Issue 20 • Swine
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Science & Solutions

Overcoming Heat Stress

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Maximizing Sow Productivity

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What's wrong with my pigs?

Part 2: Abortion

Editorial

Hot time for nutrition

Going into summertime we again see sows paying a toll in terms of lower fertility and performances from heat stress. Each year more farms worldwide add cooling system equipment to alleviate the detrimental effects of high temperatures. In this issue of **Science & Solutions** we look at a few more tips to keep pigs protected.

First, remain diligent against mycotoxin poisoning, particularly in severe risk zones, e.g. Southern Europe, since these toxins impair liver function (along with the gut wall and immune tissue) that in turn lowers animals' digestion and produces more heat in an already hot season. Second, remember to check water pipelines since fresh clean water is paramount for welfare. Third, accepting a little more body weight loss during lactation is not a problem provided it is not over 13% percent of sow weight, otherwise recovery becomes a real trouble in the first month after weaning. Fourth, the diet can be modulated to increase digestibility. Phytogenic feed additives in particular can have multiple beneficial effects on feeding, like palatability, carminative and choleretic effects, enhancing feed digestibility by increasing physiologically endogenous enzymes.

As we show in this issue, supplementing sows' diets with phytogenic feed additives increases voluntary feed intake during lactation and prevents intestinal stress by providing a pronounced antioxidative capacity and modulating inflammatory processes.

Finally, this issue brings the second part of our series on differential diagnosis covering abortion.

Hot weather will often be a source of stress for animals and workers on the farm. Through these few simple, fundamental actions the consequences can be greatly reduced.

Diego PADOAN
Swine Technical Manager

Contents

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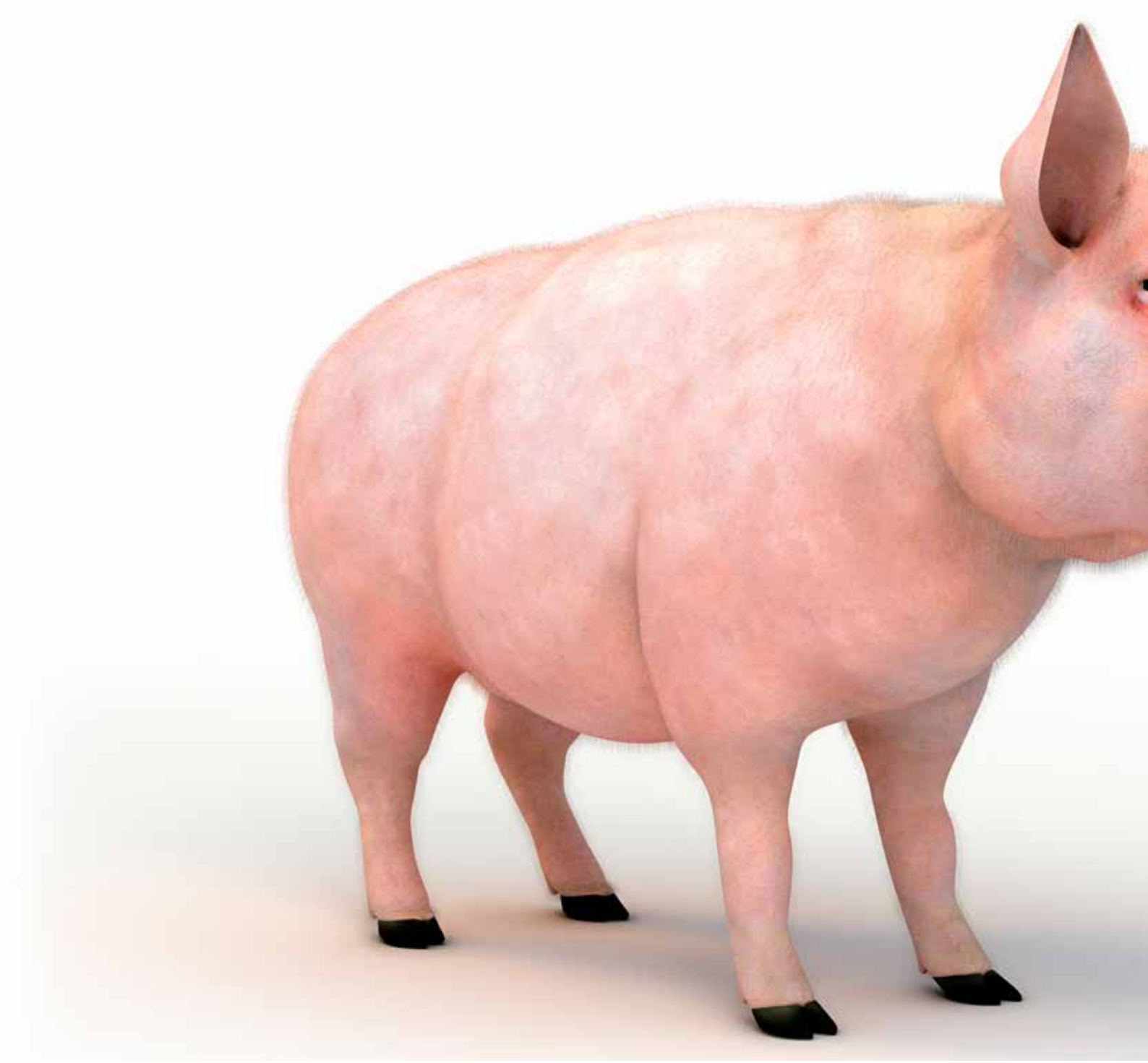
Editor: Ryan Hines
Contributors: André van Lankveld, Diego Padoan, Simone Schaumberger, Jose Soto
Marketing: Herbert Kneissl, Cristian Ilea
Graphics: Reinhold Gallbrunner, Michaela Hössinger
Research: Franz Waxenecker, Ursula Hofstetter
Publisher: BIOMIN Holding GmbH
Industriestrasse 21, 3130 Herzogenburg, Austria
Tel: +43 2782 8030
www.biomin.net



