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Managing turkey foot pad health through an innovative, nutritional gut health strategy

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Introduction
Over the past several years, intensive research around the world is focusing on developing and assessing strategies to improve intestinal health in poultry. A healthy gut promotes a proper absorption and utilization of nutrients, prevents proliferation of intestinal pathogens, and supports an optimal functioning of the immune system. It is thus vital for a profitable bird performance and enhances animal welfare. Understanding and maintaining a healthy digestive tract is a very complex area and can be impacted by farm management as well as nutrition. The intestinal microflora plays a key role and is significantly influenced by the diet composition. Over the last years, a variety of feed additive solutions have been developed to control the gut flora balance, with more or less success rate. In 2013 an innovative, scientifically tested nutritional solution based on a blend of protected aromatic compounds (BPAC) including benzoic acid (AVIMATRIX®, Novus Int.) was introduced in the broiler industry. Various research with experimental facilities and trials under field conditions in Europe have demonstrated that this unique premixture optimizes the intestinal microflora composition, allowing an improved performance and health status, in particular seen in an enhanced foot pad health in broilers. Its slow release formulation is developed specifically for use in commercial poultry diets and to act optimally in a poultry intestinal tract environment. This article will take a closer look to the science behind the innovative concept and first experiences with this dietary additive in turkey fattening.

Mode of action
This newly developed gut health control tool is based on a vegetable fat embedding matrix, calcium formate and a mixture of flavoring compounds with benzoic acid being the major ingredient. These active substances have been selected by measuring the anti-bacterial effects of a number of flavoring substances, organic acids and blends thereof in an in-feed intestinal model, developed to simulate conditions in the intestinal tract. Such an approach provides a more rigorous evaluation of the impact of different active substances on the complex microflora of the gut.

A special manufacturing process (Novus Premium Blend Technology) guarantees a high convenience of use and ensures a gradual release of the active ingredients in the birds up till the lower intestines. It is well known that feeding anti-microbial ingredients in a protected, slow release formulation can have benefits over applying them in a free form in the diet; free acids e.g. are more rapidly absorbed, already in the upper part of the digestive tract and thus having a limited to no effect on the gut flora. Such an example is presented in Figure 1 showing that none of the added benzoic acid could be found in the duodenum and ileum due to the rapid absorption.

![Figure 1: Rapid absorption of benzoic acid in the digestive tract of broilers, fed a diet with 0.1% free benzoic acid (Institute of Animal Nutrition, University of Berlin, 2012)](image)

To ensure a stable intestinal microbial flora, it is therefore crucial that the anti-bacterial compounds are released at the right place in the GIT. Therefore they must be embedded or coated in a chemical or physical way, in order to shift their absorption from the upper part of the digestive tract to the small intestine and beyond. Intensive research of the release profile of the active substances of this BPAC, in comparison with the respective free ingredients clearly shows the benefit of the protective technology (Fig. 2.)
The intestinal tract contents of all birds within the same pen were pooled in order to quantify the concentration of active ingredients using a method based on Ion Chromatography. Embedding the gut effective substances clearly alters the release profile and allows a gradual release of the anti-bacterial compounds until the lower parts of the intestinal tract. A peak could be observed in the duodenum, the jejunum and the ceca. In contrast, the non-protected ingredients were absorbed quickly in the crop and proventriculus, resulting in a low concentration in the small and large intestine.

Further studies were performed to assess the direct effect on different bacteria in the gut. Goodarzi (2013) demonstrated this BPAC can change the microbial flora in-vivo, in comparison with non-supplemented birds (Fig.3). When analyzing the microbial balance in the digesta in the ileum of 35 day old birds (5 birds per group, 8 replicates) with a quantitative Real Time PCR, a significant ($p<0.05$) increase of the ratio between numbers of beneficial lactobacilli and $E. coli$ was observed. Such a shift can be associated with a better gut health and higher growth of the bird.

Results on performance and foot pad health in turkeys

Based on the positive results in broilers, the efficacy of the BPAC was tested in a turkey research farm (Moorgut Kartzfenz GmbH, Bösel, Germany). The aim of this trial was to assess if similar benefits could be seen on growth and foot pad health in turkeys. 4 floor pens were distributed randomly at the experimental facility. The trial set up was as follows:

Control group: 2 pens, each 80 turkeys, 160 in total 6-Phase standard feeding program

Treatment group: 2 pens, each 80 turkeys, 160 in total 6-Phase standard feeding program including 500 g/t BPAC

Type of birds: Male B.U.T. Big 6

Trial period: From d1 to d145

Parameters: Individual weight at start and end of trial
Feed conversion ratio (kg feed/kg weight gain)
Foot pad lesion scoring

Diet composition, lightning and temperature program, management etc. were in accordance to the breeders guidelines. Food pad scoring was evaluated according to
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the standard European footpad dermatitis scoring system for use in turkey processing plants (Hocking, 2008).

