Successful weaning requires adequate pre-weaning preparation

Conference report

The abrupt transition from the sow's milk to solid feed, combined with environmental changes and social restructuring, creates a challenging situation for young piglets. Weaning is a critical phase that subjects piglets to multiple stressors, which can have cumulative effects on their health and development. Weaning stressors are inevitable in the piglets' development; however, effective pre-weaning management practices can significantly minimize their impact on health and performance.

Pre-weaning measures help improve weaner performance.

"Successful weaning of piglets is a multifaceted process that requires careful management and strategic planning well before the actual weaning event," says Dr. Merideth Parke, Global Application Manager, Swine, EW Nutrition. She emphasized the following key pre-weaning factors that can significantly influence success during this most critical time.

Genetics

Selecting the right genetics for your specific production system is crucial for ensuring successful weaning outcomes. The genetic traits of sows with a direct impact include sow resilience, litter size, piglet birth weights, and overall growth rates.

Furthermore, it is decisive for piglets' survival and performance that the sow shows strong maternal instincts, and, to ensure enhanced colostrum and milk uptake, an adequate number of functional teats and high milk production.

Gestation and farrowing influencers

Having an optimal body condition score at farrowing is essential for sows. Being overweight or underweight poses the risk of prolonged farrowing and reduced colostrum and milk production.

On the piglet side, prolonged farrowing negatively impacts their vitality at birth, which correlates with reduced colostrum uptake and increased pre-weaning mortality rates.

Environmental conditions

Newborn piglets are particularly vulnerable to hypothermia and have a minimal critical temperature of 33-35°C. Below this range, they struggle to maintain their body temperature, which can lead to increased mortality rates. Cold piglets are less likely to suckle, compromising their energy reserves and ability to maintain body temperature.

In contrast, lactating sows have an optimal temperature of 18-22°C to maximize feed intake and milk production. Therefore, to balance the temperature needs of sow and piglets, it is essential to create a controlled temperature, draft-free creep microenvironment for piglets.

Hygiene

The hygiene of farrowing crates plays an essential role in the successful weaning of piglets. Maintaining a clean environment significantly impacts the health and growth of piglets, ultimately influencing their survival and weight at weaning. "We must consider the time spent cleaning, disinfecting, and drying farrowing crates an investment, not a cost," emphasized Dr. Parke. "Doing these routine tasks really well will inevitably reduce the time spent treating sick pigs."

Lactation phase

The primary objective of pre-weaning measures is to ensure adequate colostrum and milk production throughout lactation while beginning the adjustment to solid feed. Efforts should be directed toward facilitating nursing access for all piglets, with particular attention to smaller or weaker ones probably facing difficulties accessing teats.

Split suckling can be the method of choice for improving their colostrum and milk intake, particularly in large litters. For that measure, larger, more robust piglets are separated, allowing smaller or weaker piglets to nurse first. Once the weaker piglets have had sufficient time, the groups are swapped.

However, according to Dr. Parke, fostering piglets is recommended to be undertaken cautiously. "While it can be beneficial, it can significantly disrupt pathogen stability and teat hierarchy, particularly when it occurs after the first 24-48 hours of birth when piglets have established their preference for specific teats. This can increase fighting among piglets as they establish a new hierarchy. This aggression can result in injuries, especially for weaker or smaller piglets. Fighting can also cause damage to the sow's udder, leading to infections or mastitis, compromising milk production and overall sow health," she stated.

Nurturing the gut

Providing creep feed for a minimum of 7 days before weaning significantly boosts litter weight at weaning and reduces the risk of post-weaning fallback. Early exposure to solid feed accelerates the development of digestive enzymes and acid production, both essential for breaking down carbohydrates and proteins.

Combining pre-weaning creep feeding with high-quality, palatable post-weaning diets has been shown to lead to piglets with increased post-weaning feed intake, health, and growth during the critical post-weaning transition.

As the swine sector evolves with larger litter sizes and, therefore, increased competition for sows' milk, using milk replacers is becoming common practice. Following a "little and often" approach by providing small amounts of fresh milk replacer multiple times a day is most effective. The hygienic preparation and feeding of milk replacers go without saying to prevent the growth of harmful bacteria and molds that can lead to diarrhea and other health issues in piglets.

Collaborative approach

The swine industry is grappling with mounting challenges associated with post-weaning stress and health, exacerbated by the prohibition of AGPs and the use of pharmacological levels of dietary zinc and copper in many regions. Addressing these issues requires a coordinated strategy to improve piglet welfare and optimize production outcomes. "By adopting a proactive approach emphasizing collaboration and comprehensive management strategies across the production system, piglet welfare and long-term productivity can be enhanced," concluded Dr. Parke.

EW Nutrition's Swine Academy took place in Ho Chi Minh City and Bangkok in October 2024. Dr. Merideth Parke, Global Application Manager, Swine, was one of the highly experienced speakers of EW Nutrition. She is a veterinarian who strongly focuses on swine health and preventive medicine.

The ongoing battle with food poisoning: A pressing public health concern

By Dr. Inge Heinzl

Globally, unsafe food leads to 600 million cases of foodborne illnesses each year, resulting in 420,000 deaths, with 40% of these deaths occurring among children under 5 years of age. Especially for immunocompromised elderly and children, the pathogens can be dangerous.

In 2019, 27 European Union (EU) member states reported a total of 5,175 foodborne outbreaks, leading to 49,463 cases of illness, 3,859 hospitalizations, and 60 deaths. This year, e.g., salmonella-contaminated arugula from Italy caused 98 cases in Germany, 16 in Austria, and 23 in Denmark (Whitworth, 2024).

In the United States, the E. coli outbreak recently reported by 13 states and linked to McDonald's is just one of the foodborne disease incidents this year. Several salmonella infections have also spread nationwide, with pathogens detected in various foods, including eggs, cucumbers, fresh basil, and charcuterie meats (CDC, 2024 LINK).

Symptoms of foodborne diseases may vary

The most common symptoms of food poisoning include stomach pain or cramps together with diarrhea and vomiting, nausea, and probably fever. In severe cases, diarrhea can get bloody and/or last more than 3 days. Fever (temperature over 38°C within the body) can occur, and vomiting can get so severe that the sick person cannot keep liquids inside and suffers from dehydration.

E. coli contamination, particularly from pathogenic strains like E. coli O157:H7, can pose serious health risks to consumers. It has been associated with symptoms ranging from mild gastrointestinal distress to severe conditions like hemolytic uremic syndrome (HUS), which can lead to kidney failure.

Possible sources of contamination

Usually, food is not sterile. It contains beneficial microorganisms such as lactic acid bacteria or cultured molds, but also unwanted ones such as E. coli or salmonella. The crucial point is the proliferation of the harmful ones. Food poisoning is often the result of poor hygiene or wrong processing. Here are some possible causes of getting a foodborne disease.

1. **Undercooked meat products or eggs:** Undercooked meat and eggs are primary sources of, e.g., E. coli or salmonella. If these foodstuffs are not cooked to a high enough internal temperature (meat: 70 – 80°C for at least 10 min.), the bacteria can survive and pose risks to consumers. High-speed cooking processes, standard in fast-food restaurants, can lead to unevenly cooked food, increasing the risk of contamination. However, the more probable origins of food poisoning are
2. **Raw vegetables and fresh produce:** Leafy greens and other raw vegetables are increasingly associated with E. coli outbreaks. Contamination often occurs during harvesting, processing, or transportation. When vegetables are served raw, such as in salads, the pathogens present might not be eliminated, which can lead to consumer exposure.
3. **Cross-contamination in preparation areas:** E. coli can spread easily in food preparation areas if strict separation between raw and cooked foods is not maintained. For example, if raw beef juices come into contact with salad ingredients or utensils, the risk of cross-contamination increases significantly.
4. **Cross-contamination in the slaughterhouse:** If infected animals are slaughtered together with healthy animals, the meat of the healthy ones can be contaminated with the juices of the ill ones.
5. **Inadequate supplier protocols and traceability:** The complex supply chains used by fast-food companies often involve multiple suppliers across various locations. A lack of strict hygiene and safety practices among suppliers can introduce contaminated food into the restaurant chain’s supply, leading to potential outbreaks.

