Dietary Supplementation of Pig

Subjects: Zoology

Contributor: Giulia Ferronato

Reduction of antibiotic use has been a hot topic of research over the past decades. The European ban on growth-promoter use has increased the use of feed additivities that can enhance animal growth performance and health status, particularly during critical and stressful phases of life. Pig farming is characterized by several stressful periods, such as the weaning phase, and studies have suggested that the proper use of feed additives during stress could prevent disease and enhance performance through modulation of the gastrointestinal tract mucosa and microbiome. This review focuses on commonly used acids and their beneficial and potential effects. Acids have long been used as feed acidifiers and preservatives, and were more recently introduced into feed formulated for young pigs with the goal of stabilizing the stomach pH to offset their reduced digestive capacity. In addition, some organic acids represent intermediary products of the tricarboxylic acid cycle (TCA), and thus could be considered an energy source. Moreover, antimicrobial properties have been exploited to modulate microbiota populations and reduce pathogenic bacteria. Given these potential benefits, acids are no longer seen as simple acidifiers, but rather as growth promoters and potential antibiotic substitutes owing to their beneficial action on the gastrointestinal tract (GIT).

Keywords: acids ; feed additives ; pig health ; antibiotics use reduction

1. Introduction

Since 2006, the European ban of antibiotic growth promoters has been ratified by the Regulation (EC) n. 1831/2003 on additives for use in animal nutrition [1]n of. As reported by the Food and Agriculture Organization of the United Nations (FAO) “Animal Production and Health Division (AGA)”, the use of antimicrobial agents is essential, but the development of antimicrobial resistance (AMR) is a critical point for both animal and human health. The identification of alternative agents that can promote growth, improve feed efficiency, and reduce enteric diseases in pig farming has become a hot topic, with researchers seeking to reduce antibiotic use, while continuing to prevent pathologies and reduce mortality, so as to improve economic and environmental outcomes.

Pig farming is characterized by several critical phases; some, such as weaning or any other major change (i.e., in management, feeding strategy or environment), can cause stress and disturb the optimal physiological status. These stresses are often reflected by the appearance of gastrointestinal disorders and worsening of growth performance and feed efficiency. Gastrointestinal tract (GIT) plays a key role in achieving growing performance. Thus, modulating the health and functionality of the GIT mucosa through feeding strategies could reduce disease appearance and, consequently, decrease antibiotic use. For example, weaning piglets are characterized by under-developed digestive capacity and intestinal microbiota, and feed additives could be used to promote growth performance and prevent enteric diseases. Growing evidence suggests feed additives should also be given to fattening pigs, not only to improve performance, but also to reduce nitrogen excretion, phosphorous excretion, and the environmental impact [2].

2. The function of feed additive

Feed additives may be classified into the following groups: acids, minerals, prebiotics, probiotics, yeast, nucleotides, and phytoproducts [3]. Among them, acids offer many beneficial properties. Acid are molecules able to donate protons and are characterized by a dissociation constant and acidifier power that influence its effect. Acids may be administered as feed additives in various ways, including as a pure form, as a blend of organic and/or inorganic acids, or in association with phytoextracts or enzymes that can enhance the beneficial impacts. The group of feed additives categorized as acids includes inorganic acids, organic acids, fatty acids, and their salts. The members of the organic acid group may be classified by their saturation level (saturated or unsaturated) and/or carbon chain length (short, medium, or long chain) [4]. Some acids, like volatile fatty acids (VFAs) or intermediate products of tricarboxylic acid cycle, are naturally produced at the enteric level as a result of digestive processes, and/or at the cellular level [5].

Acids have long been used as feed acidifiers and preservatives; more recently, they have been included in feed stock for young pigs, with the goal of stabilizing the stomach pH to improve their digestive capacity [6]. Some organic acids could also be considered an energy source, such as those acting as intermediary products of the TCA cycle [2]. Moreover, the antimicrobial properties of some organic acids have been exploited to modulate microbiota populations and reduce pathogenic bacteria. These potential benefits mean that organic acids are no longer viewed as simple acidifiers of animal feed, but rather as growth promoters and potential antibiotic substitutes.

However, the effects of acid supplementation reported in the bibliography are not uniform both across different physiological phase and within the same physiological phase. Various authors have reported that the efficacy of acids can be dose-, stomach pH-, and microbiota population-dependent. Moreover, acid blends are more commonly used as feed additives, as blends tend to have wider-ranging action against pathogens than single acid formulations. Acids do not have a consistent mode of action in this context, but their beneficial effects could be due to the following:

- capacity of acids in undissociated forms to cross pathogen cell membranes and act on membrane enzymes or components of the cytoplasm (bactericidal/bacteriostatic effects);
- stabilization of the stomach pH (especially during the weaning period, when there is insufficient endogenous gastric HCl secretion) because of H^+ ions produced by acid dissociation, reduction of intestinal pH creating a barrier and/or hostile condition against pathogen growth and colonization, and/or activation gastric pepsinogen;
- improvement of nutrient digestibility and endogenous VFA production;
- acting as an energetic substrate for epithelial mucosa cells of GIT, improving the villus crypt/depth ratio and relative absorptive capacity;
- acting as a precursor for amino acids (AAs) synthesis;
- increasing blood flow [7][8].

The aim of this review is to provide a state-of-the-art overview of the acid group of feed additives, which act not only as acidifiers, but also as promoters of intestinal health and performance, nutritional compounds, and antimicrobials.

References

1. European Parliament and the Council of the European Union Regulation (EC) No 1831/2003. Off. J. Eur. Union 2003, 4, 29–43. Available online: http://eur-lex.europa.eu/legal-content/PT/TXT/?uri=celex:32003R1831 (accessed on: day m onth year).
2. Suiryanrayna, M.V.A.N.; Ramana, J.V. A review of the effects of dietary organic acids fed to swine. J. Anim. Sci. Biotech nol. 2015, 6, 1–11, doi:10.1186/s40104-015-0042-z.
3. Liu, Y.; Espinosa, C.D.; Abelilla, J.J.; Casas, G.A.; Lagos, L.V.; Lee, S.A.; Kwon, W.B.; Mathai, J.K.; Navarro, D.M.D.L.; Jaworski, N.W.; et al. Non-antibiotic feed additives in diets for pigs: A review. Anim. Nutr. 2018, 4, 113–125, doi:10.101 6/j.aninu.2018.01.007.
4. Rossi, R.; Pastorelli, G.; Cannata, S.; Corino, C. Recent advances in the use of fatty acids as supplements in pig diets: A review. Anim. Feed Sci. Technol. 2010, 162, 1–11, doi:10.1016/j.anifeedsci.2010.08.013.
5. Desbois, A.P.; Smith, V.J. Antibacterial free fatty acids: Activities, mechanisms of action and biotechnological potential. Appl. Microbiol. Biotechnol. 2010, 85, 1629–1642, doi:10.1007/s00253-009-2355-3.
6. Kim, Y.Y.; Kil, D.Y.; Oh, H.K.; Han, I.K. Acidifier as an alternative material to antibiotics in animal feed. Asian-Australasia n J. Anim. Sci. 2005, 18, 1048–1060.
7. Mroz, Z. Organic Acids as Potential Alternatives to Antibiotic Growth Promoters for Pigs. Adv. Pork Prod. 2005, 16, 169 –182.
8. Sun, Y.; O'Riordan, M.X.D. Regulation of Bacterial Pathogenesis by Intestinal Short-Chain Fatty Acids, 1st ed.; Elsevier Inc.: Amsterdam, The Netherlands, 2013; Volume 85, ISBN 9780124076723.