The big challenge: Keeping sows healthy and productive – Part 2 Nutritional interventions – Phytomolecules

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The first of the two articles focused on general aspects to be observed to achieve a particular stock of healthy and well-performing sows, as well as high productivity on the farm. In addition to general measures, feed supplements can be used to further support the sows. Phytomolecules with characteristics supporting gut and overall health are effective for this purpose.

Phytomolecules – how can they help?

Phytogenics, also known as phytomolecules, are plant-derived, natural bioactive compounds that promote livestock health and well-being, as well as improve growth performance and production efficiency. Phytomolecules encompass a diverse range of compounds, including terpenes, phenols, glycosides, saccharides, aldehydes, esters, and alcohols.

The literature describes some of their effects, including stimulation of digestive secretions, immune stimulation and anti-inflammatory activity, intestinal microflora modulation, and antioxidant effects

(Durmic and Blanche, 2012; Ehrlinger, 2007; Zhao et al., 2023), as well as estrogenic and hyperprolactinemic properties (Farmer, 2018) and effects on colostrum and milk porcine sensory profiles (Val-Laillet et al., 2018). They represent exciting antibiotic alternatives in swine production (Omonijo et al., 2018).

1. Phytomolecules modulate intestinal microbiota

Phytomolecules are microbiome modulators through different mechanisms. They can directly impact pathogenic bacteria by damaging the cell membrane, cell wall, or cytoplasm, interrupting the anion exchange, resulting in changes to cellular pH, and inhibiting the cell's energy production system. Additionally, phytomolecules interfere with the virulence capacity of pathogenic bacteria through the indirect quorum quenching mechanism. (Rutherford and Bassler, 2012).

The favorable consequence of this differential microbial modulation is maintaining gut microbiome diversity, shifting it to a bacterial population with reduced pathogenic and increased beneficial microbes.

Proof of Ventar D's pathogen-inhibiting effect

An in vitro study evaluated the effect of Ventar D on pathogenic *Clostridium perfringens* and beneficial *Lactobacillus spp*.

Process

To test the effect of Ventar D on four different beneficial *Lactobacillus spp.*, and pathogenic *Clostridium perfringens*, the phytogenic formulation (Ventar D) was added to the respective culture medium in the following concentrations: 0 µg/mL – control, 500 µg/mL (only *C. perfr.*), 750 µg/mL, 1000 mg/mL (only *C. perfr.*), and 1250 µg/mL.

After cultivating the bacteria in the culture medium, the colony-forming units (CFU) were counted.

Results and discussion

The study demonstrated a dose-dependent decrease in the Clostridium perfringens population. At the lowest tested concentration (500 µg/mL), Ventar D's antimicrobial effect was already detectable; at 750 µg/mL, scarce colonies were observed; and at 1000 µg/mL, *C. perfringens* could no longer grow.

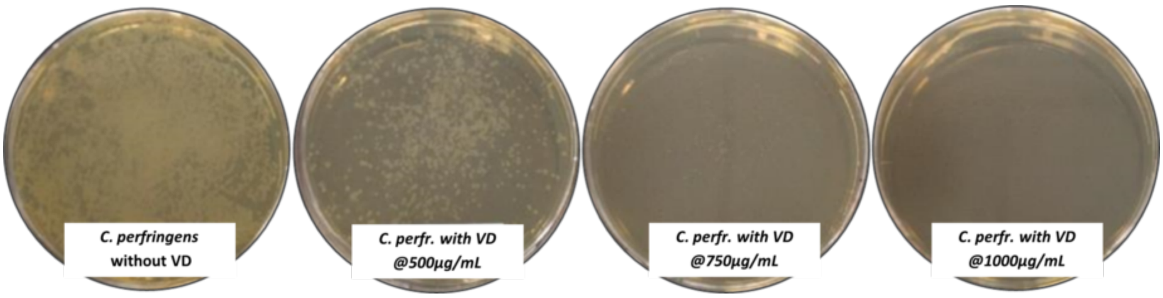


Figure 1: Effect of Ventar D on Clostridium perfringens

In contrast, even at higher concentrations of Ventar D, the beneficial *L. agilis* S73 and *L. agilis* S1 populations were only mildly affected, and *L. casei* and *L. plantarum* were unaffected.

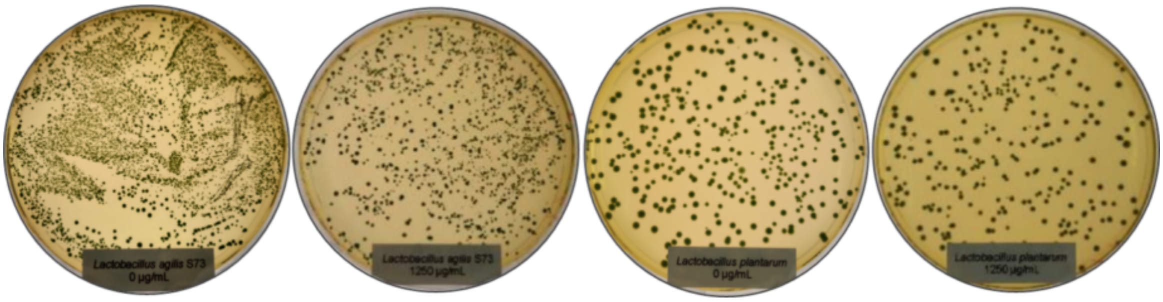


Figure 2: Effect of Ventar D on Lactobacillus spp.

These findings confirm the differential antimicrobial activity of Ventar D's formulation, specifically a bactericidal effect on pathogenic C. perfringens populations and a mild to no inhibition of beneficial *Lactobacillus spp*.

2. Phytomolecules improve intestinal integrity

The gut barrier is semipermeable and is responsible for immune sensing and regulating the movement of nutrients and undesirable microbes and substances.

The "gatekeepers" are tight junctions (TJ), adherent junctions (AJ), and desmosomes situated between the intestinal enteric cells (IEC). The tight junctions regulate the transport of small molecules and ions. The adherent junctions and desmosomes maintain the integrity of the intestinal barrier by keeping the IECs together through cell-adhesion bonds.

Oxidative stress resulting from factors such as heat stress or fat oxidation in the feed, as well as dysbacteriosis caused by changes in diet, out-of-feed events, poor dietary formulation, or bacterial contamination, can compromise the integrity of these critical adhesions and junctions between enterocytes.

The support of these tight junctions prevents bacteria and toxins from passing into the organism. Besides reducing disease occurrence, it also reduces the activation of the immune system and inflammatory processes. Ingested nutrients can be used for growth and need not be spent for the defense of the organism.

Proof of Ventar D's gut barrier-stabilizing effect

An experiment was conducted to determine the level of tight junction gene expression biomarkers closely related to gut integrity.

Process

The experiment was conducted in broilers. They were fed 100 g of Ventar D/ t of feed, and the gene expression of Claudin and Occludin was measured (the higher the gene expression, the higher the level of gut barrier damage).

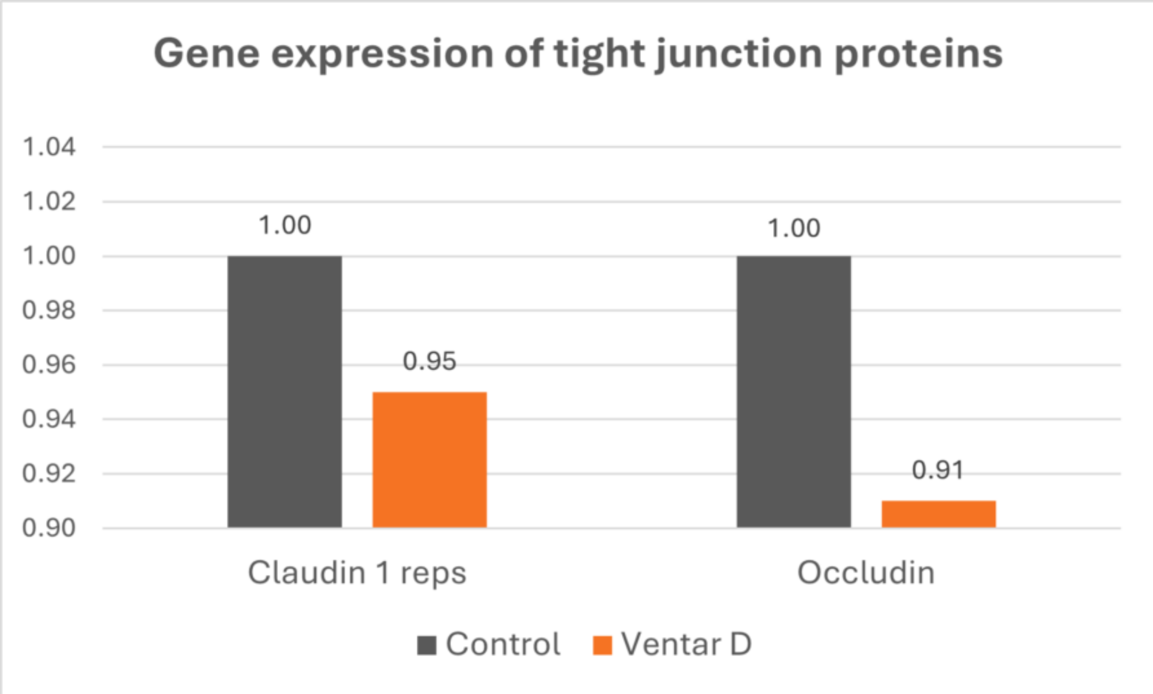


Figure 3: Effect of Ventar D on gut barrier function

Results

The lower levels of both gut tight junction gene expression biomarkers, Claudin and Occludin, in Ventar D-supplemented birds support a lower level of damage and a more robust gut barrier function (Figure 3).

