animal and human physiology.

Germ free animals have reduced growth performance and viability in comparison to animals with indogenous microflora.

Different solutions in order to maintain the equilibrium of the gut flora have been developed in the past and the use of antibiotic growth promoters, the use of acidifiers to control pH, the use of nutritional substances as specific sugars (MOS or FOS), and, more recently, essential oils and herbal extracts.

All of these solutions, through working in different ways, pursue the same target to maintain the balance of the gut flora

The probiotic concept is quite unique in this gut flora perspective. Probiotics act by reducing the feed conversion, resulting in an increase of daily live weight gain.

The improvement of the growth of the animal is achieved in a natural physiological way, improving digestion by balancing the gut flora. Probiotics help the animal to fulfil their genetic potential

The word 'probiotic' was introduced by R. P. Parker in 1974 and his original definition was 'organisms and substances which contribute to intestinal microbial balance'.

R. Fuller revised the definition in 1989; 'Live microbial feed supplement which beneficially affects the host animal by improving its intestinal microbial balance'.

Use of probiotics

The use of probiotics for poultry started more than 30 years ago by the development of the concept of Competitive Exclusion by Nurmi and Rantala in 1973. The concept was originally designed for salmonella reduction in growing chickens and was based on introducing gut contents originating from healthy adult birds to young birds.

From a safety point of view the concept has some disadvantages due to the unknown content of the gut originating from adults that could harbour pathogens or transferable resistance against antibiotics or different virulence factors.

Table 1. Pelletising study on selected probiotic strains on the market. Viable cell count in average cfu/g feed: Pelletising at 85°C 30 seconds: External facility. Bioteknologisk Institut, Denmark. Microbiological analysis: External laboratory, LUFA, ITL, GmbH, Germany.

Sample ID	Calculated cfu/g	Meal feed cfu/g	Pellet feed cfu/g	Recovery of cells after pelleting (%)
Control total aerobic	NA	2.6E + 06	3.6E + 04	1
L. farcimis	NA	3.1E + 04	<10	<1
P. acidilactici	4.0E + 06	3.6E + 06	2.7E + 04	1
E. faecium	4.0E + 06	8.5E + 06	1.5E + 06	18
S. cereviciae	8.0E + 06	8.0E + 06	2.7E + 04	<1
B. licheniformis	1.3E + 06	1.2E + 06	1.2E + 06	100
B. subtilis	1.3E + 06	1.2E + 06	1.2E + 06	100

The variation of the gut content is also unknown due to difficulties characterising the total microflora.

Authorities like EFSA have therefore not accepted such product based on extract from gut content. Therefore most probiotic products are based on single or combination of well characterised bacteria or live yeast.

A number of commercial probiotic products for broilers are based on lactic acid bacteria (LAB) and a number of publications document the beneficial effect of the use of LAB.

Jin et al (1998) documented increased body weight and feed conversion in broilers after inclusion of Lactobacillus cultures or a single strain of L. acidophilus. The numbers of coliforms in caecum were also significantly reduced by the addition after 10 and 20 days.

Unfortunately, the application of LABs for use in animal feed for production animals have some challenges. LABs are not heat tolerant and are sensitive to humidity, antibiotics, coccidiostats and oxygen.

Among the large number of probiotic products in use today are bacterial spore formers, mostly of the genus Bacillus.

The products comprise primarily bacillus in their spore form. These products have been shown to prevent gastrointestinal disorders and the diversity of species used and their applications are astonishing.

Bacillus is defined as Gram positive spore forming organisms. The spore form is a dormant resistant stage that can transform into vegetative cells. Bacillus is a facultative aerobe but can, in the presence of nitrate or nitrite, grow anaerobic. Bacillus spores are particularly well suited for use as live microbial products as they are metabolically dormant and highly resilient to environmental stresses.

Commercial desirability

These intrinsic properties are highly desirable from a commercial perspective and mean that spore based products have a long shelf life and retain their viability during distribution and storage.

Tam et al (2006) documented that bacillus are not transient passengers of the gastrointestinal tract but have adapted to carry out their entire life cycle within this environment and therefore bacillus should also be categorised as part of the 'gut microflora'.

Cartman et all (2008) showed that orally administered spores of Bacillus subtilis germinate in the gastrointestinal tracts of chicken. Some

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20 hours after spores were administered, vegetative cells outnumbered spores throughout the GI tract. This demonstrated that spore based probiotic may function in this host through metabolically active mechanisms.

Bacillus spores

For commercial use of probiotics it is important that the application route is easy and it ensures that the viable probiotic strain ends up at the right place in the GI tract of the bird. Due to the capability of bacillus to form spores ensure that the probiotic bacillus spore product can be mixed into the feed meal and go through a feed pelleting process without loss of its viability to form vegetative cells.

Table 1 lists the result of a pelleting study of the survival of different probiotic strains.

A number of studies have proven that Bacillus subtilis improves feed conversion and weight gain in broiler chickens. In Fig. 1 an overview of 17 studies performed at different location showed an average improved weight gain of 2.8% and decreased feed conversion of 3.8%. One of the explanations for this improved performance of feeding bacillus could be related to increased villus height, cell area and cell mitosis. This observation indicates increased digestibility capacity of the birds fed bacillus.

B. subtilis
Alcalin phosphatase
Esterase
Esterase lipase
Lipase
Leucine amino-peptidase
Valine amino-peptidase
Acid phosphatase
Glucosidase

Table 2. Enzymes from B. subtilis.

Bacillus is also known to be enzyme producing and in many cases bacillus is used as the production strain in the industrial production of enzymes. A simple test can be performed in fermentation broth following measurement of the enzyme activity. From such study the enzymes from two different bacilli could be found (Table 2 and 3).

The capability of the bacillus to produce enzymes could very well also be part of the explanation for the improved nutrient utilisation in the birds. The enzymes comprise both starch, fat, protein and phytic acid degrading enzymes.

B. licheniformis
Alcalin phosphatase
Esterase
Esterase lipase
Lipase
Leucine amino-peptidase
Valine amino-peptidase
Cystine amino-peptidase
Chymotrypsin
Acid phosphatase
Galactosidase
Glucosidase

Table 3. Enzymes from B. licheniformis.

A general better health of feeding bacillus to birds could also be the explanation for the improved performance. Bacillus subtilis modulates the ileal microflora in birds fed bacillus. Knarreborg et all (2008) reported increased microbial diversity in ileum and increased growth of lactic acid bacteria in birds fed Bacillus subtilis compared to the control birds. Several of the LAB found in the bacillus treated group and not in the control birds could be identified as species that have been reported with putative health conferring properties.

On farm results in the UK, using GalliPro (Bacillus subtilis based product) has shown an impressive improvement in FCR. The broiler producer reported an improvement of FCR from 1.9 to 1.8 just by adding GalliPro to his broiler feed.

Bacillus does not only modulate the microflora in the chicken towards a healthier flora. Bacillus could also protect against chicken specific pathogens. Feeding Bacillus subtilis spores to chickens gives a reduced level of campylobacter and salmonella.

Bacillus is also reported to stimulate the immune response in chickens. Inooka and Uehara (1985) found that feeding Bacillus subtilis for 27 days from hatch gave increased splendic T and B lymphocytes compared to the control group. Bacillus spores should also play a primary role in the development of the gut-associated lymphoid tissue (GALT).

Conclusion

The use of probiotics in broiler chicken production can be a tool to ensure more healthy birds with increased nutrient utilisation that leads to better production performance.

To be able to choose the best probiotic product for commercial use – the application route has to be considered to ensure the probiotic strain is viable at the time it enters the intestine of the birds. ■

References are available from the author on request