Overcoming Heat in Pigs Through N

By **André van Lankveld,** Swine Technical Manager and **Simone Schaumberger,** Product Manager Mycotoxins

Heat stress affects the pig industry in tropical climates and temperate regions as in the US swine industry alone are estimated at US$316 million annually.

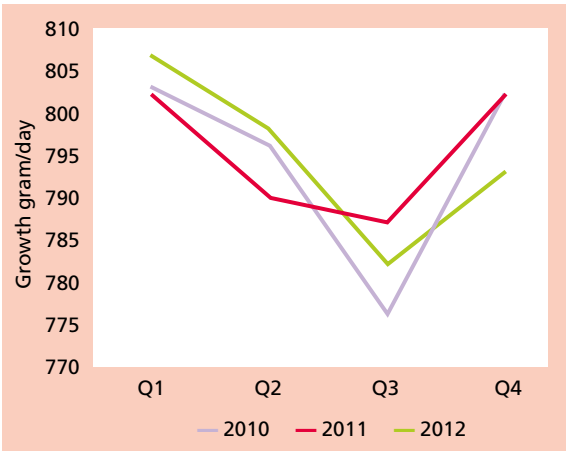
Photos: iStockphotoHenrik5000/Tala

Stress utrition

well. Economic losses due to heat stress

These losses include non-productive days for sows and economic losses in growing-finishing pigs. Even in mild climate conditions such as the Netherlands pigs have problems in the summer with performance losses due heat stress (*Figure 1*).

Figure 1. Seasonality and the impacts of heat stress on swine in mild climates.



Source: Agrovision 2013

Pigs more heat stressed

Pigs are much more sensitive to hot weather than other livestock animals—largely due to the fact that pigs hardly sweat and their lungs are relatively small compared to body size. When pigs are exposed to heat stress, their respiration rate increases, pulse rate falls, they start heavily panting and they stop eating because this contributes to further heat production. The fact that heavier pigs are more sensitive to heat stress can be clearly seen in growth performance parameters. Investigation of different weight classes (75, 80 and 28 kg body weight) showed a direct negative correlation on average daily gain (ADG) with increasing room temperature. While 75 kg pigs start to decrease their ADG at around 23°C, pigs with 25 kg can compensate up to 27°C (*Langridge, Western Australia, 2014*). A commonly

Figure 2. Summary of pigs' reactions to increasing temperatures.

Overheated >180 breaths / min	• Dramatic rise in body temperature • High gut permeability • Increased passage of endotoxins & pathogens	Death 34°C
Hot 50-180 breaths / min	• Spread out • Lower feed intake • Increased floor contact • Increased body temperature • Increased splashing, fouling	30°C 27°C
Comfortable 20-30 breaths / min	• Normal behavior	23°C 18°C

Air temperature

Source: BIOMIN

accepted temperature range for sows in the farrowing house typically spans between 21°C and 25°C —though this range is too high. Nursery sows begin to show signs of heat stress starting at 22°C (*Table 1*). The feed intake drops almost 0.5 kg/day as temperature increases to 25°C.

