Essential oils and organic acids in broilers

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In poultry production, feeding represents a large part of the total production cost. Consequently, both public and private research institutes continuously investigate feed additives that benefit the birds' zootechnical performance and ensure a good return on investment for the producers.

In the last 15 years, this research topic has gained even more interest in the light of the search for alternatives to antibiotic growth promoters after the ban of the latter in the European Union as well as the general worldwide trend to use more natural products. In this context, this article is focused on the synergy between essential oil compounds and organic acids in poultry production.

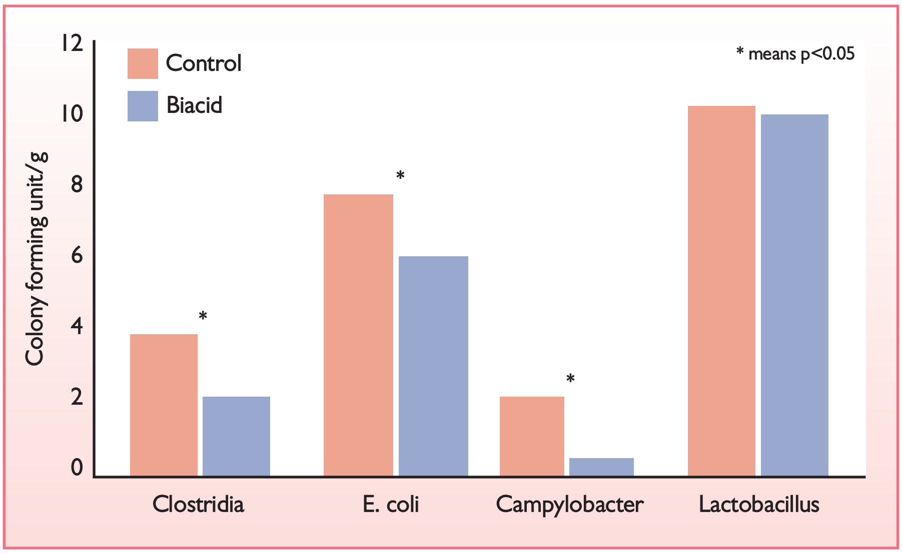

Fig. 1. The effect of a commercial mixture of OA and EO components on the counting of some specific bacteria in the upper part of the intestinal tract.

Definitions

Essential oils (EOs) are volatile oils obtained from plants by distillation methods, usually steam or hydrodistillation.

Among the most known effects of essential oil compounds such as thymol, eugenol, carvacrol, cinnamaldehyde, linalole and cineole, Kamel (1999) reported the stimulation of digestion, antioxidant activity, antimicrobial properties and stimulation of feed intake.

An organic acid (OA) is an organic compound with acidic properties. Weak acids such as acetic, propionic, lactic and sorbic acids have been used in preservation of foods for generations.

On top of their important role as an acidifier per se, it has been shown by several groups that high concentrations of acetic, propionic and butyric acids are produced in the large intestine through fermentation and they can inhibit the growth of pathogens that encounter them in the intestinal environment.

Organic acids such as butyrate are also key nutrients for the intestinal cell growth and proliferation. Therefore, they can play an important role in intestinal wall development and reparation.

The efficacy of the combination of EOs and OAs on digestive tract function and subsequently on growth and feed utilisation may be based on their ability to better balance the gut microflora and to stimulate digestive process.

Mode of action

The mode of action of antimicrobial effects of EO compounds and OAs still deserves to be investigated. However, it is known that the efficacy of these molecules depends on their ability to cross the lipid layer of micro-organisms.

EO compounds have the ability to perforate the lipid bilayer of pathogens, increasing the cell wall permeability. Once EOs are inside the micro-organism's cytoplasm, they can damage the genetic material, preventing cell replication.

For example, thymol and carvacrol are reported to increase the membrane permeability of bacteria cells, causing leakage of various substances such as ions, ATP, nucleic acids and amino acids.

They also interfere with the enzyme system, thereby interrupting cell metabolism. Increased cell wall permeability leads to leaking of cell contents and increased osmotic stress. Undissociated OAs can cross the cell wall and dissociate inside the cell lowering the pH. The pathogenic cell expends energy pumping out hydrogen ions in an attempt to maintain its pH. Dissociated anions further damage both DNA and enzyme systems within bacteria cells.

