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INCLUSION OF β – MANNANASE IN CHICKEN DIETS

INCLUSÃO DE β – MANANASE EM DIETAS DE FRANGOS

INCLUSIÓN DE β-MANANASA EN DIETAS PARA POLLOS

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ABSTRACT
In Brazil, commercial broiler feeds consist primarily of energy and protein, exemplified by cracked corn and soybean meal, respectively. Although considered excellent quality due to their high digestibility, these ingredients contain antinutritional factors that negatively impact animal performance, such as the presence of Non-Starch Polysaccharides (NSPs). Therefore, the industry, in its constant evolution, develops alternatives capable of improving the animals' utilization of these ingredients, such as supplementing diets with exogenous enzymes. β-mannanase is responsible for hydrolyzing β-mannans, components found in soybean hulls and meal, and thus helps reduce intestinal viscosity, favoring increased digestibility and utilization of dietary nutrients. Despite numerous results regarding the inclusion of β-mannanase on zootechnical performance parameters in broilers, such as feed conversion (FCR), weight gain (WG), and feed intake (FI), few studies have elucidated its effects on amino acid digestibility. Therefore, it is concluded that there is a need for further studies to clarify the impacts of β-mannanase on this specific aspect.

Keywords: Additives. Poultry. Performance. Anti-nutritional Factors. Mannans.

RESUMO
Em território brasileiro, as rações comerciais para frangos de corte são constituídas majoritariamente por alimentos energéticos e proteicos, exemplificados respectivamente pelo milho triturado e farelo de soja. Apesar de serem considerados de excelente qualidade, por apresentarem alta digestibilidade, esses ingredientes apresentam fatores antinutricionais que influenciam negativamente no desempenho animal, como a presença de Polissacarídeos Não Amiláceos (PNA). Dessa maneira, a indústria em sua constante evolução, desenvolve alternativas capazes de melhorar o aproveitamento dos

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ingredientes pelos animais, exemplificando-se pela suplementação das dietas com enzimas exógenas. A β-mananase é responsável por hidrolisar os β-mananos, componentes encontrados na casca e no farelo de soja e assim, contribuir com a redução da viscosidade intestinal, favorecendo o aumento da digestibilidade e o aproveitamento dos nutrientes da dieta. Apesar dos inúmeros resultados acerca da inclusão da β-mananase sobre os parâmetros de desempenho zootécnico em frangos de corte, como na conversão alimentar (CA), ganho de peso (GP), consumo de ração (CR), ainda sim, poucos trabalhos elucidam os efeitos na digestibilidade de aminoácidos. Conclui-se, portanto, que há uma necessidade de novos estudos que esclareçam os impactos da β-mananase no que diz respeito a esse ponto em especial.

Palavras-chave: Aditivos. Aves. Desempenho. Fatores Anti-nutricionais. Mananos.

RESUMEN

En Brasil, los alimentos comerciales para pollos de engorde se componen principalmente de energía y proteína, como lo demuestran el maíz partido y la harina de soja, respectivamente. Si bien se consideran de excelente calidad debido a su alta digestibilidad, estos ingredientes contienen factores antinutricionales que afectan negativamente el rendimiento animal, como la presencia de polisacáridos no amiláceos (PNA). Por lo tanto, la industria, en constante evolución, desarrolla alternativas capaces de mejorar el aprovechamiento de estos ingredientes por parte de los animales, como la suplementación de las dietas con enzimas exógenas. La β-mananasa es responsable de hidrolizar los β-mananos, componentes presentes en la cáscara y la harina de soja, y, por lo tanto, ayuda a reducir la viscosidad intestinal, favoreciendo una mayor digestibilidad y utilización de los nutrientes de la dieta. A pesar de los numerosos resultados sobre la inclusión de la β-mananasa en parámetros de rendimiento zootécnico en pollos de engorde, como la conversión alimenticia (ICA), la ganancia de peso (GMP) y el consumo de alimento (CA), pocos estudios han dilucidado sus efectos sobre la digestibilidad de los aminoácidos. Por lo tanto, se concluye que es necesario realizar más estudios para aclarar los impactos de la β-mananasa en este aspecto específico.

