PHYTOGENIC FEED ADDITIVES FOR A MORE RESILIENT POULTRY PRODUCTION

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"In the last decade, there has been an increased awareness about the risks associated with antimicrobial resistance development and this has resulted in a global trend to reduce or eliminate the use of in-feed antimicrobials in animal production. Phytogenic feed additives, containing bioactive compounds extracted from plants, serve a variety of functions that can contribute to improved health and productivity in poultry production."

Animal-based food products play an important role in the human diet. The poultry industry is the leading supplier of animal protein sources to the world. In 2020, the production of poultry meat (mainly chicken) represented almost 40% of global meat production, and the demand for poultry meat and eggs is expected to increase even further in the next decade (FAO). This calls attention to the significant impact that poultry pathogens can have on food security and the profitability of poultry production. The poultry industry is continuously challenged to optimise production and economic efficiency, while maintaining good animal health and food safety. Going forward, one of the main obstacles is the complete removal or gradual reduction of prophylactic or sub-therapeutic antimicrobials in feed.

THE ANTIMICROBIAL RESISTANCE (AMR) CRISIS AND THE POTENTIAL OF PHYTOGENICS

Apart from therapeutic use, antimicrobial drugs have been used in poultry production for the preventive treatment of entire flocks, and to improve growth performance and profitability of production. Unfortunately, the overuse of antimicrobial drugs has contributed to the development and spread of antimicrobial drug resistance. Already in 2006, the use of antimicrobials in animal feed for growth promoting purposes has been banned in European Union countries. The World Health Organisation (WHO) classified antimicrobial drug resistance as a global public health concern and, in 2015, a Global Action Plan on AMR was adopted which outlines objectives to decrease AMR under a "One Health" approach (WHO, 2023). The removal of antimicrobial drugs from poultry feed has resulted in challenges in maintaining intestinal health and consequently performance and economic efficiency. As such, it is important to find or develop non-antibiotic compounds as alternative and complementary strategies to promote resilience to disease in poultry.

In recent years, particularly phytogenic feed additives have gained an increasing interest as natural alternatives to antimicrobials in poultry production. Phytogenic feed additives are plant-derived compounds added to animal feed to increase pro-

duction efficiency by reducing pathogen pressure and improving health, improve feed properties such as palatability, or to improve the quality of animal products. Depending on their origin and processing method, phytogenic compounds can be classed into categories such as herbs (flowering, nonwoody, and nonpersistent plants), spices (non-leaf parts of plants with an intensive smell or taste), essential oils (volatile lipophilic compounds derived by cold expression or via steam or alcohol distillation), or oleoresins (extracts derived by nonaqueous solvents). The bioactive compounds and concentrations thereof in phytogenic feed additives may vary according to the part of the plant used for processing, geographical origin, harvesting season, and processing techniques (Windisch et al., 2008). Phytogenic feed additives have the ability to improve the production efficiency of animals directly via an antibacterial or antiparasitic activity, or indirectly due to their antioxidative properties and immunomodulatory effects, by stimulating digestive secretions, enhancing enzyme activity, and their positive effects on intestinal morphology, gut barrier integrity, and nutrient digestibility (Windisch et al., 2008; Abdelli et al., 2021; Biswas et al., 2023).

SAPONINS TO PROMOTE RESILIENCE AGAINST COCCIDIOSIS

Orffa, as an innovative feed solutions provider, has developed natural products to support poultry health. One of them is Excential Sapphire Q, a unique blend of *Quillaja saponaria* extract, a source of triterpenoid saponins, and an aluminosilicate. Among the many different bioactive compounds found in plants, saponins have been extensively studied due to their diverse biological activities. Saponins are found in many plant species and are known to be antimicrobial, antifungal, and to protect plants from insect attack (Francis et al., 2002). Consequently, saponin extracts from plants such as the *Quillaja saponaria* Molina tree have a wide range of applications in livestock production and can be used as antibacterial, antiviral, and antiparasitic agents, as well as vaccine adjuvants (Fleck et al., 2019). Saponins are amphiphilic molecules because they contain a lipophilic nucleus and hydrophilic carbohydrate side chains (Francis et al., 2002; Augustin et al., 2011). The hydrophobic part can integrate into the membrane of protozoa (such as *Eimeria* spp.), resulting in pore formation and cell lysis (Augustin et al., 2011; Fleck et al., 2019). This amphiphilic property positions saponin-rich plant

extracts among the promising approaches to control coccidiosis in poultry. Furthermore, apart from a direct anti-parasitic effect, *Quillaja* saponins can also enhance the immune responsiveness of broilers to the presence of *Eimeria* infection (Kensil, 1996; Barr et al., 1998).