Reports indicate that EOs containing carvacrol, eugenol, thymol, cinnamaldehyde and citral have the highest antibacterial performance.

In broilers, in vivo antimicrobial efficacy of EOs on E. coli and Clostridium perfringens was demonstrated. Furthermore, in a review made by Windish et al., 2007, it is mentioned that some phytogenic feed additives have been shown to act against Eimeria species (coccidia) after experimental challenge. In layer hens, Bölükban and Erkan, 2007 have shown that thyme herbs significantly decrease the total E. coli count in faecal samples.

Furthermore, Ordonez et al., 2008, have demonstrated that dietary eugenol can decrease the contamination of eggs with Salmonella enterica.

Looking at OAs, bacterial cells take up undissociated fatty acids and once these dis-

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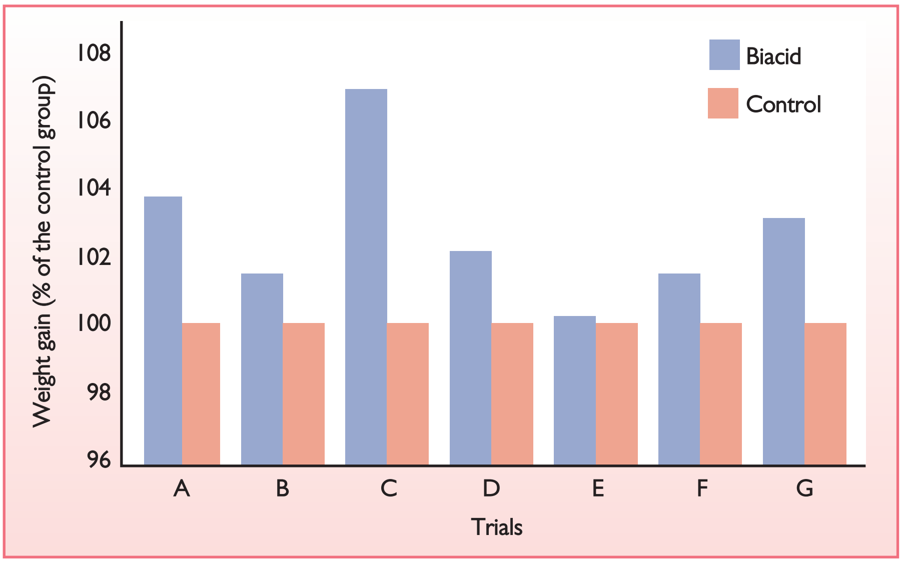

Fig. 2. Compilation of trials performed in various parts of the world in commercial farms or research centres that show the effect of a commercial mixture of EO and OA on the weight gain of broilers.

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sociate, the change in intracellular pH is usually bactericidal. Therefore, a correlation is seen between pathogen control and the presence of undissociated levels of acetate, propionate and butyrate.

Synergistic effect

Since both EO compounds and OAs display antimicrobial activity, it is worth looking at the potential synergistic effects of these two types of molecules. In vitro trials, performed by TNO in the Netherlands have demonstrated that the combination of OA and EO compounds displays higher antimicrobial effects on E. coli and Streptococcus suis than the single molecules. In 2008, an in-vivo trial was performed in Hungary to test the effect of a commercial blend of EO and OA on the number of bacteria in the broiler intestinal tract (Fig. 1).

In this product, the EOs and OAs were carefully selected to display the best efficacy. The number of colony forming units of campylobacter, clostridium and E. coli was significantly reduced in broilers fed the combination product in comparison to the control group.

In addition, no significant effect of the treatment was observed on lactobacillus which could suggest a positive change of the gut microflora balance from harmful bacteria towards bacteria that contribute to a healthy intestine.

According to Platel and Srinivaran, 2000, an important part of the nutritional action of EO is the stimulation of the secretion of bile, mucus and digestive enzymes.

