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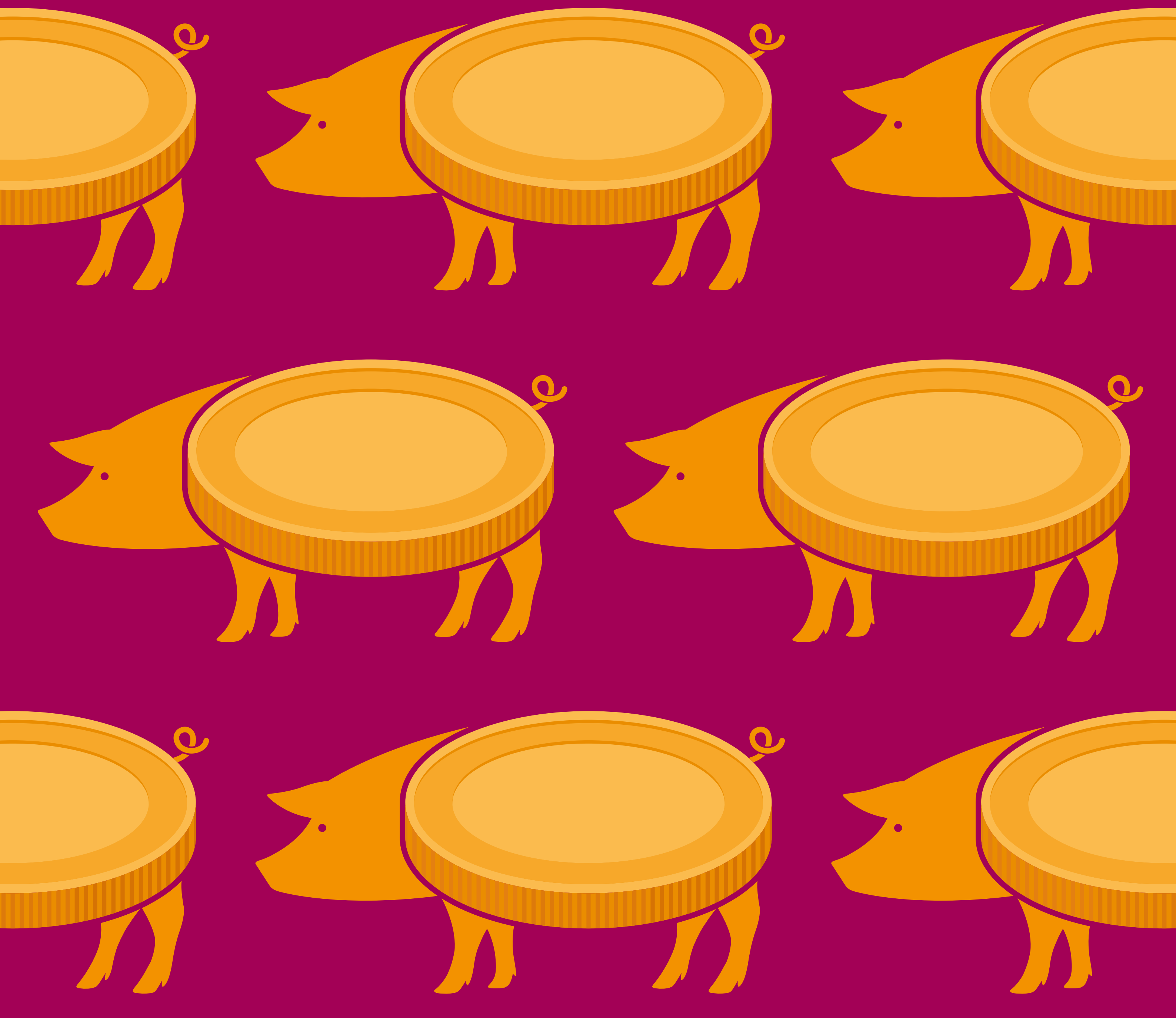
Keeping you naturally informed | Issue 64 | Swine

How to improve weaned piglet performance naturally

The effect of mycotoxins on swine fertility

Nutritional strategies to prevent postpartum dysgalactia syndrome in lactating sows



Profitable piglets and performance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Challenges in pig production: new and old

There is a constant demand for profitability and productivity in pig production, and producers must overcome challenges old and new to reach these goals.

In this issue of Science & Solutions, we will show you how to overcome these production challenges. The current tendency is to use antibiotics more prudently and stop using them as growth promoters. This creates the need to validate alternative natural nutritional additives.

One of the stages where we are most concerned with controlling health challenges is the post-weaning stage. In this edition, we will show you how using a combination of products based on organic acids, permeabilizing complexes and phytogenic additives can give consistent results, maintaining performance and controlling enteric challenges. These results make good productivity possible with fewer antibiotics and lower ammonia emissions.

We will show you how mycotoxins are an old challenge that interferes with fertility in breeding stock. Good management of mycotoxin risks will improve the reproductive indices that are critical to highly productive stock.

Postpartum dysgalactia syndrome (PDS) is another significant challenge to the breeding herd, reducing colostrum and milk production, and increasing piglet mortality in the farrowing unit. One way to minimize this problem is to use phytogenics in the breeding stock, as they can reduce the incidence of PDS by modulating the microbiota, which improves gut health and also provides other benefits.

Farms that manage to control these challenges will be more productive, and probably more profitable.

Enjoy reading this issue of Science & Solutions, keeping you naturally informed.

Borges

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How to Improve Weaned Piglet Performance Naturally with Organic Acids and Phytogenic Feed Additives

Piglets are especially susceptible to infectious diseases because of their immature immune systems, and piglet health must to be protected to ensure the future success of the herd. When added to the diet, a combination of organic acids and phytogenic feed additives can combat a wide range of bacteria, supporting gastrointestinal tract development and promoting optimal piglet performance.

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Pig production today has to overcome major challenges, such as reducing the therapeutic use of antibiotics and cutting ammonia emissions. Producers also have to struggle with the inconsistent availability and increasing price of raw materials.

Feed formulation is a delicate process that must balance the nutrient requirements of the animal at each stage of production with the nutritional value of various raw materials and ingredients, while bearing price and availability in mind. Sustainable feeding, based on selected feed additives that increase nutrient digestibility and modulate the microbiota, can help to manage gut performance and improve profitability in pig production.

