Issue 11 • Poultry
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Science & Solutions

Phytogenic potential

Defending health with antioxidants

Photo: Ugurhan Betin

Mycotoxin-induced lesions

Understanding mycotoxicosis is a key step towards proper diagnosis

WORLD NUTRITION FORUM
2014
SUSTAIN: ABILITY

Poultry in focus

Nutrition, gut health and sustainable broiler production at the World Nutrition Forum

Editorial

Spice it up!

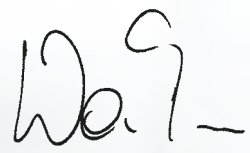
Oxidation is not a foreign concept to those working in poultry husbandry. Whether you are a nutritionist in charge of feed formulation, or a vet ensuring the health and wellbeing of the flock, or further along the supply chain as part of product quality control, you would have heard of oxidation.

Remember that time a rancid oil spoiled your batch of feed? Or those inflamed intestines when you perform necropsies on birds? Oxidation is part of every cell's metabolism and usually occurs when oxygen comes into contact with other substances and loses electrons (free radicals). In living beings, free radical generation is intentional and massive, and is an important mechanism that protects the organism from viruses and bacteria. Problems occur when the body cannot handle excessive free radicals. Lipids—especially phospholipids in cell membranes—are susceptible to oxidative damage, which contributes to the role of free radicals in cell inflammation and diseases.

The fact that we use herbs and spices to condiment our food is not a random act. In fact, a large study conducted and published by Paur *et al.* (2011) showed that the categories 'spices and herbs' and 'herbal/ traditional plant medicine' included the most antioxidant-rich products.

Biomin acknowledges this ancient wisdom and applies it to animal nutrition. In this issue you will read about how additives of plant origin (phytogenics) can improve the organoleptic characteristics of the feed whilst improving poultry performance and health.

We hope that you will reflect on this issue when you next use oregano in your pizza, add more chilli in your *tom yam* or marinate your meat with rosemary. And we hope that you will see the value of applying the same concept to your poultry feeds.