Countermeasures to protect consumers

To prevent future E. coli outbreaks, implementing a range of countermeasures in food-providing businesses such as restaurants, fast-food chains, and suppliers, focusing on safe food handling, better biosecurity, and improved oversight throughout the supply chain, is vital. Food safety is broader than that, however. It has a critical role in ensuring that food stays safe at every stage of the food chain – from production to harvest, processing, storage, distribution, all the way to preparation and consumption.

1. **Enhanced Cooking Standards and Temperature Monitoring:** Ensuring meat is cooked to a safe internal temperature is crucial.
2. **Routine Microbial Testing of High-Risk Foods:** Routine microbial testing, particularly of high-risk items like ground beef and fresh produce, can detect E. coli contamination before the food reaches consumers. Testing can be carried out at the supplier level and within restaurants. In cases where contamination is detected, affected products can be removed from circulation promptly, minimizing the risk to customers.
3. **Separation of Raw and Cooked Food Handling Areas:** Cross-contamination can be reduced by establishing dedicated areas and utensils for handling raw and cooked foods. For instance, separate workspaces for salad preparation and burger assembly can prevent contact between potentially contaminated raw ingredients and ready-to-eat items. Staff training on the importance of these practices is essential to their successful implementation.
4. **Supplier Standards and Transparent Audits:** Supplier chains must ensure that suppliers adhere to strict food safety protocols, including regular sanitation and testing practices. Supplier audits conducted by independent third parties can help verify compliance and identify any gaps in food safety practices. Transparency in these audits can also build consumer trust, as customers are more likely to feel reassured when they know safety checks are in place.
5. **Implementation of High-Pressure Processing (HPP):** High-pressure processing (HPP) effectively reduces bacterial contamination in foods without using heat, which can be particularly beneficial for items like fresh produce that are often served raw. HPP uses high levels of pressure to kill pathogens, including E. coli. However, as HPP provokes changes in the

structure of vegetable cell walls, it is unsuitable for salads and other leafy greens.

6. **Enhanced Employee Training on Hygiene Practices:** Proper hygiene practices are fundamental in preventing contamination. Employees must wash their hands frequently, especially after handling raw foods. Fast-food chains should provide thorough training on proper food safety protocols, including how to handle food items safely and maintain a clean working environment.
7. **Crisis Response Protocols and Traceability Systems:** In the event of an outbreak, rapid response is critical. Fast-food companies should have crisis protocols in place that include steps for immediate product recalls, customer notifications, and investigation procedures. Improved traceability systems can also allow companies to track the source of contamination quickly, limiting the spread and reducing the impact on consumers.
8. **Preventing infections with harmful enteropathogens already in the animal:** To get "clean" animals arriving at the slaughterhouse, already the farmer must aspire to prevent/treat infections of the animals with pathogens possibly provoking foodborne diseases. For this purpose, the farmer can resort to vaccines and feed supplements supporting gut health, both for prevention and on medicine such as antibiotics when treatment is needed.

A path forward: Strengthening food safety standards

This new E. coli outbreak in the fast-food industry highlights the ongoing challenges of maintaining food safety standards at all food preparation and distribution stages. By implementing stricter cooking standards, enhancing biosecurity measures, enforcing supplier compliance, and improving traceability, fast-food chains like McDonald's can significantly reduce the risk of E. coli contamination. Ultimately, consumer protection depends on a multifaceted approach that integrates strong hygiene practices, supplier oversight, and advanced technology in food safety. Through these measures, companies can work to restore consumer confidence, minimize health risks, and set a standard for food safety across the industry.

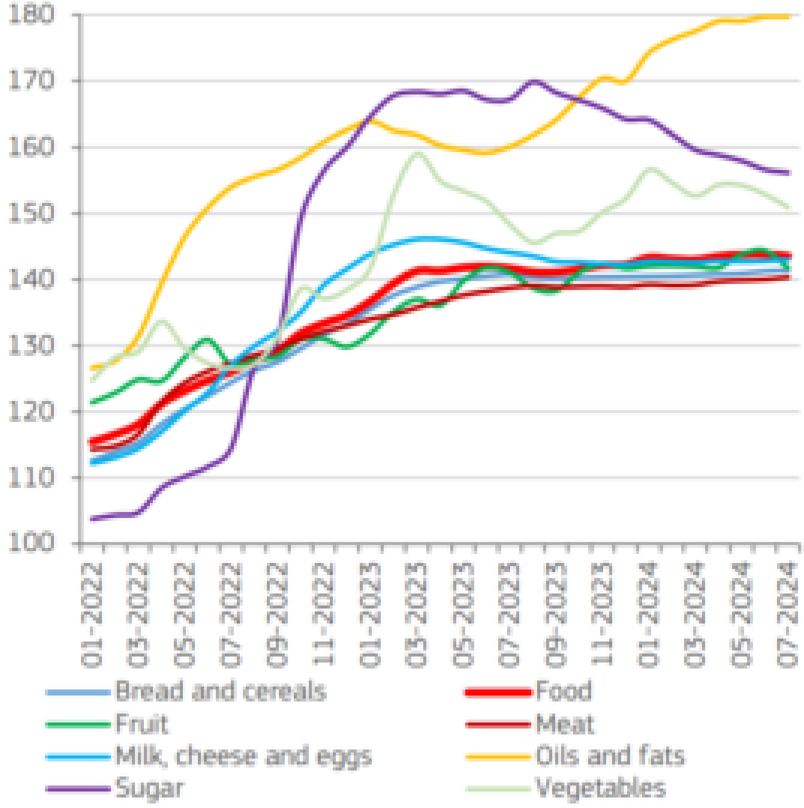
EU publishes Short-term Outlook for Agricultural Markets (Autumn 2024)

The EU's ***Short-term Outlook for Agricultural Markets (Autumn 2024)*** reveals significant challenges in agriculture, with adverse weather, geopolitical instability, and fluctuating trade conditions impacting production. The report identifies declining cereal and oilseed outputs, particularly for soft wheat and maize. Meanwhile, milk production is expected to remain stable despite a shrinking cow herd, and the meat sector shows mixed trends, with poultry production rising but pigmeat and beef facing structural challenges.

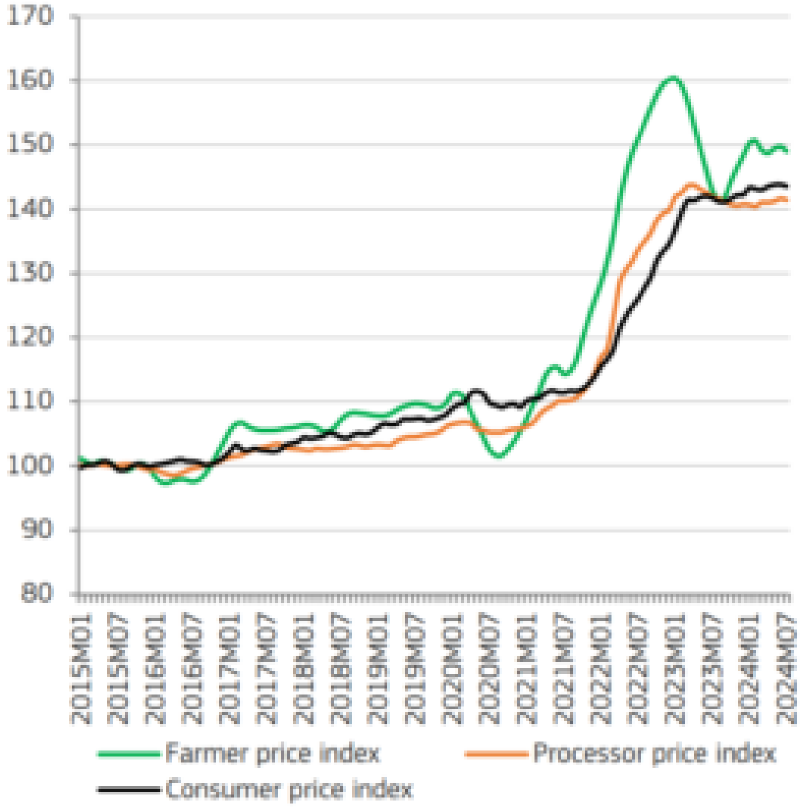
EU's Short-term Outlook for Autumn 2024 highlights the following key findings collectively shaping EU agricultural markets:

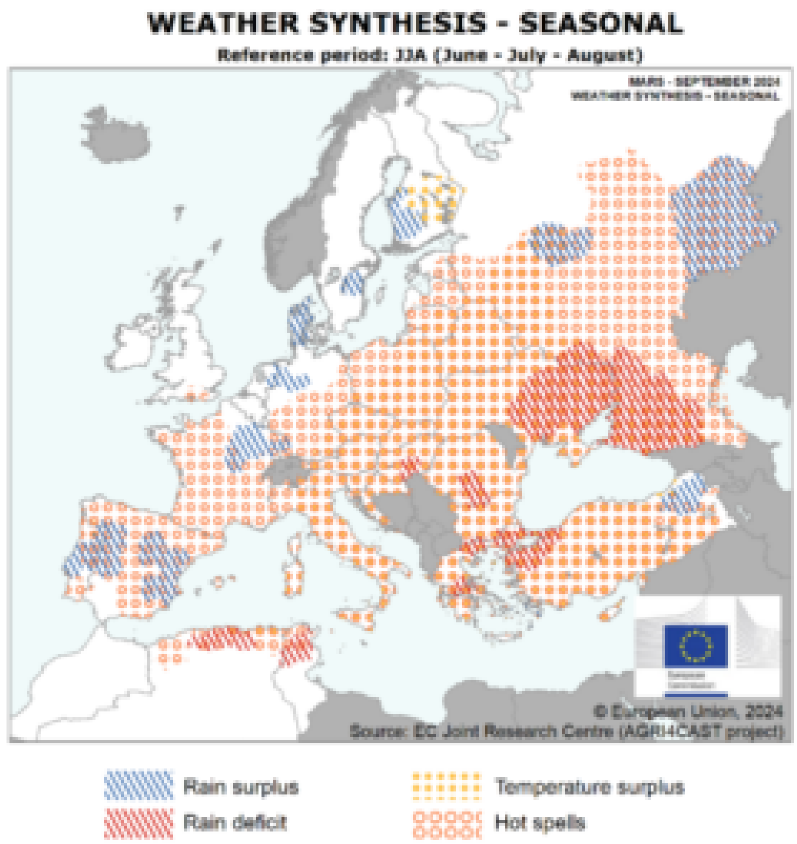
1. **Weather conditions**: Severe drought in Southern and Eastern Europe and excess rainfall in Northwestern regions have reduced cereal and oilseed yields.
2. **Energy and input costs**: Inflation is stabilizing but remains high, with elevated prices for inputs like fertilizers and energy.
3. **Geopolitical tensions**: The ongoing war in Ukraine and trade disputes are disrupting supply chains and impacting exports.
4. **Global demand**: While global agricultural demand is recovering, trade flows face disruptions due to regulatory changes and volatile market conditions.

EU consumer price inflation of selected food products (2015=100)



Price transmission along the food chain (2015=100)



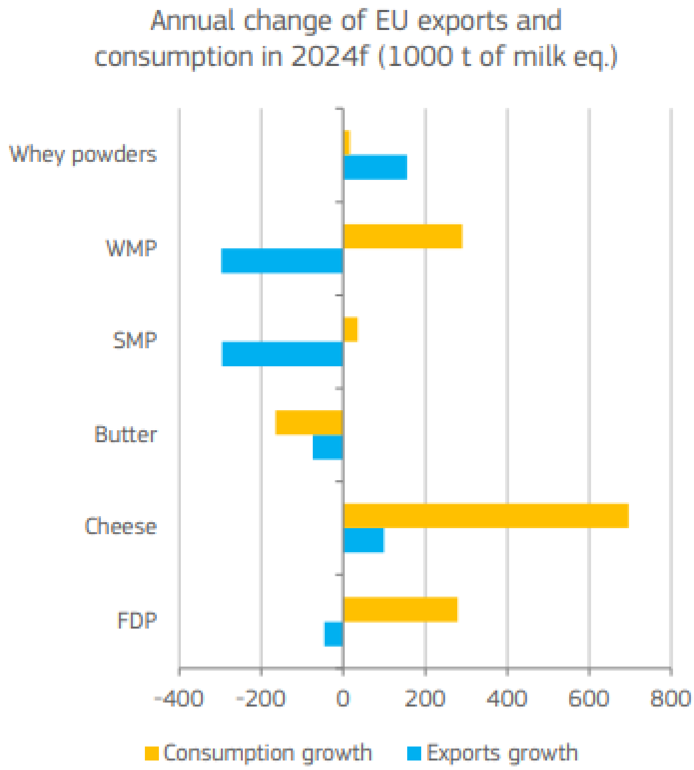


Cereals

The EU cereal production in 2024/25 is projected at **260.9 million tons**, approximately **7% below the 5-year average**. This marks the lowest production in the past decade, driven by unfavorable weather conditions, including excessive rain in Northwestern Europe, which impacted planting, particularly for soft wheat, and drought in Southern and Eastern regions, severely affecting maize yields. Production of **soft wheat** and **maize** is expected to decline year-on-year by 9.5% and 4%, respectively. On the other hand, **barley** and **durum wheat** production are increasing by about 6% and 3%, respectively, compared to the previous year.

EU cereal exports are projected to decline by 22% year-on-year due to reduced production and quality issues. At the same time, domestic demand remains relatively stable, with animal feed consumption holding steady as livestock production stagnates. In terms of prices, cereal prices fell throughout 2024, pressuring farmers’ cash flow, which could hinder their ability to afford inputs such as fertilizers in the coming year.

Milk and Dairy Products



The EU milk market is expected to see relatively stable supply, despite a continuously shrinking cow herd. **Milk yields** have increased, compensating for the herd's decline. Milk prices are forecast to stabilize after a period of volatility in the past few years, remaining above historical averages, and input costs for farmers, such as feed and energy, are showing signs of stabilizing, allowing for a potential improvement in farmer margins.

Despite the stability in milk supply, demand for **dairy products** continues to show mixed trends, influenced by shifts in consumer preferences and trade dynamics. The balance of milk supply and prices could provide an opportunity for dairy farmers to recover some profitability after several challenging years.

In the **dairy products** sector, cheese and butter continue to dominate EU production, with butter production projected to rise slightly in 2024, driven by stable milk supplies and strong domestic demand. The demand for butter in the global market remains relatively strong, although competition is rising.

Cheese production is also expected to remain stable, reflecting a balance between domestic and export markets. The cheese sector has seen steady growth over the years, supported by increasing consumer demand for premium and specialty cheeses. The demand for skimmed milk powder (SMP) and whole milk powder (WMP) is projected to remain subdued due to fluctuating global demand, particularly from key markets such as China, although some growth is expected in non-European markets.

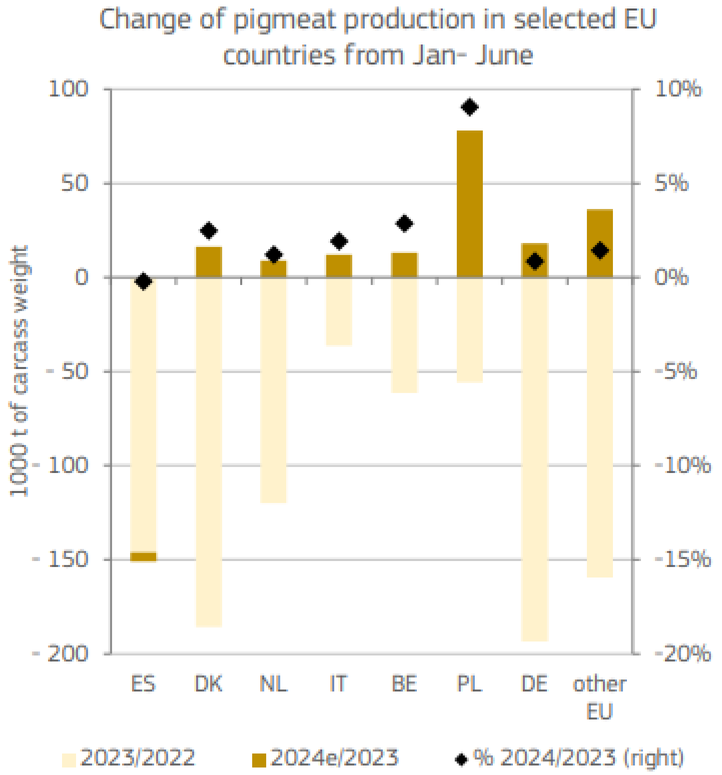
Meat Products

The meat sector in the EU remains a mixed picture, with structural changes and external factors shaping production and trade in 2024.