IN BRIEF

- Organic acids combat Gram-negative bacteria. PFAs combat Gram-positive bacteria.
- Combining organic acids and PFAs in piglet diets combats the widest range of diarrhea-inducing bacteria.
- The combination of organic acids and PFAs also reduces the need for antibiotics, increases protein digestibility and reduces ammonia emissions.

Challenges in pig production

Factors that affect pig performance and productivity include:

- Genetics
- Housing (temperature, stocking density, air flow and ventilation, regrouping policy)
- Health of the animals (birth weight, vitality, immune status)
- Environment (pathogen load in pens, biosecurity)
- Water availability (flow rate, quality) and biofilms in water pipes
- Nutrition (feed components, particle size, dietary fiber, protein content and amino acid balance, energy density, anti-nutritional factors)
- Presence of mycotoxins and endotoxins (gut integrity, contamination levels, period and extent of intake).

Other stress factors, such as environmental changes, feed changes, vaccinations and transportation, can affect animal health and performance. Feed contaminants like mycotoxins disrupt the barrier function of the gut, creating opportunities for the invasion of bacteria and endotoxins.

Low endogenous acid and enzyme secretion, coupled with an immature immune system, make piglets highly susceptible to infectious diseases. Reduced feed intake and dysbiosis are the result of these challenges, especially after weaning. Post-weaning diarrhea is linked to poor protein digestion and an overload of bacteria in the gastrointestinal tract (GIT). Pathogenic toxins can cause intestinal inflammation, resulting in high energy losses (up to 30%) and negative effects on growth.

Natural feed additives support gut health in weaned piglets

It is very important to find sustainable solutions that combine various strategies to control pathogens like *E. coli* and clostridia. Strict biosecurity, an appropriate feeding regime and good mycotoxin risk management are all crucial in modern pig production. Feed additives, such as mycotoxin deactivators, organic acids, phytogenics, probiotics and prebiotics, and enzymes, help modulate the GIT, controlling pathogens, supporting the immune system and improving nutrient digestibility. These preventive tools reduce the risk of dysbiosis, inflammation and scour in weaned piglets.

There is growing public concern over the spread of bacterial resistance and its repercussions on animal and human health, so natural feeding strategies that can help reduce the need for antibiotics are highly sought after.

Organic acids in piglet feed

Organic acids are well known for their ability to modulate the intestinal microbiota in pigs, which has a positive effect on gut health and performance, so organic acids are very commonly added to piglet diets.

Free organic acids can:

- Reduce the microbial and fungal contamination that causes feed spoilage
- Reduce the buffering capacity of the diet
- Reduce feed pH
- Reduce the pH in the upper part of the piglet GIT

The positive effect of acidifiers depends on the type and concentration of the product.
Various studies have demonstrated that acidifying piglet diets can reduce coliform counts throughout the GIT, reducing scours and mortality. Organic acids have a positive effect on the growth of *Lactobacillus* in the GIT, which may competitively inhibit *E. coli* proliferation.

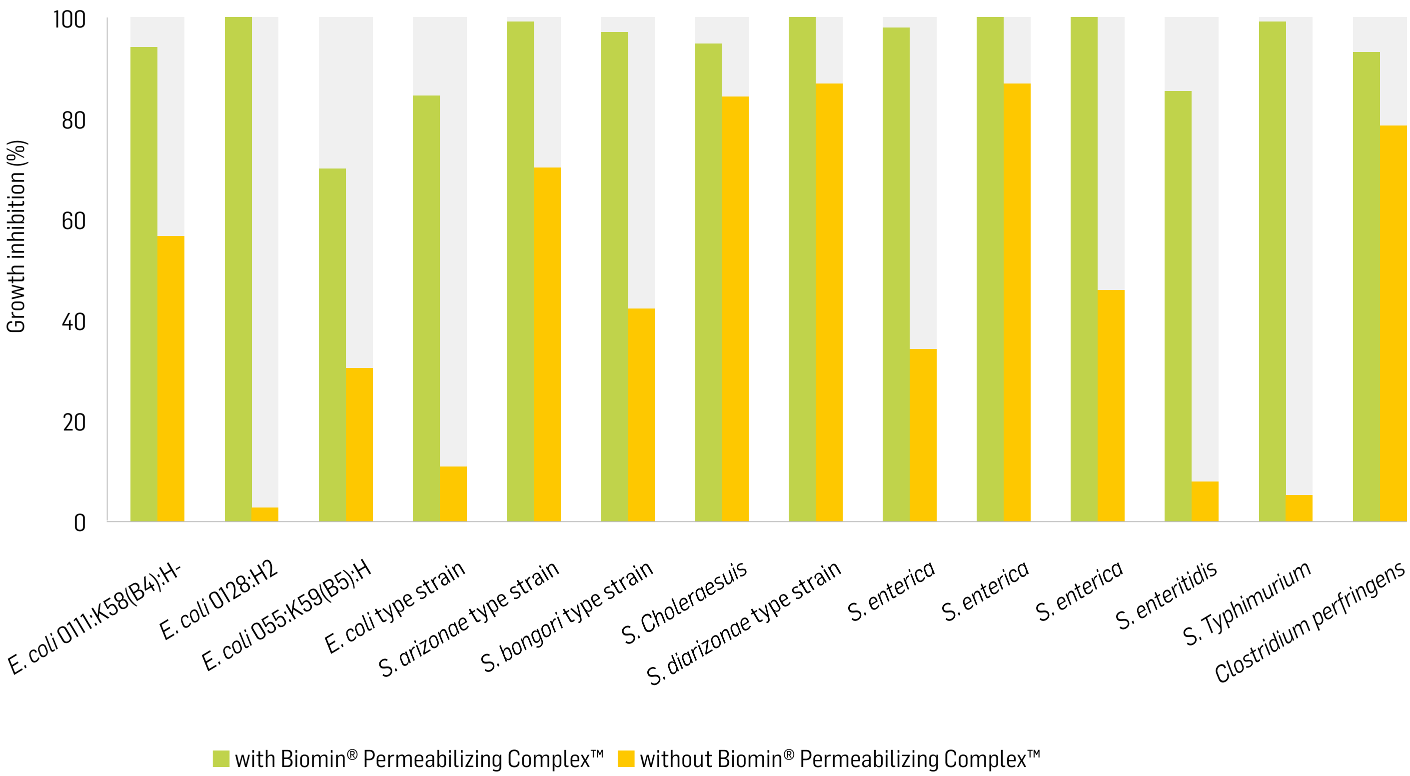
Organic acids, e.g., formic, propionic, lactic, benzoic, butyric and acetic acid, are used individually or as a blend in swine diets. The level of dietary acidification and pH reduction depends on the diet's composition and the quantity of organic acid.

