CAPÍTULO 8

USE OF EXOGENOUS ENZYMES IN POULTRY AND PIG NUTRITION

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ABSTRACT: The use of exogenous enzymes in animal nutrition is an area of increasing importance in modern industrial production. These globular proteins act as biological catalysts that accelerate chemical reactions in organisms. Its main purpose is to improve the nutritional value of feed by

breaking down antinutritional elements, improving the absorption of dietary ingredients, and strengthening the activities of animal metabolism. The strategic use of exogenous enzymes is becoming more common and promises to evolve, providing benefits for industry and society. Thus, the objective of this literature review was to prepare a document on the use of exogenous enzymes in poultry and swine nutrition, highlighting their relevance and positive impact on animal production and environmental management.
KEYWORDS: Antinutritional Factors, Animal Nutrition, Biological Catalysts, Exogenous Enzymes, Hydrolases.

UTILIZAÇÃO DE ENZIMAS EXÓGENAS EM NUTRIÇÃO DE AVES E SUÍNOS

RESUMO: A utilização de enzimas exógenas na nutrição animal é uma área de crescente importância na produção industrial moderna. Estas proteínas globulares atuam como catalisadores biológicos, acelerando reações químicas nos organismos. Seu principal propósito é aprimorar o valor nutricional das rações, quebrando elementos antinutricionais, melhorando a absorção de ingredientes das dietas e fortalecendo as atividades do metabolismo animal. O uso estratégico de enzimas exógenas está se tornando mais comum e promete evoluir no futuro, proporcionando benefícios para a indústria e a sociedade. Assim, objetivou-se com essa revisão de literatura elaborar um documento sobre a utilização de enzimas exógenas na nutrição de aves e suínos, destacando sua relevância e impacto positivo na produção animal e na gestão ambiental.
PALAVRAS-CHAVE: Fatores Antinutricionais, Nutrição Animal, Catalisadores Biológicos, Enzimas Exógenas, Hidrolases.

1 I INTRODUCTION

The use of exogenous enzymes in animal nutrition has become an area of great relevance in modern industrial production. Enzymes are globular proteins used as additives in animal nutrition, playing the role of biological catalysts, which accelerate chemical reactions in organisms (Souza et al., 2022). Its main purpose is to improve the nutritional value of components present in the feed, releasing the down antinutritional elements found in food (e.g., non-starch polysaccharide (NSP), fiber, and phytate) (Adeola and Cowieson, 2011; Alsersy et al., 2015), improve the absorption of dietary ingredients (Mireles-Arriaga et al., 2015), such as proteins, minerals, and starch, catalyze the breaking of chemical bonds, and reinforce the enzymatic activities of animal metabolism. They play a significant role in the processes of digestion and absorption (Vieites et al., 2020; Souza et al., 2022).

The actions of exogenous enzymes play a key role in reducing the challenges associated with malabsorption in the gastrointestinal tract. This fact results in optimizing the animals' productive performance, contributing to a significant improvement in zootechnical indicators (Krabbe et al., 2019).

Furthermore, exogenous enzymes play a vital role in reducing residues in animal production (Munir & Maqsood, 2013; Souza et al., 2022). This use is essential in the context

of growing concern about agricultural sustainability. With more efficient digestion, fewer undigested nutrients are excreted, reducing the risk of water and soil contamination from excess nutrients.

Therefore, the strategic use of exogenous enzymes is becoming increasingly common and is an area of research and application that promises to continue to evolve in the future, providing benefits to both industry and society. In this context, this study proposes conducting a literature review of exogenous enzymes used in poultry and swine nutrition.

2 | EXOGENOUS ENZYMES IN ANIMAL NUTRITION

Brazil has a prominent place in the agricultural market, where professionals always seek to improve their knowledge and techniques in animal production to obtain more and more quality products. In poultry and pig production, advances have occurred in the most diverse areas, including genetics, management, health, and nutrition. In nutrition, specifically, the concern is always to improve zootechnical indexes associated with reducing production costs (Silva, 2004).

The first reports in the literature on the use of enzymes in poultry and swine feed were obtained from discovering that moistened grains associated with enzyme supplementation had greater nutritional use by the animals. Since then, interest in using enzymes in poultry and pig feed has grown because of the expense of traditional raw materials and the search for alternative ingredients such as barley, oats, rice, and wheat (Campestrini et al., 2005).