Franz Waxenecker
Director Development Department

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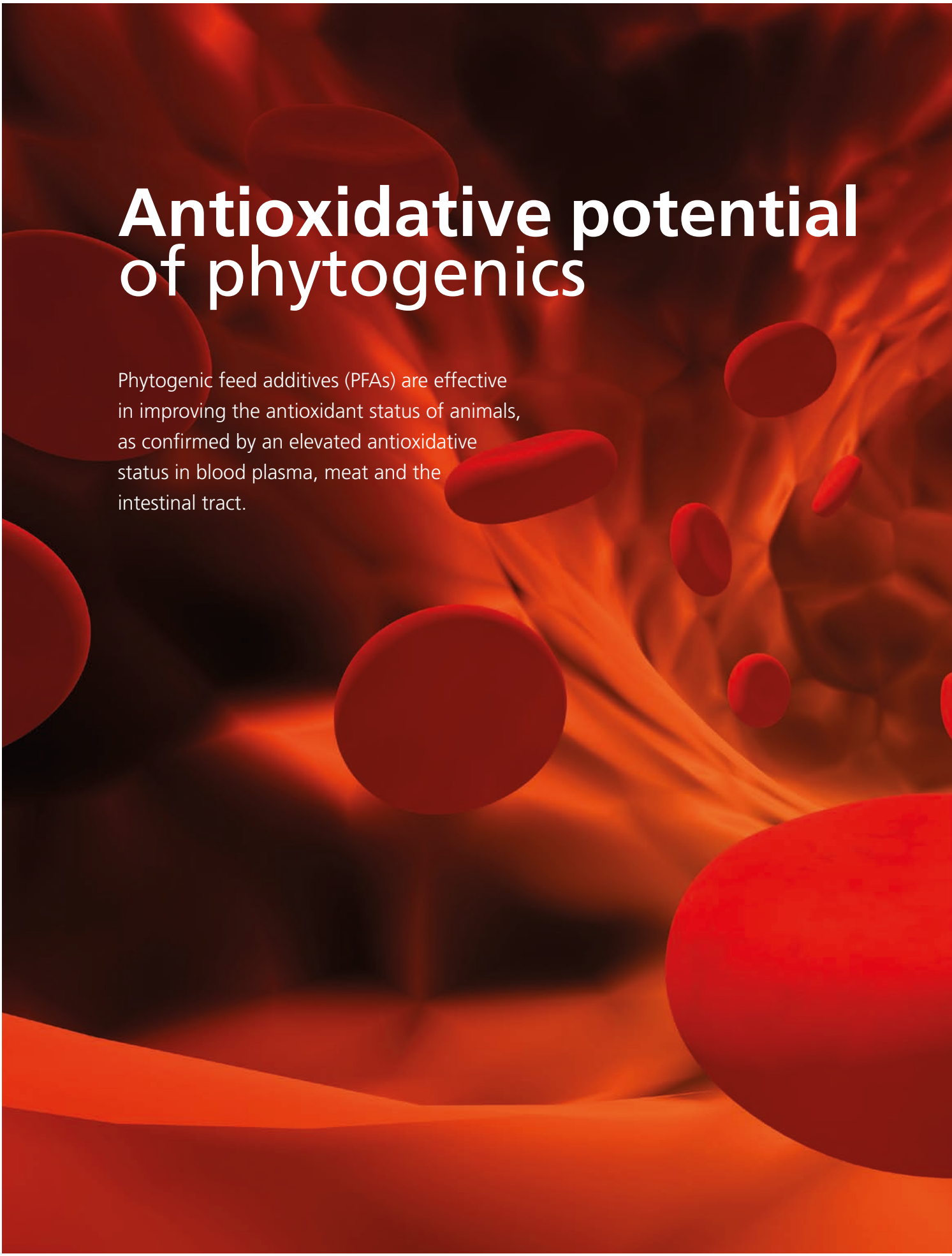
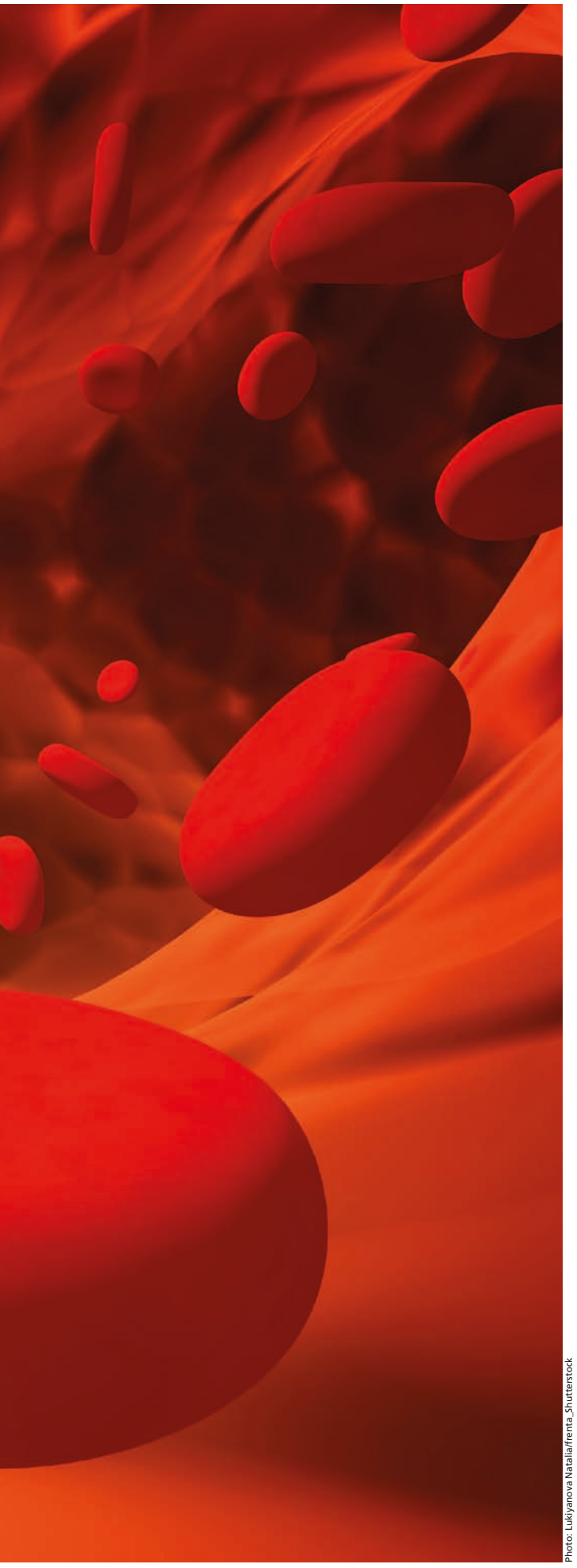


Antioxidative potential of phytogenics

Phytogenic feed additives (PFAs) are effective in improving the antioxidant status of animals, as confirmed by an elevated antioxidative status in blood plasma, meat and the intestinal tract.

