Int. j. adv. multidisc. res. stud. 2023; 3(3):42-44

Received: 12-03-2023
Accepted: 22-04-2023

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

The Utilization of β-Glucan in Feed as Growth Promoter for Broilers: A Mini Review

[1] Nguyen Thuy Linh, [2] Nguyen Hoang Qui, [3] Nguyen Van Tho

[1, 2, 3] Department of Animal Science and Veterinary Medicine, School of Agriculture and Aquaculture, Tra Vinh University, Tra Vinh province, Vietnam

Corresponding Author: **Nguyen Hoang Qui**

Abstract

Broiler production plays a crucial role in human nutrition by providing meat for consumption. Due to antibiotic resistance in broiler meat, the free antibiotic regulation has been issued in many countries around the world. By this way, the emerging problems for scientists are to find a new approach to improve broiler production while it is safe for human health. β-glucan is applicable and could be found in plants. Besides, β-glucan, a potential substance for broiler production which can increase growth rate, reduce disease infection and improve immunity by various biology contents. Some β-glucans have been shown to enhance gut health by increasing the introduction of new immunocytes, macrophage function, phagocytosis, and intestinal morphology. Therefore, β-glucans may provide a new instrument for poultry producers seeking to reduce or eliminate antibiotic use. This article offers a comprehensive overview of the current use of β-glucans as additives and their potential use as an antibiotic substitute in broilers.

Keywords: B-Glucan, Growth Performance, Broilers, Nutrition

Introduction

The poultry industry is an integral part of agricultural production. The rise in human meat consumption causes an increase in poultry production, particularly broiler production. In the era of no antibiotics in feed due to antibiotic resistance concerns, it is necessary to investigate the application of a novel feed alternative. The chicken industry has advanced in a number of different fields, including nutrition, genetics, engineering, management, and communications, in order to enhance the effectiveness of growth performance (weight for age and feed conversion). In addition, disease outbreaks are one of the current issues affecting poultry production. Thus, β-glucan is a potential substance for meeting these requirements.

β-glucan is among the most widely used prebiotics. β-glucan compounds are present in the bran husks of cereal grains, barley, and the cell walls of yeasts, fungi, and bacteria. Cereal sources of β-glucans include oat and barley, and non-cereal sources can include mushroom, algae, bacteria and seaweed (Murphy *et al*., 2020) [3]. B-glucan has a variety of biological activities, including immune function enhancement, anti-infection, and glucose regulation (Xiong *et al*., 2015) [1]. The clusters of dietary fiber polysaccharides that make up β-glucan are the ones that are attached to D-glucose monomer via glycosidic linkages. Because of the positive impact that β-glucans have on both human and animal health, the pharmaceutical industry and the functional feed industry are both investigating its potential as a biological response modulator. According to Oliviera *et al*. (2009) [2], the molecular weight, tertiary structure, and degree of branching of a molecule all influence its biological effects. Because of its ability to boost the immune system, increase natural resistance, and enhance animal defense mechanisms, β-glucan helps prevent disease, which in turn increases poultry productivity and decreases poultry mortality.

The application of β-glucan not only for animals but also for human nutrition. For poultry, the utilization is clearly mentioned in feed for broilers to improve growth performance and health. The addition of 1, 3-β-glucan to the diets of chickens increased immune cell activation and migration to the intestine (Levine *et al*., 2018) [4]. Other studies have found improvements in bacterial infection resistance (Chen *et al*., 2008) [5], intestinal health after coccidiosis infection (Levine *et al*., 2018) [4], and overall growth rates and feed conversion efficiency (Levine *et al*., 2018) [4]. The application of β-glucan has a hypolipidemic effect and enhances the hormonal profile of birds, as demonstrated by Amer *et al*. (2022) study utilizing 120 mg Kg^{-1}. In addition, yeast-extracted β-glucan can be used as a growth promoter and has the potential to replace antibiotics in poultry against certain enteric pathogens by increasing the population of IgA secretory cells (Anwar *et al*., 2017).

As the useful function of β-glucan mentioned above, the utilization of β-glucan could be a potential alternative for antibiotic and used as promoter to improve broiler growth and health. Thus, the study aims to synthesize the effects of β-glucan on broilers and give the overall information of the application of β-glucan for broiler production.

B-Glucan source

According to Vetvicka and Vetvickova (2014) [6], beta-glucans are a type of carbohydrate that is made up of complex glucose polymers. They are the primary structural component of the cell walls of yeast, fungus, algae, and cereal grains such as oats and barley. According to Synytsya and Novak (2014) [7], the structures of β-glucans change depending on the origin of the glucose polymers and the types of linkages that are present on the glucose polymers. The β-glucans that are found in the cell walls of yeast and fungi are made up of 1, 3-linked glycopyranosyl residues, with only trace amounts of 1, 6-linked branches present. In contrast, the cell walls of oat and barley include unbranched β-glucans with 1, 3 and 1, 4-linked glycopyranosyl residues, whereas β-glucans from the bacterial origin are unbranched 1, 3-linked glycopyranosyl residues (Brown *et al*., 2003a; Brown *et al*., 2003b) [8, 9].