Negative effects on gut and immune systems

Effects of heat stress can be explained by changes in the intestinal barrier. If the barrier is impaired through heat stress, this impairment can lead to an increased permeability for endotoxins, which in turn will result in local or systemic damage or inflammatory reactions (*Lambert, 2009*) (*Figure 2*).

A significant increase in serum endotoxin concentrations was shown by Pearce et al (2013) when pigs were assigned to acute heat stress (35°C, 24-43% humidity) for 24 hours. Especially effects on milk production can be brought in context with endotoxin circulation as it is described that endotoxin decreases prolactin concentrations in postpartum plasma (*Smith and Wagner, 1984*), which in turn has a negative impact on piglet development.

Addressing heat stress through nutrition

Technical solutions to reduce heat stress are often time consuming and capital intensive investments, e.g. building cooled stables. A nutritional approach can prove more adaptable and quicker to implement. Based on current knowledge there are some aspects which can improve swine productivity during periods of heat stress.

Feeding handling

- Smaller, more frequent meals per day and/or night feeding.
- A sufficient supply of fresh, clean water. Eliminate bacterial growth in the water by adding acids, such as Biotronic® SE forte liquid or TOP liquid, to avoid infections through the system.

Physical rations adjustment

- Wet the feed with water.
- Use pelleted feed instead of mash.

Lower crude protein

Noblet showed in a lactating trial under heat stress that sows lose less weight with a feed with lower crude protein (*see Table 1: Noblet* et al., *2000*). One of the explanations for this fact is that during digestion, proteins generate more metabolic heat than fats (26% against 9%), due to the complex reactions for the metabolism of the amino acids that compose them (*Church and Pond, 1982*).

Replace starch with fat as an energy source

Fats are excellent sources of energy for swine to compensate for lower feed intake. Fat is also a more digestible ingredient that generates less metabolic heat during digestion compared to starch.

Table 1. Effect of the level protein of ration in the behavior of lactating sows in atmospheres of thermal comfort and caloric stress (*Noblet* et al, *2000*).

Temperature	20°C		29°C	
Ration Protein in %	17.6	14.2	17.6	14.2
Feed intake in kg/d	6.71	6.51	3.56	4.05
Pigs' weight at weaning	10.5	10.3	10.4	10.3
Milk Production, kg/d.	10.0	9.6	7.4	7.7
Loss weight of sow in kg	16	15	41	29

Everything You Need to Know about Fumonisins

Our understanding of fumonisins –a major mycotoxin– and the dangers they pose to livestock has **expanded considerably since the first probable case of** fumonisin intoxication in 1970. Reports of high fumonisin contamination in feed have been recorded in Latin America, Southern Europe, the United States, Asia and Africa.

Based on the latest scientific knowledge, the BIOMIN Fumonisin Compendium offers readers a practical guide to fumonisins, the symptoms they cause in various animal species and the strategies available to counteract them.

For more information, contact your local BIOMIN representative.

André van Lankveld, Swine Technical Manager
Simone Schaumberger, Product Manager Mycotoxins

Less fiber

The higher the tenor of fiber of an ingredient, the worse the digestibility. Undigested fiber goes to the large intestine where it stimulates the growth of microorganisms that will generate heat in fermentation processes.

Maintain the right electrolytic balance

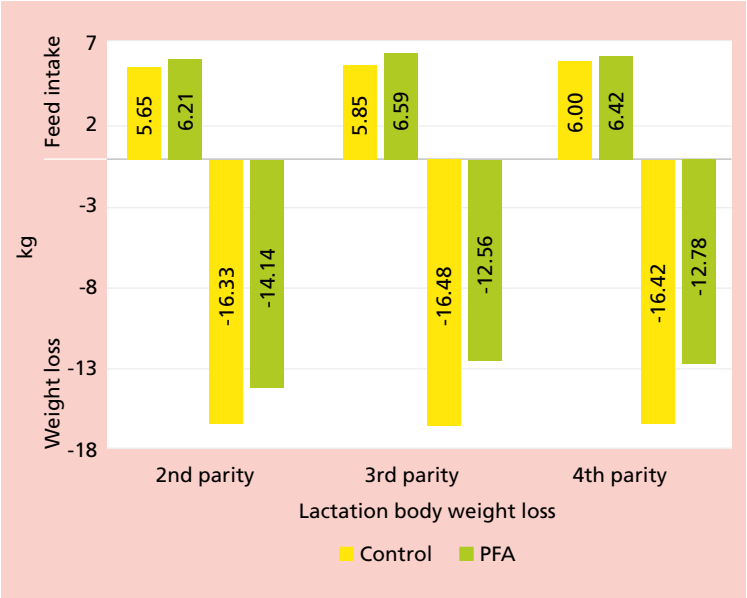
As temperatures increase, an animal's breathing tension increases.

