

## REDUCTION OF HARMFUL GASES EMISSIONS IN PIG FARMING THROUGH NUTRITION

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### Abstract

Emissions of harmful gases are a long-term problem in livestock farming. In pig farming, these are mainly ammonia, carbon dioxide, methane and hydrogen sulfide. These gases are mainly released from pig faeces and urine. They have a negative impact not only on the barn environment, but also on the performance and health of animals and on the health of staff working in the stable (Hossain et al., 2024). Currently, various methodologies are being promoted that contribute to improving the stable environment, animal health and improving performance. The largest part of the measures are technological measures in the stables, manure removal systems, manure storage, manure acidification, and the use of air scrubbers. The production of harmful gases includes enzymatic, microbial and chemical reactions that convert feed mixture or organic materials into gases. There is growing interest in developing appropriate and effective methods to reduce gas emissions in pig farms. One such approach is nutritional management, which involves manipulating the pig ration to reduce the production of gas-forming compounds in the large intestine. This can be achieved through strategies such as limiting the intake of fermentable carbohydrates or increasing the intake of indigestible fiber. Overall, reducing gas emissions in pigs is a complex process. One approach that has shown promise is the use of feed additives. These additives may include the use of probiotics, prebiotics, enzymes, and medicinal plants (Rowland et al., 2018; Park et al., 2018).

**Key Words:** Pig; gas emissions; nutrition

### **Probiotics**

In pig farming, probiotics are used as feed additives to improve animal health, digestion and growth. Probiotics such as *Bacillus amyloliquefaciens*, *Limosilactobacillus reuteri* and *Levilactobacillus brevis* are specifically selected for their ability to restore and maintain the balance of the gut microbiota. This balance is crucial for optimal gut health, but can be disrupted due to various factors such as stress, disease and changes in nutrition. Probiotics play a crucial role in improving feed digestion, ensuring efficient nutrient uptake and reducing the incidence of gastrointestinal diseases, improving gut health and feed digestion, which reduces the amount of undigested organic matter in manure and reduces the production of methane and other gases during manure decomposition. In addition,

they can help the proliferation of beneficial bacteria (e.g. *Lactobacillus* spp.) and suppress the growth of *Escherichia coli* in the gut. A balanced microbial environment is key to reducing the production of gases such as methane, ammonia and hydrogen sulfide (Yirga, 2015; Kenny et al., 2011; Oh et al., 2021; Chu et al., 2011).

### **Prebiotics**

Prebiotics are non-digestible feed ingredients that selectively stimulate the growth and activity of beneficial intestinal microorganisms. These include oligosaccharides, inulin, and other complex carbohydrates that resist digestion in the small intestine and are fermented by beneficial bacteria (e.g. *Lactobacillus*) in the colon. By promoting the growth of beneficial bacteria that compete with methane-producing microorganisms, prebiotics (lactic acid bacteria)

can reduce the production of methane and other gases in the gut (Davani-Devari et al., 2019; Slavin, 2013). The mechanism by which prebiotics reduce harmful gas emissions in pigs is complex and involves several pathways. The first pathway is that prebiotics can promote the growth of beneficial bacteria in the gut, such as lactobacilli and bifidobacteria (Davani-Devari et al., 2019). Second, prebiotics can improve digestive efficiency by improving nutrient absorption and reducing fermentation of undigested food in the colon (Rowland et al., 2018). By promoting the growth of beneficial bacteria, prebiotics can shift the microbial balance towards a population that is less likely to produce excessive amounts of gases such as hydrogen sulfide and ammonia. At the same time, prebiotics are not conducive to the growth of some harmful bacteria. The change in microbial composition induced by prebiotics can lead to a reduction in the abundance of gas-producing bacteria because they have reduced opportunities to colonize and grow. Once these gas-producing bacteria can be controlled, the production of harmful gases will also be reduced.

### **Enzymes**

Enzymes, essential naturally occurring proteins, play a key role in pig nutrition by catalyzing critical chemical reactions in the digestive system. These enzymes are widely used in the food and feed industries to improve digestion and nutrient utilization. Enzymes are also used to reduce harmful gas emissions in livestock farming (Ravindran, 2013; Park et al., 2023).