Basharat Syed
Product Manager



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Antioxidants are naturally occuring substances that can protect an animal organism from harmful influences. They prevent oxidation reactions termed as oxidative stress. Antioxidants, being a defense system *in vivo*, comprise several defense lines. The main defense line inhibits the formation of free radicals and reactive oxygen species by isolating metal ions while destroying superoxide and singlet oxygen, reducing hydrogen peroxide and hydro peroxides in every cell of the organism.

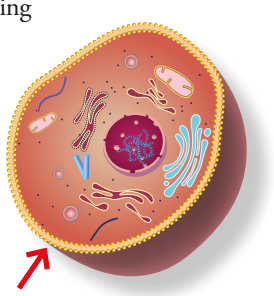
Performance losses and decline in livestock production as a result of the damage by free radicals and oxidative stress have become major issues and the subject of much research and concern in recent years. Free radical damage and oxidative stress are not diseases but are often the by-products of normal cellular processes.

Counteracting free radicals

Much attention has been paid in recent years to the involvement of free radicals and active oxygen in aging and in disease processes such as like inflammation, arthritis, heart disease, impairment of the immune system and cancer. Oxidative stress is an imbalance between increased levels of reactive oxygen species (ROS) and reduced antioxidant activity. Increased oxidative stress can potentially destroy tissues and induce damage to cellular structures.

Natural antioxidants are widely accepted worldwide and preferred to synthetic antioxidants. Aeschbach *et al.* (1994) reported that thymol, carvacrol and 6-gingerol possess useful antioxidant properties and may become very important in the search for "natural" replacements of "synthetic" antioxidant food additives.

The antioxidative properties of certain phytogenic substances have been attributed to the phenolic terpenes in their essential oils. Plants high in terpenes include oregano, rosemary

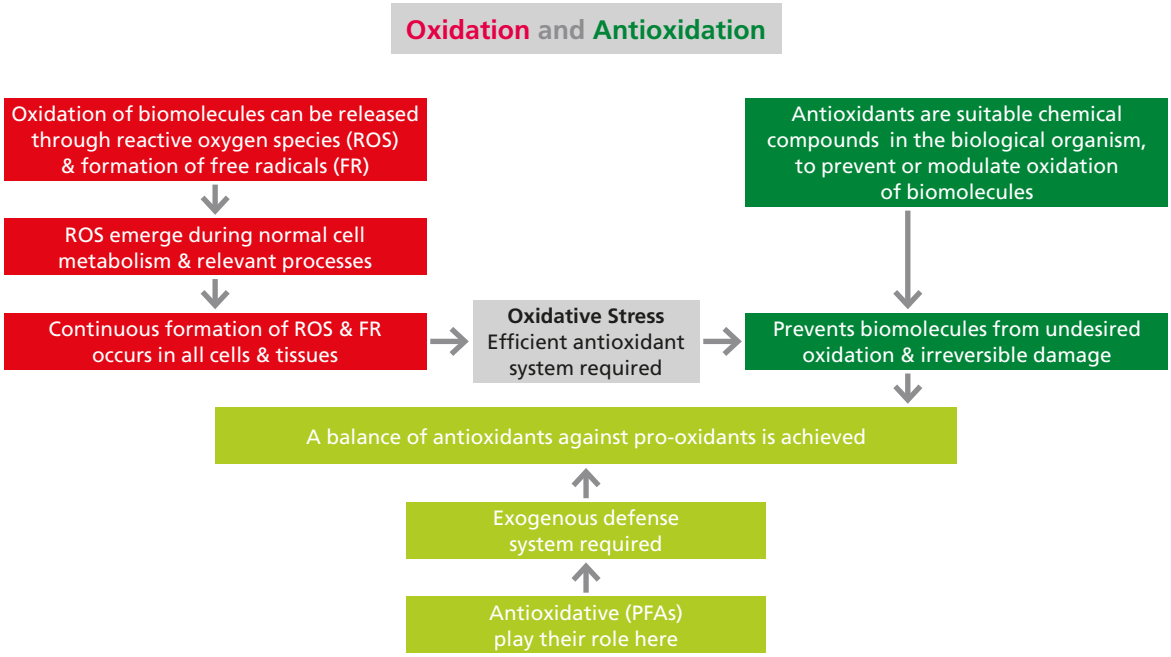


Oxidative stress is an imbalance between increased levels of reactive oxygen species (ROS) and reduced antioxidant activity.
Increased oxidative stress can potentially destroy tissues and induce damage to cellular structures.