Barley has a higher concentration of β-glucan than any other cereals, with levels ranging from 5.0 to 11.0%. This substance may be found in both the endospermic and aleuronic layers of the grain. Oats contain between 4.5 and 5.5% β-glucan, the majority of which is found in the aleuronic and subaleuronic layers. The proportion of beta-glucan in oats ranges from 4.5 to 5.5%. Wheat has a beta-glucan level that ranges between 0.2% and 1.2%. This is considered to be a rather low amount. Wheat bran has a significant amount of β-glucan, which is why wheat milling by-products are typically used as the primary raw material for β-glucan extraction. In mushroom, it varied between 3.1% and 46.5%. Mycelia and/or fruiting bodies are the primary locations in mushrooms where β-glucan is concentrated. It is found mostly in the outer cell wall of yeasts such as *Debaryomyces hansenii, Saccharomyces cerevisiae, Schizosaccharomyces pombe, Candida milleri, Zygosaccharomyces bailii*, and *Pichia membranifaciens, Kloeckera apiculata*. Its concentration in yeast ranges from 5% to 7%.

Function of β-Glucan in growth

According to Moon *et al*. (2016) [10], a promising alternative to the use of antibiotics to increase the survival rate and performance of broilers is the administration of 60 parts per million of β-glucan. According to Amer *et al*. (2022), the ideal dose of 1,3-β-glucan is 120 mg Kg^{-1} which helps to increase body weight growth and FCR, reduce blood total cholesterol, triglyceride levels, and low-density lipoprotein cholesterol. In comparison to the control group, broilers that were given 200 ppm of β-glucan and mannan oligosaccharide from yeast cell wall experienced a 13.2% increase in their live weight gain and a 12.17% improvement in their FCR. Carcass percent of 300 ppm β-glucan and mannan oligosaccharide from yeast cell wall group was the highest carcass and being higher by 4.52% over the control (Abd-Elsamee *et al*., 2021). According to Zhang *et al*. (2020), increasing the amount of β-1, 3-glucan in one's diet at a dosage ranging from 100 to 200 g/T can improve energy digestion and lower cooking loss.

According to the research of Ding *et al*. (2019), the good benefits of β-glucans on body weight were due to the priming of the microflora in the gut, which promoted its development and contributed to its growth. This was responsible for the positive results. β-glucans have the ability to both minimize the amount of competition for nutrients that occurs between the host and its microflora by decreasing the amount of pathogenic bacteria that colonize the intestinal tract, which in turn improves intestinal health and mucosal integrity. This has been accomplished by allowing more available or higher ileal protein digestibility (Ferket *et al*., 2002; Gómez *et al*., 2012).

On the other hand, the results of certain studies suggested that β-glucan had no influence whatsever on the rate of growth. The explanation for this may be described as follows: the insignificant effects that β-glucan has on the growth of birds may be the consequence of a reorganization of energy toward the improvement of the immune system, which leads to an inefficient use of nutrients during the growth process. According to Huff *et al*. (2006) [11], in addition to the examination of β-glucan, other parameters such as composition, dose, purity, species, strains, and the existence of challenges also contribute to these different findings.

Function of β-Glucan in health

According to the study of Torki *et al*. (2022), taking β-glucan supplements was able to improve animal's health. The early treatment of β-glucan to broiler chickens resulted in a considerable boost in feed conversion rates. The levels of nitric oxide, lysozyme activity, phagocytic activity, and the phagocytic index, in addition to improving the oxidative state by decreasing malondialdehyde and boosting glutathione, and a high concentration of β-glucan increasing immunological response to vaccinations against newcastle disease virus and alvian influenza virus (El-Tawab *et al*., 2019) [12]. According to Aoe *et al*. (2019) [17], the abundance of *Bacteroidetes* in the cecum greatly rose, whereas the abundance of *Firmicutes* in the cecum significantly decreased. This was useful to promote secretory IgA, which neutralizes the toxins produced by microbes.

By binding complement receptor type three, Dectin-1, or TLRs on neutrophils, macrophages, natural killer cells, and dendritic cells, beta-glucan promotes B cells to create IgG immunoglobulin and ultimately encourages the body to produce an immunological response (Walachowski *et al*., 2017) [13]. Ross and Vetvicka (1993) [16] found that soluble β-glucan had the ability to activate receptor type three. According to the research of Bazan *et al*. (2014) [14], there is evidence that β-glucan can improve humoral immunity by stimulating T-cells. According to Jensen *et al*. (2008) [15], β-glucans cause an increase in the release of lysozyme from broiler phagocytic cells, which boosts the body's non-specific immune response.