Combining various organic acids, and using acid blends instead of individual organic acids, has become increasingly common, as using organic acids in combination broadens their spectrum of activity. The antimicrobial effect of a blend of formic and propionic acids on *Salmonella* and *E. coli* was up to 24% better than the efficacy of the individual acids.

Combining various organic acids, and using acid blends instead of individual organic acids, has become increasingly common.

Figure 1.

Bacterial inhibition by an organic acid mixture (formic acid, acetic acid, propionic acid and cinnamaldehyde) with and without the Biomin® Permeabilizing Complex™



Source: BIOMIN, 2010

There is also growing evidence to suggest that some essential oils or their phytochemical constituents, and permeabilizing substances, can act synergistically with organic acids. The permeabilizers generally have no bactericidal effect themselves, but they can weaken the outer membrane of Gram-negative bacteria and facilitate the action of other antimicrobials on the bacteria. These synergistic effects have been confirmed in Biotronic® Top3 (*Figure 1*).

What makes Biotronic® Top 3 unique?

The Biotronic® product line combines selected organic acids and a phytochemical substance with the unique Permeabilizing Complex™ blend. The special carrier in the solid forms of the Biotronic® Top product line, also called the sequential release medium, starts to release the active substances in the feed, as well as in the GIT.

The Permeabilizing Complex™ boosts the activity of the active ingredients in both the product and the feed, and helps them pass through the membrane and into the cytoplasm of Gram-negative bacteria.

In vivo trials confirm efficacy

Several studies have demonstrated that adding a feed additive based on a blend of organic acids and a phytochemical, combined with Permeabilizing Complex™ (Biotronic® Top3, BIOMIN), to piglet diets enabled levels of other acids to be reduced due to its boosting effect. Feed palatability is improved and feed intake by weaned piglets increases.

In a German field trial with 380 weaned piglets, 6 kg of a product based on formic acid salt was replaced by 1.5 kg of Biotronic® Top3 per ton of feed. The feed also contained other standard acids that were included at the same rate for both the trial and control groups. The trial demonstrated that

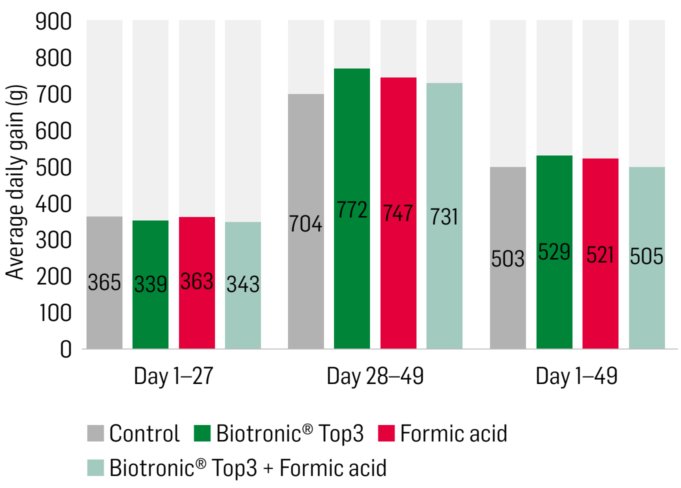
Table 1.

Trial groups and treatments

Trial group (TG)	Feed treatment
Control group	Standard feed
TG I	Standard feed + Biotronic® Top3 at 1.5 kg/t of feed
TG II	Standard feed + formic acid at 6.0 kg/t of feed
TG III	Standard feed + Biotronic® Top3 at 1.0 kg/t of feed + formic acid at 3.0 kg/t of feed

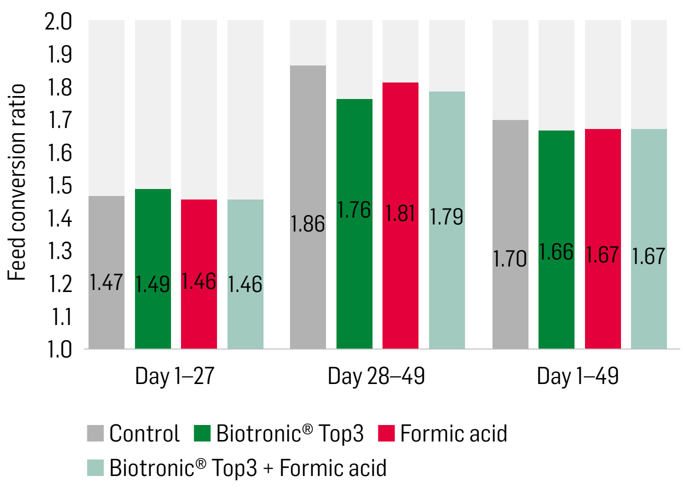
Source: BIOMIN

Figure 2.
Average daily gain (g) in the four treatment groups



Source: BIOMIN

Figure 3.
Feed conversion ratio in the four treatment groups



Source: BIOMIN

weaned piglet growth improved when potassium diformate in the feed was replaced by Biotronic® Top3. Average daily gain increased by 8.4% and feed conversion improved by 2.1% in the trial group.

Another trial was carried out at the Center of Applied Animal Nutrition in Mank, Austria: a total of 84 weaned piglets [(Landrace x Large White) x Pietrain] were allocated to 12 pens with seven piglets each (four groups, with three pens per replicate) and were assigned to one of four treatments. All piglets were fed a two-phase diet during the trial period: a starter diet, which was fed from day 0 to day 14, and a grower diet, fed from day 15 until the end of the trial. The trial lasted 49 days. The trial groups and treatments are shown in *Table 1*.

The results demonstrated that growth was better in the groups given feed supplemented with Biotronic® Top3 alone or in combination with formic acid.

From day 1 to day 27, the average daily gain (ADG) was very similar in the different trial groups (TG), ranging from 359 to 365 g, except in TG III, which had an ADG of 348 g. Between day 28 and day 49, ADG was highest in TG I. Over the whole trial period, the ADG of TG I was 5.2% better than the control group, 1.5% better than TG II and 4.8% better than TG III (*Figure 2*).