3. Phytomolecules act as antioxidants

As mentioned, oxidative stress can disrupt gut barrier function and negatively impact the health of sows and piglets. Therefore, it is vital to scavenge reactive oxygen species (ROS) to reduce the damage these free radicals can cause to enterocytes and tight junctions.

Proof of Ventar D’s antioxidant effect in vitro

In this case, an in vitro trial was conducted to show Ventar D’s antioxidant effects.

Process

Ventar D’s antioxidant activity was tested in vitro using the ORAC (Oxygen Radical Absorbent Capacity) test. The ORAC test measures the antioxidant activity of a compound compared to that of the Vitamin E analog Trolox.

Result

The components in Ventar D demonstrated its capacity as an antioxidant, with a more substantial effect than the Vitamin E analog Trolox (see Figure 4).

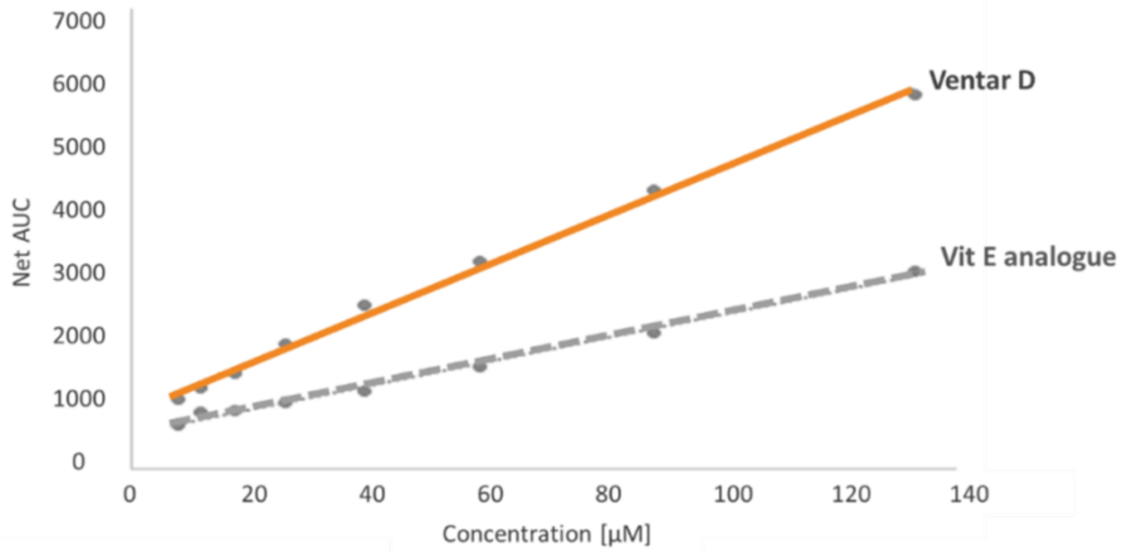


Figure 4: Antioxidant capacity of Ventar D compared to Vit. E analogue (AUC – Area under curve)

4. Phytomolecules decrease inflammation

In intensive production, animals face daily inflammation associated with various stressors, including gut incidents and intestinal dysbiosis, social hierarchy-associated fighting resulting in musculoskeletal or skin injuries, farrowing and lactation trauma to reproductive organs, and diseases affecting any system in the pig.

Animals with high-performance expectations, such as gestating, farrowing, and lactating sows, are particularly susceptible to high nutrient diversion, which can lead to inflammation and activation of the immune system. To mitigate the excessive continuation of inflammatory processes, phytomolecules with anti-inflammatory effects can be utilized.

Proof of Ventar D’s anti-inflammatory effect in vitro

The anti-inflammatory effect of Ventar D was shown in an in vitro trial conducted in the Netherlands.

Process

For the trial, cells from mice (Murine macrophages, RAW264.7) were stressed with lipopolysaccharides (LPS, Endotoxin) from E. coli O111:B4 (0.25 µg/ml) to provoke an immune response. To evaluate the effects of Ventar D, two different concentrations (50 and 200 ppm) were tested, and the levels of NF-κB, IL-6, and IL-10 were determined. IL-6 and IL-10 could be measured directly using specific ELISA kits, whereas, in the case of NF-κB activity, an enzyme induced by NF-κB (secreted embryonic alkaline phosphatase – SEAP) was used for measurement. The trial design was as follows (Figure 5):

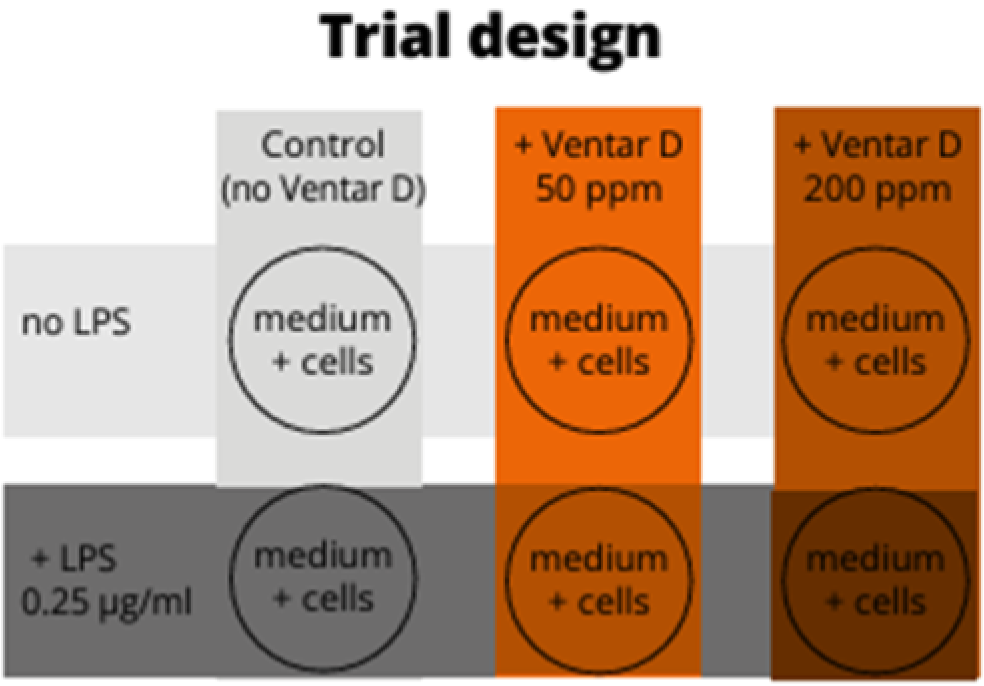


Figure 5: Trial design

Results

The trial results showed a dose-dependent reduction of NF-κB activity in LPS-stimulated mouse cells, with 11% and 54% reductions at 50 and 200 ppm Ventar D, respectively. The pro-inflammatory cytokine IL-6 was downregulated, and the anti-inflammatory cytokine IL-10 was upregulated by 84% and 20%, respectively, resulting in a decrease in the IL-6 to IL-10 ratio. This ratio is essential in balancing the pro- and anti-inflammatory outcomes of cellular signaling.