As the immune ograns of poultry, spleen and bursa of Fabricius also increase when supplemented β-glucans. Some studies showed that the effects of β-glucans on the relative weight of the spleen and the bursa of Fabricius varied, depending on the dose, as well as the presence or absence of pathogen challenges (Zhang *et al*., 2020).

Conclusion

Positive impacts on productivity, including increased body weight and improved immune function as a result of β-glucans administrative are going to be looked at as a potential growth booster for broilers. The use of β-glucans as an alternative to antibiotics and as a growth stimulant is possible. In order to understand the role that β-glucans play in broiler nutrition and the mechanism by which they do so, additional research on β-glucans should be carried out.

References

1. Xiong X, Yang H, Li B, Liu G, Huang R, Li F, *et al*. Dietary supplementation with yeast product improves intestinal function, and serum and ileal amino acid contents in weaned piglets. Livestock Science. 2015; 171:20-27.
2. Oliveira M, Figueiredo-Lima D, Faria Filho D, Marques R, Moraes VMBD. Effect of mannanoligosaccharides and/or enzymes on antibody titers against infectious bursal and Newcastle disease viruses. Arquivo Brasileiro de Medicina Veterinária e Zootecnia. 2009; 61:6-11.
3. Murphy EJ, Rezoagli E, Major I, Rowan NJ, Laffey JG. β-Glucan Metabolic and Immunomodulatory Properties and Potential for Clinical Application. Journal of Fungi, 2020, 6-356.
4. Levine R, Horst G, Tonda R, Lumpkins B, Mathis G. Evaluation of the effects of feeding dried algae containing beta-1, 3-glucan on broilers challenged with Eimeria. Poultry Science. 2018; 97:3494-3500.
5. Chen KL, Weng BC, Chang MT, Liao YH, Chen TT, Chu C. Direct enhancement of the phagocytic and bactericidal capability of abdominal macrophage of chicks by β-1, 3-1, 6-glucan. Poultry Science. 2008; 87:2242-2249.
6. Vetvicka V, Vetvickova J. Natural immunomodulators and their stimulation of immune reaction: True or false? Anticancer Research. 2014; 34:2275-2282.
7. Synytsya A, Novak M. Structural analysis of glucans. Annals of Translational Medicine. 2014; 2:17.
8. Brown GD, Gordon S. Fungal β-Glucans and Mammalian Immunity. Immunity. 2003; 19(3):311-315.
9. Brown GD, Herre J, Williams DL, Willment JA. Dectin-1 Mediates the Biological Effects of β- Glucans. Journal of Experimental Medicine. 2003; 197(9):1119-1124.
10. Moon SH, Lee I, Feng X, Lee HY, Kim J, Ahn DU. Effect of Dietary Beta-Glucan on the Performance of Broilers and the Quality of Broiler Breast Meat. Asian-Australasian. Journal of Animal Sciences. 2016; 29(3):384-389.
11. Huff G, Huff W, Rath N, Tellez G. Limited treatment with β-1, 3/1, 6-glucan improves production values of broiler chickens challenged with Escherichia coli. Poultry Science. 2006; 85:613-618.
12. L Tawab AE, Awad A, Elnaggar OMAA, Elsissi AF. The impact of β glucan on the Immune Response of Broiler Chickens Vaccinated with NDV and AI H9V Vaccines. Benha Veterinary Medical Journal. 2019; 36(2):100-108.
13. Walachowski S, Tabouret G, Fabre M, Foucras G. Molecular analysis of a short-term model of β-glucans-trained immunity highlights the accessory contribution of GM-CSF in priming mouse macrophages response. Frontiers in Immunology. 2017; 8:1089.
14. Bazan SB, Breinig T, Schmitt MJ, Breinig F. Heat treatment improves antigen-specific T cell activation after protein delivery by several but not all yeast genera. Vaccine. 2014; 32:2591-2598.
15. Jensen G, Patterson K, Yoon I. Yeast culture has anti-inflammatory effects and specifically activates NK cells. Comparative Immunology, Microbiology and Infectious Disease. 2008; 31:487-500.
16. Ross G, Veˇtvicˇka V. CR3 (CD11b, CD18): A phagocyte and NK cell membrane receptor with multiple ligand specificities and functions. Clinical & Experimental Immunology. 1993; 92:181-184.
17. Aoe S, Yamanaka C, Fuwa M, Tamiya T, Nakayama Y, Miyoshi T, Kitazono E. Effects of barley max and high-beta-glucan barley line on short-chain fatty acids production and microbiota from the cecum to the distal colon in rats. PLoS ONE. 2019; 14(6):e0218118.