Illustration: Ivcandy_iStockphoto

Basharat Syed
Product Manager

Figure 1. The interplay: Antioxidation versus oxidation.



and thyme. The essential oils from plants e.g. of the *Labiatae* family have been used at large as antioxidants in human and pet foods with high fat content.

Evaluating the influence of feeding *Artemisia annua* on muscle lipid oxidation products in broiler chickens, Cherian *et al.* (2013) recommended *A. annua* as a natural phytogenic feed additive (PFAs) with antioxidant potential for use in poultry diets. Luna *et al.* (2013) reported the usefulness of natural phenols (main components of essential oils) as contained in thymol and carvacrol to delay lipid oxidation, which is the main cause of nutritional and organoleptic deterioration of birds' meat.

Restricting antioxidative processes is of prime importance for proper animal health, growth, production and economic feasibility. Based on the available literature to date, PFAs comprising single or combinations of components offer a significant potential as a new generation of feed additives with pronounced antioxidative capacity for progressive and healthy food animal production.

When more ROS are formed than the antioxidants are able to intercept, the outcome is oxidative stress, the cause of many chronic diseases.

Biomin has not only considered the performance data by the supplementation of its phytogenic product line Digestarom® but also its influence on antioxidative processes in the intestine and meat.

Oxidation and Antioxidation

To explain antioxidation simply, an antioxidant binds potentially dangerous free radicals (FR) and pulls them out of circulation. A radical bound in this way cannot cause any more damage to the organism. When more ROS are formed than the antioxidants are able to intercept, the outcome is oxidative stress, the cause of many chronic diseases.

There are a variety of mechanisms for antioxidation, namely endogenous and exogenous (nutritional). However, all of them have the same positive effects counteracting harmful substances. As long as there are enough antioxidants available, free radicals pose no serious problem to the organism. But if too many free radicals are formed and not removed, all the biological structures suffer lasting damage. Therefore, it is absolutely useful and often necessary to support the animal through a variety of positive measures that are effective, valuable and at the same time, natural. *Figure 1* represents the interplay between antioxidants and pro-oxidants.

Antioxidative effects of phytogenics

In addition to the pronounced anti-inflammatory properties of phytogenic compounds in the digestive tract, protective effects of phytogenic compounds may also re-

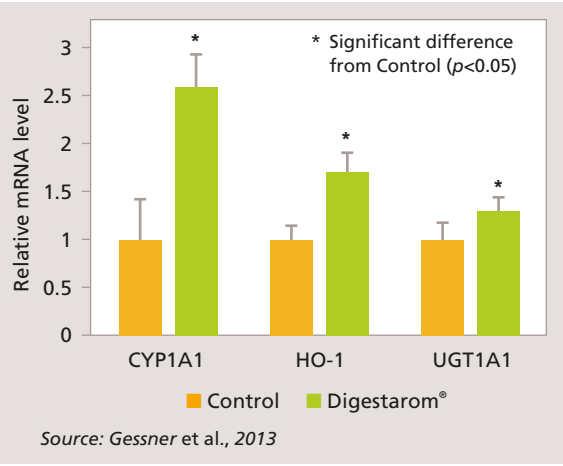
The effects of Digestarom® in intestinal cells

- Down-regulates inflammatory processes (NF-κB)
- Up-regulates antioxidant gut protection (Nrf2)

Source: Gessner et al., *2013*

Photos: Digitalpress-Fotolia

Figure 2. Antioxidative effect of Digestarom® (up-regulation of Nrf2 target genes).



Source: Gessner et al., *2013*

sult from their antioxidative properties. Antioxidative effects were reported for a large number of plant substances.