Feed intake per piglet per day was higher in TG I than all the other trial groups. Feed conversion ratio (FCR) from day 1 to day 27 was poorest in TG I; 1.4% higher than the control group and 2.1% higher than TG II and TG III. However, from day 28 to day 49, the FCR of TG I had dropped to the lowest level out of all the treatment groups; 5.4% lower than the control group, 2.8% lower than TG II and 1.7% lower than TG III. Over the whole trial period, FCR was again best in TG I (*Figure 3*).

Based on the cost-benefit analysis, net income was highest in TG I, resulting in a return on investment of 1:6.85. Moreover, having extra space in the feed formulation allows greater flexibility regarding the inclusion level of raw materials to optimize nutrient levels and costs. Other feed additives can be used to improve growth further and support animal health.

Organic acids + phytogenics = the perfect match to manage gut performance

Organic acids are mainly effective against Gram-negative bacteria but other bacteria often cause post-weaning diarrhea, so it is useful to combine organic acids with other feed additives that can help to control Gram-positive bacteria (e.g., *clostridia*, *staphylococci*, *streptococci*).

Phytogenic feed additives (PFAs) are some of the most common additives to be paired with organic acids. Various PFAs are commercially available in the feed industry, including essential oils, nature-identical products, herbal extracts and their complexes, and their effects on piglets vary, depending on their formula.

In addition to the flavoring and antimicrobial properties of complex PFAs, they also stimulate endogenous enzyme secretion and improve the digestibility of nutrients, especially proteins and amino acids. They can reduce the effects of stress by down-regulating the release of inflammatory proteins and/or increasing the production of cytoprotective protein .

Phytogenic feed additives (PFAs) are some of the most common additives to be paired with organic acids.

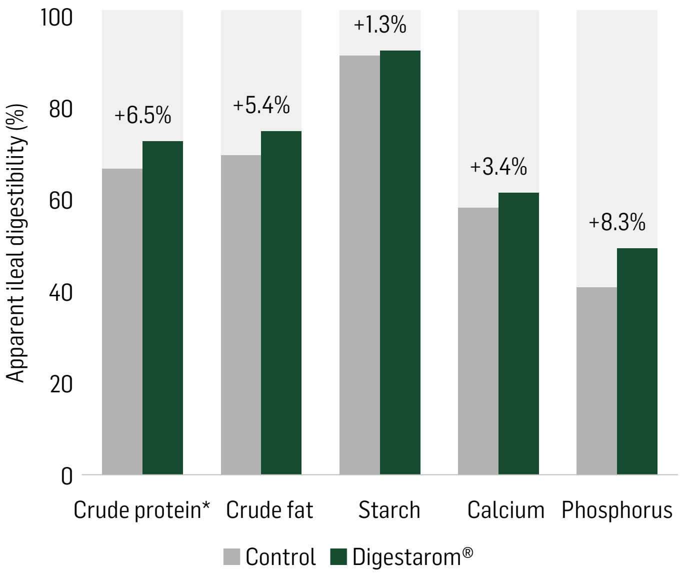
Complex PFAs reduce inflammatory processes and improve nutrient digestibility

The complex PFA Digestarom® modulates the gut microbiota, has anti-inflammatory and anti-oxidative effects, and improves digestion.

In vitro studies with Digestarom® demonstrate that it inhibits the pro-inflammatory transcription factor NF-kB, counteracting inflammatory processes. It also promotes transactivation of the 'gut protection marker' Nrf2, stimulating antioxidant enzyme expression.

A digestibility study conducted at the Free University of Berlin demonstrated that Digestarom® increased the digestibility of proteins, amino acids and other nutrients in piglets (*Figures 4* and *5*). Fewer undigested nutrients remained in the GIT, so gut health improved and ammonia emissions were reduced.

Figure 4.
Effect of Digestarom® on apparent ileal digestibility of crude protein, fat, starch, calcium and phosphorus



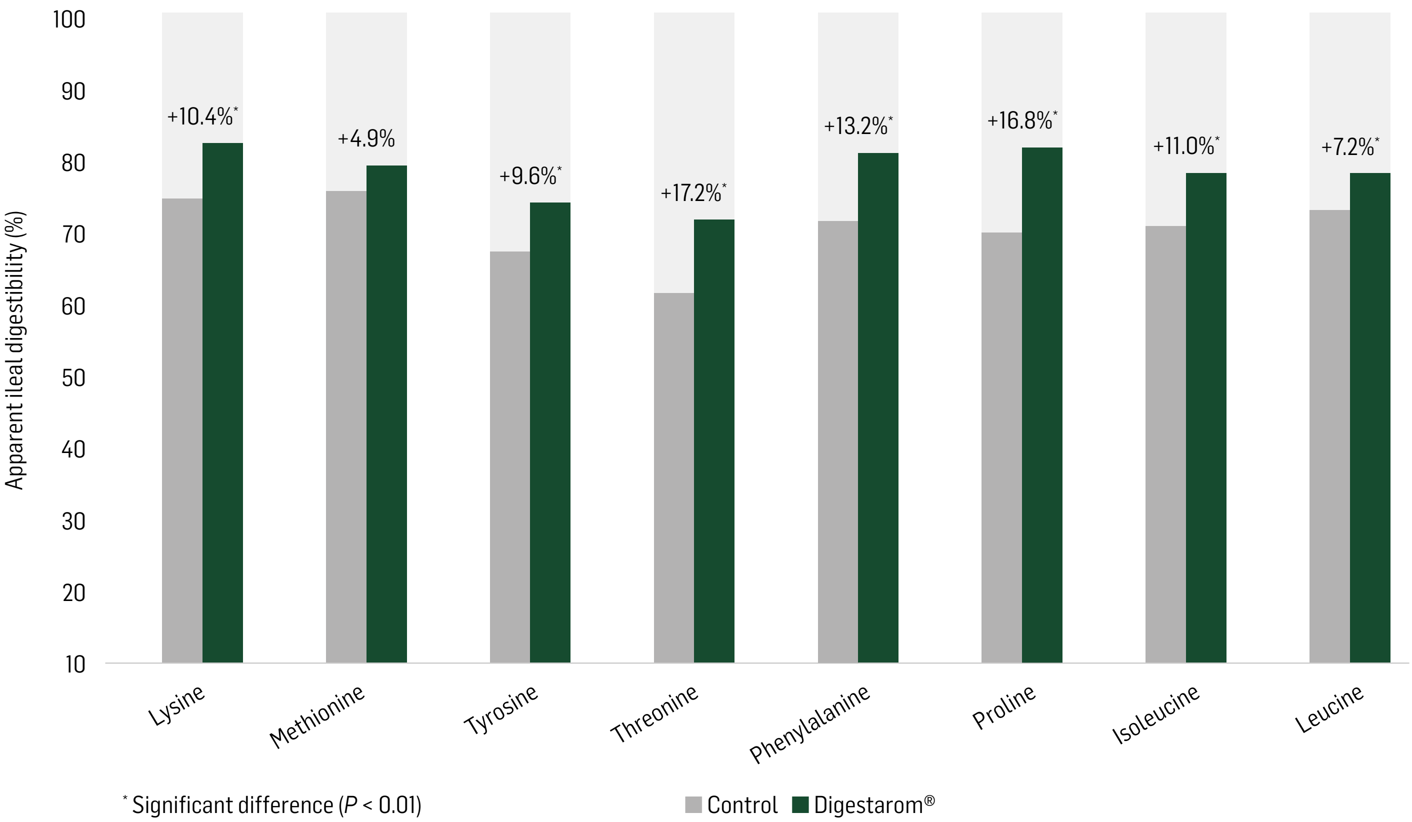
* statistically different difference ($P < 0.05$)

