Nutrition and intestinal integrity in poultry

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Intestinal integrity for commercial poultry can be defined as the maintenance of intestinal health for maximum utilisation of dietary nutrients to express the full genetic potential for growth and yield. The genetic potential of today's commercial poultry makes it even more critical to maintain an optimal intestinal integrity to maximise productivity.

Intestinal health problems are noticeable in commercial poultry operations by the presence of wet litter, reduced feed intake, loss of performance, poor uniformity, poor feathering, huddling, and increased mortality. From the nutritional point of view, it is important to recognise the feed quality, the incidence of ingredients and the nutritional decisions such as quantity and quality of protein on the intestinal integrity and the selection of feed additives.

Feed quality

● **Mycotoxins and gastrointestinal health.**

In addition to the typical damages caused by mycotoxins in poultry, they can decrease performance by affecting the gastrointestinal integrity of the birds. Trichothecenes are especially toxic to the mucosa of the digestive tract, affecting oral mucosa, gastric mucosa, gastric granular epithelium, and intestinal crypt cell epithelium. Ingestion of fusarium mycotoxin contaminated feed decreased villus height in the duodenum and jejunum. Mycotoxins can also affect the nutrient digestion and absorption in the intestine, intestinal secretions of enzymes, alter intestinal motility, and they could enhance some pathogens colonisation.

The most practical prevention of mycotoxin problems is the use of an effective, in vivo scientifically proven, mycotoxin binder in the diet.

● **Oxidised fat.**

Fats and oils have the potential to become oxidised and the resulting rancid fats compromise digestibility and can cause gastrointestinal disturbance, wet litter and changes in gut microflora, with the consequent negative effect in poultry performance. Rancid fat increases cell turnover in the intestine and reduces the barrier function of the villi. The use of a good antioxidant, such as ethoxyquin, can completely prevent the damages produced by oxidised fat.

Feed formulation

● **Anticoccidial additives.**

Effective control of coccidiosis is necessary for optimal poultry performance. The presence of mild or sub-clinical coccidiosis, especially those caused by Eimeria acervulina and Eimeria maxima, is an important contributing factor in increasing the population of Clostridium perfringens in the intestine with the risk of developing a subclinical or even a clinical form of necrotic enteritis. Eimeria sp. colonisation of small intestine creates intestinal mucosal damage, providing natural substrates – plasma proteins – for C. perfringens proliferation.

The commonly used ionophores anticoccidials monensin, lasalocid, narasin, salinomycin, and maduramycin are not only good preventive dietary additives against coccidiosis but also have a limited anti-clostridium effect.

● **Protein.**

Protein quantity and quality are important to maintain gastrointestinal health. On the other hand, intestinal health affects the ideal amino acid profile in broilers by increasing the threonine requirement. High levels of protein, especially animal protein, can contribute to the prevalence and severity of clostridial enterotoxaemia.

Soya is the largest source of protein in poultry diets and heat inactivation of the naturally occurring trypsin inhibitor is crucial to the bird's ability to efficiently digest the protein component of this ingredient. Inadequate heat treatment of full-fat soya and soybean meal or high levels of inclusion can lead to enteritis and wet litter.

Digestible amino acid formulation using ideal amino acid profile is the most efficient and economical system to provide adequate quantity and quality protein for optimum growth and muscle tissue accretion in poultry.

● **Feed ingredients.**

There are several ingredients that contribute significantly to the proliferation of Clostridium perfringens in the small intestine, precipitating outbreaks of necrotic enteritis.

Dietary inclusion of cereal grains rich in water soluble non-starch polysaccharides, such as wheat, barley, and rye without using effective enzymes, increase intestinal mucus secretion and ingestal viscosity creating an excellent medium for Clostridium growth.

The utilisation of ingredients high in indigestible oligosaccharides (raffinose, stachiose, and verbascose) such as beans, lupin, and soya can also promote the proliferation of Clostridium due to the ability of these anaerobic bacteria to utilise these oligosaccharides.

Use of antibiotics

Traditionally, the use of antibiotics in the feed has been the best option to maintain intestinal health. They create changes in the microflora, increase nutrient absorption, and reduce maintenance of the intestinal epithelium. The type of ingredients used in the diet has a great influence in the performance response to the inclusion of AGPs. Thirty years ago at Washington State University the magnified effect of AGPs when used in diets containing non-traditional ingredients was demonstrated.

However the excessive and prolonged use of antibiotics in poultry production has caused the appearance of resistant bacterial strains worldwide, affecting performance and overall poultry health status. As a consequence, there has been an increase in digestive problems associated with infections by clostridium, E. coli and salmonella.

Alternative product

Concerns about microbial resistance due to the use of antibiotics in feed

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Table 1. Performance of Ross males at 42 days of age fed a corn-soy diet.