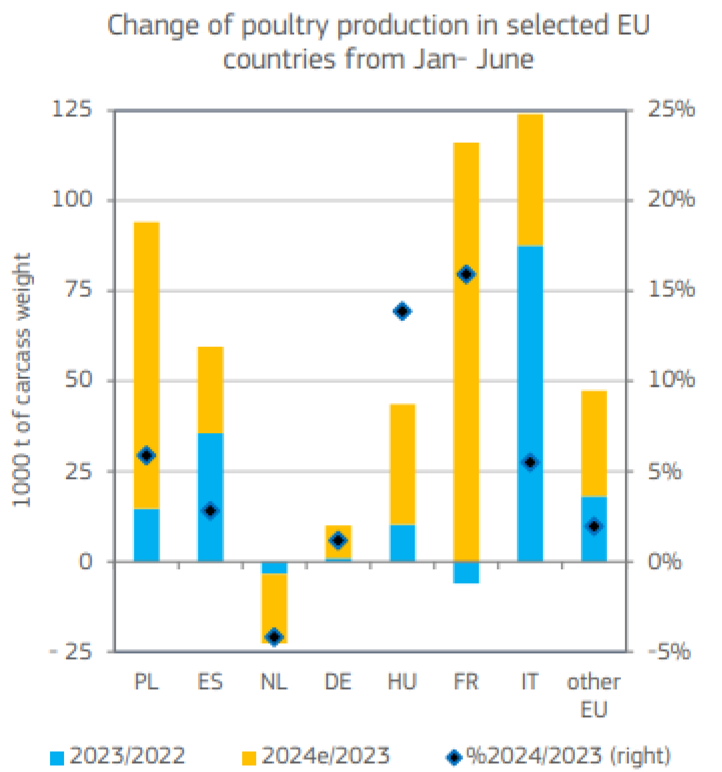
Beef and Veal: Beef production continues to face structural decline due to a shrinking herd size, with the sector stabilizing but at lower levels of production. The demand for EU beef remains relatively high, and exports are increasing, but domestic production is likely to remain constrained by environmental and economic pressures. Additionally, the number of animals has been declining consistently, reflecting longer-term trends within the EU beef industry.

Pigmeat: The EU pigmeat sector is facing diverse challenges, with some countries recovering from production setbacks, while others struggle with ongoing disease outbreaks and economic issues. The overall EU pigmeat production is expected to decline slightly, and exports have become less competitive, particularly with reduced demand from key markets such as China. However, opportunities exist in other

Asian countries, where EU exporters are gaining ground. Domestically, consumption is forecast to decrease slightly, reflecting shifting consumer preferences toward plant-based alternatives and poultry.



Poultry: Poultry production is expected to rise, driven by strong domestic demand and favorable export conditions. The EU poultry sector has shown resilience, with increasing production and exports, despite higher input costs. Poultry remains a preferred source of protein for consumers, especially as prices for other meats rise. The sector continues to grow in competitiveness on the international stage, with exports expected to increase in 2024 despite the challenges posed by higher EU prices.



Sheep and Goat Meat: Production of sheep and goat meat continues to decline due to the structural reduction of flocks across the EU. High EU prices have made sheep and goat meat less competitive on the global market, reducing export opportunities. Domestically, consumption remains stable but at lower levels than other meat types. The ongoing structural decline in the sector highlights long-term challenges related to animal health, productivity, and market competitiveness.

Volatility and challenges persist

The report highlights the ongoing challenges faced by the cereals, dairy, and meat sectors. Weather conditions and global trade dynamics are shaping the future of EU agriculture, with many sectors grappling with production declines and shifting market demands. Despite these challenges, opportunities exist for some areas of growth, particularly in dairy and poultry, where rising consumer demand and stable supply conditions offer optimism for the future.

Piglet rearing – there is still room for improvement!

*By **I. Heinzl**, Editor, and **Predrag Persak**, Regional Technical Manager North Europe*

Optimal rearing conditions for piglets are crucial for ensuring their healthy growth, reducing mortality, and enhancing productivity. These conditions include proper temperature, nutrition, housing, hygiene, and care. Here are the key aspects:

1. Temperature and ventilation

Piglets are sensitive to cold because they cannot regulate their body temperature effectively in the first few days after birth. Proper temperature control is essential to prevent chilling, possibly leading to illness and death. Additionally, regulating the temperature would cost energy, which otherwise could be spent for growth.
Signs of a too-cold environmental temperature are piling on top of one another, tucking the legs under the body, being unable to get up, laying near a corner or wall, or shivering, which may stop if the conditions worsen. Measuring the body temperature shows less than 35°C in the case of chilling.

The following temperatures are recommended for successful piglet rearing:

Farrowing unit (for newborns)	32 – 35°C (90–95°F) during the first few days
After the first week	The temperature can gradually decrease by about 1.5-2.0°C per week until it reaches 25°C (77°F)

For supplemental heating, heat lamps, heated floors, or creep areas (a designated warm spot) can be used to maintain the ideal temperature, especially in cooler climates.

Temperature is often closely related to ventilation. Ventilation is essential to reduce dust, humidity, ammonia, and other harmful substances occurring in the air. However, if fresh/cold air enters the pigsty, the temperature decreases, which can get dangerous for the piglets. Suitable ventilation means finding a good balance between providing fresh air and maintaining temperature to prevent energy losses and chilling of the piglets.

Comfort zones can be a solution. They are an effective way to keep the piglets warm and ventilation rates where needed to maintain proper air exchange and humidity levels.

2. Nutrition

Nutrition is critical for piglet growth and immune system development. Most important after birth is the access to colostrum. Piglets are born with an immature immune system, and the maternal antibodies ingested with the colostrum are vital for their survival. They should consume colostrum within the first 6 hours after birth.

It will take 5 to 7 days for piglets to stabilize and get regular on suckling schedule.

At around seven days of age, it is recommended to introduce a highly digestible, nutrient-dense creep feed that helps transition piglets from milk to solid food. Fresh and clean water of the best quality must always be available.

Never forget most important nutrient, beside sow´s love and care – water. Allow piglets free access to the excellent quality water.

3. Housing and Space

A well-designed, clean, and dry environment is critical for reducing stress and promoting health. Farrowing crates help prevent sows from accidentally crushing the piglets during the first few weeks. However, these farrowing crates should provide enough space for the sow to nurse the piglets while allowing piglets to move freely.

Separate warm and clean areas (creep spaces) for the piglets within the farrowing pen are helpful to help the piglets escape from cooler or potentially dangerous parts of the crate. Straw, sawdust, or rubber mats should be provided to keep the piglets warm and comfortable, and good drainage is essential to maintain dryness.

4. Hygiene and Health

Hygiene is crucial to prevent disease and promote the health of piglets. For this purpose, pens and farrowing units should be thoroughly cleaned. Regular removal of waste and keeping bedding dry helps control pathogens. It is essential to clean and disinfect the farrowing unit from one farrowing to the other to reduce disease risks.

Health: After birth, the piglets' umbilical cord stump should be disinfected to prevent infections. A further essential precautionary measure to prevent anemia is an oral supplementation or an iron injection within the first three days of life, as piglets are born with low iron levels.

For further health monitoring and management, it should be ensured that the piglets are vaccinated against common diseases, such as E. coli, Mycoplasma, and Porcine Circovirus. Additionally, deworming protocols and monitoring for signs of parasites should be implemented for parasite control.