Palabras clave: Aditivos. Avicultura. Rendimiento. Factores Antinutricionales. Mananos.

1 INTRODUCTION

In Brazil, commercial rations for broiler chickens are mostly made up of energy and protein feeds, exemplified respectively by crushed corn and soybean meal (UTIMI, 2016). Despite being considered of excellent quality, due to their high digestibility, these ingredients have antinutritional factors that negatively influence animal performance (BAVARESCO et al., 2021), such as the presence of Non-Starch Polysaccharides (NAP).

The presence of non-starch polysaccharides (soluble and/or insoluble NSPs) causes the need for the use of exogenous additives in diets (FRANCESCHINA, 2020). The addition of enzymes, whether in a single way or in combination with others, allows to increase the use of ingredients, in addition to contributing to less excretion of polluting metabolites in the environment (WICKRAMASURIYA et al., 2019).

Carbohydrases are exogenous enzymes introduced into the diet in order to hydrolyze or decompose Non-Starch Polysaccharides, being able to interfere with the hygroscopicity of NSPs and thus reduce the water retention capacity of the ingredients (MINAFRA et al., 2016). From the moment these enzymes act on the components of the cell wall, the availability of nutrients becomes greater and consequently improves the efficiency of the enzymatic action (CHOCT, 2004).

Structurally, β-mannans are linear mannose residue structure polymers bound to β-1,4 without (linear mannan) or with a combination of glucose and mannose residues (glucomannan) and occasional galactose residue side chains linked to α-1,6 (galactomannan or galactoglucomannan) (KIARIE et al., 2021). Therefore, the enzymatic action of β-mannanase is responsible for hydrolyzing β-mannans and contributing to the reduction of intestinal viscosity, favoring the increase of digestibility and the use of nutrients in the diet.

When evaluating the effects of the inclusion of β-mannanase (0, 200 and 400 g/ton) at different concentrations of galactomannan in the diet of broilers (0, 1500 and 3000 ppm), LATHAM et al., (2018) noted that β-mannanase improved ileal digestible energy as well as was able to decrease intestinal viscosity and improve the zootechnical performance of the animals. However, the maximization of these parameters depended on the concentration of galactomannan.

In addition to the PNA's, the inclusion of legumes such as soybeans must also take into account the presence of antinutritional factors, such as trypsin inhibitors, also known as antitrypsin factors. Frequently, this raw material is subjected to thermal processing with the aim of reducing the deleterious effects of these compounds (FILHO, 2022).

Despite this, soybean hulls come from oil extraction, thus not undergoing heat treatment, and may, depending on the origin, present great variation in the concentration of these factors (SOUSA et al., 2019).

For all these reasons, the objective of this work is to highlight the action of β-mannans, evaluate the effect of mannanase on the performance of birds, as well as better elucidate the digestibility of amino acids of broilers in relation to the supply of these additives to diets.

2 LITERATURE REVIEW

2.1 NON-STARCHY POLYSACCHARIDES

Non-Starch Polysaccharides (NSPs) present in ingredients of vegetable origin can be characterized as soluble or insoluble, according to the hygroscopicity of the ingredients to retain water, that is, by the ability to form a homogeneous or heterogeneous solution with water. Among its structural constituents, cellulose, hemicellulose, as well as pectins, beta-glucans, among others, can also be found xylans, arabinoxylans, pentosans (RIOS, 2014).

Soluble ones, when in excess, have high hygroscopicity and increase the viscosity of the digesta, disabling the enzymatic action under the substrates and consequently reducing the absorption of nutrients by the cells of the intestinal wall (MORGAN; BHUIYAN; HOPCROFT, 2022). However, when included appropriately, they can contribute to the balance of the rate of passage of the digesta and thus allow nutrients to be absorbed (MATEOS et al., 2012).