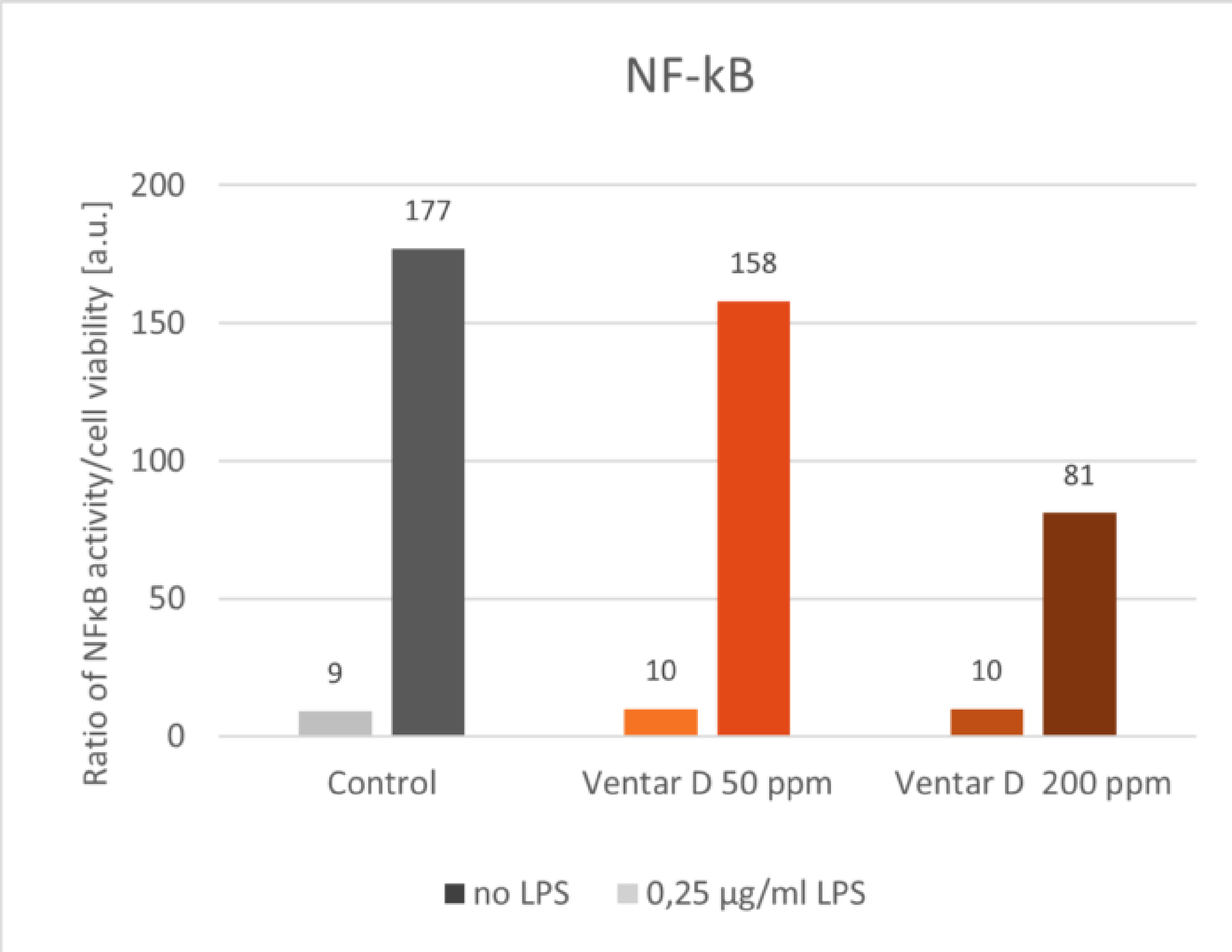


Figure 6: Activity of NFκB

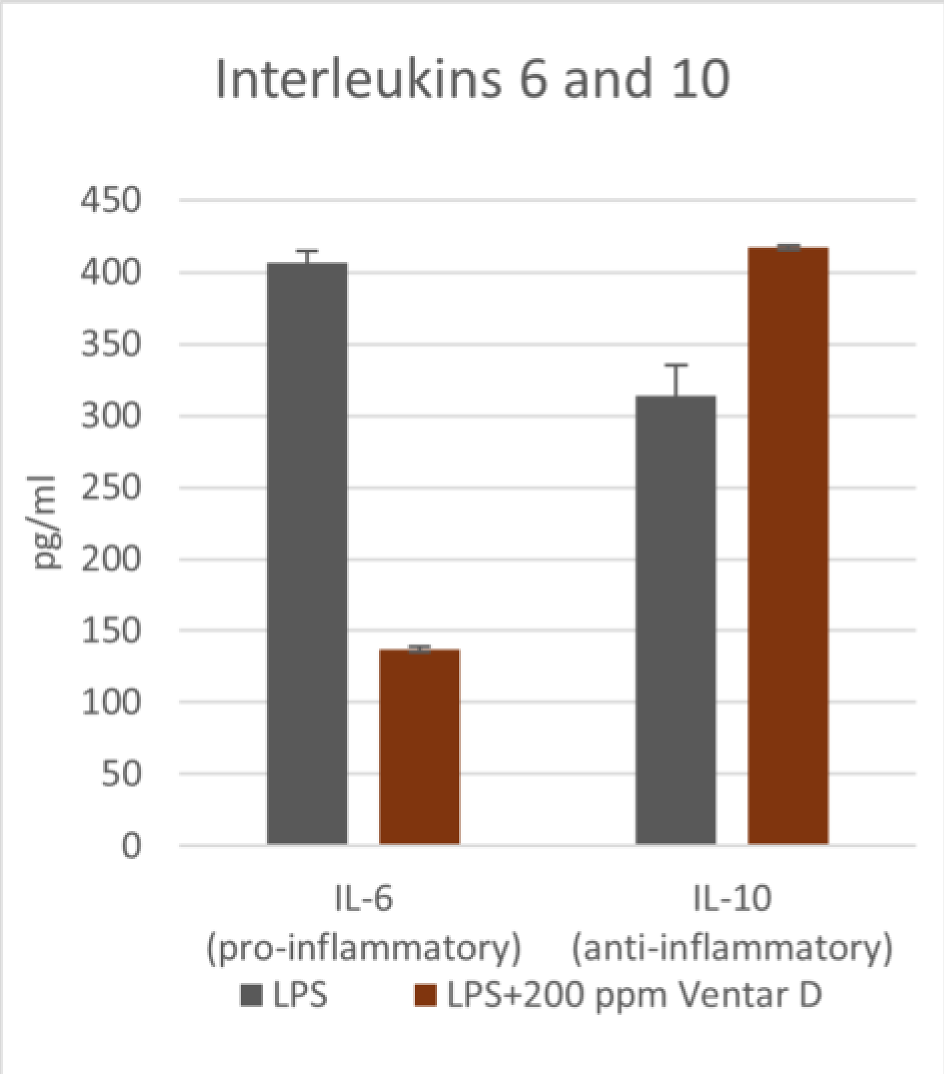


Figure 7: IL-6/IL-10 ratio

5. Phytomolecules improve production performance and efficiency

The intensive production systems of today encompass many factors that create stress in the animals. Phytomolecules exhibiting the positive characteristics mentioned in points 1 to 4 result in better performance in animals.

In pigs in suboptimal conditions, the antimicrobial effect of phytomolecules is the most important. However, in pigs held under optimal conditions and with extraordinary growth, the antioxidant and anti-inflammatory effects are most relevant. Anabolic processes, driven by strong growth, increase oxidative stress, while non-infectious inflammations burden the immune system.

Proof of Ventar D’s performance-promoting effect in pigs

To evaluate growth-promoting effects in pigs, a study was conducted on a commercial farm in the United States.

Process

A total of 532 approx. 24-day-old weaned piglets were housed in 28 pens, each containing 19 non-castrated males or gilts. Piglets were blocked by body weight and fed a three-phase feeding program

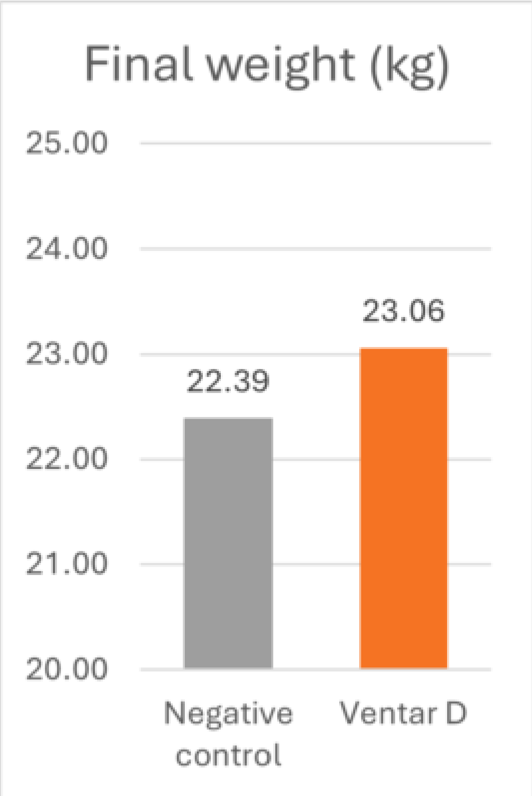
(Table 1). Phase 1 and 2 diets were pellets, and phase 3 was mash. Diets were based on corn and soybeans, and a concentrate including soy protein concentrate, whey permeate, and fish meal was added in phases 1 and 2, at a ratio of 50% of the total feed in phase 1 and 25% in phase 2. No feed medication was used in this trial.

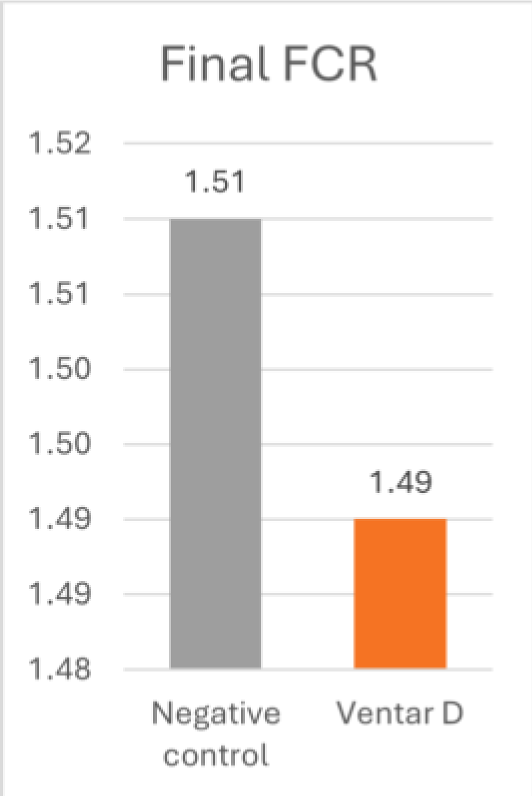
Table 1: Feeding scheme and product application

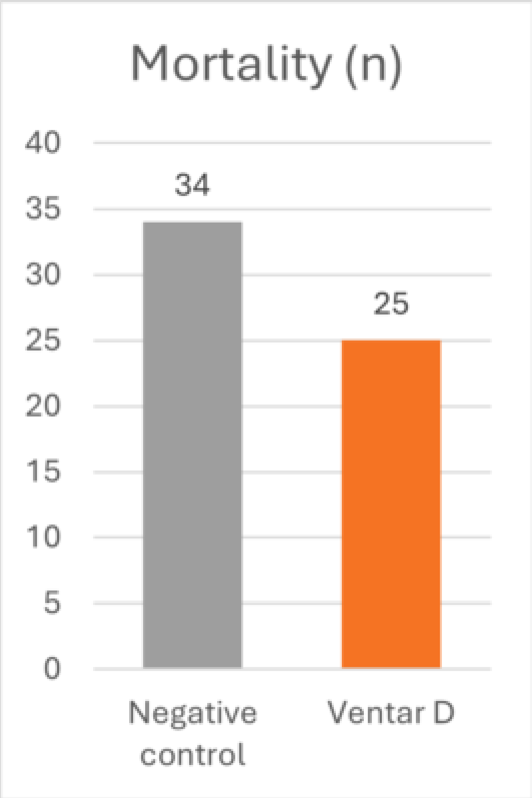
Trial groups	Feeding Phase 1 (day1 – day 14)	Feeding Phase 2 (day 15 – day 24)	Feeding Phase 3
Control	No additive	No additive	No additive
Ventar D	Ventar D 200 g/MT	Ventar D 200 g/MT	Ventar D 200 g/MT

Results

Adding Ventar D increased final body weight and improved FCR (see Figures 8 to 10). Furthermore, the addition of Ventar D to the feed reduced mortality.