Results on animal performance are presented in Table 1. Turkeys fed the BPAC had a significant higher weight (+500 g) after 145 days compared to the non-supplemented birds. The final weight was also very similar in each group (pen 1 & 2 and pen 3 & 4). At the same time, the feed conversion rate was reduced with 0.06 points in the treatment group. The highest feed conversion (corrected FCR of 2.93) was observed in pen 2, for toms receiving the control diet, and the lowest in pen 4 (corrected FCR of 2.78.)

Table 1: Performance results of B.U.T. 6 male turkeys after 145 days

<table>
<thead>
<tr>
<th>Pen</th>
<th>Avg. body weight (kg)</th>
<th>Standard deviation</th>
<th>Coefficient of variation</th>
<th>Daily weight gain (g)</th>
<th>Corrected FCR</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td>Control</td>
<td></td>
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</tr>
<tr>
<td>1</td>
<td>20.80</td>
<td>2.95</td>
<td>5.5</td>
<td>144</td>
<td>2.82</td>
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<tr>
<td>2</td>
<td>20.83</td>
<td>2.96</td>
<td>6.1</td>
<td>144</td>
<td>2.93</td>
</tr>
<tr>
<td>Total mean</td>
<td>20.82</td>
<td>2.95</td>
<td>5.8</td>
<td>144</td>
<td>2.87</td>
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<tr>
<td>BPAC</td>
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<tr>
<td>3</td>
<td>21.41</td>
<td>3.35</td>
<td>5.7</td>
<td>144</td>
<td>2.83</td>
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<tr>
<td>4</td>
<td>21.41</td>
<td>3.35</td>
<td>5.8</td>
<td>144</td>
<td>2.78</td>
</tr>
<tr>
<td>Total mean</td>
<td>21.32</td>
<td>3.37</td>
<td>5.5</td>
<td>147</td>
<td>2.81</td>
</tr>
</tbody>
</table>

Different letters per row indicate significant differences, p<0.05

There was a significant reduction on the incidence and severity of food pad lesions by the supplementation of the diet with the BPAC (Fig. 4). The amount of severe foot pad lesions (score 3+4) was strongly reduced from 43% down to 13%. At the same time the number of foot pads with low levels of lesions increased (score 1-2) from 12% to 33%. Together, this resulted in a significant reduction of the total foot pad score (FPS) by group from 106.5 down to 55.0 (p<0.05).

Figure 4: Supplementing birds with a BPAC reduced the severity of foot pad lesions compared to non-supplemented birds

FPS = \( \frac{100 \times (\text{number of birds with score 0-1 x 0}) + (\text{number of birds with score 2 x 0.5}) + (\text{number of birds with score 3-4 x 2})}{\text{Total number of birds scored}} \)

These outcomes demonstrate that nutritional solutions supporting a healthy balance of the intestinal microflora can affect the incidence and severity of footpad dermatitis (FPD) in turkeys. This is in line with other recent trial results under field conditions in broilers, showing similar improvements on footpad health. FPD is a complex area and many risk factors have been identified such as farm management, litter quality, type of litter, stock density and nutrition. In principle, anything that causes wet litter could contribute to the severity of FPD. In the above presented trial, the conditions in both groups were identical with the exception of the diets. Litter moisture was not analyzed in this particular study; however it is most likely the results on FPD are a consequence of achieving a dryer litter in the farm. Studies in turkeys and broilers are clearly indicating that litter moisture is the major factor causing foot pad dermatitis. As litter material is a mixture of excreta and bedding material, through a better balanced gut flora, the moisture content of the excreta can be reduced improving the quality of the litter.

The correlation between an improved foot pad health and the better performance of the birds is not surprising. Similar related benefits have been published in different other researches. A high incidence of foot pad lesions will reduce locomotion due to pain. Birds will spend more time lying down, with a lower feed intake and growth as result. FPD is, besides a possible influence on performance, poorer carcass quality and profitability, also in an important indicator for animal welfare.

Conclusion

Maintaining a balanced, healthy microflora in the intestinal tract is a prerequisite for an optimal health and performance of poultry. Supplementing broiler and turkey diets with a nutritional solution working on gut level can be an important strategy. However, the site in the digestive tract, where antibacterial feed ingredients become active, plays a significant role in the final success rate. A special manufacturing technology can ensure the active substances are gradually released, also in the lower part of the gut. Adding 500 g/t of a BPAC including benzoic acid in broiler and turkey diets has shown to significantly modify the gut flora balance, final weight, feed efficiency and foot pad health. The application of in turkey diets can therefore be regarded as a promising nutritional strategy, together with a proper farm management, to reduce the incidence of FPD and to optimize the profitability.