5. Weaning Practices

Piglets are typically weaned between 3 and 4 weeks of age, but early weaning (around 21 days) can be practiced in intensive systems. Optimal weaning requires gradual adaptation to solid feed and a stress-free environment.

If the piglets are weaned at 21 to 28 days, a high-quality starter diet after weaning is essential to maintain growth rates and minimize post-weaning stress.

6. Minimizing Stress

Stress management is essential to prevent disease and poor growth. For this purpose, minimize handling to the minimum during the first few days and, if necessary, handle the piglets gently to reduce stress.

A new environment also means strain for the piglets, so keep the litter groups together during weaning to reduce fighting and social stress.

7. Supportive functional feed ingredients

Depending on veterinary and managing practices, the availability of feed, and the possible use of antimicrobials or other medicals as prophylactics, there can be high variability in rearing conditions in diverse areas of the world. In the following, two functional feed ingredients with entirely different modes of action are presented that support piglets at different rearing conditions.

7.1 Egg immunoglobulins (IgY) support piglets under poor rearing conditions

Egg immunoglobulins are beneficial if piglets are not raised under the best conditions, meaning lower hygienic standards and higher pathogenic pressure. With egg immunoglobulins coming from hens having been in contact with pathogens relevant to piglets, it is possible to support the young animals. What is the background? Hens are able to transfer maternal antibodies against diseases that they are confronted with to the egg. With this mechanism, they can provide their progeny with a starter kit for the first time after hatching. However, the best thing is that these antibodies are also helpful for mammals.

A trial conducted on a commercial farm in Spain shows the weight development of piglets fed an IgY-containing egg powder product (EP) compared to a negative control. The weaned piglets were fed a two-phase feeding (15 days prestarter, 22 days starter). The control (n=51) received no additional functional feed ingredient, whereas the EP group was fed 2 kg of the product/t of feed during the prestarter phase. The animals were weighed individually on days 16 and 37.

The results are shown in Figures 1 and 2.

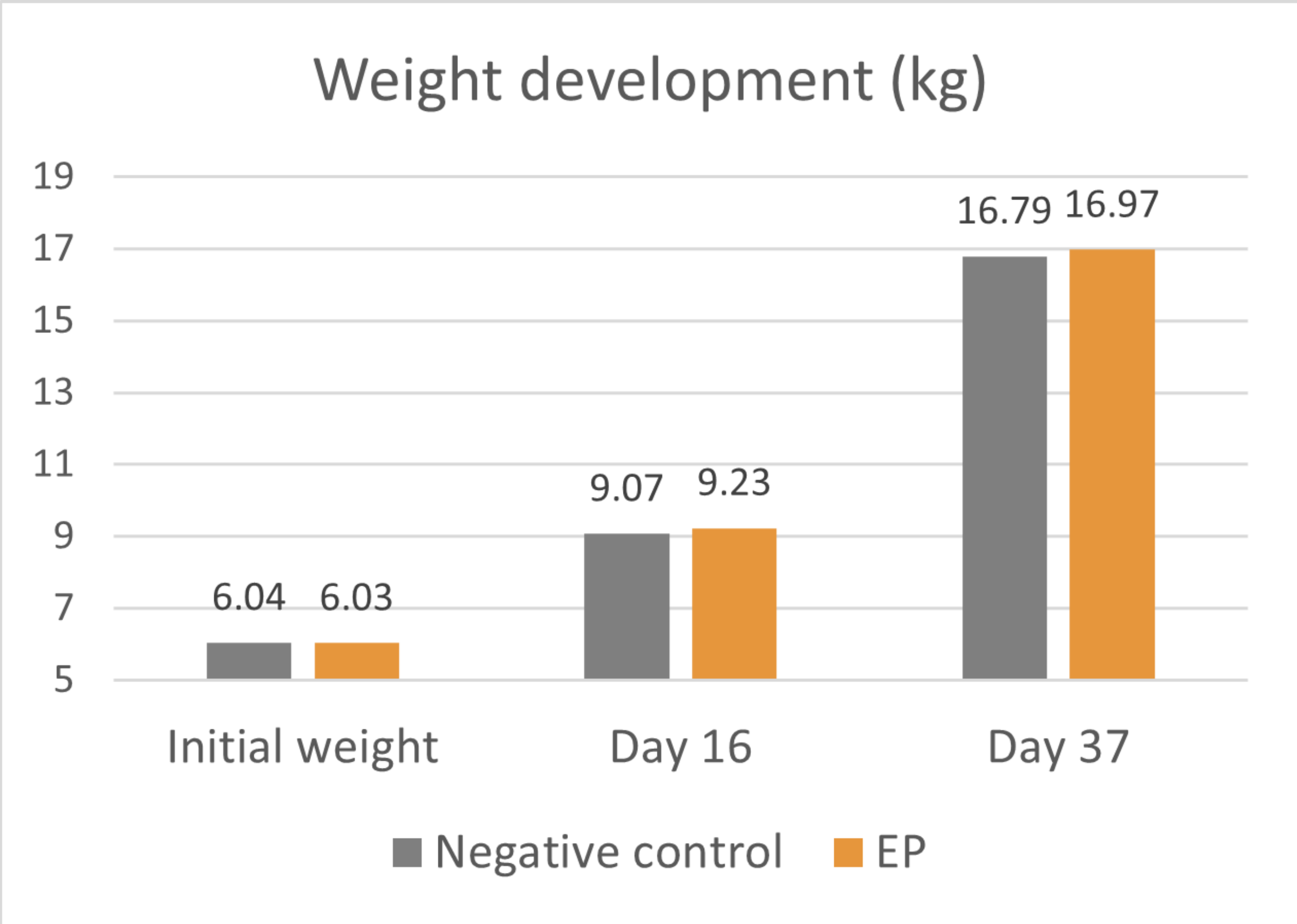


Figure 1: Weight development of piglets receiving an IgY-containing egg powder product compared to a negative control