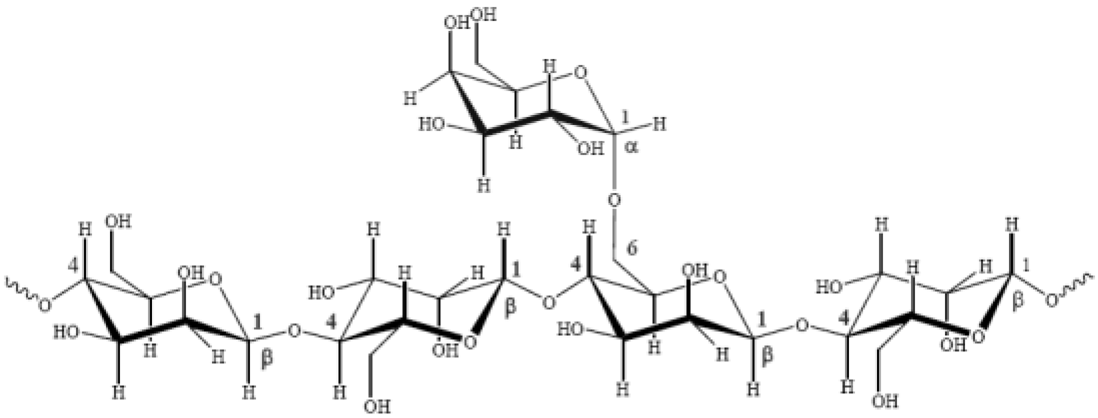
SORBARA (2008) reports that water-insoluble NSPs can prevent the absorption of nutrients adhered to the endosperm of the grain, although their effect is of lesser impact when compared to soluble NSPs. Therefore, it is necessary to evaluate the inclusion levels as well as the physicochemical properties of NSPs in the diet of broilers in order to predict the effects on zootechnical performance and intestinal health. In addition, use appropriate nutritional strategies to maximize the benefits of these compounds (MORGAN; BHUIYAN; HOPCROFT, 2022).

2.1.1 β-manans

β-mannans (also known as β-galactomans) are commonly found in the hull and fibrous fraction of soybean meal (Reid, 1985) and structurally are polysaccharides of D-mannose units connected by glycosidic bonds β-(1-4) (KIARIE et al., 2021), as shown in Figure 1.

Figure 1

Structural chemical formula of β-mannans



Source: Mudau, 2006.

In addition, in addition to being an insoluble NSP, they also comprise surface components of multiple pathogens that the innate immune system recognizes, generating a costly and purposeless energy-saving immune response (ARSENAULT et al., 2017; HSIAO; ANDERSON; DALE, 2006). During this process, several substances such as cytokines are released and the distribution of energy resources occurs, that is, part of the energy that would be used for other purposes in the animal body, such as reproduction and production, is diverted to the production of defense cells (MARÇAL, 2024).

The reduction in nutrient absorption is related to the interaction between β-mannans and glycocalyx (a kind of mucus located on the intestinal mucosa), causing the thickening of the mucus layer that physically hinders absorption. Therefore, favorable conditions are created for the growth and development of beneficial microorganisms and/or pathobionts, from nutrients that have not been completely absorbed by the intestinal lumen (MARÇAL, 2024).

However, as approximately 90% of the composition of rations in the national territory is given by the use of corn and soybean meal (LEANDRO et al., 2001), the use of strategies that reduce the effects of antinutritional factors is a viable alternative for maximizing zootechnical indices, such as enzyme supplementation, especially carbohydrases.

As they originate from the outer cell wall of yeast and have immunomodulatory characteristics (ALAGAWANY et al., 2023) capable of modulating the composition of the gut microbiota in favor of the proliferation of beneficial microorganisms (JOSEPH; REMYA; GREESHMA, 2023), the inclusion of β-mannanase in poultry feed can bring the benefit of favoring ***Lactobacillus**,* while reducing the activity of harmful bacteria such as ***Escherichia coli*,** favoring better results in feed efficiency and weight gain of the birds, especially in the initial phase of breeding, a critical stage of broiler production due to the birds not having a fully developed immune system (MOHAMMADIGHEISAR et al., 2021).