Source: Free University of Berlin

Conclusion

Many factors, such as genetics, management and nutrition, affect health and performance in pigs. Nutritional strategies based on organic acids combined with a complex PFA help to control a wide range of bacteria, limiting their harmful effect on piglets. The Permeabilizing Complex™ blend in Biotronic® Top3 weakens the outer membrane of Gram-negative bacteria and boosts the antimicrobial effect of organic acids and phytochemicals. Organic acids and PFAs are the perfect match in piglet feed, and are effective tools to reduce the need for antibiotics, increase protein digestibility and reduce ammonia emissions.

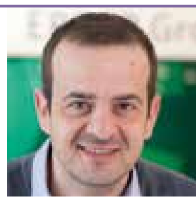
Figure 5.
Effect of Digestarom® on apparent ileal digestibility of amino acids in piglets



* Significant difference ($P < 0.01$)

Free University of Berlin

The Effect of Mycotoxins on Swine Fertility



Konstantinos Sarantis, MSc,
Product Manager Mycotoxin Risk Management

Mycotoxins are found in most raw materials worldwide. The annual BIOMIN Mycotoxin Survey indicates an increasing incidence of co-contamination, where more than one mycotoxin is found in each sample. Mycotoxins have a direct and negative effect on reproductive performance in pigs, and mitigating these is essential in high-performing pig units.

Swine fertility has a significant effect on farm profitability and the number of pigs produced per sow per year is one of the factors that define production costs per pig. It is crucial to sustain high reproductive indices like litter size, number of farrowings per year and productive days.

Various parameters affect herd fertility, including:
• Management
• Genetics
• Nutrition
• Health
• Anti-nutritional factors

Mycotoxins are known anti-nutritional factors that affect reproduction and over 400 different mycotoxins have been identified to date. The most well-known are trichothecenes, zearalenone (ZEN), ochratoxins, aflatoxins, fumonisins and ergot alkaloids. Every raw material can be affected by more than one fungus, and each fungus can produce more than one mycotoxin, so it is highly likely that there will be more than one mycotoxin in any one feed ingredient (*Figure 1*).

This increases the chances that mycotoxins will interact and produce synergistic effects, which are of great concern for livestock health and productivity.

The *Fusarium* toxins deoxynivalenol (DON) and ZEN are a good example of co-contamination. These mycotoxins are mainly produced by *F. graminearum*, *F. culmorum*, and *F. roseum* (Tiemann and Dänicke, 2007).

Direct effect on pigs

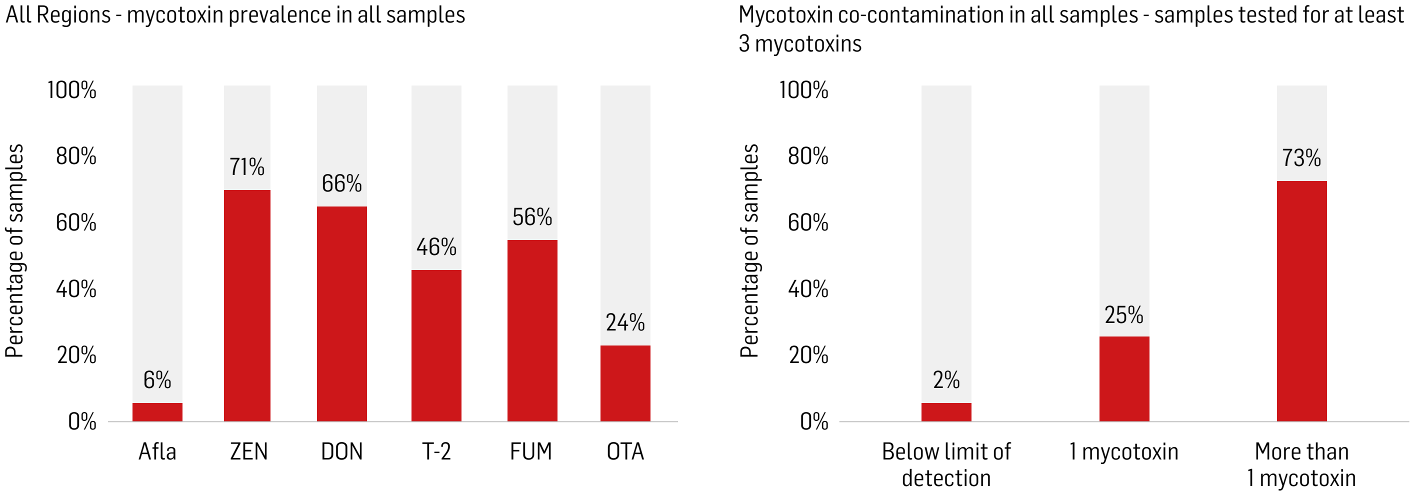
Pigs are usually considered to be the species that is most susceptible to mycotoxin contamination, with young animals and breeding females the most sensitive groups.

IN BRIEF

- Mycotoxins are found in most raw materials worldwide.
- Pigs are very sensitive to mycotoxins, especially breeding females and piglets.
- Reproductive performance is directly and indirectly affected when feed is contaminated with mycotoxins.
- The effects of mycotoxins can be mitigated by adding Mycofix® to the diet.

Figure 1.