An important cellular element is the transcription factor Nrf2. Activation of the Nrf2 pathway leads to the activation of genes responsible for cellular defense against ROS and detoxification of xenobiotics (chemical substances foreign to an organism). The PFA Digestarom® was found to upregulate Nrf2 target genes, i.e. cytochrome P450 isoform 1A1 (CYP1A1), heme oxygenase-1 (HO-1) and UDP glucuronosyltransferase isoform 1A1 (UGT1A1), thus providing further evidence of the protective effects of phytogenic compounds at the cellular level (*Figure 2*).

Therefore, the regular supplementation with PFAs through the diet may act as prophylactics against inflammatory reactions in the gastrointestinal tract by inhibiting the NF-κB pathway and stimulating the antioxidative transcription factor Nrf2.

Antioxidants and meat quality

Dietary antioxidants are recognized not only for their beneficial effects in the animal's digestive tract, but also for their positive influence on meat quality.

Oxidation of lipids during food processing and storage is crucial because polyunsaturated lipids oxidize and form hydroperoxides which are vulnerable to further oxidation and/or decomposition to secondary reaction products such as short-chain aldehydes, ketones and other oxygenated compounds. These may adversely affect the overall quality of food including taste, flavor, nutritional value, concentrations of toxic compounds and shelf-life.

The effects of dietary essential oil (*Zataria multiflora*) supplementation on the microbial growth and lipid peroxidation of broiler breast fillets during refrigerated storage were studied by Javan *et al.* (2012). They concluded that essential oil delayed the peroxidation and microbial spoilage of chicken breast fillets. Similar results were reported for chicken meat, turkey meat and fish using different phytogenic compounds.

In an experimental trial with broilers at the University of Athens, Greece, Mountzouris *et al.* (manuscript in preparation) observed that including the PFA Digestarom® P.E.P. in corn-soybean meal basal diets resulted in significantly ($p<0.05$) higher plasma and total antioxidant capacity of the meat as determined by the oxygen radical absorbing capacity (ORAC) method.

Perspectives

The antioxidative efficacy of Digestarom® additives has been shown under *in vitro* and *in vivo* conditions. These PFAs are effective in improving the antioxidant status of animals, as confirmed by an elevated antioxidative status in blood plasma, meat and the intestinal tract.

Enabling healthy meat production with enhanced storage quality is an added bonus to improved animal performance.

References are available upon request.

Differential diagnosis of mycotoxin-related GIT lesions in poultry

Mycotoxins are always present in animal feeds, although at varying levels, and affect different systems such as the gastrointestinal tract (GIT) and visceral organs.

Mycotoxins produce a variety of diseases, collectively known as "mycotoxicosis", directly or in combination with other primary stressors such as pathogens. These diseases are exhibited by symptoms and lesions, which can be used to clinically diagnose the presence of mycotoxins.

However, these lesions are not just specific to mycotoxins and are also caused by diverse nutritional, management and pathogenic conditions. Hence it is significant to differentially diagnose these symptoms—i.e. to distinguish a disease or condition from others presenting with similar signs—before arriving at a conclusion. This article reviews the differential diagnosis of various conditions that cause similar lesions as mycotoxins in the GIT of chickens.

Mycotoxic lesions

The GIT is the first system exposed to the effects of mycotoxins upon ingestion. T-2 toxin (T-2), HT-2 toxin, deoxynivalenol (DON), monoacetoxyscirpenol (MAS) and diacetoxyscirpenol (DAS) from the Fusarium-derived trichothecenes group, and cyclopiazonic acid (CPA) from either *Aspergillus flavus* or *Penicillium fungi*, are the primary mycotoxins that affect the GIT. These mycotoxins are capable of causing oral lesions, crop necrosis, gizzard erosion, proventriculitis, inflammation of epithelial mucosa and intestinal hemorrhage.

Raj MURUGESAN
Poultry Specialist

Table 1. Conditions that may be related to lesions in the GIT.