The intestinal mucosa is the host's largest immune defense system and is permanently activated, either by the microbial population itself or by dietary changes. A stable microbial population can protect the host against pathogen colonization by competing for intestinal epithelial and nutrient binding sites, strengthening the immune response, and producing bacteriocins (SONG et al., 2018).

2.1.2 β—mananase

According to Normative Instruction No. 44, of December 15, 2015, an additive is understood to be "any ingredient intentionally added to food, without the purpose of nourishing, with the objective of modifying the physical, chemical, biological or sensory characteristics", where they can perform different functions, including flavorings, acidifiers, colorings and preservatives to foods.

Knowledge about each enzyme, its limitations of use, mechanism of action, moisture content, temperature, pH, enzyme concentration and variability of the ingredients used in the feed should be considered when choosing the ideal enzyme to be used, at the risk of inaccuracy of the results or even damage to the animal's performance and also increase in the cost of the diet (RAVINDRAN, 2013).

In addition, enzyme supplementation allows nutritionists to reduce the energy level in diets, allowing to improve the performance response of broilers and make up for the metabolizable energy deficit (BEDFORD; COWIESON, 2020), since monogastric animals do not have sufficient endogenous enzymes capable of breaking the bonds of indigestible compounds (BEDFORD; PARTRIDGE, 2010).

The enzyme β-mannanase is an endocarbohydrase obtained from the fermentation of bacteria *Bacillus lentus*, responsible for hydrolyzing the 1,4-β glycosidic bonds of the main chain of mannans, galactomannans, glucomannans and galactoglucomannans, obtaining as a product during hydrolysis: manobiosis, manotriosis and mannose (DHAWAN; KAUR, 2007).

Therefore, exogenous carbohydrases depolymerize NSPs and reduce viscosity, improving nutrient availability and potentially increasing broiler growth performance (NUSAIRAT; ODETALLAH; WANG, 2022).

MARÇAL (2024) also states that β-mannanase supplementation in diets for broiler chickens allows the increase of β-mannan hydrolysis and reduces harmful effects, such as activation of the immune system and inflammation in the epithelium, resulting in better nutrient digestibility and energy utilization.

2.2 USE OF Β--MANNANASE AND ITS EFFECTS ON BROILER PRODUCTION

SILVA GOUVEIA (2024), when evaluating the effects of reducing metabolizable energy levels with and without β-mannanase supplementation in Cobb 500 broilers, found that inclusion significantly influenced ($p<0.05$) the uniformity of the flock throughout the experimental period (42 days), regardless of energy level (45 and 90 Kcal/kg). The birds maintained the uniformity of body weight, which can impact the number of animals rejected in the lot as well as the variations in carcasses (SILVA GOUVEIA, 2024).

In addition, the author also observed significant effects of the reduction of metabolizable energy levels on the average final weight (PMF), weight gain (WG) and feed conversion (FC) in the first 21 days of age of the birds. For AC, only the energy reduction of 90 Kcal had a negative effect, increasing feed conversion in this period.

Similarly, SANTOS et al. (2023) when evaluating the Effect of β-mannanase enzyme supplementation with and without sugarcane yeast (***Saccharomyces cerevisiae***) for broilers from 1 to 21 days of age, noted that in the pre-starter phase (1-7d) the treatments with DL + β-mannanase (80, 100 and 120 g/t) presented the best feed conversion averages. In the initial phase (1-21 d), broilers that consumed the basal diet (DB) and DB + β-mannanase showed higher average weight, weight gain and feed conversion.

CALDAS et al. (2018), using male broilers fed three different experimental diets, , and β-mannanase was added to the 3 basal diets at 3 inclusion rates (0, 200 and 400 ppm) observed that birds fed the high inclusion diet (400ppm), had lower feed intake compared to those fed 0 ppm (878 g vs. 937 g/bird, respectively). In addition, significant effects were also observed for the feed conversion of the birds, where the inclusion level of 400 ppm produced the best conversion (1.406) compared to the group that received 0 ppm (conversion of 1.693).