Faster respiration takes more carbon dioxide out of the blood stream which is then exhaled. This changes the pH levels in the blood, leading to metabolic acidosis and lower feed intake. Blood 'buffers' such as sodium bicarbonate or potassium can restore the electrolytic balance and support feed intake.

Use Digestarom® to aid protein digestion

Certain plant-based compounds can promote better enzyme secretion and reduce protein loss by lowering pigs' inflammatory response. A heat stress trial for lactating sows in Thailand showed an almost 10% increase in feed intake using a phytogenic Digestarom® P.E.P. which resulted in a 20% reduction in weight loss in the different parities (*Figure 3*).

Figure 3. Digestarom® improves feed intake by sows.



Source: Khon Kaen University in Thailand, 2008

Combat toxins that negatively impact animal health

Hot and humid weather increases the chance of mycotoxin contamination on the field and under storage conditions. In heat stress conditions the liver is often under stress.

This often appears as poor nutrient utilization and/or chronic inflammation of the liver. It is important to keep the liver as healthy as possible and avoid additional stress from toxins, e.g. mycotoxins. Many trials have shown the negative effect of heat stress on development of endotoxins in the gut.

A significant increase in serum endotoxin concentrations was shown by Pearce et al (2013) when pigs were assigned to acute heat stress (35°C, 24-43% humidity) for 24 hours. Innovative feed additives such as Mycofix® can actively combat major mycotoxins and decrease the production of pro-inflammatory cytokines.

Conclusion

Heat stress affects swine performance much of the time in tropical climates and seasonally in more moderate ones.

While there are many ways to improve management and feed formulations to address heat stress, the techniques listed above provide a good start based on the most current scientific knowledge. These reflect a greater focus on the reduction of toxins and gastrointestinal inflammation under these stress conditions. The best strategies combine different modes of action or techniques that reduce animal stress, improve animal performance and boost the financial result for the farmers.

Photo: iStockphoto/marilyna

A Nutritional Approach to Maximizing Sow Productivity using Phytogenics

By **Jose Soto,** Technical Manager Swine

While genetic improvement has been the main driver for improved prolificacy of sows and production of high lean progeny, better nutrition offers a way for further gains.

Today's sow produces three more pigs per litter and 40% heavier piglets than four decades ago. A sow needs to produce an adequate amount of milk to sustain the growth of a larger and leaner litter. Nutritional requirements of the sow are heavily influenced by phase of production and parity. Efficient sow herd management and continuous updates to the nutritional program are required to ensure high levels of sow productivity and producer profitability. Phytogenic feed additives have consistently proven to be beneficial in increasing the feed intake of sows during lactation and providing intestinal relief by preventing oxidative stress and reducing inflammatory processes.

Economics of sow retention and lactation feed intake

Targeting 70% retention of the gilts entering the reproductive pool and retaining them in the herd through at least the fourth parity will optimize profitability. Sow margins are optimized later in life when reaching the highest return on investment (ROI) between the fourth and seventh parity (*Figure 1*). However, on many commercial units 40% to 50% of sows are culled before reaching their third or fourth parity.

Sow retention is influenced by multiple factors, including genetics, nutritional programs, gilt development and health status. From a nutritional perspective, suboptimal intake of amino acids and/or energy during lactation have been associated with prolonged wean-to-estrus interval, subsequently reduced litter size and lighter litter weights at weaning along with lower retention rates.

Research suggests that if a sow consumes ≤ 3.5kg of feed per day during the first two weeks of lactation, it is likely to be removed from the herd prior to the next parity. Insufficient feed intake during lactation becomes critical especially for younger parity sows when nutrients are

prioritized for milk production and maintenance, reducing nutrients available for reproduction.