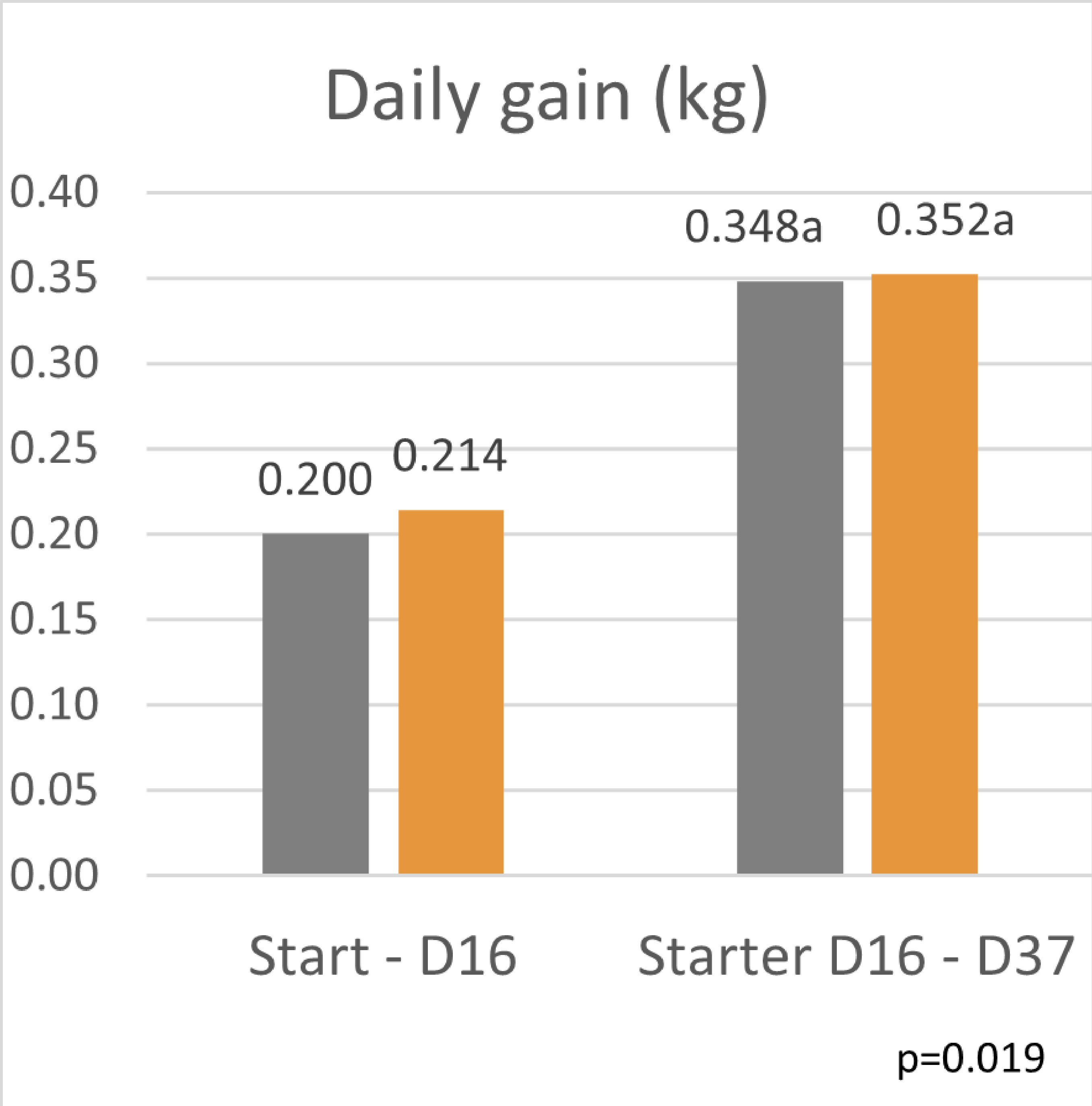


Figure 2: Daily gain of piglets receiving an IgY-containing egg powder product compared to a negative control

Explanation of the results: Under poor hygienic conditions, the pathogenic pressure is relatively high, and everything lowering this pressure helps to improve gut health, the utilization of nutrients, and performance. Egg immunoglobulins positively influence the gut microbiome, thus helping reduce diarrhea. By lowering the pathogenic pressure, the organism's energy can be used for growth and must not be employed for the body's defense.

7.2 Phytomolecules can even show improvement under optimum conditions

Phytomolecules generally show diverse gut health-promoting effects, from driving the intestinal microbiome in the right direction and strengthening the intestinal barrier to acting as antioxidants or anti-inflammatories or increasing the secretion of digestive juices and, therefore, improving digestion. Which mode of action is relevant if the piglets are raised under already optimal conditions (best hygiene, no prophylactic antibiotics or zinc oxide) and show the highest growth? Is there still room for improvement?

Yes, it is. A trial conducted in Germany adduces evidence.

In this trial, 220 piglets weaned on average at 26 days and weighing around 8 kg were housed in 20 pens of 11 castrated males or gilts each. Piglets were blocked by body weight and fed a two-phase feeding program (phase 1 from day 1 to day 13 and phase 2 from day 17 to day 40; pelleted diet). Neither feed or water medication nor therapeutic levels of ZnO were used.

The results of this piglet trial can be seen in Figures 3 and 4.

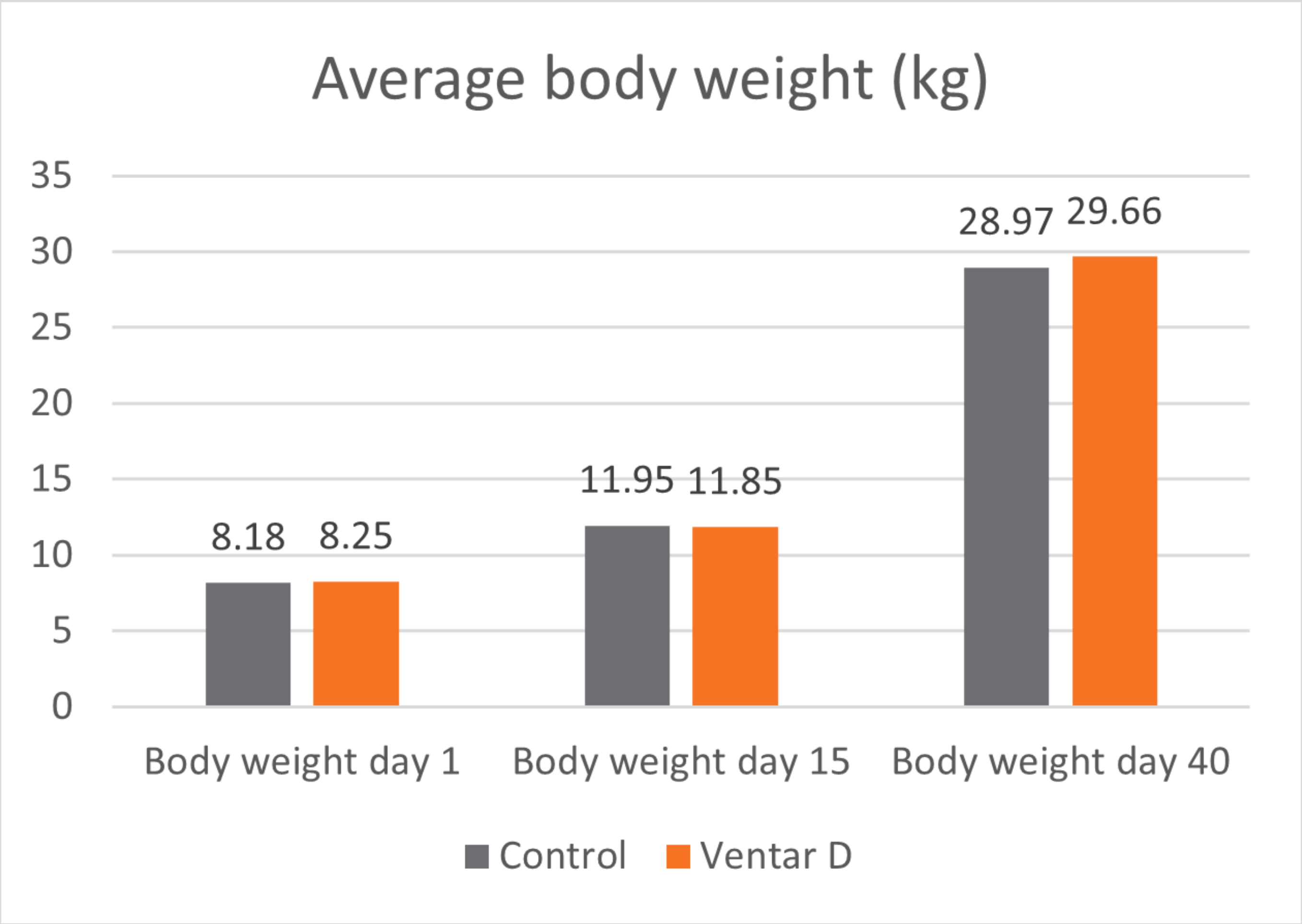


Figure 3: Weight development of piglets fed Ventar D compared to a negative control