Treatment	Bodyweight (g)	FCR (%)	Mortality (%)	Productive index
Bacitracin 55ppm	2426[b]	1.80[a]	6.62	300[b]
Acidifier 1000ppm	2442[b]	1.78[a]	4.41	312[b]
Citrex[1] 125ppm	2506[a]	1.79[a]	2.21	326[a]

Values within a column with different letters differ significantly (P< 0.05)
[1]Citrex powder in the feed

Table 2. Performance of Cobb males at 42 days of age fed a corn-soy diet.

Treatment	Bodyweight (g)	FCR (%)	Mortality (%)	Productive index
Control	2180[b]	1.81[a]	3.33	277[b]
Flavomycin 4ppm	2252[ab]	1.78[ab]	3.33	292[a]
Citrex[1] 100ppm	2284[a]	1.75[a]	2.59	302[a]

Values within a column with different letters differ significantly (P< 0.05)
[1]Citrex powder in the feed

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has generated a search for alternative products to act both as prophylactics against enteric pathogens and as growth promoters. Citrex, an organic complex resulting from the activation of vitamin C with citric and lactic acids protected by a glycerin matrix acting as carrier, represents an excellent option as a growth promoter and to control the spread of pathogenic bacteria in the avian gastrointestinal tract.

Growth promoter.
Results of using Citrex as a growth promoter are presented in Table 1, 2 and 3. Experiments were conducted at the University of Antioquia, Medellin Colombia 2002; Southern Poultry Research, Athens, GA, USA, 2002; and IDA-UNAM, Mexico 2004.

All experiments showed that Citrex was an effective growth promoter in broilers whether the product was added to the feed or to the drinking water.

Necrotic enteritis control.
A study was conducted at Southern Poultry Research in Athens, GA, USA, in 2008 to evaluate the anticlostridial efficacy of Citrex.

After an experimental challenge with Clostridium perfringens results in Table 4 indicate that broilers treated with Citrex in the drinking water or in the feed showed a statistically significant improvement in body weight, feed conversion, lesion score and mortality caused by necrotic enteritis compared to those receiving non-medicated feed.

Birds treated with Citrex and an AGP showed statistically similar performance, lesion score and mortality caused by necrotic enteritis.

Treatment	Bodyweight (g)	FCR (%)	Mortality (%)	Productive index
Control	2660[c]	1.86[b]	3.33	282[b]
Avilamycin 10ppm	2760[a]	1.78[a]	2.50	308[a]
Citrex[1] 150ppm	2704[b]	1.81[a]	5.00	288[b]
Citrex[1] 200ppm	2708[b]	1.80[a]	2.50	299[a]

Values within a column with different letters differ significantly (P< 0.05)
[1]Citrex powder in the feed

Table 3. Performance of Ross x Cobb males at 49 days of age fed a corn-soy diet.

Summary

Intestinal integrity for poultry can be defined as the maintenance of intestinal health for maximum utilisation of dietary nutrients to express the full genetic potential for growth and yield.

It is important to recognise the incidence of ingredients and the nutritional decisions such as quantity and quality of protein or the use of oxidized fat on the intestinal integrity and the selection of feed additives.

Traditionally, the use of antibiotics in the feed has been the best option to maintain intestinal health; however the excessive use of antibiotics in poultry production has caused the appearance of resistant bacterial strains worldwide.

Concerns about microbial resistance due to the use of antibiotics in feed has generated a search for alternative products to act both as prophylactics against enteric pathogens and as growth promoters. Citrex represents an excellent option as growth promoter and to control the spread of pathogenic bacteria in the avian gastrointestinal tract. ■

Table 4. Performance and necrotic enteritis of broilers at 28 days.

Treatment	Day 12-28		Necrotic enteritis	
	BWG (g)	FCR (%)	Lesion score (0-3)	Mortality (%)
Control	739[a]	1.65[a]	0.00[a]	0.00[a]
Control + Clostridium	587[b]	2.06[b]	0.67[b]	12.50[b]
Clostridium + Citrex Liquid 200ppm	742[a]	1.60[a]	0.00[a]	1.80[a]
Clostridium + Citrex Powder 400g/ton	733[a]	1.65[a]	0.05[a]	1.80[a]
Clostridium + Virginiamycin 22g/ton	681[a]	1.67[a]	0.00[a]	0.00[a]

Values within a column with different letters differ significantly (P< 0.05)
At 14 days of age all chicks were only orally inoculated with 5000 oocyst of Eimeria maxima per bird. At day 19 (5×10^7) day 20 (1.8×10^7) day 21 (1.5×10^8) all chicks, except those in the control, were given a broth culture of Clostridium perfringens.