Figures 8-10: Performance of piglets fed Ventar D in comparison to a negative control

Phytomolecules can help to keep sows healthy and productive

Intensive animal production places a significant strain on animal organisms. High stocking density often accompanies high pathogenic pressure and stress, and high growth performance can lead to increased oxidative stress and inflammation. It isn't easy to keep all challenges under control. However, phytomolecules can be a solution as their modes of action cover different relevant topics.

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The big challenge: Keeping sows healthy and productive – Part 1 General aspects to be observed

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Sow mortality critically impacts herd performance and efficiency in modern pig production. Keeping the sows healthy is, therefore, the best strategy to keep them alive and productive and the farm’s profitability high.

Rising mortality rates are alarming

In recent years, sow mortality has increased across pig-raising regions in many countries. Eckberg's (2022) findings from the MetaFarms Ag Platform (including farms across the United States, Canada, Australia, and the Philippines) determined an increase of 66.2% between 2012 and 2021.

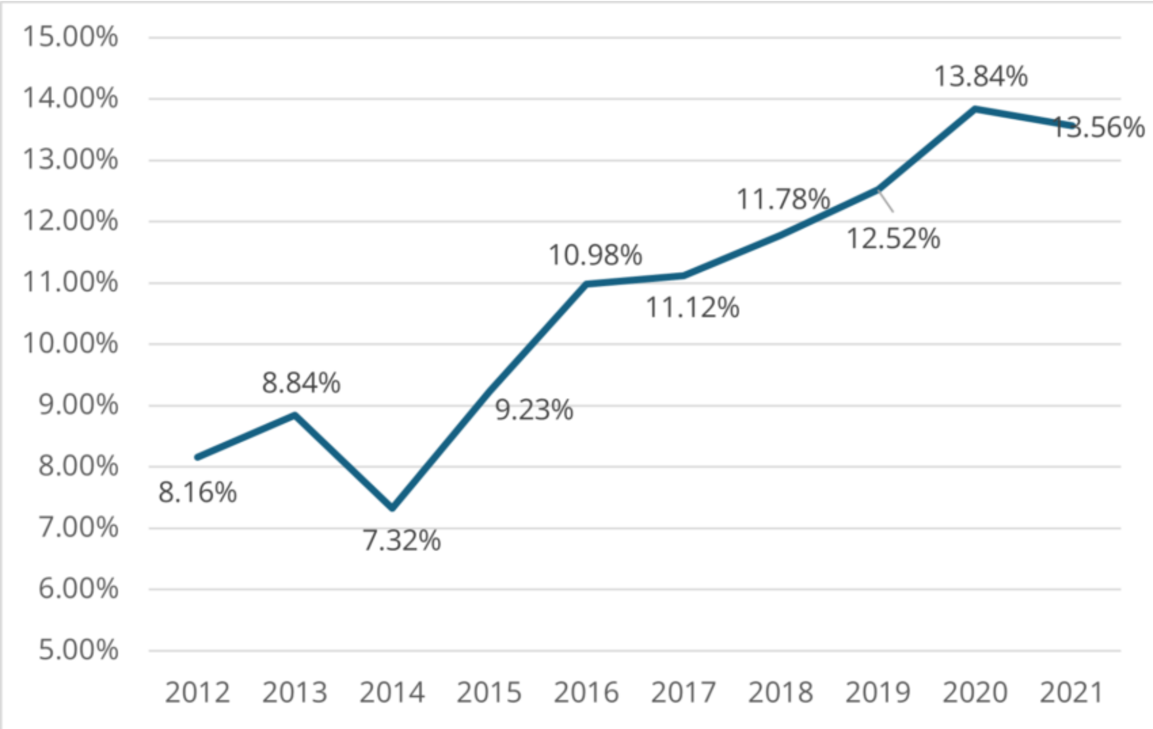


Figure 1: Sow mortality rates from 2012 to 2021 (Eckberg, 2022)

What can be done to decrease mortality rates?

Several measures can be taken to reach a particular stock of healthy and high-performing sows. In the following, the main remedial actions will be explained.

1. Determination of the cause of death

If a sow is dead, it must first be clarified why it has died. If the sow is culled, the reason for this decision is usually apparent. If the sow suddenly dies, investigations, including a thorough postmortem, are extremely valuable to determine the cause of death. Kikuti et al. (2022) provided a collection of the most-occurring causes of death in the years 2009 to 2018. As often, no necropsy is conducted, and the causes of death remain unclear, as shown by the high numbers of "other". Locomotory (e.g., lameness) and reproductive (e.g., prolapse, endotoxemic shock from retained fetuses) incidents account for approximately half of the recorded sow mortalities (Kikuti et al., 2022), especially during the first three parities. (Marco, 2024).

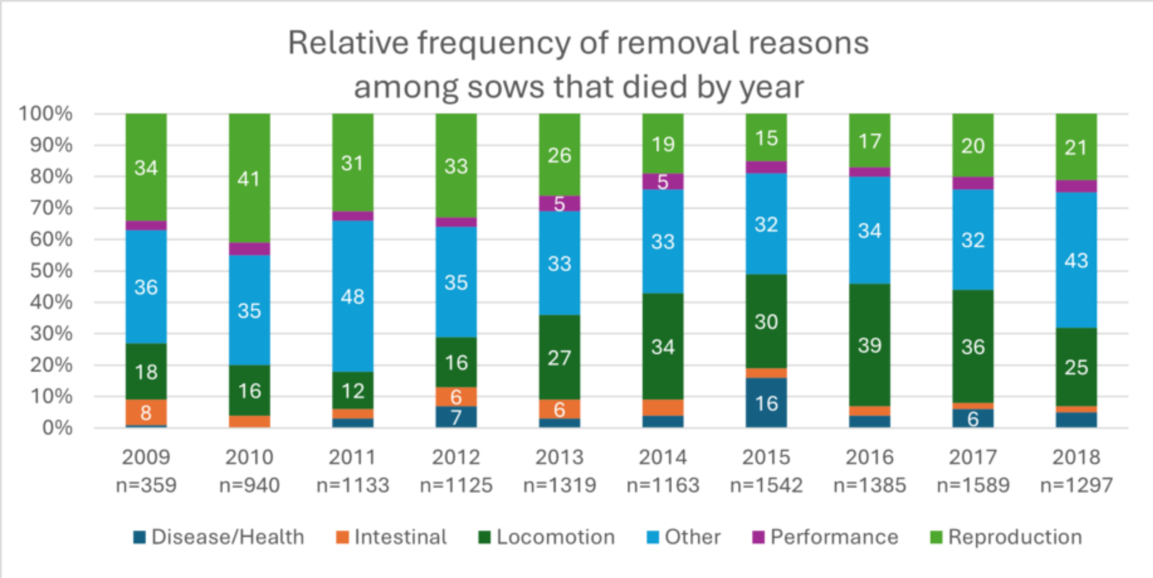


Figure 2: Removal reasons and their frequency from 2009 to 2018 (Kikuti et al., 2022)

Evaluating detailed breeding history together with the cause of death will provide perspective and assist veterinary, nutritionist, and husbandry teams with interventions to prevent similar events and early sow mortality.

Selection of the gilts

After selecting the best genetics and rearing the gilts under the best conditions, further selection must focus on physical traits such as structure, weight, height, leg, and hoof integrity.

Additionally, as we have more and more group housing for sows, the **selection for stress resilience** can positively impact piglet performance (Luttmann and Ernst, 2024). The following table compares stress-resilient and stress-vulnerable sows concerning piglet performance and shows the piglets of the vulnerable sows with worse performance.

Table 1: Influence of stress resilience on performance (Luttmann and Ernst, 2024)

Trait	SR	SV	p-Value
Birth weight (kg)	1.350 ± 0.039	1.246 ± 0.041	0.083
Wean weight(kg)	6.299 ± 0.185	5.639 ± 0.202	0.033*
Suckling ADG (kg/d)	0.191 ± 0.005	0.165 ± 0.005	0.004**

Least square means and standard error of stress resilient (SR) and stress vulnerable (SV) for each trait; significance threshold of $p<0.05$ with * indicating $0.01<p<0.05$, ** indicating $0.001<p<0.01$

How to manage the gilts best

The management of the gilts must consider the following:

1. Age at first estrus should be <195 days:
   Gilts having their first estrus earlier show higher daily gain and usually higher lifetime productivity. In a study conducted by Roongsitthichai et al. (2013), sows culled at parity 0 or 1 exhibited first estrus at 204.4±0.7 days of age, while those culled at parity ≥5 exhibited first estrus at 198.9±2.1 days of age (P=0.015).
2. Age at first breeding should lay between 200 and 225 days:
   If the sows are bred at a higher age, they have the risk of being overweight, leading to smaller second-parity litters, longer wean-to-service intervals, and shorter production life.
3. The body weight at first mating should be between 135 and 160 kg:
   To reach this target within 200-225 days, the gilts must have 600-800 g of average daily gain.

Breeding underweight gilts reduces first-litter size and lactation performance. Overweight gilts (>160 kg) face higher maintenance costs and locomotion issues.

4. The number of estruses at first mating should be 2 or 3:
   Accurately track estrus and breed on the second estrus. Research shows that delaying breeding to the second estrus positively affects litter size. Only delay breeding to the third estrus to meet minimum weight targets.

Housing

Gestating sows are more and more held in groups. Understanding the process of group housing is essential for success. The following graphic shows factors impacting successful grouping.