Phytogenics have a positive impact on voluntary feed intake during lactation. Furthermore, there is evidence that phytogenics have a stabilizing effect on digestion, resulting in improved feed conversion. The data presented in *Figure 2* were obtained from a trial in the United States. Sows were fed a basal diet either with or without Digestarom®, a phytogenic feed additive. Sows fed Digestarom® consistently ingested more feed when compared to Control (P<0.01). Total feed intake over the period was 6.2kg, more than 14% higher than the control at 5.4kg.

Oxidative stress on sow and fetus

Current nutritional recommendations suggest that sows might benefit from a two-phase feeding program due to higher amino acid requirement during late gestation, based on dramatic changes in fetal tissue gain. However current gestation feeding programs use only a single diet, regardless of gestation phase and parity. This does not provide enough nutrients during late gestation for fetal and mammary growth, causing catabolic conditions in sows.

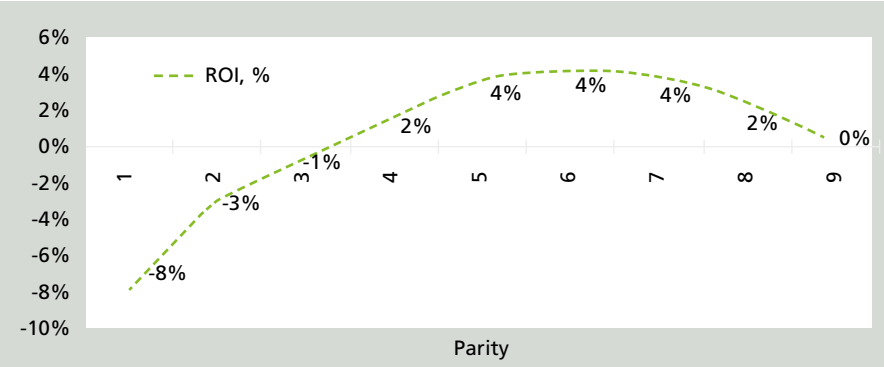
New housing systems, retrofitted on new facilities can be designed to accommodate multiple phases feeding options. However, with the existing gestation facilities in many farms in the USA, feeding two gestation diets is impractical.

Catabolic conditions increase the production of reactive oxygen species, causing oxidative stress which is related to decreased availability of antioxidants during late gestation and lactation. Oxidative stress then begins to normalize towards the end of lactational period.

Oxidative damage is a strong indicator of health status and well-being of animals in relation to aging, stress, nutritional status and disease. Increased oxidative stress is responsible for a reduction in milk production, reproductive performance and eventually the longevity of sows.

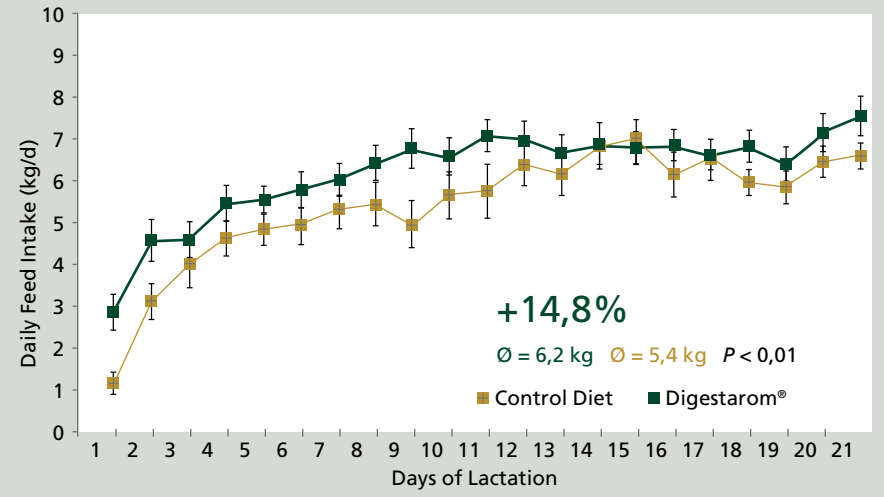
During gestation, there is high energy demand and an increased oxygen requirement, which also leads to oxidative stress characterized by the placental production of reactive oxygen species including superoxide and hydrogen peroxide. Excessive free radical production may cause both lipid and protein oxidation and impair normal endothelial cell function. The elevated oxidative stress could alter placenta and fetal skeletal formation as well.

