Mycotoxins: one step forward in effective demedicalisation

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The gut and the immune system form a complex integrated structure that has evolved to provide effective digestion and defence against ingested toxins and pathogenic bacteria.

Nowadays, animal health has major implications for the food supply, public health and international trade. There is increasing reluctance to rely upon therapeutic solutions in animal health using drugs and medicines. Consequently nutrition is being more widely used as a practical solution to maintain animal health.

To develop a positive nutrition-based health strategy it is necessary to consider the basic interactions between health and nutrition and to challenge the current concepts of nutritional requirements based on avoidance of deficiency symptoms.

Feed components and nutrients influence health in many different ways. By manipulating or selecting them, feed quality may be maintained and risk of mycotoxin contamination may be reduced.

Nutritional components have a positive effect in maintaining the gastrointestinal tract and alleviating the threat of enteric diseases.

They influence many non-infectious diseases through control of oxidative stress. It is becoming evident in raising animals for food that nutrition is all there is and a nutrition-based health strategy must play a major role in the future development of animal production.

Contamination of feed commodities by moulds and mycotoxins is considered to be one of the most important negative factors in crop production and animal feed quality. It is well documented that mycotoxin consumption causes a decrease in performance including decreased growth rate and poor feed efficiency. There has been extensive research addressing the different causes by which mycotoxins can alter animal productivity. The gastrointestinal tract represents the first barrier against ingested chemicals, feed contaminants, and natural toxins.

Following ingestion of mycotoxin-contaminated feed, intestinal epithelial cells can be exposed to high concentrations of toxins. Direct intestinal damage can be exerted by the biological action of mycotoxins.

Antimicrobials have been used for more than 50 years to enhance growth performance and to prevent disease in livestock feeding environments. There is growing concern about the potential of antimicrobials in livestock diets to contribute to the growing list of antibiotic resistant human pathogens. Although the use of antimicrobials for growth promotion in livestock diets is still allowed in the United States, most countries in Europe are implementing strict guidelines and regulations for the use of dietary antimicrobials (Regulation (EC), 2003).

In the event that restrictions are placed upon the use of antimicrobials in commercial swine feeding operations, many animal scientists have begun to investigate natural alternatives to conventional chemotherapeutic agents. The use of antibiotics in farming operations (therapeutic use) clearly leads to the development of antibiotic-resistant pathogens. This causes problems when those antibiotic-resistant pathogens get into people.

That is why a feed additive was developed for its positive effect on health and immune status of animals exposed to mycotoxins.

The Mycofix product line offers a complex strategy solution for the counteraction of mycotoxin effects, support of immune system and consequently decrease in antibiotic usage. ■

Combating health issues

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Every day new reports are published in newspapers worldwide reporting about the effects of antibiotic resistant bacteria and its consequence on human health.

The World Health Organisation (WHO) gives warning of unknown germs, but also makes us aware of known pathogenic bacteria, which have become resistant or dangerous due to changes in their DNA.

Animal production also contributed to the development of antibiotic resistance as antibiotics have been used as growth promoters in animal feed at sub-therapeutic levels for many years.

In Europe, where the use of antibiotic-growth promoters (AGPs) is prohibited, research has focused on finding alternatives to AGPs.

Acidifiers were moved into the centre of attention, as they are, amongst others, one of the most adequate alternatives to the use of antibiotics.

Acidifiers create, via the reduction of the pH, unfavourable conditions for potentially harmful bacteria. They also have direct antimicrobial effects as, in their non-dissociated form, they can penetrate into the bacterial cell inhibiting vital cellular functions, resulting in cellular death.

However, the effects of organic acids on the inhibition of pathogenic bacteria are somehow limited. Therefore, continuous effort is made in order to find an even more powerful way to combat bacteria. This was believed to be achieved by combining organic acids with essential oils as in literature synergisms when combining organic acids and essential oils are described.

Also, phytochemicals, which are defined as components of pure essential oils, are known to have antimicrobial effects.

This is clearly the case for cinnamaldehyde as it targets the so called FtsZ protein, which is responsible for the division of bacteria. Furthermore, cinnamaldehyde acts selectively, targeting pathogenic bacteria.

The most difficult part when it comes to combating pathogenic bacteria is, to combat Gram-negative bacteria, as their additional outer membrane is serving as an additional barrier against antimicrobials.

However, by using permeabilising substances, the outer membrane of Gram-negative bacteria can be weakened and the entry of antimicrobial substances, such as organic acids or/and a phytochemical can be facilitated.

In house research at Biomin has shown synergistic effects in vitro when a permeabilising substance was added to a mixture of organic acids and a phytochemical.

Combating pathogens in livestock production is of high importance to avoid economical losses, especially under the present market conditions, in which the pressure on producers is very high and achieving economical benefits difficult.

Therefore, new naturally derived products at reasonable prices have to be developed in order to more effectively combat bacteria and not only reduce adverse effects on livestock but also on humans. The combination of a blend of organic acids, a phytochemical and a permeabilising substance was shown to provide the possibility to meet these targets.

However, it has to be mentioned that if bacteria can be combated more effectively highly depends which substances and at which inclusion level the single substances are combined. ■

Mycotoxins: when maths and reality do not fit

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The effects of individual myco- toxins are well described in literature, but what about different mycotoxin combinations? Very often individual mycotoxins associated with poor live- stock performance and/or disease symptoms in commercial operations are usually lower than those reported to cause toxic effects in controlled research studies.