Coccidiosis, caused by protozoan parasites of the genus *Eimeria*, is one of the most economically important disease challenges affecting broiler production worldwide. With a global cost estimated at US$13 billion or US$0.20 per bird (Blake et al., 2020). In order to replicate, these parasites invade the intestinal cells of the host, which results in tissue damage, impaired nutrient digestion and absorption, and compromised well-being and growth performance in broilers (Mesa-Pineda et al., 2021). Furthermore, coccidiosis is also associated with promoting secondary diseases such as necrotic enteritis induced by *Clostridium perfringens* (Lee et al., 2011). The extensive prophylactic use of anticoccidials has resulted in resistant *Eimeria* strains and loss of efficacy (Abbas et al., 2011). Vaccines, on the other hand, are expensive and, if managed incorrectly, can predispose the animals to subclinical coccidiosis and necrotic enteritis. In broilers, vaccines often do not lead to a timely build-up of immunity (Mesa-Pineda et al., 2021). Therefore, broiler producers are looking for new tools to add to their coccidiosis management strategy.

Recently, a trial was completed to study the effect of Excential Sapphire Q (Orffa Additives B.V.) in broilers raised on used litter. A total of 1152 one-day-old Ross 708 male broilers were divided over four treatments, each with 12 replicates:

- Positive control reared on clean litter, with no additive or anticoccidial in the feed (PC)
- Negative control reared on used litter, with no additive or anticoccidial in the feed (NC)
- NC with 60 ppm coccidiostat (salinomycin) added to the feed (NC+sal)
- NC Excential Sapphire Q, providing 30 ppm of *Quillaja saponaria* extract in the feed (NC+sap-al).

Used litter was generated by housing chicks that received a 10x dose of Coccivac® B52 via feed for two days and raised until 18 days of age to allow birds to shed oocysts. Litter was then mixed and redistributed into the trial pens.

In the trial period, between 22 to 24 days of age, oocyst excretion was reduced by 39.7% and 41.3% compared to negative control, when salinomycin or the saponin-aluminosilicate blend was fed, respectively, indicating a direct anticoccidial effect of these additives (Figure 1).

For the overall rearing period from 0 to 42 days, NC + sal had a higher body weight compared to NC, with the PC and NC + sap-al treatments being intermediate but not significantly different from the NC and NC + sal treatments (P = 0.030). For FCR,

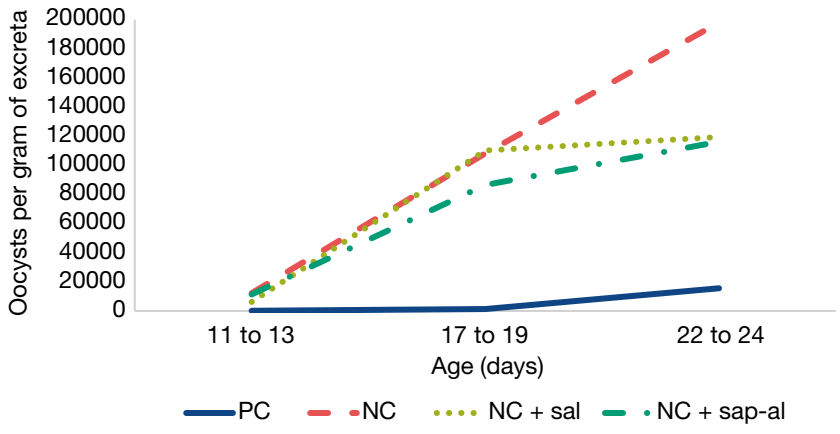

Figure 1. Effects of treatments on oocyst counts in excreta of broilers during three collection periods.