Figure 1. Impact of sow retention on return on investment.



Source: Adapted from Pinilla and Lecznieski, 2010

Figure 2. Effects of dietary inclusion of Digestarom® on lactation feed intake for multiparous sows.



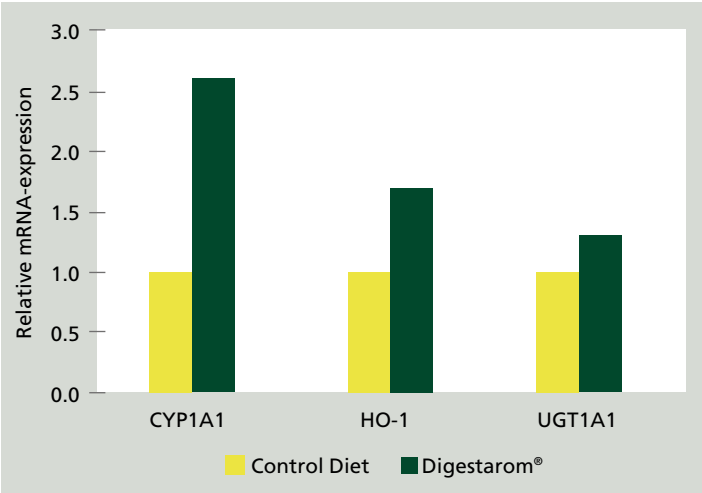
Source: Gorman et al., *2005. Texas A&M University*

Power of plants

Phytogenic feed additives offer a pronounced antioxidative capacity. The antioxidative properties of some phytogenic substances have been attributed to the phenolic terpenes in their essential

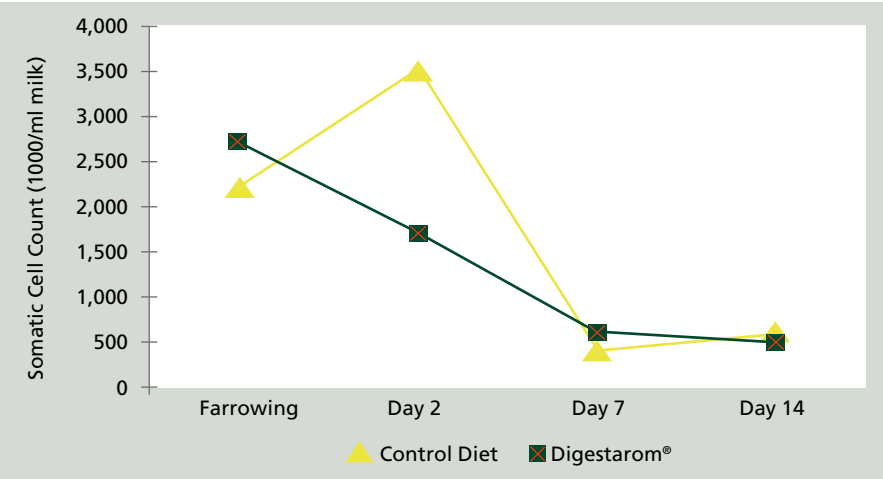
Efficient sow herd management and continuous updates to the nutritional program are required to ensure high levels of sow productivity and producer profitability.

Figure 3. Up-regulation of Nrf2 target genes.



Source: Gessner et al., *2013*

Figure 4. Effects of dietary inclusion of Digestarom® on somatic cell counts for multiparous sows.



Source: BIOMIN, 2008

oils. An important cellular element is the transcription factor Nrf2 system, one of the major cellular defense mechanism against oxidative and xenobiotic stresses in the intestinal tract. Activation of the Nrf2 pathway leads to the induction of genes responsible for cellular defense against reactive oxygen species and detoxification.

In vitro evaluations of Digestarom® were found to upregulate Nrf2 target genes in comparison to the Control ($P<0.05$) (*Figure 3*).

Reduced inflammation and gut protection

Regular supplementation of phytogenic feed additives improves performance, not only by upregulating the transcription factor Nrf2 but also by acting as a prophylactic against inflammatory reactions in the gastrointestinal tract by down-regulating the NF-κB factor.

Digestarom® significantly reduced the mRNA levels of the NF-κB target genes IL-8, ICAM-1 and MCP-1, which initiate and maintain inflammatory reactions stimulated by antigens. To improve the performance of pig through higher feed intake and feed efficiency, subclinical inflammatory processes need to be reduced in order to increase the availability of energy and nutrients for performance rather than defense mechanism.