In the field, the response of affected animals to exposure to more than one mycotoxin can be the same as the response from each toxin individually (additive), more than the predicted sum of the responses from each individual mycotoxin (synergistic) and, more rarely, less than the predicted response from each toxin individually (antagonistic).

Aflatoxin B1 (AFB1) and ochratoxin A (OTA) are involved in most of the studies regarding synergistic interactions between mycotoxins in poultry. AFB1 as a hepatotoxin and OTA as a nephrotoxin were fed simultaneously to broiler chicks and the toxicity was synergistic. Three week old chickens had significantly greater relative weight of gizzards and kidneys as well as less weight gain compared to either mycotoxin fed singly. AFB1 acts in synergism with T-2 toxin as well.

Both mycotoxins affect protein synthesis, but by different mechanisms, which finally leads to synergistic effects between them. Body weight gain in 21 day old broilers was reduced by 16% by aflatoxin (Afla) alone, 11% by diacetoxyscirpenol (DAS) alone, and 36% by the combination of Afla and DAS, indicating a significant synergistic interaction between them. Cyclopiazonic acid (CPA) at 50mg/kg (ppm) interacted synergistically with Afla at 3.5mg/kg feed and adversely affected growth of treated birds.

The combination of OTA and CPA significantly reduced the levels of serum total protein, albumin, and cholesterol, whereas uric acid, triglycerides, and creatine kinase activity were increased by the combination of OTA and CPA.

The effect resulting from the interaction of OTA and CPA in combination was additive. Citrinin and penicillic acid were found to potentiate the nephrotoxic and carcinogenic effects of OTA, respectively.

Fusaric acid (FA) was shown to be mildly toxic to embryos and when a relatively non-toxic concentration of it was combined with graded doses of fumonisin B1 (FB1), a synergistic toxic response was obtained. Total body weight gains, final body weights and FCR of three week old broilers were significantly reduced by a deoxynivalenol (DON) / T-2 toxin combination but were not significantly affected by the toxins singly. The incidence and severity of oral lesions induced by T-2 toxin was increased in the DON/ T-2 toxin combination, which indicates a synergistic effect between these two mycotoxins. The increased toxicity in poultry fed the combination of FB1 (300mg/ kg) and T-2 toxin (5mg/kg) can best be described as additive, although some parameters not altered by FB1 or T-2 singly, were significantly affected by their combination. The additive effects (reduced BW gains, feed intake and impaired chicken immune function) of co-contamination of OTA and T-2 toxin have been reported.

All these combinations plus the fact that every year several new mycotoxins are 'discovered', tells us that a great deal of attention must be given to this issue. ■

References are available upon request

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Multispecies probiotic to reduce necrotic enteritis

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Necrotic enteritis (NE) is one of the world's most common and financially crippling poultry diseases which when triggered, can cause mortality rates of up to 50%.

NE and the subclinical form of Clostridium perfringens infections in poultry are caused by C. perfringens type A, that carry the newly identified netB toxin.

In the commercial poultry industry there are many management tools used to control enteric pathogens including antibiotics, vaccines, acidifiers, phytogenics, prebiotics and probiotics.

The use of specific probiotics and synbiotics have been shown to be an effective means of manipulating or managing the composition of the microbial population in the gastrointestinal tract of poultry and thus protecting poultry flocks from infections with pathogenic bacteria.

In view of the worldwide spreading ban of antibiotic growth promoters (AGPs) and the rising concerns of consumers with the use of antibiotics in animal production, the evaluation of alternatives to antibiotics, becomes more appealing to the commercial poultry industry.

In order to serve the needs of the industry Biomin initiated a multinational research project, which was funded by the European Union in order to develop a well defined, host specific, multispecies probiotic product for poultry. Numerous intestinal bacteria were isolated out of the gut of several healthy chickens and thoroughly characterised combining morphological, physiological and genotypic methods. The most promising strains were evaluated for important probiotic criteria.

Based on these results a probiotic product consisting of five well defined strains belonging to the genera Enterococcus, Pediococcus, Lactobacillus and Bifidobacterium was designed (PoultryStar, Biomin GmbH).

As the probiotic strains were able to inhibit Clostridium perfringens, the main causative agent of NE, in vitro with good reproducibility of results it was decided to evaluate the effect of the product on NE in the course of in vivo experiments.

A series of studies, which were conducted at the US Department of Agriculture (USDA), investigated the effect of the probiotic product on the development of experimentally induced NE in broilers. The researchers could show that the multispecies probiotic product was able to significantly reduce the lesion scores ($P<0.05$) in comparison to the NE challenged positive control group and even maintain the lesion scores, mortality and bacterial counts to the level of the unchallenged negative control birds.

Further experiments were carried out from a research group at the Faculty of Veterinary Medicine, Ghent University in order to study the effects of the multispecies probiotic product on the development of necrotic enteritis in broilers using a subclinical NE model to reproduce the disease. Results showed that in the probiotic group a significant ($P<0.05$) lower amount of birds showed necrotic lesions in comparison to the positive control group. In conclusion, the data of these studies suggest that the multispecies probiotic may be beneficial in the control of poultry dis- eases which are related to Clos-tridium perfringens like NE. ■

References available on request