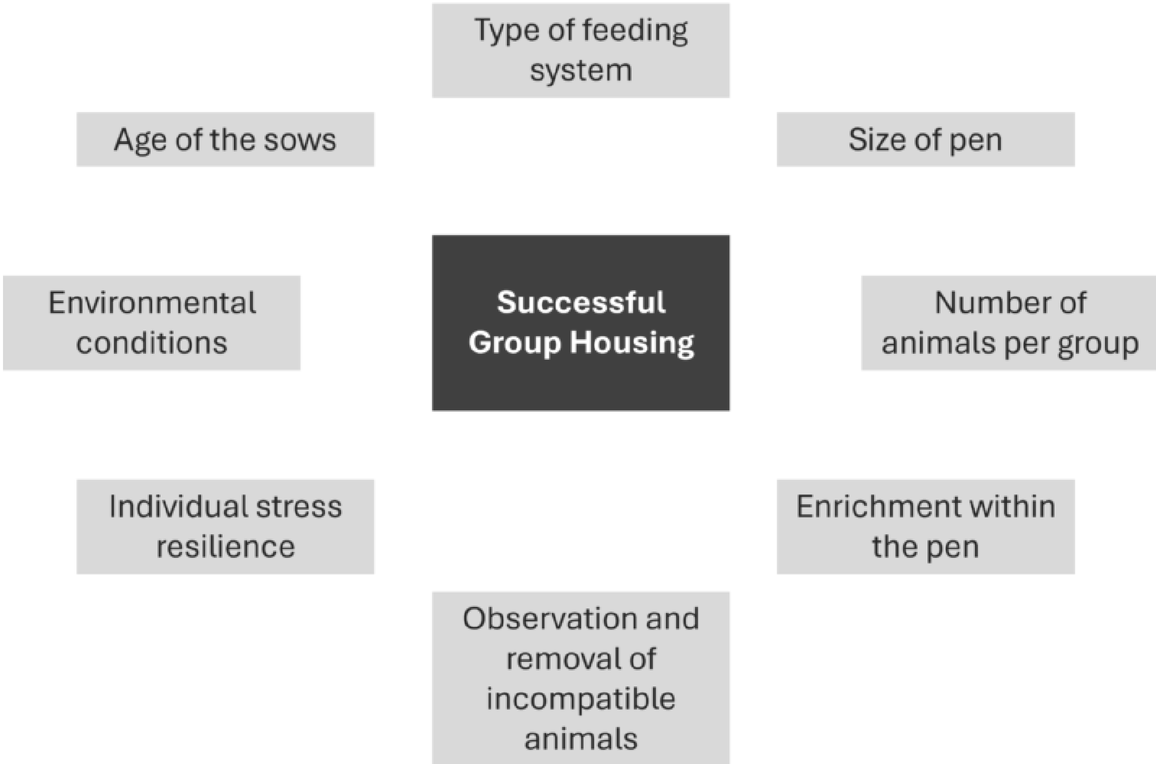
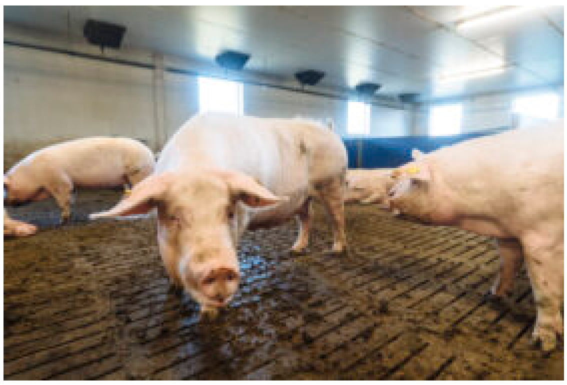


Figure 3: Factors influencing group housing

If the groups are not well-established yet, the stress levels among sows are higher, leading to

- More leg injuries due to aggressive behavior or fighting for resources
- Higher rates of abortions and returns to service
- Reduced sow performance, including decreased productivity, lower milk yield, and poor piglet growth due to compromised immune function and overall health



To mitigate stress in group housing, it is crucial to implement proper group management practices, which include gradual introductions, maintaining stable social structures, and ensuring adequate space and resources. This helps promote a calmer environment, improving animal welfare and herd performance.

Responsible on-farm pig care

Caregivers must be well-trained and equipped to provide high-quality care. Insufficient or unskilled pig caregivers can significantly affect the growth and development of prospective replacement gilts, ultimately influencing their suitability for the breeding herd:

- **Growth Rates**: Suboptimal nutrition and health management result in slower growth rates and poor body condition.
- **Health Issues**: Unskilled handling may increase the risk of disease transmission, injuries, and stress, all of which can adversely affect growth and overall development.
- **Behavioral Problems**: Poorly managed environments can increase aggression and competition among animals, hindering growth and health.
- **Selection Criteria**: Ineffective growth and health monitoring can result in misjudging the potential of gilts, leading to the selection of less suitable candidates for the breeding herd.

Table 2: Influence of handling on growth performance and corticosteroid concentration of female grower pigs from 7-13 weeks of age (Hemsworth et al., 1987)

	Unpleasant	**Pleasant**	**Inconsistent**	**Minimal**
ADG (g)	404^{a}	455^{b}	420^{ab}	4.58^{b}
FCR (F:G)	2.62^{b}	2.46^{a}	2.56^{b}	2.42^{a}
Corticosteroid conc (ng/mL)	2.5a	1.6b	2.6a	1.7b

Responsible on-farm pig care is crucial to keep sows healthy and performing. Poor sow observations (e.g., failure to identify stressed, anorexic, or heat-stressed sows) or inappropriate farrowing interventions can directly influence sow health and potentially reduce subsequent performance or mortality. On the contrary, rapid and proactive identification of sows needing intervention can save many animals that would otherwise die or need to be culled.

Keeping sows healthy and performing is manageable

The maintenance of sows' health is a challenge but manageable. Observing all the points mentioned, from selecting the right genetics over rearing the piglets under the best conditions to managing the young gilts, can help prevent disease and performance drops. For all these tasks, farmers and farm workers who do their jobs responsibly and passionately are needed. The following article will show nutritional interventions supporting the sow's gut and overall health.

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Nutritional strategies to maximize the health and productivity of sows

Conference Report

During lactation, the focus should be on maximizing milk production to promote litter growth while reducing weight loss of the sow, stated Dr. Jan Fledderus during the recent EW Nutrition Swine Academies in Ho Chi Minh City and Bangkok. A high body weight loss during lactation negatively affects the sow’s performance in the next cycle and impairs her longevity.

Milk production – ‘push’ or ‘pull’?

“Is a sow’s milk production driven by “push” – the sow is primarily responsible for milk production, or “pull” – suckling stimulates the sow to produce milk?” asked Dr. Jan Fledderus at the beginning of his presentation. The answer is that it is primarily a pull mechanism: piglets that suckle effectively and frequently can activate all compartments of the udder, leading to increased milk production. Therefore, the focus should be optimizing piglet suckling behavior (pull) to enhance milk production. This highlights the importance of piglet vitality and access to the udder in maximizing milk yield.”

Modern sows are lean

Modern sows have been genetically selected for increased growth rates and leanness, which alters their body composition. This makes traditional body condition scoring (BCS) methods, which rely on subjective visual assessment and palpation of backfat thickness, less effective. This may not accurately represent a sow’s true condition, especially in leaner breeds where muscle mass is more prominent than fat. Technology, such as ultrasound measurements of backfat and loin muscle depth, provide more accurate assessments of body condition and can help quantify metabolic reserves more effectively than visual scoring.

Due to their increased lean body mass, we must consider adjusted requirements for amino acids, energy, digestible phosphorus, and calcium. Their dietary crude protein and amino acid requirements have increased drastically.

Importance of high feed intake for milk production

Sows typically catabolize body fat and protein to meet the demands of milk production. Adequate feed intake helps reduce this catabolism, allowing sows to maintain body condition while supporting their piglets’ nutritional needs.

Feeding about 2.5kg on the day of farrowing ensures that sows receive adequate energy to support the farrowing process and subsequent milk production. Sows that are well-fed before farrowing tend to have shorter farrowing durations due to better energy availability during labor.

A short interval between the last feed and the onset of farrowing (□3 hours) has been shown to significantly reduce the probability of both assisted farrowing and stillbirths without increasing the risk of constipation. To enhance total feed intake, feeding lactating sows at least three times a day is helpful.

Dr. Fledderus recommended a gradual increase in feed intake during lactation, then from day 12 of lactation to weaning, feeding 1% of sow’s bodyweight at farrowing + 0.5 kg/piglet. For example, for a 220kg sow with 12 piglets:

$$(220 \text{ kg} \times 0.01) + (12 \times 0.5 \text{ kg}) = 2.2 + 6 = 8.2 \text{ kg total daily feed intake}$$

Energy source – starch versus fat

The choice between starch and fat as an energy source in sow diets has substantial implications for body composition and milk production.

Starch digestion leads to glucose release, stimulating insulin secretion from the pancreas. Insulin is essential for glucose uptake and utilization by tissues. Enhanced insulin response can help manage body weight loss by promoting nutrient storage and reducing the mobilization of the sow's body reserves.