Nutritional	Management	Pathologic
Copper	Quaternary ammonium compounds (QAC)	Thrush/ Candidiasis
Zinc	Starvation	Pseudomembranous ingluvitis/ Aspergillosis
Choline chloride	Hatching stress	Helminthiasis
Sulfur amino acids	Debeaking	Histomoniasis/ Blackhead disease
Deficiency of Vitamins A, E, B6, Biotin		Coccidiosis
Biogenic amines		Clostridium colinum infection
Fishmeal		Clostridium perfringens infection
Feed structure (mash/ pellet)		Avian poxvirus
Feed composition (fiber content)		Avian adenovirus

T-2 and DAS have a more caustic effect compared to other toxins in the group, and produce lesions in the mouth (tongue, beak, palate) as well as erosion in the gizzard. The gizzard is the primary organ affected by DON. At high concentrations, DON affects the gizzard by increasing gizzard weight and causing gizzard erosion. Other mycotoxins that affect the gizzard and cause gizzard ulcers include moniliformin and fumonisin B_1 and B_2.

CPA affects the mucosa of the proventriculus and causes proventriculitis. These mycotoxins dissolve the protoplasm of cells in the mucosa, and the presence of saliva in mouth for instance, facilitates their adherence to the mucosa. Upon their absorption through intestines, they are translocated into the circulation and reach back to the oral cavity through saliva, again causing secondary lesions in the mouth and possibly in the gizzard.

What causes lesions?

There are a variety of conditions, of either non-pathogenic or pathogenic origin, that cause lesions in the GIT. The majority conditions of non-pathogenic etiology are contributed by either nutritional causes or management procedures, while the pathologic etiologic agents include living organisms such as fungi, protozoa, bacteria and virus. Some of the frequent conditions that should be ruled out when considering mycotoxicoses are listed in *Table 1*.

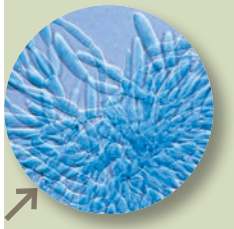
Diagnosis

When GIT lesions are detected in the field, an effective differential diagnosis will help determine the measures to be taken to control the condition. Under commercial conditions, it is difficult to associate these lesions with only one etiologic agent, since they represent the result of the combination of several agents including mycotoxins, which are more prone to act along with a major causative agent.

Several published experiments have demonstrated potentiation of the negative effects (not only in terms of lesions in GIT) caused by the association between mycotoxins and the agents listed here, such as biogenic amines, gizzerosine, *Aspergillus fumigatus*, *Clostridium spp*., and reovirus, etc. Hence, there is no doubt that feed contamination with mycotoxins play an important role in causing these lesions in the GIT.

The routine testing of feed samples for mycotoxins, as well as an understanding of the effects of mycotoxicosis, will be a good start towards preventing such lesions.

Lesions in the oral mucosa are caused by T-2 toxin.



Fusarium spp. is one of the main sources of mycotoxins that affect the gastrointestinal tract.

WORLD NUTRITION FORUM

MUNICH 2014
15-18 October

SUSTAIN: ABILITY

Poultry

1. Nutrition and gut health

Gut health is the backbone of performance for poultry and plays a critical role in influencing animal productivity.

This session looks at the parameters of gut health and how probiotics prevent osteomyelitis and lameness in poultry. The adverse effects of mycotoxins and sub-clinical challenges on gut health are also discussed.

2. Sustain:able broiler production

Are sustainable practices business savvy and profitable? A resounding YES!

This session explores sustainable feeding practices by sharing the success stories, feeding strategies and the results on broiler production, by two of the world's biggest broiler meat integrators—CP Foods of Thailand and Tyson Foods of the US.

Also topical are how Europe's move away from antibiotics has impacted broiler feeding trends, and the use of a practical tool, Ovali, for assessing sustainability.

A tradition of the **World Nutrition Forum (WNF)** since 2010, the species-specific Breakout sessions address timely topics in poultry farming and other animal production sectors.

Each four-hour long Breakout session covers two topics. Sessions for each species are held in parallel on the afternoon of the first day (Thursday, 16 October 2014).

The World Nutrition Forum, sponsored by Biomin, is a premier biennial industry event where leading professionals, scientists and decision-makers gather to brain-storm and exchange ideas and strategic prospects on the future of animal nutrition. To be held in Munich, Germany, the WNF 2014 will explore the theme of "sustain:ability".

For up-to-date information, please visit **www.worldnutritionforum.info**.

What's wrong with my birds?

Part 2: Gizzard lesions

Cut & Keep Checklist

Science & Solutions presents a handy checklist for diagnosing poultry mycotoxicosis.
Cut this out and take it along with you to the farm!