These results can be explained by the enzymatic action on the substrates present in the intestinal lumen, eliminating the physical barrier of the endosperm cell wall and the encapsulation of nutrients (KACZMAREK et al., 2014). The degradation of NSPs by enzymes can release portions of starch and protein encapsulated by the cell wall structure, facilitating the use of additional energy and, therefore, a greater use of nutrients by the animals due to enzyme supplementation, especially after the first week of life (SCAPINI, 2015).

Similar evidence was found by ÇALIŞLAR (2020), when evaluating the effects of the inclusion of guar meal with and without the addition of Β-mannanase on the performance and quality of eggs from laying hens. In these birds, live weight decreased as guar meal (GG) levels increased, especially from 8% inclusion. In addition, results were also found for food intake, which reduced by 4-6g in the inclusion of 16% of GG and 32-38g to 24% of GG. For the authors, these results elucidate the impact of saponins present in guar flour on consumption.

In addition to changes in feeding behavior, it is also possible to observe changes in water intake by animals. What was described by DASKIRAN et al. (2004), which in a study with broilers observed that water consumption is excessive proportionally to the inclusion of β-mannans in the diet, this occurs due to the greater need of birds to maintain the contact of digestive enzymes with substrates, since the viscosity promoted by the presence of PNA's delays gastric emptying and decreases the action of endogenous enzymes on nutrients, increasing the contact surface between the enzyme and the substrate.

2.3 USE OF Β-MANNANASE AND ITS EFFECTS ON AMINO ACID DIGESTIBILITY

From the aspects raised in this review, it becomes clear the relevance of studying the nutritional value of raw materials added to commercial feeds, especially processed whole soybeans. Although the amino acid content of soy is appreciable, its nutritional value still depends on their biological digestibility (CAFÉ et al., 2000).

In the industry, the maximization of the use of nutrients present in soybeans and the minimization of the effects of antinutritional factors are supported by the thermal processing of the grains, since the cooking of the grains under pressure is capable of deactivating such factors without changes in the energy and protein value of the soybean in natura (JAHANIAN; RASOULI, 2016). However, when subjected to heating, protein denaturation and modification of the carbohydrate structure occur, altering the availability and use of these nutrients (SILVA; VALENTINE; ARAUJO, 2022).

Therefore, the formulations of diets for broilers, when based on digestible amino acid contents, are able to improve the zootechnical performance of broilers as well as the economic perspectives of use, when compared to traditional diets based on total amino acids (ROSTAGNO; PUPA; PACK, 1995). This is due to the better use of nutrients.

Studies on the digestibility of amino acids from whole soybeans processed by different methods are scarce in the literature. SHANG; AZCONA, [n.d.], working with soybeans processed by extrusion, steam and hot air, found digestibility values of methionine, cystine and lysine, respectively of 92%, 86% and 92% for extruded soybean; 88%, 79% and 86% for steam-roasted soybeans and 72%, 69% and 70% for soybeans heated with hot air.

Corroborating those described above, SILVA et al. (2022), noted that the carcass yield of chickens fed diets containing deactivated soybean supplemented with mannanase enzyme levels was significantly affected in terms of the type of soybean, for the inclusion of the enzyme and for the interaction of both.

For the authors and also for ROMERO et al. (2013), such findings come from better energy utilization and apparent ileal digestibility of amino acids.

3 FINAL CONSIDERATIONS

During this literature review, the mode of action and impacts of β-mannanase in the diet of broilers on zootechnical performance and amino acid digestibility were demonstrated. However, few studies have demonstrated the direct effects on the digestibility of amino acids, covering mostly only the digestibility of nutrients, such as Dry Matter Digestibility Coefficient, Digestibility Coefficient of Neutral Detergent Fiber and Acid, among others. Therefore, the need for a greater literary foundation on the subject is evident.

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