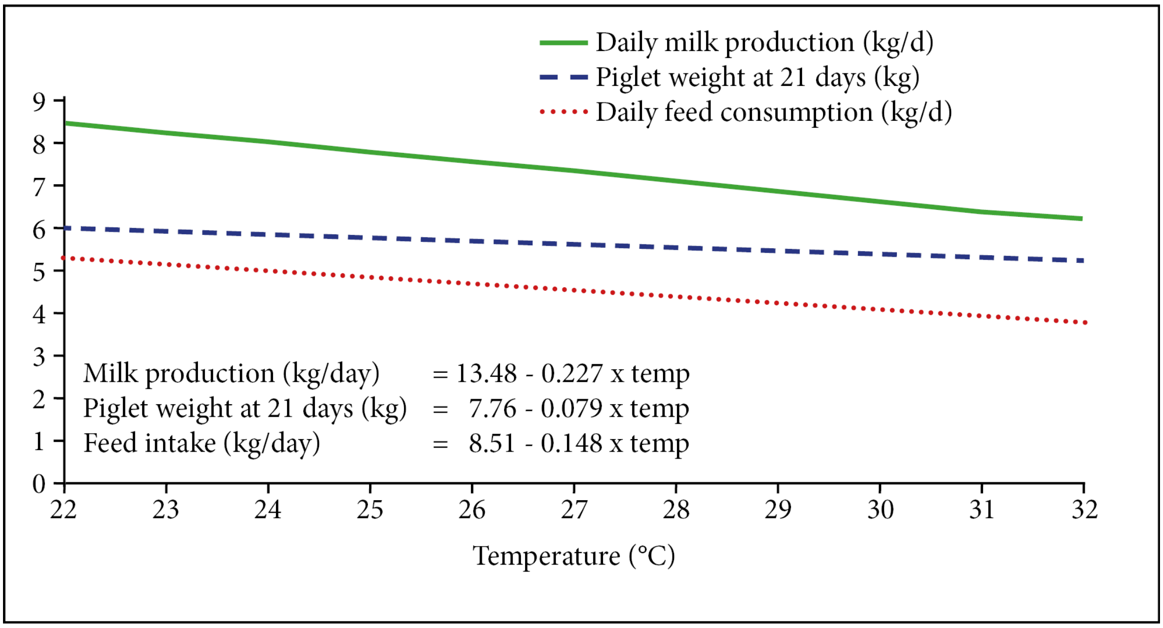
Sows fed diets with a higher fat supplementation had an increased milk fat, which is crucial for the growth and development of piglets.

Table 1: Effect of energy source (starch vs. fat) on sows' body composition and milk yield (Schothorst Feed Research)

	Diet 1	Diet 2	Diet 3
Energy value (kcal/kg)	2,290	2,290	2,290
Starch (g/kg)	300	340	380
Fat (g/kg)	80	68	55
Feed intake (kg/day)	6.7	6.7	6.8
Weight loss (kg)	15	11	10
Weight loss (kg)	3.1	2.7	2.3
Milk fat (%)	7.5	7.2	7.0
Milk fat (%)	260	280	270

Heat stress impacts performance

The optimum temperature for lactating sows is 18°C. A meta-analysis concluded that each 1°C above the thermal comfort range (from 15° to 25°C) leads to a decrease in sows' feed intake and milk production and weaning weight of piglets, as shown below.



Effect of heat stress on lactating sows (according to Ribeiro et. al., 2018 Based on 2,222 lactating sows, the duration of lactation was corrected to 21 days)

To mitigate the effects of heat stress, which reduces feed intake, it is beneficial to schedule feeding during cooler times of the day. This strategy helps maintain appetite and ensures that sows consume sufficient nutrients for milk production. Continuous access to cool, clean water can also enhance feed consumption.

Pigs produce much heat, which must be "excreted". Increased respiratory rate (>50 breaths/minute) has been shown to be an efficient parameter for evaluating the intensity of heat stress in lactating sows.

When sows resort to panting as a mechanism to dissipate heat, this rapid breathing increases the loss of carbon dioxide, resulting in respiratory alkalosis. To prevent a rise in blood pH level, HCO_3 is excreted via urine, and positively charged minerals (calcium, phosphorous, magnesium, and potassium) are needed to facilitate this excretion. However, these minerals are crucial for various physiological functions. As their loss can lead to deficiencies that affect overall health and productivity, this mineral loss must be compensated for.

Implications for management

Implementing effective nutritional strategies together with robust management practices is crucial for maximizing the health and productivity of sows. The priority is to stimulate the sow to eat more. This not only enhances milk production and litter growth but also supports the overall well-being of the sow. Regularly assessing sow performance metrics – such as body condition score, feed intake, and litter growth – can help identify areas for improvement in nutritional management.

EW Nutrition’s Swine Academy took place in Ho Chi Minh City and Bangkok in October 2024. Dr. Jan Fledderus, Product Manager and Consultant at the S&C team at Schothorst Feed Research, with a strong focus on continuously improving the price/quality ratio of the diets for a competitive pig sector and one of the founders of the Advanced Feed Package, was a reputable guest speaker in these events.

Rearing pigs without antibiotics

Conference Report

Holistic management is essential for successfully rearing pigs, particularly in systems that aim to minimize antibiotics. The method emphasizes the interconnectedness of various factors contributing to sustainable pig health and productivity. Some of the key components of this holistic management were discussed by Dr. Seksom.

Sow lifetime productivity

Suggested targets for sow lifetime productivity are

- >70 marketed fattening pigs
- At least 6 parities with at least 10.5 pigs marketed per parity
- 25 fattening pigs/sow/year (2.4 parities/year x 10.5 fattening pigs)

To achieve these targets, we need 29.2 born alive piglets/sow/year (or 12.2 born alive piglets/parity), and it is essential to control losses during each production period: <10% pre-weaning, <3% during nursery, and <2% in fattening.

Since the occurrence of African swine fever (ASF), with improved genetics, we can now produce pigs with 120 kg+ bodyweight at slaughter without carcass problems and reach about 3 tons of bodyweight/sow/year, compared to around 2 tons before.

Modern pig genetics and subsequent problems

Despite the advancements in modern pig genetics leading to improved production and bigger litters, several ensuing problems have emerged:

- Less average body weight of piglets at birth
- Large number of piglets born with less than 1.0 kg (target <5%)
- High pre-weaning mortality
- High post-weaning mortality and morbidity

Dr. Seksom highlighted that birthweights decrease with increasing sow prolificacy. He stated that “piglets should be divided into groups with similar body weights at weaning” and that “a key objective for successful weaning is a piglet that weighs a minimum of 6-6.5 kg at three weeks of age, and that less than 25% of the piglets have a weight of ≤5.9 kg.”

Sow body condition

Sows should be fed to feed to body condition score (BCS), not a fixed amount of feed. Ideally, the sows have a BCS of 2.75 (the sow’s backbone is visible, and the tips of the short ribs can be felt but are smooth) or 3.0 (well-rounded appearance, hips, and spine can only be felt with firm pressure) at 12 weeks of pregnancy, so we can feed more in the last month to achieve a BCS of 3-3.25 at farrowing. This is essential to ensure that sows have sufficient energy reserves for lactation and overall health.

Target body condition score – 2.75 at three months of gestation

Feed intake must be increased gradually during the last month of gestation as most fetal growth and mammary gland development occur during this period. This may involve raising energy-dense feeds or adjusting protein levels as needed.

Dr. Seksom stressed that “nutrition is not just the feed; it’s about feeding as well. To feed sows to BCS, assessments of BCS should be done regularly throughout gestation, ideally every 2-4 weeks. This allows for timely adjustments in feeding based on individual sow’s needs. Ensure that staff are trained one-on-one to accurately assess the body condition of sows. This includes recognizing the visual and tactile indicators of different scores and understanding how BCS impacts reproductive performance, longevity, and overall farm profitability.”

After farrowing, the sows must be monitored closely for any signs of excessive weight loss and feeding strategies adjusted accordingly to support recovery and lactation needs.

Piglet diarrhea

Many factors cause diarrhea and must be thoroughly investigated. For bacteria-caused diarrhea, Dr. Seksom advised a good hygiene program, whereas for viral causes, a vaccination program is essential. However, he emphasized that “for a vaccination program, you can’t just copy from another farm; it needs to be created specifically using the titers for diseases on your farm.”

Swine influenza is an often-overlooked cause of diarrhea in piglets. While it is primarily recognized for causing respiratory issues, the virus can also lead to scours in the first two weeks of piglets’ life. So, sows should be checked for symptoms of swine influenza (such as nasal discharge, sneezing and coughing, and inappetence) before farrowing. If necessary, they must be treated with paracetamol to reduce fever and symptoms.

Main disease causes of pre-weaning diarrhea

	Nursery period				**Mortality level**
	Days 1-3	**Days 3-7**	**Days 7-14**	**Days 14-21**	
Agalactia	√	√	√	√	Moderate
Clostridia	√	√	√		High
Coccidiosis		√	√	√	Low
E. coli	√	√	√		Moderate
PED	√	√	√		Variable

PRRS	√	√	√	√	Variable
Rotavirus			√	√	Low
TGE	√	√	√	√	High
Influenza		√	√		Low

Ensuring colostrum intake

The intake of an adequate quantity of colostrum is crucial for piglets to be protected during the first days of life. Best practices to ensure that piglets get □250 mL of colostrum include:

- **Teat access –** if a sow has a large litter or is unable to nurse all her piglets effectively, consider split suckling by separating larger, more vigorous piglets from the litter for a couple of hours after birth. This allows smaller or weaker piglets better access to the udder without competition. Syringe-feeding colostrum to smaller piglets is also effective.
- **Early access –** six hours after farrowing, the quality of colostrum begins to decline significantly. Additionally, the piglet can only absorb intact large IgG molecules, the major source of passive immunity, during the first 24 h after birth, prior to gut closure. In any case, by this time, the sow will start producing milk and not colostrum.
- **Sow behavior –** if a sow experiences pain or discomfort from injuries caused by her piglets' teeth, she may become less willing to allow them to nurse, leading to delays in colostrum intake. Genetic background influences maternal behavior significantly. For example, some breeds exhibit stronger maternal instincts and better nursing behaviors than others. Selecting sows with proven good maternal traits can lead to improved outcomes in piglet survival and growth.
- **Drafts –** newborn piglets are born with low fat reserves and are highly susceptible to hypothermia. Drafts significantly impact the effective temperature experienced by piglets.
- **Staff training –** Staff must be trained to recognize signs of distress in both sows and piglets; training in techniques enables them to assist with nursing and feeding, which is crucial for timely interventions.