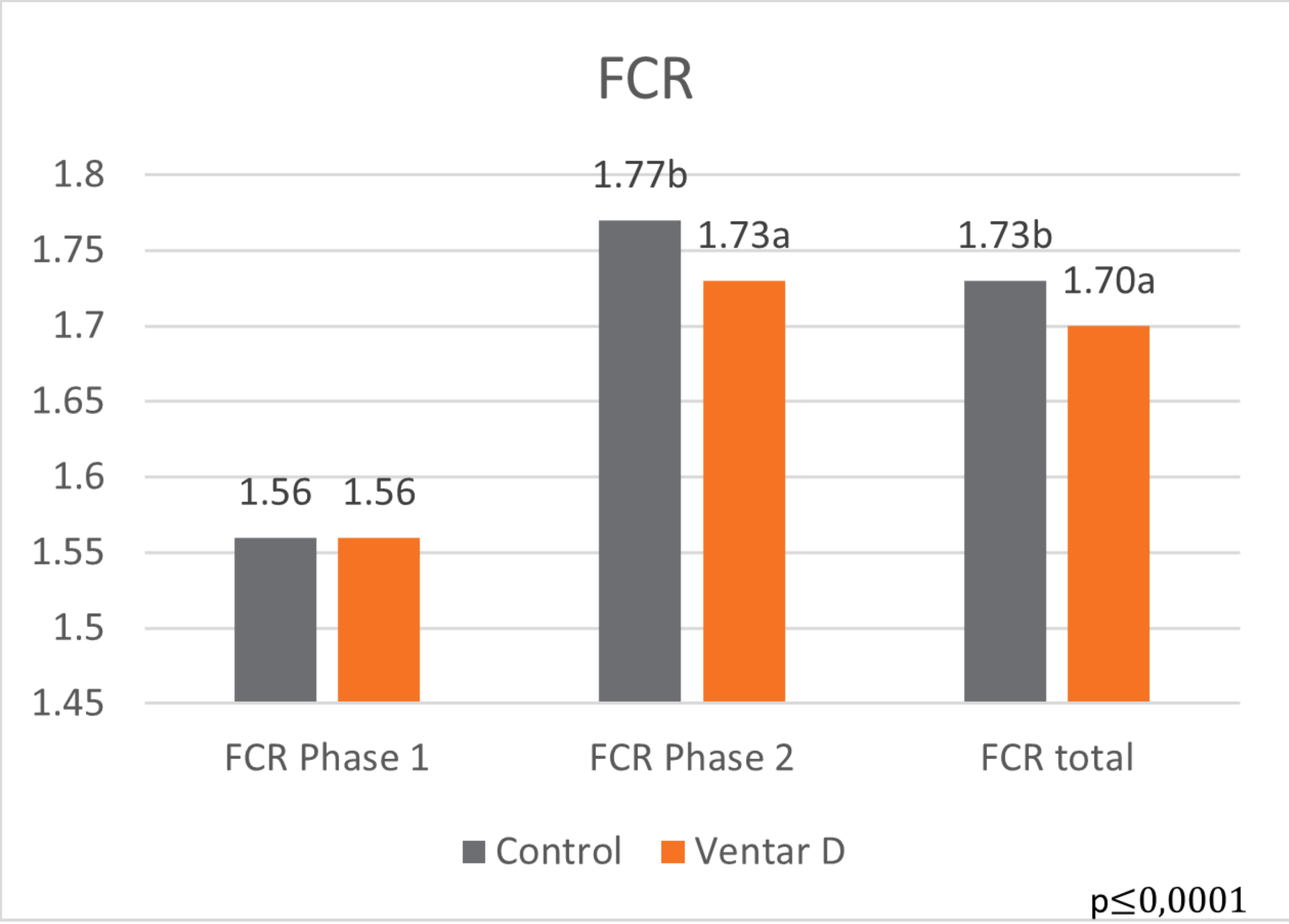


Figure 4: Feed conversion rate in piglets fed Ventar D compared to a negative control

Explanation of the results: The figures show that the piglets in the control already have an extremely high weight compared to those of a similar age in the previous trial, indicating the best rearing conditions in this trial. But, even here, Ventar D has the capacity to improve performance. Why? High-performing animals stress their body more than low-performing ones. Anabolic processes increase oxidative stress and non-infectious inflammation and burden the immune system. The relevant mode of action of Ventar D is not the gut health-promoting or the antimicrobial one because there is no issue. The relevant modes of action in this case are antioxidant and anti-inflammatory. With these two characteristics, Ventar D still has the capacity to improve the performance of piglets that are already at the top level.

8. Conclusion

For high piglet performance, providing the best possible rearing conditions is essential. However, there are differences concerning these conditions in different areas of the world. Depending on them, different feed strategies can be used. Egg immunoglobulins show the best effects if there is a certain pathogenic pressure. Phytomolecules, however, due to their various modes of action, can be beneficial under different levels in rearing conditions. In a low standard, the antimicrobial and gut health-promoting effect is more relevant; in the case of best conditions, the anti-oxidant and anti-inflammatory effects are decisive.

In summary, it could be said that functional feed ingredients have significant advantages in piglet rearing, but the right choice must be made depending on the prevailing conditions.

The crucial role of short-chain fatty acids and how phytomolecules influence them

*by **Dr. Inge Heinzl**, Editor EW Nutrition*

For optimum health, the content of short-chain fatty acids (SCFAs) is decisive. On the one hand, they act locally in the gut, on the other hand, they are absorbed via the intestinal mucosa into the organism and can affect the whole body. Newer studies in humans show a connection between the deficiency of SCFAs and the occurrence of chronic diseases such as diabetes type 2 or chronic inflammatory gut diseases.

SCFAs – what are they, and where do they come from?

SCFAs consist of a chain of one to six carbon atoms. They are crucial metabolites primarily generated through the bacterial fermentation of dietary fiber (DF) in the hindgut. However, SCFAs and branched SCFAs can also arise during protein fermentation. Short-chain fatty acids predominantly include acetate, propionate, and butyrate, which together account for over 95% of the total SCFAs, typically in a 60:20:20 ratio.

Acetate is produced in two different ways, via the acetyl-CoA and the Wood-Ljungdahl pathways where Bacteroides spp., Bifidobacterium spp., Ruminococcus spp., Blautia hydrogenotrophica, Clostridium spp. are involved. Additionally, acetogenic bacteria can synthesize acetate from carbon dioxide and formate through the Wood-Ljungdahl pathway (Ragsdale and Pierce, 2021). Acetate counts for more than 50% of the total SCFAs in the colon and is the most abundant one.

Propionate can also be produced in two ways. If it is produced via the succinate pathway involving the decarboxylation of methyl malonyl-CoA, the essential bacteria are Firmicutes and Bacteroides. In the acrylate pathway, lactate is converted to propionate. Here, only some bacteria, such as Veillonellaceae or Lachnospiraceae, participate.

Butyrate is produced from acetyl-CoA via the classical pathway by several Firmicutes. However, also other gut microbiota such as Actinobacteria, Proteobacteria, and Thermotogae, which contain essential enzymes (e.g., butyryl coenzyme A dehydrogenase, butyryl-CoA transferase, and butyrate kinase) can be involved. Butyrate can also be produced via the lysine pathway from proteins.

Besides the production of SCFAs from dietary fiber, there is another possibility for the synthesis of SCFAs as well as branched SCFAs – the fermentation of protein in the hindgut. This is something we want to avoid, since it´s clear signal of incorrect animal nutrition. It tells us that there is either oversupply of protein or decrease in protein digestion and absorption.

Which roles do SCFAs play?

SCFAs play a crucial role in the maintenance of gut health. Some benefits originate from these substances' general character, while others are specific to one acid. If we talk about the benefits of all SCFAs, we can mention the following:

1. Primarily, SCFAs are absorbed by the intestine and serve enterocytes as an essential substrate for energy production.
2. By lowering the pH in the intestine, SCFAs inhibit the invasion and colonization of pathogens.
3. SCFAs can cross bacterial membranes in their undissociated form. Inside the bacterial cell, they dissociate, resulting in a higher anion concentration and bactericidal effect (Van der Wielen et al., 2000)
4. SCFAs repair the intestinal mucosa
5. They mitigate intestinal inflammation by G protein-coupled receptors (GPRs).
6. They enhance immune response by producing cytokines such as IL-2, IL-6, IL-10, and TNF-α in the immune cells. Furthermore, they enhance the differentiation of T-cells into T regulatory cells (Tregs) and bind to receptors (Toll-like receptor, G protein-coupled receptors) on immune cells (Liu et al., 2021).
7. SCFAs are involved in the modulation of some processes in the gastrointestinal tract, such as electrolyte and water absorption (Vinolo et al., 2011)

After seeing the general characteristics of short-chain fatty acids, let us take a closer look at the specialties of the single SCFAs.

Acetate might play a crucial role in the competitive process between enteropathogens and bifidobacteria and help to build a balanced gut microbial environment (Liu et al., 2021). Additionally, acetate promotes lipogenesis in adipocytes (Liu et al., 2022).