Diagnosing common poultry ailments correctly and precisely can be a challenge even for experienced vets, nutritionists or farm managers. In the case of mycotoxin-related problems, differential diagnosis can be especially difficult as symptoms vary greatly. The following table provides an overview of the potential causes and a checklist of corrective actions; however, please exercise due caution and discretion in use.

	Potential cause	Description of problem	Check list	Corrective actions
MYCOTOXINS	Cyclopiazonic acid (CPA) Deoxynivalenol (DON) and/or T-2 toxin (T-2)	Lesions develop in the proventriculus, gizzard, liver and spleen. The proventriculus is dilated and the mucosa is thickened and sometimes ulcerated.	☐ Positive for CPA, DON and/or T2 in raw materials (ELISA) or feed (HPLC) ☐ Raw materials originating from supplier/ region with history of CPA contamination ☐ Histopathology: Proventriculus hyperplasia of mucosa with heavy infiltration of lymphocytes ☐ Overall decline in flock performance	☐ Check average contamination levels ☐ Use Mycofix® at a correct dosage level ☐ Avoid feed bins or feed/ water lines that have become contaminated by stale, wet or moldy feed
MANAGEMENT	Copper sulphate	$CuSO_4$ can promote gastric lesions especially at the gizzard level.	☐ Concentration of $CuSO_4$ in premix ☐ Concentration of $CuSO_4$ in water ☐ Water dosing system is working properly (if applicable)	☐ Apply group B vitamins and K_3 vitamin to the water ☐ Correctly set-up the water dosing system
	Acetylsalicylic acid and sodium salicylate	Use of salicylates may induce proventriculus and gizzard ulceration.	☐ Dosage of salicylates used (check overestimation of feed intake in feed restricted animals) ☐ Mixability of commercial product in water	☐ Avoid low quality products (low mixability, low homogeneity in water) ☐ Adjust the feed intake of feed-restricted animals
NUTRITION	Biogenic amines (Gizzerosine)	Low quality/ over-processed fishmeal can result in high levels of gizzerosine. Hyper-production of HCl in the proventriculus causes erosions in the gizzard.	☐ Level of gizzerosine in raw materials (especially fishmeal)	☐ Lower the level of fishmeal in diets ☐ Avoid using low quality fishmeal ☐ Replace standard fishmeal with low temperature (LT) fishmeal
	Rancid fats	Low quality fats (long storage, overheating) can contain high levels of superoxide radicals and hydroxyl radicals.	☐ Quality of fats in term of peroxide value, rancidity and free fatty acids	☐ Avoid low quality fats ☐ Use low quality fats in the grower/ finisher phases ☐ Replace animal fats with vegetable fats
	Tannins	Toxic levels of tannins in the feed cause oesophageal and gastric edema, hemorrhagic ulceration, necrosis and sloughing of the mucosal lining.	☐ Level of tannins in some raw materials (sorghum) and in tannin-based products	☐ Use high quality tannin-based product (chestnut is preferred to quebracho) ☐ Reduce % of sorghum in high-tannin diets
PATHOGENS	Adenovirus serotype 1	Vertically transmitted, usually sub-clinical but provides more exposure to secondary bacterial infection. • Group I is exhibited through inclusion body hepatitis (sudden onset of mortality, typically 10% and rarely up to 30%) or hydro pericardium (same symptoms as IBH, but severe mortality at 20-80%). • Group II is exhibited through hemorrhagic enteritis and marble spleen disease in turkeys, and avian adenovirus group II splenomegaly in chickens. • Group III affects most poultry due to the egg drop syndrome.	☐ Isolation of serotype I, II or III from the lesions by serological assays	☐ Use inactivated vaccines (only available for group 1) ☐ Check the breeding stock and eliminate affected birds
	Infectious bursal disease (IBDV/ Gumboro)	IBDV is very immunosuppressive and causes lesions at the junction of the proventriculus-gizzard.	☐ Maternal antibody titers are very low in day-old chicks	☐ Implement/ correct vaccination program in breeders ☐ Change from mild- to strong-reaction vaccine ☐ Correct vaccination age (Deventer formula) ☐ Increase biosecurity level

For more information, visit **www.mycotoxins.info**

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Better digestion for *better feed efficiency*

Add the power of Phytogenics to your diet:

- A unique blend of herbs, essential oils and functional flavors
- Proven in science and practice
- Tailored to the animal's needs

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