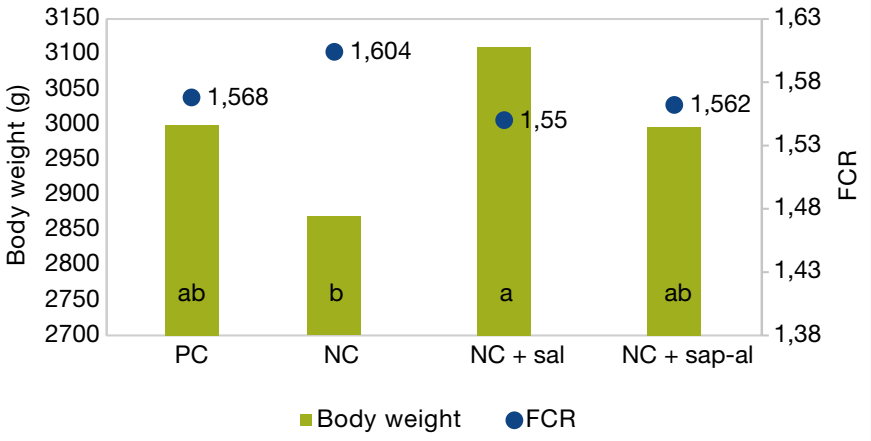

Figure 2. Effects of treatments on broiler body weight and feed conversion ratio (FCR) from 0 to 42 days of age.

from 0 to 42 days, the NC + sal and NC + sap-al treatments tended to improve the overall FCR compared to the NC treatment (P = 0.053) (Figure 2).

The results of the current study indicate that the saponin-aluminosilicate blend can promote the resilience to coccidiosis in broilers. Therefore, this blend can be implemented as a replacement of, or complementary strategy to anticoccidials to further reduce the negative effect of subclinical coccidiosis on growth and feed efficiency in broilers and reduce the costs associated with these performance losses.

GARLIC AND CINNAMON – A HEALTHY GUT FOR HEALTHY FOOD

Many foodborne diseases can be transferred through the food chain. The chicken gastrointestinal tract is a reservoir of many zoonotic pathogens which contribute to foodborne diseases, the most relevant being *Salmonella* spp. *Campylobacter* spp., *Enterococcus* spp., *Escherichia coli*, and *Staphylococcus aureus*. Antimicrobial products have played an important role to ensure the safety of poultry products. Therefore, the development of resistant bacteria is also a public health concern.

Another product from Orffa's range of natural feed additives is Excential Alliin Plus, a blend with a high concentration of the active compounds of cinnamon and garlic. Garlic (*Allium sativum*) has many different bioactive compounds, including the organosulfur compounds alliin and allicin, of which the latter is formed by the action of the alliinase enzyme on alliin. Historically, garlic has been used medicinally and has a wide range of health benefits, and therefore it has also been used extensively as a feed additive for poultry (Abd El-Ghany, 2024). Garlic has specific antibacterial properties, meaning that it can reduce the numbers of pathogenic bacterial populations in the gut such as *Escherichia coli, Clostridium perfringens,* and *Salmonella* spp., while beneficial intestinal bacteria such as *Lactobacillus* spp. are the least sensitive to the inhibitory effects of garlic (Rees et al., 1993).

Cinnamaldehyde is the main bioactive compound of cinnamon essential oils, obtained from the bark of aromatic cinnamon plants of the genus *Cinnamonum* (Friedman et al., 2017). Cinnamaldehyde has strong bactericidal effects against four major foodborne pathogens: *Escherichia coli*, *Salmonella enterica*, *Campylobacter jejuni*, and *Listeria monocytogenes* (Friedman et al., 2002). Apart from its antipathogenic effects, cinnamaldehyde has also been shown to increase intestinal epithelial barrier integrity and decrease paracellular permeability of porcine en-

terocytes. Furthermore, the protein abundance of amino acid transporters was enhanced which may lead to improved amino acid transport and absorption in animals (Sun et al., 2017).