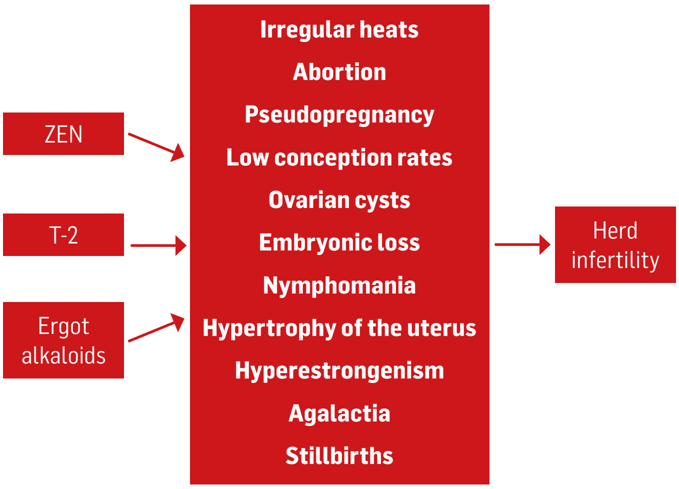
Global mycotoxin prevalence from January to June 2018



Source: BIOMIN Mycotoxin Survey

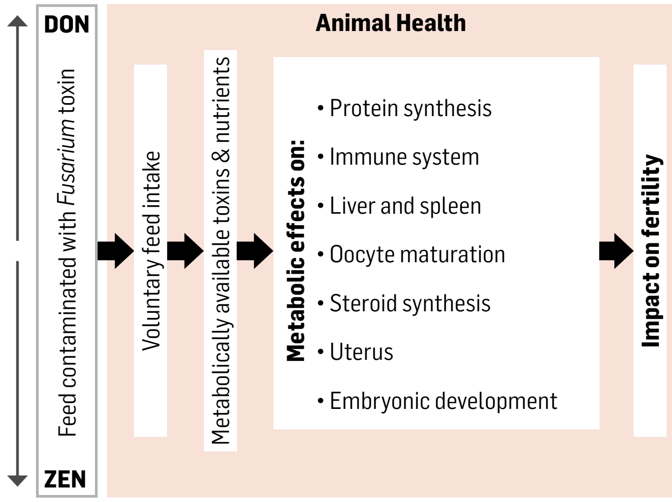
Photo: GettyImages_Jevtic

Figure 2.
Direct effects of mycotoxins on reproductive performance



Source: BIOMIN

Figure 3.
Combined effects of ZEN and DON on fertility



Source: Tiemann and Dänicke, 2007

Figure 2 shows some of the direct effects of mycotoxins on reproductive performance.

Zearalenone (ZEN)

ZEN is most notorious for its effects on reproduction (*Table 1*). It blocks normal hormone synthesis due to its resemblance to the estradiol molecule and competes for estradiol (estrogenic) receptors. This estrogenic effect disrupts the hypothalamic-pituitary-ovarian axis and suppresses secretion of the follicle-stimulating hormone (FSH) in the ovaries, disrupting the endocrine system.

Table 1.
Effects of ZEN in swine

Group	Effect	Consequences
Adult females	Reproductive	Altered reproductive cycle, conception, ovulation and implantation Pseudopregnancy, abortion, anestrus, nymphomania Embryonic death, inhibition of fetal development, reduced litter size, reduced birth weight Enlarged mammary glands Swollen and reddened vulva Rectal and vaginal prolapse Reddened teats Atrophied ovaries Uterine hypertrophy
Adult males	Reproductive	Feminization Enlarged mammary glands Poor semen quality Testicular atrophy Swollen prepuce
Piglets	Teratogenic	Splay legs

Source: BIOMIN

Deoxynivalenol (DON)

If DON is present in feedstuffs, it compromises feed intake and may cause vomiting (Diekman and Green, 1992). It also inhibits protein synthesis, alters the immune system response and causes reproductive problems by targeting oocyte and embryo development (Pestka *et al.*, 2004; Alm *et al.*, 2006).

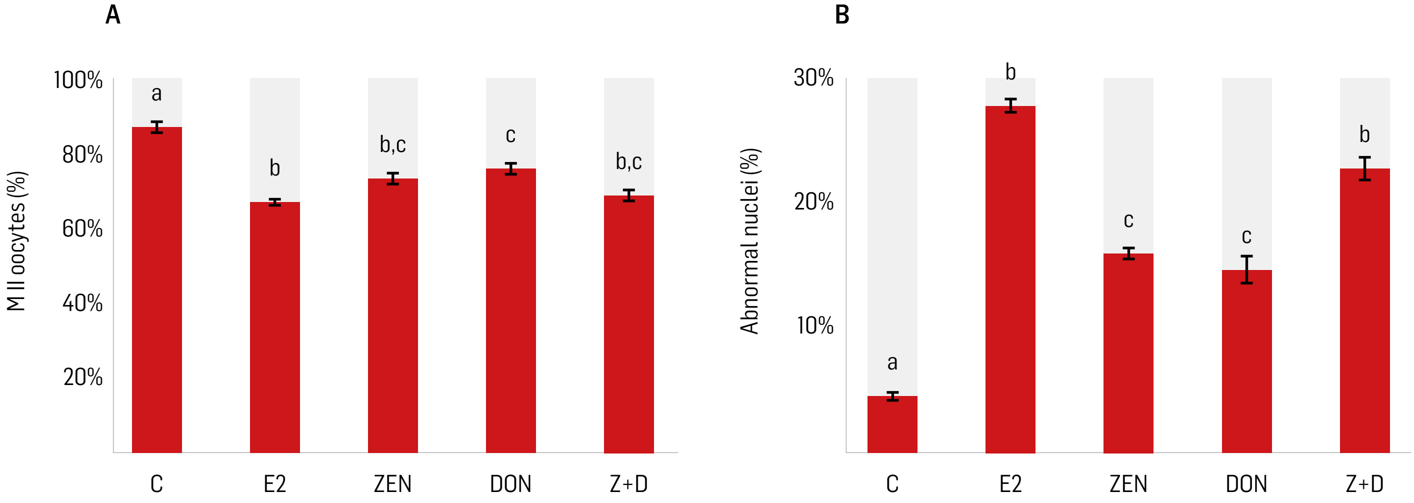
The effect of DON on reproduction in pigs is more indirect (*Figure 3*) as the lower feed intake reduces nutrient availability and poses a threat to the metabolic pathways in the reproductive system. Any dysfunction of the vital organs that have a key role in metabolism, such as the liver and spleen, also has an adverse effect on health. Once health is compromised, metabolic priorities change and the requirements of the reproductive system move lower on the list of priorities (Kanora and Maes, 2009).