In above mentioned trial (Fig. 1) performed in Hungary in 2008, in broilers fed a commercial EO and OA combination product, the digestibility of threonine and starch were increased by 3% and 1.5% in comparison with the control group, respectively. In this trial, the dietary inclusion of Biacid significantly increased the activity of amylase in broilers.

Furthermore, OA and EO antimicrobial activity into the jejunum and ileum would also be critical for an optimal nutrient utilisation. In fact, lower microbial proliferation in the jejunum may reduce the competition of the microflora with the host for nutrients.

As explained by Windish, (2007), improved digestible capacity in the small intestine may be considered as an indirect side effect of feed additives stabilising the microbial eubiosis in the gut.

An improved pre-caecal digestive capacity reduces the flux of fermentable matter into the gut and thus lessens the post-ileal microbial growth and the excretion of bacterial matter in faeces.

As bacterial protein is the dominant fraction of total fecal protein, an improved pre-caecal digestive capacity results indirectly in an increased apparent digestibility of dietary protein.

The efficacy of the combination of EOs and OAs on the digestive process and eventually on general gut integrity could consequently lead to an improvement of the litter score.

A trial was performed in the Netherlands to compare the litter score of broilers fed a negative control diet without antibiotics with a group fed a positive control diet with 10ppm of avilamycin and a third group fed a diet with Biacid.

The litter score was improved when using this product in comparison to the negative control group.

This improvement is at the same level as the one observed in the positive control diets with avilamycin. In the same trial, mortality was also significantly decreased in chickens fed the combination of EOs and OAs compared to the negative control group.

In broilers fed with a blend of EOs and OAs such as Biacid, intestinal function is better preserved. Consequently the birds may be less exposed to the side effects of microbial toxins and undesired microbial metabolites. In turn, the absorption of essential nutrients would be improved leading to a better feed conversion ratio and a better growth rate.

In addition, if stress occurs and health is under pressure, the animal is also better prepared to handle it, which is, for example, shown through a reduction of the occurrence of wet litter.

The following addresses the in vivo efficacy of EO and OA on growth, feed efficiency, litter quality and other important zootechnical parameters.

Improving growth

Many years of research in Provimi have shown that the supplementation of a mixture of EOs and OAs can contribute to an improvement in growth (Fig. 2) and FCR.

The various trials, done in different countries all over the world, with different basal diets, show that this effect is independent from the genetic of the animal and the basal diet. It is also interesting to compare the efficacy of Biacid with that of antibiotics.

Fig. 2 shows that broilers fed this product perform at the same level as those fed with avilamycin. Furthermore, in some trials it was observed that together with an improvement of growth, the homogeneity of the flock was significantly improved.

Recently, a trial was performed in The Netherlands to monitor the effect of this product. Ross 308 male broilers were fed consecutively two basal diets: a starter diet from 0 to 14 days and a grower diet from 14 to 35 days containing 20.7 and 19.8% of protein, respectively, and 2969 and 3090 Kcal/kg AMEn.

Other nutrients were provided according to the Provimi nutrient requirements. The Biacid group was fed with the basal diet containing 1kg/T of this product replacing corn throughout the starter and growing period. Environmental temperature, humidity and ventilation were computer controlled.

Over the whole trial period, the addition of Biacid increased body weight gain and feed intake by 3 and 2%, respectively.

Between 14 and 35 days, growth was increased by 3.4%. In the Biacid group, corrected feed conversion ratio was reduced by 2.7%. The average improvement in growth and feed utilisation is very comparable to the average found in the compilation of studies (Table 1).

Conclusion

Both in vitro and in vivo studies show that EO compounds and OAs have interesting antimicrobial properties. They are also known in the literature to improve the digestive processes. Based on these facts and on in vivo observations, it can be concluded that Biacid is a strategic tool to help the animal to reach good zootechnical performances. ■

References are available from the author on request
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Table 1. Effect of a mixture of EO and OA on growth and FCR.

Treatment	Control	Biacid	Improvement with Biacid (%)
No. of replicates	6	6	
Gain (0-35 days) (g)	2232	2298	+2.9
Feed intake (0-35 days) (g)	3496	3571	+2.1
FCR corrected*	1,493	1,454	-2.7

Correction of -0.01 for each 25g extra weight