In broilers, the effects of a combination of cinnamon and garlic powder (Excential Alliin Plus, Orffa Additives B.V.) was evaluated on reducing crop, cecal and environmental prevalence of *Salmonella* at the end of the rearing period. A total of 216 male broilers at 35 days of age were allocated to one of three treatments, each with 6 replicates:

- Control with no additive (CC)
- Garlic and cinnamon blend added to mash feed at 900 ppm (AP-F)
- Garlic and cinnamon blend added to drinking water at 1 g/L (AP-W)

At 7 days post placement, the birds were challenged with *Salmonella* Typhimurium (STM) via oral gavage. The effect of Excential Alliin Plus on the STM challenge was measured in the litter of each pen and sampled by using intermittently stepped-on drag swabs. Litter was classed as 'high prevalence' if STM recovery was higher than 10^2 CFU/mL via direct plating. If STM was recovered only after enrichment, the litter samples were classed as 'low prevalence'. STM was also measured in cecum and crop samples.

Although all litter tested positive for STM, the AP-W treatment had the lowest prevalence at 6 days post challenge as there was no recovery of STM with direct plating (Table 1).

Table 1. Number of pens within each treatment group with a high or low prevalence of STM 6 days post infection.

Treatments	High prevalence	Low prevalence
CC	2	4
AP-F	3	3
AP-W	0	6

With regards to the cecal recovery of STM at 7 days post challenge, a reduction of over 1 log CFU was observed for the AP-F (1.49) and AP-W treatment (1.85) compared to the control treatment (3.07). At 12 days post challenge a reduction in the CFU of STM of around 0.6 log was observed in the ceca of birds receiving the garlic and cinnamon blend via feed or drinking water compared to the control. Also in the crop a reduction in STM of over 1 log CFU was observed at 12 days post challenge with AP-W (0.23) and AP-F (0.15) compared to the control (1.39) (Figure 3).

These results suggest that the bioactive compounds in garlic and cinnamon may help to reduce the prevalence of environmental and crop/cecal colonized *Salmonella* in chickens prior to processing, and may therefore reduce the risk of transmission to poultry meat for consumption.

TO CONCLUDE

Due to the dissemination of AMR and an increasing consumer pressure for animal products raised without antibiotics, there is a global trend to reduce or restrict the usage of in-feed antimicrobials in animal production. The poultry industry faces many difficulties in maintaining optimal health and performance of animals without antimicrobial usage. Phytogenic feed additives are among the promising approaches to promote a more sustainable and healthy poultry production. Plant extracts containing saponins for example, have interesting anti-parasitic activity, while the bioactive compounds from garlic and cinnamon can reduce the numbers of pathogenic bacteria in the intestinal tract.

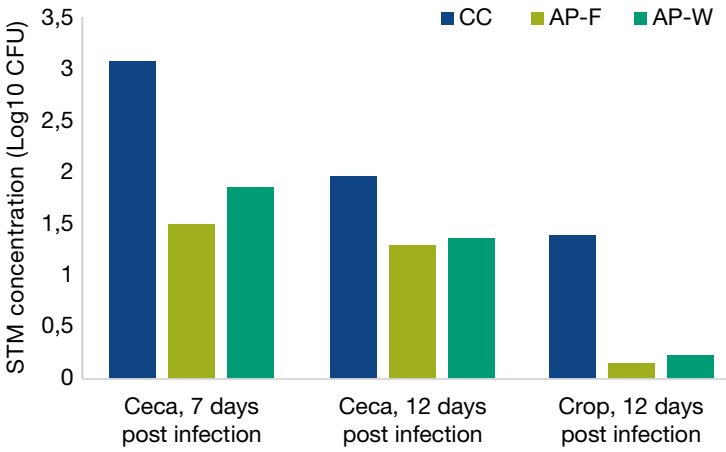

Figure 3. STM recovery in samples of the ceca and crop at 7 and 12 days post infection.

About Madri Brink

Madri Brink joined Orffa as a Central Technical Manager in 2022. She holds a Ph.D. in Veterinary Sciences at Ghent University (Belgium). In collaboration with the ILVO in Belgium, her research focused on source-oriented nutritional and management strategies to reduce ammonia emission from broiler production. She also holds a Master's degree in Bioscience Engineering at the KU Leuven (Belgium), a B.Sc. Honours degree in Agriculture, with specialisation in Animal Nutrition, as well as a B.Sc. Agriculture degree, both at the University of the Free State (South Africa).