Follicle development, oocyte maturation and embryo development

In vitro studies of porcine oocytes have shown that ZEN, DON or a combination of ZEN and DON disrupt oocyte development (*Figure 4*), making them unable to mature. This may compromise embryo viability, maintenance of pregnancy, and birth weight. DON had the most potent effect on embryo development after fertilization, resulting in fewer and abnormal blastocysts.

In a recent trial contracted by BIOMIN at the University of Berlin, Institute for Animal Nutrition, Department of Veterinary Medicine, the reproductive performance of sows challenged with DON and ZEN during long-term (three-cycle) exposure to *Fusarium* toxins was investigated. Sows

Figure 4.
Exposure to estradiol, ZEN, DON, and ZEN + DON significantly reduced the percentage of oocytes that reached metaphase II (M II) (A) and significantly increased nuclear abnormalities in the oocyte (B).



C = control, E2 = estradiol, ZEN = zearalenone, DON = deoxynivalenol, Z+D = zearalenone plus deoxynivalenol.
Different letters indicate significant differences between columns.

Source: Malekinejad *et al.*, 2007

Table 2.
Summary of trial groups and diets

Group	Diet
Control	Uncontaminated feed
Toxin	Feed contaminated with high levels of DON and medium levels of ZEN
Trial	Feed contaminated with high levels of DON and medium levels of ZEN, and supplemented with Mycofix® Plus

Source: BIOMIN

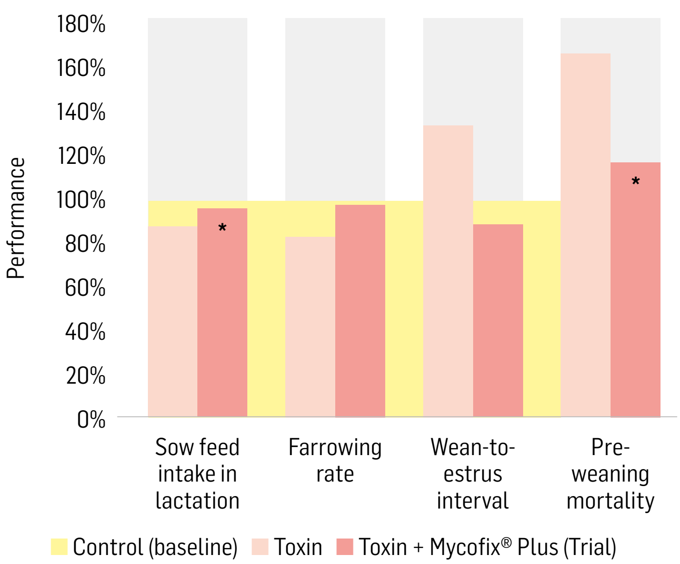
were allocated to one of three different groups, as per *Table 2*.

The results in *Figure 5* show that the mycotoxins impaired various reproductive parameters. The most common index of reproductive performance is the number of piglets weaned per sow per year. Farrowing rate and wean-to-estrus interval both affect this index. The presence of mycotoxins, especially ZEN, increased returns to heat in inseminated sows and reduced the farrowing rate.

Feed intake fell, affecting the sows' body condition score at weaning and their milk yield. Underweight sows take longer to come into estrus after weaning, which reduces the number of farrowings per year, so fewer weaned piglets are produced per sow per year. Lower milk yields could also compromise litter growth and weaning weights, resulting in lower weights at slaughter or more days on feed.

Mycotoxins also affected piglet quality (*Figure 6*): the percentage of underweight piglets (<1.2 kg) increased, suggesting that mycotoxins have a detrimental effect on embryo development and maternal nutrition. This negative effect on piglet quality, accompanied by the reduction in milk yield, may increase pre-weaning mortality and reduce weaning weights.

Figure 5.
Effects of ZEN and DON on reproductive indices. The yellow area represents the control group, presented as 100% performance.



* statistically significant differences ($P < 0.05$).

Source: BIOMIN

However, animals recovered well when Mycofix® Plus was added to the diet.