Concerning general health, acetate inhibits, e.g., lung inflammatory response and the reduced air-blood permeability induced by avian pathogenic E. coli-caused chicken colibacillosis (Peng et al., 2021).

Propionate is thought to be involved in controlling intestinal inflammation by regulating the immune cells assisting and, consequently, in maintaining the gut barrier. Furthermore, propionate regulates appetite, controls blood glucose, and inhibits fat deposition in broiler chickens (Li et al., 2021).

In a trial conducted by Elsherif et al. (2022), birds fed a diet with 1.5 g sodium propionate/kg showed considerably ($P<0.05$) longer and wider guts, higher counts of lactobacillus($P<0.05$) and no colonization of Clostridium perfringens. The immunological state improved significantly ($P<0.05$), which could be seen by the higher antibody titers when the birds were vaccinated against Newcastle disease or avian influenza.

Butyrate additionally improves the function of the intestinal barrier by regulating the assembly of tight junctions (Peng et al., 2009) and stimulating cell renewal and differentiation of the enterocytes. Butyrate-producing microbes on their side prevent the dysbiotic expansion of potentially pathogenic E. coli and Salmonella (Byndloss et al., 2017; Cevallos et al., 2021) by stimulating PPAR-γ signaling. This leads to the suppression of iNOS synthesis and a significant reduction of iNOS and nitrate in the colonic lumen. Furthermore, the microbiota-induced PPAR-γ-signaling inhibits dysbiotic Enterobacteriaceae expansion by limiting the bioavailability of oxygen and, therefore, respiratory electron acceptors to Enterobacteriaceae in the colon.

In a trial conducted by Xiao et al. (2023), sodium butyrate enhanced broiler breeders' reproductive performance and egg quality due to the regulation of the maternal intestinal barrier and gut microbiota. Additionally, it improved the antioxidant capacity and immune function of the breeder hens and their offspring.

SCFAs' production can be managed

The extent of production depends on the diet and the composition of the intestinal flora. Nutritional strategies can be taken to regulate the production of short-chain fatty acids by providing dietary fiber and prebiotics, the respective bacteria but also additives in the diet or, on the other, negative way, use of antibiotics.

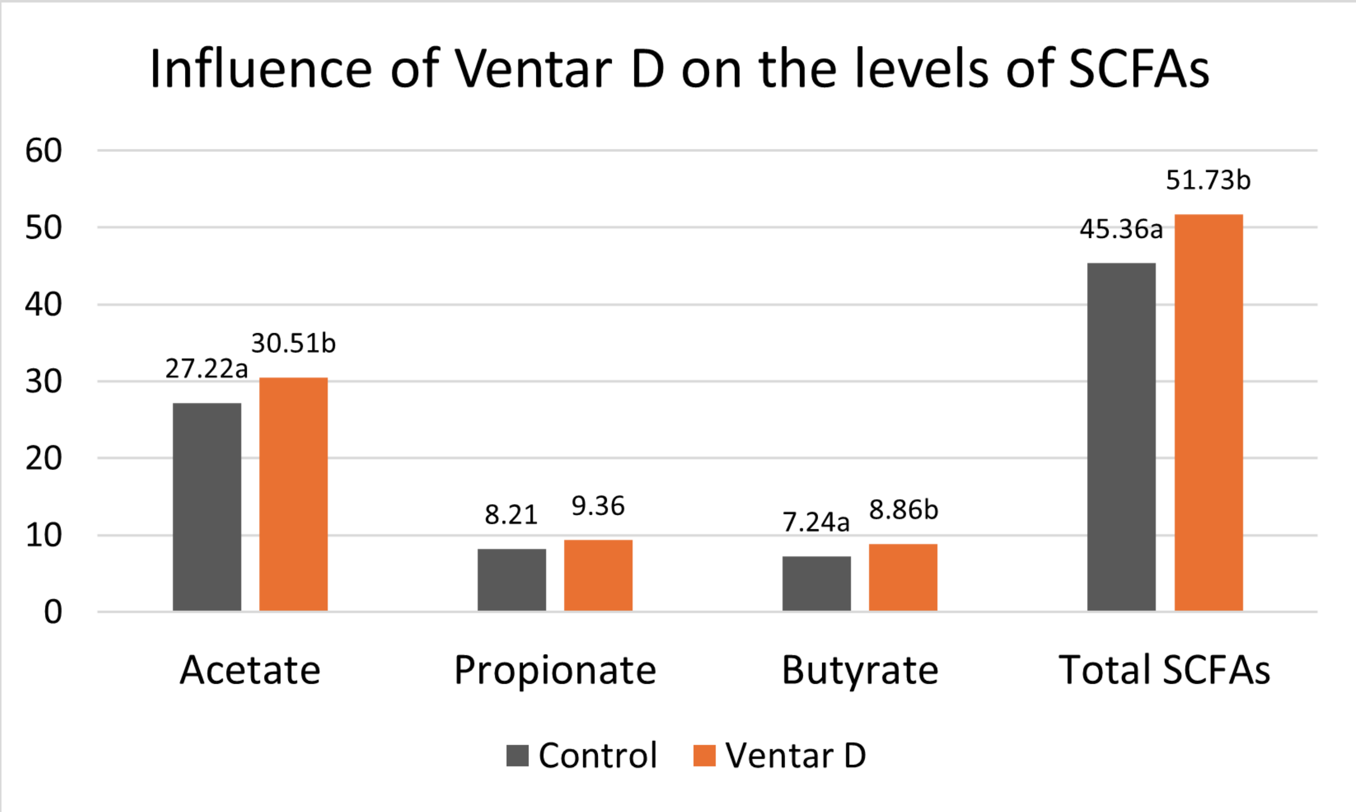
One example of SCFA-promoting additives is phytomolecules. Ventar D, a blend of diverse gut health-promoting phytomolecules, shows its SCFAs-increasing effect in a trial with Ross 308 broilers.

Trial design: The 41-day research study was conducted at an R&D farm in Turkey, with 3200 Ross 308 broilers in total. The day-old broiler chicks were randomly divided into two groups with 8 replicates in 16-floor pens (6.5×2 m each), each of 200 chicks (100 males and 100 females). One group was managed as a control group with regular feed formulation, and the other group was supplemented with Ventar D. All the birds were provided feeds and water ad libitum. Temperature, lighting, and ventilation were managed as per Ross 308 recommendation.

Groups	Application dose	
	Starter (crumbles)	Grower & Finisher – 1 & 2 (pellet)
Control	No additive	
Ventar D	100 gm/MT	100 gm/MT

All the birds and feed were weighed on days 0, 11, 23, and 41. Dead birds were also weighed, and the feed consumption was corrected accordingly. At the end of the experiment, one male and one female chicken close to the average weight of each pen were separated, weighed, and slaughtered. Short-chain fatty acid (SCFA) concentration in the caecum was measured by gas chromatography (Zhang et al. 2003). Statistical analysis of the data obtained in this study was carried out in the Minitab 18 program using the T-test following the randomized block trial design ($P \leq 0.05$). The research results were subjected to statistical analysis on a pen basis. Mortality results were evaluated with the Chi-square test.

Results: Ventar D significantly increased the levels of acetate, butyrate, and total SCFAs. The level of propionate was numerically higher. Additionally, higher final body weights (on average 160 g), improved feed efficiency (6 points), a higher EPEF (33 points), and lower mortality (0.5%) could be asserted in this experiment.



One explanation could be the microbiota-balancing effect of Ventar D. Meimandipour et al. (2010), for example, saw in their study that increased colonization of Lactobacillus salivarius and Lactobacillus agilis in cecum significantly increased propionate and butyrate formation in caeca.

Phytomolecules: Balancing intestinal microbiome and increasing healthy SCFAs

By promoting beneficial intestinal bacteria and fighting the harmful ones, phytomolecules drive the microbiome in the right direction and promote the production of short-chain fatty acids. Their gut health-protecting effect, in turn, provides for adequate digestion and absorption of nutrients, leading to optimal feed conversion and growth rates. The support of the immune system and the promotion of the antioxidant capacity additionally enhance the health of the animals. Healthy animals grow better, which ultimately leads to a higher profit for the farm.

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