In the last decade, the use of enzymes in poultry and pig diets in Brazil has gained wide space due to several reasons, among which can be highlighted: the technical-economic effectiveness of the use of phytases broke paradigms found in the implementation of new technological tools, in this case, the use of enzymes and multi-enzyme complexes; the search for a reduction in the cost per unit of gain in the poultry industry, which is intrinsically linked to the reduction in feed costs; variability in the costs of the main inputs and raw materials for diets; and regional availability of specific alternative ingredients that have a different nutritional profile concerning the standard diet (corn-soybean meal) (Araújo et al., 2008).

Enzymes are also considered a way to reduce environmental contamination with nutrients in excreta, such as phosphorus, nitrogen, copper, and zinc. Exogenous enzymes can be used as additives for poultry and swine feed, as they increase the digestibility of nutrients, reducing the need for high-cost ingredients to be included in the diet formulation. Therefore, it provides lower production costs without compromising the performance of the animals (Sorio et al., 2011). In feed formulations for poultry and pigs, approximately 75% of the phosphorus from foods of plant origin is combined with inositol, forming the phytic acid molecule, which has great chelating potential and reduces the solubility and digestibility of nutrients.

Phosphorus is an essential mineral because it plays an important role in various metabolic processes in the body. When formulating diets for poultry and pigs, it is necessary to supplement with a source of inorganic phosphorus, which, after energy and protein, is the nutrient that the cost of commercial feed increases (Silva et al., 2012).

Exogenous enzymes can assist in the degradation of specific components in food and are obtained naturally from fermentation (Liu et al., 2010). They are produced in all living organisms, from the most developed animals and plants to the simplest life forms, because enzymes are required for cellular metabolism. Microorganisms generally involved in enzyme production include bacteria (*Bacillus subtilis*, *B. lentus*, *B. amyloliquefaciens*, and B. *stearothermophils*), filamentous fungi (*Trichoderma longibrachiatum*, *Aspergillus oryzae*, and *A. niger*) and yeast (*Saccharomyces cerevisiae*) (Liu et al., 2010).

Most enzymes currently used in the food and beverage industry are derived from Aspergillus. However, hemicellulases and cellulases are derived from fungi of the genus Trichoderma. Recently, genes encoding different enzymes, including phytases, β-glucanases, and xylanases, have been cloned and expressed in different microorganisms and plant systems (Liu et al., 2010).

Among the main enzymatic additives used in poultry and swine feed, we can highlight lipases, xylanases, glucanases, proteases, and phytases. In their mechanism, these exogenous enzymes act like endogenous enzymes, first binding to a substrate and forming an enzyme-substrate complex (Henn, 2009).

Hydrolytic enzymes or hydrolases catalyze the hydrolytic cleavage of -C-O, -C-N, and -C-C bonds in addition to other types of bonds, including phosphoric anhydride bonds. The systematic classification of enzymes by the Enzyme Commission (EC) system divided them into six large groups or classes, which can, in turn, be subdivided into subclasses related to the specific action of each enzyme (Uenojo & Pastore, 2007).

Because of their characteristics, hydrolases have great biotechnological potential, constituting a group of enzymes that are most commercially explored. Commercialized hydrolases are used in various industries, such as detergents, leather, textiles, pulp and paper, oils and fats, bakeries, dairy products, juices and wines, breweries, animal feed, cosmetics, medicines, environment, and genetic engineering (Krabbe & Lorandi, 2014).

Enzymatic activity is the catalytic activity necessary to convert a specific amount of substrate into a specific amount of product per unit of time under a specific condition. In this context, enzymes are evaluated for their activity. However, in practice, in the digestive tract of animals, the passage time conditions and even physical-chemical conditions may change because of the type of diet (granulometry, fibers, ether extract, pH and buffering effect of the food, among others), environmental conditions (respiratory alkalosis and metabolic acidosis), physical-chemical quality of the water (pH, content and type of minerals present), in addition to other aspects (Krabbe & Lorandi, 2014).