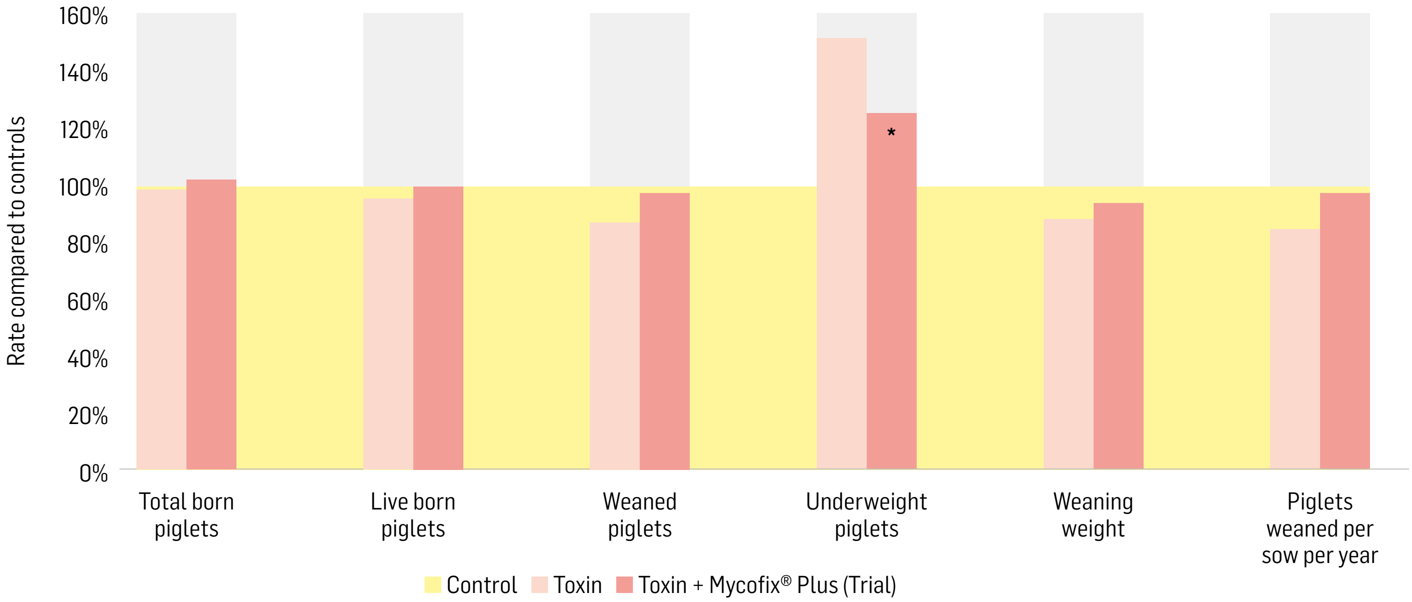
Multiple mycotoxins; many consequences

Mycotoxin co-contamination of raw materials is more common than contamination with a single mycotoxin, as routinely reported in the BIOMIN Mycotoxin Survey. Each mycotoxin acts in a specific manner and affects multiple tissues, organs and functions. When combined, these challenges cause a myriad of different clinical or subclinical signs, often not linked to the known effects of direct mycotoxin contamination in animals.

Each mycotoxin acts in a specific manner and affects multiple tissues, organs and functions.

Figure 6.

Effect of ZEN and DON on reproductive indices. The yellow area represents the control group, presented as 100% performance.



* statistically significant differences ($P < 0.05$).

Source: BIOMIN

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Nutritional Strategies to Prevent Postpartum Dysgalactia Syndrome in Lactating Sows

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Regional Technical Sales Manager

Postpartum dysgalactia syndrome (PDS) in lactating sows is very costly, as it prevents the newborn piglet getting the vital early nutrition it needs to survive and thrive. Phytogenic feed additives can be used to support sow health before, during and after farrowing to prevent PDS from affecting herd performance.

Clinical signs and causes of lactation failure

Lactation failure in sows is a common issue, mostly caused by mastitis-metritis-agalactia (MMA). Signs of mastitis, metritis or agalactia, or any combination thereof, may be exhibited following infection of the udder or uterus, or reduced milk production.

The term MMA is starting to be used less often, as the condition is now categorized as a subtype of postpartum dysgalactia syndrome (PDS). Sows affected by PDS produce insufficient colostrum and milk in the first few days after farrowing. Sows or gilts that develop agalactia will typically have normal milk production 12 to 24 hours post partum, but this is followed by partial to complete agalactia. The farm manager or producer will know something is wrong when healthy newborn piglets stop growing, and some piglets may die without any clinical signs of disease.

PDS is closely related to herd health, water intake, nutrition and the farrowing house environment. Risk factors of PDS include:

- Concurrent disease
- High bacterial infection pressure (poor disinfection of farrowing pens)
- Mycotoxicosis (aflatoxins, zearalenone)
- Hypocalcemia and ketosis
- Poor quality or inadequate water supply
- Inadequate farrowing house temperature
- Prolonged duration of farrowing
- Lack of supervision during farrowing
- Sows dirty prior to farrowing

IN BRIEF

- Sows with PDS are unable to provide colostrum or milk for their newborn piglets, stunting piglet growth and causing piglet mortality.
- Various factors contribute to PDS, including farrowing house environment, management practices and nutrient supply.
- Adding a PFA to sow diets throughout the production cycle can reduce the incidence of PDS.

Role of nutrition and feeding regime

Nutrition is a significant factor in the development of PDS, and how the sow is fed from before gestation to farrowing, and throughout lactation affects the incidence of PDS. Sows are fed restricted amounts of a complete diet in days before parturition. These diets have high nutrient and energy densities, and low fiber content, which often causes drier and harder feces, indicating an impaired passage of digesta and constipation. Hermansson et al. (1978) reported constipation in approximately 25% of sows with agalactia. Constipated animals suffer a reduction of intestinal peristaltic movements, which changes the environmental conditions in the intestine.

The levels and quality of fiber and protein in the diet are both important factors to consider. First, a higher fiber content in the transition diets fed during the periparturient period reduces the incidence of hard feces (constipation) and increases feed intake by the sow in early lactation. Second, it has been reported that supplementing feed with functional amino acids (e.g., arginine, cysteine, L-glutamine and leucine) can change the composition of the intestinal microbiota in the animal to improve gut health and function. Sows that are too fat at parturition are also at a higher risk of PDS (Göransson, 1989) and feeding sows *ad libitum* shortly after farrowing increased the risk of PDS compared to restricted feeding (Papadopoulos et al., 2010). Milk let-down and subsequent milk production was more problematic in sows fed diets with lower vitamin E levels (Mahan, 1991).

Diets containing a phytogenic feed additive (PFA) may reduce the incidence of PDS and increase feed intake during lactation. Selected PFAs have shown to have the following effects in sows:

- Stimulation of endogenous secretions
- Improvement of nutrient digestibility
- Modulation of the gut microbiota
- Reduction of inflammatory processes
- Upregulation of anti-inflammatory target genes

In the following trial, the BIOMIN PFA, Digestarom®, was added to a sow diet for 55 days (from the 80th day of gestation until weaning). Sows fed the Digestarom® diet showed increased lactation feed intake (+10%) and milk production (+15%) (*Table 1*). Consequently, 5.8% more piglets were weaned per litter and piglet weight was 6% higher at weaning, and the incidence of diarrhea was substantially lower (-50%).

High colostrum and milk yields are essential for piglet viability and growth during the pre-weaning period. However, many modern pig herds have a problem with PDS. Therefore, preventive measures should be put in place in both management practices and diet formulation. Adding PFAs to the diet could form part of a nutritional strategy to improve the performance of lactating sows, and therefore their offspring.

Table 1.
The effect of Digestarom® on performance

	Control	Digestarom®
Number of sows	30	30
Daily feed intake during lactation (kg/sow)	5.77^{b}	6.35^{a}
Milk yield per sow (l/d)	10.17^{b}	11.70^{a}
Piglets born alive per litter	9.70^{b}	10.17^{a}
Average piglet birth weight per litter (kg)	1.59	1.58
Weaned piglets per litter	9.33^{b}	9.90^{a}
Pre-weaning mortality (%)	3.72	2.46
Pre-weaning diarrhea (%)	14.84^{b}	7.19^{a}
Litter weight at weaning (kg)	68.17^{b}	77.04^{a}
Uniformity of live weight at weaning (CV %)	79.19^{b}	82.67^{a}

Values with different superscripts differ significantly ($P < 0.05$)

Source: BIOMIN

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