Weaning is a process, not just a one-time event

Research has shown that heavier piglets at weaning have better lifetime performance than lighter ones. Weaning weight is a more accurate indication of post-weaning growth than either birth weight or age. It is, therefore, important to establish the weaner immediately post-weaning to maintain growth rates, reduce pen variation, and lessen the amount of ‘tail-enders’ at the point of sale.

Dr. Seksom emphasized that “viewing weaning merely as a single event, rather than a process, overlooks the complexities involved in ensuring a smooth transition for the animals. He advocated for a comprehensive approach to weaning that includes the shown well-planned steps to support piglets during this critical phase. If the weaning process is managed effectively, you can significantly reduce the need for antibiotics.”

Conclusion

“By integrating these holistic management strategies, pig producers can effectively raise pigs without antibiotics while promoting animal health, improving productivity, and addressing consumer concerns about antibiotic use in livestock production,” summarized Dr. Seksom.

EW Nutrition’s Swine Academy took place in Ho Chi Minh City and Bangkok in October 2024. Dr. Seksom Attamangkune, a leading expert in the nutrition and management of pigs in tropical conditions and former Head of the Animal Science Department and Dean of the Faculty of Agriculture at Kamphaeng Saen, Kasetsart University, was a reputable guest speaker at this event.

Oxidative & Inflammatory stress in reproductive Sows

By Twan van Gerwe, DVM PhD Dipl ECPVS, Technical Director
Dr. Inge Heinzl, Editor

One of the biggest challenges in swine production is keeping the modern, hyperprolific sow healthy and in good shape so that she can wean large, healthy litters and maintain her high reproductive performance.

Unfortunately, sows often suffer from stress and increased systemic inflammation around farrowing and during lactation. This leads to impaired feed intake and disturbed endocrine homeostasis, negatively affecting reproductive and litter performance.

The key to increasing the efficiency of pig production is to reduce the metabolic burden of sows while maintaining the reproductive performance of high-yield sows. A deep understanding of the complex interplay between environmental factors, sow well-being, health, and productivity is necessary to implement enhanced nutritional regimens and meticulous management practices.

Why does oxidative stress occur in today’s sows?

Nowadays, hyperprolific sows produce between 30 and 40 weaned piglets per year and are at a higher risk of suffering from stress. What are the reasons?

A high number of piglets causes oxidative stress

Oxidative stress occurs when reactive oxygen species (ROS) are produced faster than the body's antioxidant mechanisms can neutralize them and cause damage to lipids, proteins, and DNA. During gestation, the sow needs high amounts of energy to provide for the fetuses. This energy is produced in the placental mitochondria. The placenta, therefore, is a place of active oxygen metabolism during gestation and a source of oxidative stress. In hyperprolific sows, a higher number of fetuses need even more energy to grow. Consequently, ROS production and the risk for intrauterine growth retardation (IUGR) increases (Figure 1). Moreover, evidence shows that the body's antioxidant potential is reduced in late gestation and after parturition (Szczubial, 2010), resulting in increased oxidative stress biomarkers (Yang, 2023). Increased milk production for large litters demands a substantial amount of energy, risking similar oxidative distress. Therefore, both the final phase of gestation and the subsequent lactation period are predestined for oxidative stress, which has been demonstrated by reduced TEAC (Trolox equivalent antioxidant capacity) levels during these phases (Lee et al., 2023).

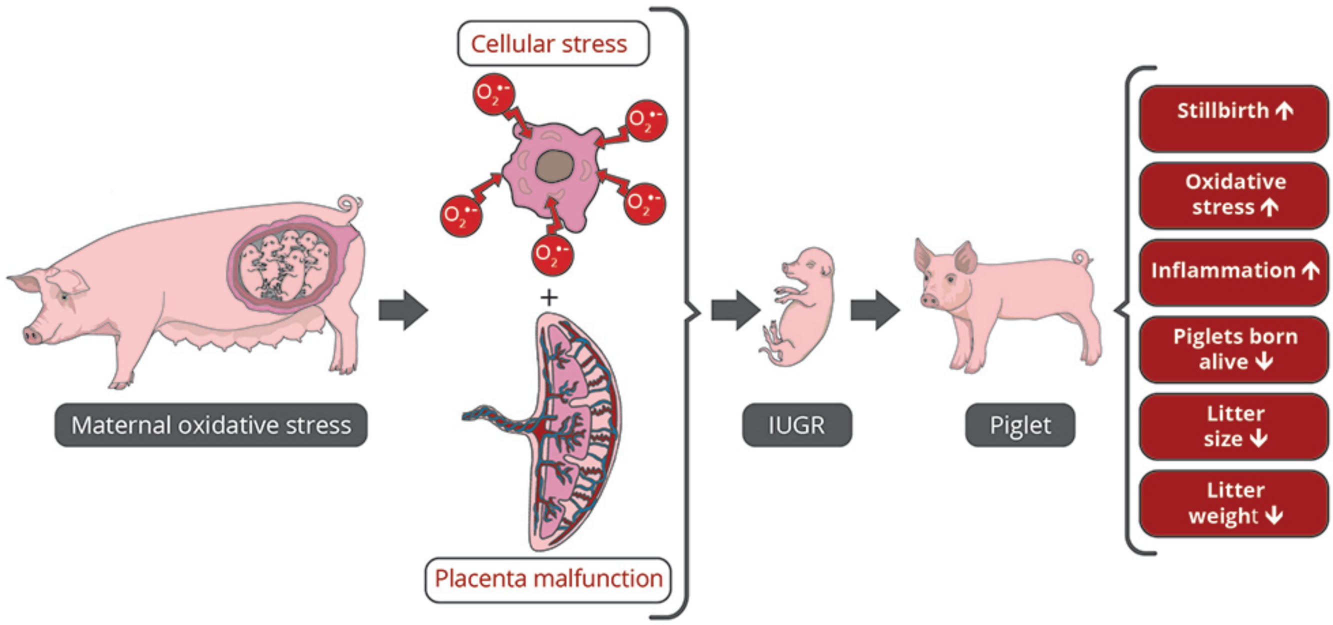


Figure 1. Illustration of the effect of oxidative stress on the fetus: intrauterine growth retardation (IUGR) (adapted from Yang et al., 2023)

Heat and ambient stress also contribute

The reproductive sow produces lots of heat. From the beginning of gestation, the sow's thermoneutral zone decreases. This, however, does not always correspond with the ambient conditions. Especially during the last days of gestation, the discrepancy is exceptionally high as everything is prepared for the newborn piglets, which need a temperature of about 27-35°C. The sow, on the contrary, would be happy with 18-22°C. Additionally, changes around farrowing – moving to the farrowing unit, social stress, change of feed, and the preparation for parturition – exert additional stress for the sows.

Why does the inflammation level increase?

After parturition, systemic inflammation is a normal phenomenon: the reproductive organs have sustained injuries during the parturition process and require remodeling. Inflammation is a natural and desired process, to repair the tissues and return to a normal status. However, inflammation is increased in modern sows, adversely affecting their inflammatory balance. Some possible underlying reasons are:

1. The high numbers of piglets need a lot of space in the uterus, often leading to damage of the uterine tissue and an inflammatory response in the sows. Lee et al. (2023) found significantly ($p<0.10$) higher TNF-α concentrations in sows with litters of 15-20 piglets than in sows with 7-14 piglets. TNF-α is a biomarker of inflammation.
2. Pathogenic infections – particularly infections of the reproductive tract – can induce a prolonged or excessive inflammatory state. A further reason can be the need for more obstetric interventions in hyperprolific sows, which can injure the birth canal or the uterus.
3. Imbalanced nutrition: Excessive backfat is associated with a higher expression of proinflammatory cytokines, and feed contaminated with mycotoxins can impair the sow's immunocompetence.

Biomarkers can inform us about the oxidative status

Biomarkers are naturally occurring molecules that help us identify diseases or physiological processes. They provide insights into the oxidative state and inflammatory processes.

Anti-oxidative biomarkers

To check the anti-oxidative capacity, the "beneficial" substances, or antioxidants, can be quantified. These substances can neutralize free radicals or be neutralized by them. Higher levels of antioxidants indicate better antioxidant capacity; when antioxidants are abundant, fewer oxidizable substances have undergone oxidation.

Examples of antioxidant biomarkers:

Total Antioxidant Capacity (T-AOC): represents the synergistic interaction effects of all antioxidants in a matrix (E.g., diet or body fluids). It's a global measure of non-enzymatic antioxidant efficiency. Various assays, like **Trolox Equivalent Antioxidant Capacity (TEAC),** which measures a substance's antioxidant capacity compared to Trolox, can measure T-AOC.

Glutathione Peroxidase (GSH-Px) belongs to the peroxidase family and converts hydrogen peroxide to water.

Catalase (CAT): scavenges ROS. Its activity can predict oxidative stress.

Superoxide Dismutase (SOD): catalyzes the dismutation of superoxide radicals to oxygen and hydrogen peroxide.

Oxidative biomarkers

Oxidative stress biomarkers, the 'negative' substances, can also serve as general biomarkers. These include free radicals with oxidant capacity or intermediate/final oxidation products. Ideally, their levels should be minimized.

Examples of oxidative stress biomarkers:

Thiobarbituric acid reactive substances (TBARS): to measure lipid peroxidation products in cells, tissues, and body fluids.