In pigs, the primary cause of harmful gas emissions is the fermentation of undigested feed components in the large intestine, specifically non-starch polysaccharides found in plant-based feeds such as soybean meal, corn, and wheat. These complex carbohydrates present a digestive problem because pigs inherently lack the enzymes necessary to break them down, leading to fermentation and gas formation (Adeola et al., 2011). The mechanisms by which dietary enzymes reduce harmful gas emissions in pig farms are through their ability to improve nutrient

utilization and alter fermentation patterns in the intestine. Protease enzymes facilitate the hydrolysis of proteins into smaller peptides and amino acids that are more easily absorbed in the intestine. This improved protein digestion reduces the fermentation of undigested proteins and consequently reduces ammonia production. Studies suggest that the combination of different enzymes, such as protease and xylanase, can affect fermentation patterns and gas emissions, highlighting the complexity of enzyme interactions in the digestive system. By improving digestion and nutrient utilization, enzymes in feed not only contribute to better animal health and growth, but also play a significant role in environmental sustainability (Cho and Kim, 2013).

### **Medicinal plants**

Medicinal plants and herbs have long been used in traditional medicine to treat various diseases. Recently, researchers have been investigating the potential of these plants to reduce gas emissions in pig farms. Certain compounds in medicinal plant or herbal extracts, such as tannins, saponins, and essential oils, have been shown to inhibit the growth and activity of methanogens, thereby reducing methane emissions. Bioactive compounds from medicinal plants or herbs can modulate the gut microbiome, improve gut health and function, and increase digestibility, all of which contribute to better nutrient utilization (Shehata et al., 2022).

Eugenol and cinnamaldehyde extracted from plants (*Croton zehntneri*, basil, cinnamon, and cinnamon) have the ability to reduce the number of *E. coli* in the intestines of fattening pigs, which ultimately helps reduce ammonia and hydrogen sulfide emissions in the feces (Yan et al., 2012). Another study reported that the addition of a herbal extract, specifically red ginseng, modulates the microflora present in the gastrointestinal tract of pigs. This modulation led to a reduction in harmful gas emissions in pigs. Also, extracts of *Achyranthes japonica* reduce the emissions of hydrogen sulfide in the faeces of growing pigs by up to 0.1% (Yin et al., 2018).

Plant extracts contain some bioactive compounds, for example garlic contains allicin, alliin, diallyl sulfide, diallyl disulfide, milk thistle (*Silybum marianum*) contains silymarin, turmeric (*Curcuma longa*) contains curcumin, *A. japonica* contains substances called phytoecdysteroid, saponin, polysaccharide, inocosterone and 20-hydroxyecdysone. Bioactive components in plant extracts can improve nutrient digestibility in pigs through several mechanisms, including increasing digestive enzyme activity, modulating the gut microbiome and improving gut health and function. Thus, plant extracts have been shown to improve digestion and nutrient utilization in pigs and reduce the amount of undigested material available for fermentation in feces and manure (Shang et al., 2019; Szabó et al., 2023).

### **Organic acids**

Organic acids in pig feed lower the pH of the gastrointestinal tract and create an environment less favorable for the growth of *E. coli*. Commonly used organic acids include formic acid, propionic acid, butyric acid, acetic acid and citric acid. Organic acids have the potential to improve growth, improve the microbial composition of feces and reduce ammonia and hydrogen sulfide emissions (Hossain et al., 2024).

It has been shown that pigs fed a diet supplemented with protected organic acids (10% malic acid, 13% citric acid and 17% fumaric acid) significantly reduced ammonia and hydrogen sulfide emissions (Stratford et al., 2003). Another study reported that pigs fed 2% benzoic acid reduced ammonia emissions by 60–70% (Eriksen et al., 2010). The inclusion of organic acids in the pig diet causes an acidification of the intestinal environment. This decrease in pH creates conditions that are less favorable for the growth of pathogenic bacteria such as *E. coli*, while also promoting the production of lactic acid by *Lactobacillus* spp. By suppressing the growth of pathogenic bacteria, organic acids indirectly reduce fermentation reactions that typically generate gases such as ammonia and hydrogen sulfide (Upadhaya et al., 2014).

Supplementing pig feed with saponins, particularly *Quillaja* saponin (QS), may help reduce emissions of harmful gases such as ammonia and hydrogen sulfide by potentially binding directly to these gases and inhibiting urease enzymes produced by harmful bacteria in the gut. Although the impact on carbon dioxide and methane emissions may be less direct, some studies show a tendency towards reduction, probably due to better feed intake and growth, leading to lower CO<sub>2</sub> emissions per unit of body weight gain (Biswas and Kim, 2024; Dang et al., 2020).

Reducing harmful gases such as ammonia or methane improves the air quality in pig barns, which is beneficial for both animal health and welfare. The environmental benefits are also significant. Saponin supplementation can contribute to more sustainable pig production.

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