Lower somatic cell counts

Digestarom® decreased the gene expression of the transcription factor NF-κB and the apoptotic marker TNFα significantly in ileum and jejunum, respectively during *in vivo* evaluation by Kroismayr *et al.,* (2008) suggesting an improved zootechnical performance. The data presented in *Figure 4* were obtained from a trial in Slovakia. Sows were fed a basal diet either with or without Digestarom®, a phytogenic feed additive. Sows fed Digestarom® showed a lower somatic cell count compared with the control treatment.

Conclusion

An increasing number of reports have confirmed that supplementation of swine diets with phytogenic feed additives resulted in improved performance and animal health parameters. Supplementation of diets with phytogenic feed additives increases voluntary feed intake during lactation and preventing intestinal stress by providing a pronounced antioxidative capacity and modulating inflammatory processes.

Phytogenics have proven to be highly effective in improving sow nutrition and assuring producer profitability.

Cut & Keep Checklist

What's wrong with my pigs?

Part 2: Abortion

It is generally accepted that some 2% of sow pregnancies end in abortion. In these cases, an investigation must be carried out to identify causing agents that could span anything from environmental factors such as heat stress to nutritional ones such as toxins. In autumn, there may be a natural increase in the abortion rate due to daylight fading, though this ought to remain sporadic. This can be fairly well counteracted by shrewd management of lamps regarding both time and intensity. In some cases, abortions result from consumption of drinking water contaminated by yeasts or other bacteria. In other cases they result from too little water intake during early gestation.

If the abortion outbreak is dramatic and affects a wide number of sows in the herd then it is likely that an infectious disease is entering in the herd (*see table*) without any specific timing and the sows have often fever and there are other signs from the disease in sows, aborted fetuses and newborn piglets. Characteristic is PRRS abortion occurring mainly during last gestation period.

In large farms a rise in the abortion rate may be more difficult to witness, though evidence may come from a drop in feed intake and weight along with vulvar discharge.

Mycotoxins may also be a causing agent. Aflatoxins, deoxynivalenol, fumonisins, zearalenone (ZEN) and ergot alkaloids can all play a significant role in fertility problems and abortions. Pregnant sows' consumption of feed with high levels of ZEN, especially during early gestation, can lead to smaller litters and mummification. Between days 7 and 10 of pregnancy are the most critical ones with a high rate of embryonic death. Moreover, if the feed contains low to medium amounts of ZEN during the whole gestation, this will result in smaller fetuses and large variations in the weight of piglets of the same litter. Furthermore, ZEN can also lead to stillbirth and neonatal mortality and in the worst case it can even lead to the death of the entire litter. There evidence that ZEN intoxication is link to splay legs.

Decrease of feed intake and sometimes feed refusal have a self-limiting effect in mycotoxicosis.

	Potential cause	Checklist	Corrective action
MYCOTOXINS	• Zearalenone, Deoxynivalenol, Aflatoxins, Ergot alkaloids, Fumonisins	☐ Positive raw materials (ELISA) or feed (HPLC) ☐ Origin of raw materials historically contaminated ☐ Elevated sphinganine/ sphingosine ratio in serum	☐ Check raw materials and feed ☐ Hygiene of feed and water line ☐ Use Mycofix® Plus at suitable inclusion rate
PATHOGENS	***Virus:*** • African swine fever, Classical swine fever, Foot and mouth disease, PRRS, PCV type 2, Parvovirus, Influenza A virus ***Bacteria:*** • *Actinobacillus* spp., *Brucella* suis, *Erysipelothrix rhusiopathiae*, *Lawsonia* intracellularis, *Listeria* monocytogenes, *Leptospira* spp., *Salmonella* spp., *Streptococcus* spp., *Staphylococcus* spp.	☐ Epidemiology ☐ Symptomatology ☐ Necropsy ☐ Bacterial culture ☐ Histopathology ☐ PCR ☐ ELISA ☐ Immunohistochemistry (IHC)	☐ Biosecurity ☐ Vaccination ☐ Antibiotics
OTHERS	• High environmental temperature • Draught, especially in autumn • Water deficiency	☐ Check room temperature ☐ Check water flow direct after feeding time	☐ Temperature range: 10-21°C ☐ Water flow 1.0-1.2 liter / mins (min. 8 liter/day)

References are available on request

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

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Naturally ahead

Biomin®