Reactive oxygen species (ROS) or free radicals: unstable, oxygen-containing molecules that react with other molecules in a cell. They might damage DNA, RNA, and proteins and cause cell death. **Hydrogen Peroxide (H_2O_2)** is a ROS produced during normal cellular metabolism, which causes oxidative damage at excessive levels.

Malondialdehyde (MDA): a final product of oxidative fat degradation and, therefore, a biomarker for lipid peroxidation.

Pro-inflammatory biomarkers

Like oxidative stress, the interplay between pro- and anti-inflammatory signals helps develop the proper immune response for the appropriate duration.

Examples of Pro-inflammatory biomarkers or molecules produced in the case of inflammation:

- **Plasma Adenosine Deaminase (ADA-1 and ADA-2)**: involved in immune regulation, with ADA-1 inhibiting pro-inflammatory responses and ADA-2 supporting immune cell functions.
- **Interleukins (IL-1α and IL-1β), IL-6:** IL-1α and IL-1β are associated with inflammatory diseases, IL-6: is produced during inflammation and acute-phase response.
- **Tumor Necrosis Factor α (TNF-α):** endogenous pyrogen that induces fever and promotes inflammation.
- **C-reactive Protein (CRP):** liver-produced acute-phase protein responding to inflammation.

Procalcitonin (PCT) is produced by the liver during infections and helps detect bacterial infections.

Examples of anti-inflammatory substances – the "good ones":

- **Interleukines – IL-4, IL-10**: inhibit the function of the macrophages and act, therefore, anti-inflammatory
- **Cortisol**: anti-inflammatory and immune-suppressive
- **ACTH**: stimulates the production and release of cortisol

Higher stress or infection level lowers performance in sows and piglets

As mentioned, hyperprolific sows suffer from higher oxidative stress, especially during late gestation, parturition, and lactation. Additionally, systemic inflammation occurs to repair the injured tissues to facilitate the healing of the birth canal and remodeling of the uterus to establish the subsequent pregnancy. To this purpose, an inflammatory cascade, triggered by the injuries due to gestation and parturition, involves the release of critical (pro-inflammatory) mediators such as TNF-α and IL-6, leading to the activation of acute phase proteins.

After triggering inflammatory pathways, anti-inflammatory pathways must also be activated to reestablish homeostasis in the reproductive organs (Serhan & Chiang, 2008). Alterations at the onset of anti-inflammatory pathways and exacerbated activation and maintenance of inflammatory pathways can lead to uncontrolled inflammation and the onset of reproductive disease in sows (Kaiser et al., 2018), as well as reduced feed intake and insufficient milk production, resulting in poorly growing piglets and lower weaning weights or piglets suffering from clinical infectious diseases such as diarrhea. If possibly homeostasis cannot be restored, the sow is at risk of contracting diseases like post-partum dysgalactia syndrome (PPDS), lameness, and impaired fertility.

Targeted use of polyphenols can mitigate inflammation and improve the oxidative

status of sows

There are several experiments showing the beneficial effects of natural compounds. Especially polyphenols, disposing of phenyl rings and two or more hydroxyl substituents, are perfect radical scavengers and proven antioxidants (Chen, 2023). Phytogenic substances that have anti-inflammatory effects can be found in the families of polyphenols as well as terpenoids, flavonoids, saponins, and tannins (Bunte et al., 2019; Ge et al., 2022; Ginwala et al., 2019; Santos Passos et al., 2022; Ambreen and Mirza, 2020).

Here are some examples showing the beneficial effects of phytochemicals:

1. Primiparous sows fed with Moringa oleifera leaf meal, rich in polyphenols, saponins, and tannins, illustrate the potential of phytomolecules: serum levels of T-AOC (total anti-oxidative capacity), were increased in late gestation and during lactation, while MDA was reduced. Additionally, piglets that received Moringa oleifera meal showed the highest serum CAT and SOD activities. The meal significantly decreased the farrowing length and number of stillbirths, while there was an increasing trend in the number of live-born piglets (Sun et al., 2020).
2. The polyphenol Daidzein, a member of the class of compounds known as isoflavones (200 mg/kg during gestation), increased the total antioxidant capacity (T-AOC) and the activities of glutathione peroxidase and superoxide dismutase. Additionally, it elevated the level of immunoglobulin G and increased the number of piglets born and born alive per litter (Li et al., 2021).
3. Glycitein, a polyphenol occurring in the isoflavone fraction of soy products, applied during late gestation and lactation increased the total antioxidant capacity and SOD activity during the first 18 days of lactation and the CAT and GSH-Px activity in mid-lactation. Plasma MDA level was reduced from late gestation to the 18^{th} day of lactation. The enhanced oxidative status of the sow resulted in a higher daily gain of the piglets and a higher weaning weight of the litter (Hu et al., 2015).
4. Meng et al. (2018) tested Resveratrol (300 mg/kg), a stilbenes polyphenol, in sows from day 20 of gestation until farrowing. They saw noticeably higher GSH-Px, SOD, and CAT activities, as well as lower contents of MDA and H_2O_2 in the placental tissue, improving the antioxidant status of sows and piglets.
5. Xu et al. (2022) fed silymarin to sows in late gestation. They observed that IL-1ß concentration in the blood sample on the 18^{th} day of lactation was reduced in the supplemented group. The altered fecal microbiota was associated with variations in inflammatory factors, suggesting that silymarin modulates microbiota in the gut and may improve the health of lactation sow.

Phytochemicals support sows against oxidative and inflammatory stress

The above-presented examples show that phytochemicals, particularly those developed to have a potent anti-inflammatory and anti-oxidative capacity, have a high potential to alleviate oxidative stress in pregnant and lactating sows and reduce inflammation when applied in sow diets. Consequently, a broader use of these natural substances should be considered to reduce the metabolic burden of sows and increase the efficiency of pig production.

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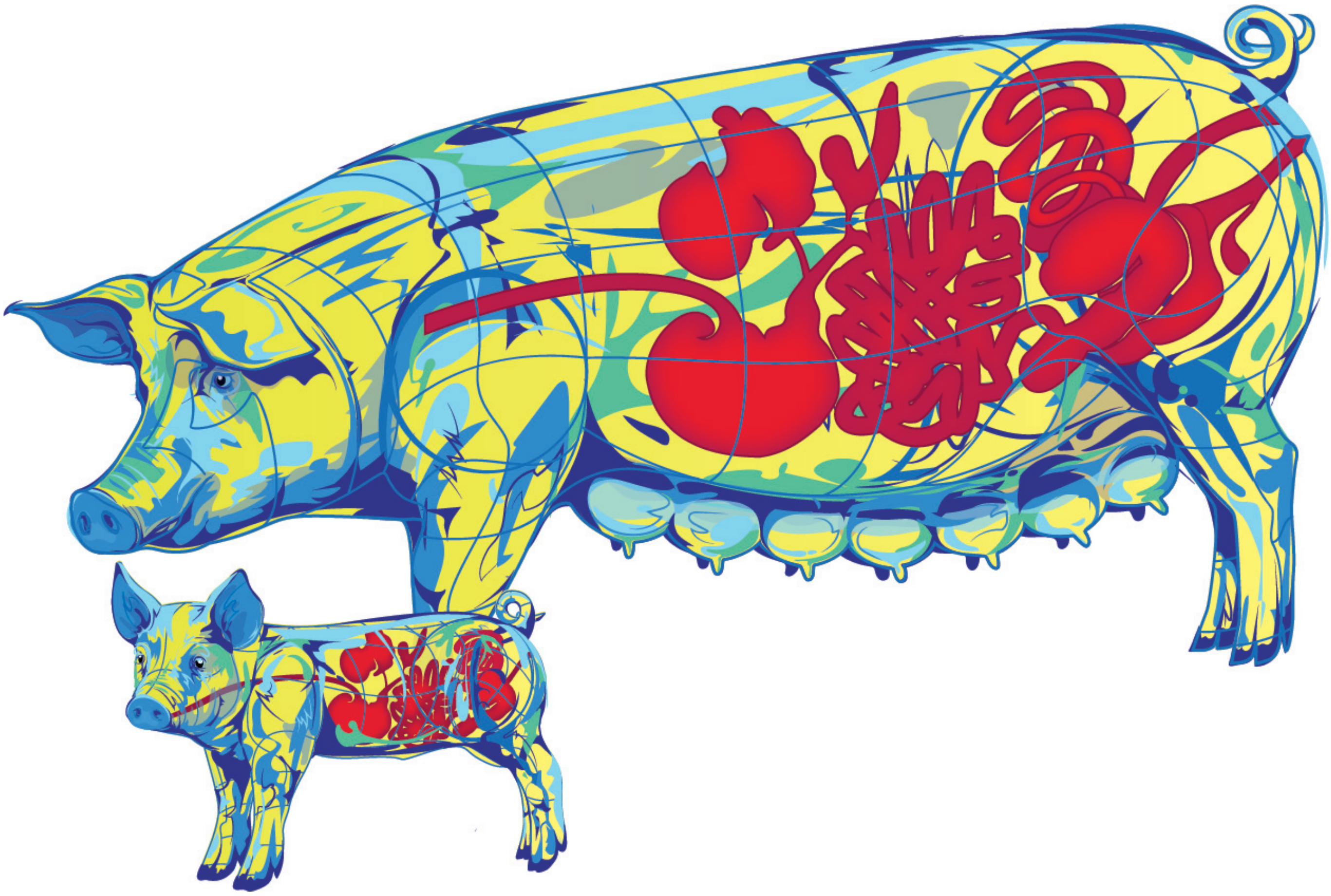
INFOGRAPHIC: Why large litters could mean higher mortality



The benefits imprinted by genetics with more piglets/sows can be lost along the way to weaning. What can decrease performance and increase mortality in such cases? Why do higher litter sizes so often correlate with higher mortality?