A commercial enzyme product can be defined as an additive that contains processed

and standardized enzyme material and is produced for use in food or raw materials intended for animal consumption. Commercial enzymes (Table 01) are obtained through fermentative processes in which microorganisms are selected for this purpose. Current commercial enzymes have a predominance of a specific activity, or activities of secondary enzymes are observed, which, in practice, can act on other substrates contained in the ingestion (Krabbe & Lorandi, 2014).

Enzyme	Substrate	Effect
Xylanase	Arabinoxylans	Reduces feed viscosity
β-glucanase	β-glucans	Reduces feed viscosity and lowers humidity in litter
Pectinase	Pectin	Reduces feed viscosity
Cellulase	Cellulose	Cellulose degradation and nutrient release
Protease	Proteins	Supplementation of endogenous enzymes to improve protein digestibility
Amylase	Starch	Supplementation with endogenous enzymes that assist in the degradation of dietary starch
Phytase	Phytic acid	Promotes the degradation of phytic phosphorus
Galactosidase	Galactosides	Removal of galactosides
Lipase	Lipids and fatty acids	Improves the utilization of dietary lipids
Mannanase	glucomannan, galactomannan, glucogalactomannan in non-starch polysaccharides (NSP)	Increasing the rate of pancreatic secretion

Table 1. Main exogenous enzymes used as additives in poultry and pig feed.

Source: Krabbe & Lorandi, 2014.

Among the benefits related to the use of enzymatic additives in the diet of non-ruminant animals, the following can be highlighted: a decrease in the viscosity of the digesta, an increase in the digestibility and absorption of nutrients, especially lipids and protein, as well as an increase in the metabolizable energy of the diet, greater feed consumption and daily weight gain, reduced environmental impact, reduced water intake and the water and ammonia content of feces, and reduced waste production with lower amounts of nitrogen and phosphorus (Regina, 2010).

It is possible to obtain an increase in food digestibility through the use of enzymes in diets, enabling changes in feed formulations to reduce costs, maximizing the use of energy and protein ingredients in feeds, and enabling the use of regional alternative ingredients in replacement for corn and soybean meal (Regina, 2010).

The inclusion of phytase in the diet of poultry and pigs increases dietary nutritional quality, favoring faster digestion and reducing levels of nutrient excretion. Thus, phytase also prevents the formation of protein-phytate complexes, increasing protein digestibility. In addition, the hydrolysis of phytate through the enzyme releases minerals such as calcium, magnesium, zinc, iron, and organic molecules, which were previously unavailable to

animals, for absorption in the gastrointestinal tract (Rocha, 2014).

Silva et al. (2012) studied the association of carbohydrase and phytase in diets for commercial layers, and enzymes caused valorization of nutrients in the diet, then were efficient in maintaining the performance and quality of eggs from semi-heavy laying hens under the conditions evaluated.

According to Han et al. (2010), in their study on the influence of the inclusion of enzymes and lysolecithin associated or not about performance, digestibility, and quality of laying hen eggs, dietary supplementation alone or in combination promoted a significant effect on the production and weight of eggs. Dietary supplementation with a multienzyme complex containing 7 U/g of α-1,6-galactosidase and 22 U/g of β-1,4-mannanase showed significant results for feed conversion. According to the authors, this increase occurred because of increased protein digestibility. However, Araújo et al. (2008) studied different levels of wheat bran supplementation in feed with or without the addition of a multienzyme complex and observed that there was no significant effect on the feed conversion of birds.

Silversides & Hruby (2009) analyzed the inclusion of phytase in the diet of laying, considering the nutritional matrix of phytase, observed a proportional increase of 34 and 47 kcal/kg in apparent metabolizable energy, 0.18 and 0.21% in crude protein, 0.12 and 0.15% of digestible protein using 300 and 600 U/kg, respectively, demonstrating that phytase increases the bioavailability of nutrients other than phosphorus, especially energy and protein.

3 I CONCLUSION

Using exogenous enzymes in poultry and swine nutrition represents a promising approach to optimize the digestion and absorption of nutrients, improving feed efficiency and the general performance of these animals. This strategy also positively impacts the sustainability of animal production, minimizing the pressure on natural resources. The growing research and application of these enzymes in non-ruminant diets point to a future where animal nutrition will allow a production more efficient and ecologically responsible.

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