TECHNICAL

A novel Australian study elucidates the efficacy of glucose oxidase in enhancing the performance of broiler chickens

Written by Dr. Gao Jun,VTR Biotech Senior Technical Director of Global Market, this article explores the potential of glucose oxidase (GOD) as an effective antibiotic alternative in animal feed. GOD enhances feed quality, nutrient digestion, and gut health by acting as an antioxidant, regulating microbiota, and boosting immune function. VTR Biotech recent trials demonstrate its positive impact on broiler performance, supporting a more sustainable livestock production.

In modern food animal production, gut health is of utmost importance as it impacts nutrient utilization and immunocompetence. Broad-spectrum antibiotics have been used for decades for disease prevention, gut health maintenance and growth promotion in food animals. However, concerns over the spread of drug-resistant pathogens and antibiotic residues in meat have led to increasing restrictions on their use in animal feed. Many countries, like the EU in 2006 and China in 2020, have banned the use of antibiotics as growth promoters in the feed, and more are likely to follow. As a result, the feed industry has been seeking alternative feed additives, and glucose oxidase (GOD) emerging as a promising solution.

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Glucose Oxidase: Properties and Production

1. Structure and Composition

GOD is a flavoprotein enzyme that contains two flavin adenine dinucleotide (FAD) cofactors covalently bound to its protein structure. It has a characteristic barrel-like three-dimensional structure that is highly conserved across different sources and provides a stable framework for catalytic activity.

2. Sources of Production

Microorganisms, particularly fungi, are the primary producers of GOD. Aspergillus niger is the most commonly used strain for industrial production, as it can efficiently secrete GOD during growth.

3. Activity and Stability

The activity of GOD is highly dependent on environmental factors. It has an optimal pH range of 4.0 - 6.0, within which its active site is in a conformation that allows efficient binding of glucose. GOD shows relatively good stability within a specific temperature and pH range, enabling it to function effectively in both the feed environment and the animal's digestive tract.

Modes of Action of Glucose Oxidase

1.Improving Feed Quality by anti-oxidation

In feed, fats and other nutrients are prone to oxidation when exposed to oxygen and light. GOD acts as an antioxidant by consuming oxygen. In the presence of glucose in the feed, and using molecular oxygen as an electron acceptor, GOD catalyzes the specific oxidation of β-D-glucose to produce gluconic acid and hydrogen peroxide. Oxygen is also consumed during this enzymatical hydrolysis reaction. By consuming oxygen, GOD mitigates the oxidation of unsaturated fatty acids in the feed, preventing the formation of rancid odors and deleterious oxidation by-products. Oxidized fats can produce aldehydes and ketones, which reduce the nutritional value and palatability of the feed, resulting in reduced feed intake by animals.

2. Promoting Nutrient Digestion and Utilization

In the animal's digestive tract, GOD enhances nutrient utilization. Gluconic acid mildly acidifies the intestines, enhancing enzyme activity. This increased nutrient absorption provides more energy for animal growth and development, improving the feed conversion ratio.

3. Regulating Intestinal Microflora

The enzymatic reaction of GOD produces H_2O_2, which exhibits bacteriostatic properties against harmful intestinal bacteria, such as Escherichia coli and Salmonella, that are susceptible to oxidative stress. Meanwhile, the acidic environment created by the production of gluconic acid favors the growth of beneficial lactic acid-producing bacteria like Lactobacillus. A balanced intestinal microflora is crucial for animal health, as it supports normal nutrient digestion and absorption.

4. Improving Animal Health

4.1 Enhancing Antioxidant Capacity

While H_2O_2 is a reactive oxygen species (ROS), when produced endogenously by GOD in controlled manner, it stimulates the animal's antioxidant defense system. This results in the upregulation of antioxidant enzymes such as superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx), which scavenge excess ROS and shield cellular components from oxidative damage. A robust antioxidant capacity is positively correlated with enhanced animal health, as oxidative stress is associated with various diseases and growth retardation.

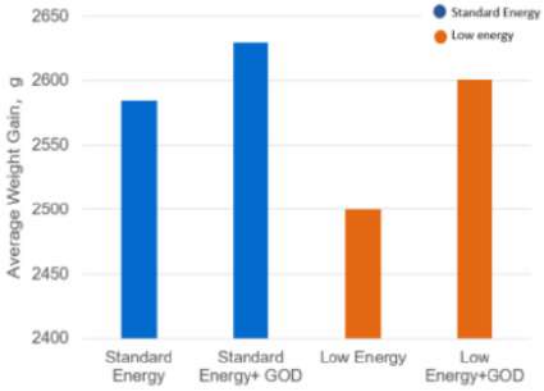
4.2 Fortifying Immune Functionality

A healthy intestinal microflora regulated by GOD is an important component of the animal's immune system. Beneficial bacteria in the intestine can interact with immune cells in the gut-associated lymphoid tissue (GALT), stimulating the production of immune factors such as immunoglobulins. Additionally, the enhanced antioxidant capacity resulting from GOD's enzymatic reaction contributes to stronger

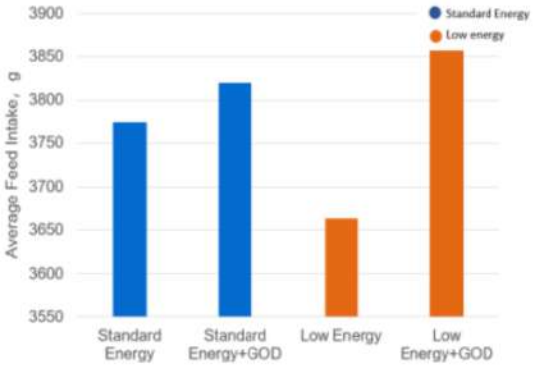
immune function. A well-functioning immune system better protect animals from pathogens, reducing the incidence of diseases and the need for antibiotic treatment.

A recent trial in Australia verified the efficacy of VTR Biotech glucose oxidase in broiler production

Researchers at the University of New England recently conducted a trial to assess the effectiveness of VTR Biotech glucose oxidase in broiler chickens fed either standard or low-energy diets. A total of 384 one-day-old Cobb 500 broiler chicks were assigned to one of four wheat-soybean meal dietary treatments in a 2 × 2 factorial design (two energy levels, with or without GOD addition) for a 35-day period. Standard diets were formulated following the recommendations outlined in the Cobb 500 Nutrition Specifications 2022, while low-energy diets were formulated similarly but with an 80 kcal/kg AMEn reduction. GOD was included at a dosage of 200 mg/kg in the GOD-supplemented diets. The results indicated no interaction between dietary energy levels and GOD addition in terms of average weight gain (P=0.421), feed conversion ratio (FCR) (P=0.177), and average feed intake(P=0.205). GOD addition was observed to increase average feed intake (P=0.023) for birds fed standard energy diets and energy reduction diets, with stronger response for birds fed energy reduction diets (Figure 1). The inclusion of GOD significantly improved body weight gain (P=0.044) for birds fed standard energy and energy reduction diets (Figure 1). A trend towards increased FCR was observed with energy reduction (P=0.051), whereas GOD addition was observed to numerically improve FCR for birds fed normal diets, and numerically increase FCR for the birds fed energy reduction diets. Interestingly, GOD supplementation significantly improved the European Production Efficiency Factor (EPEF) for birds fed standard energy diets and energy reduction diets (Figure 2). The research is ongoing, with further findings expected soon.

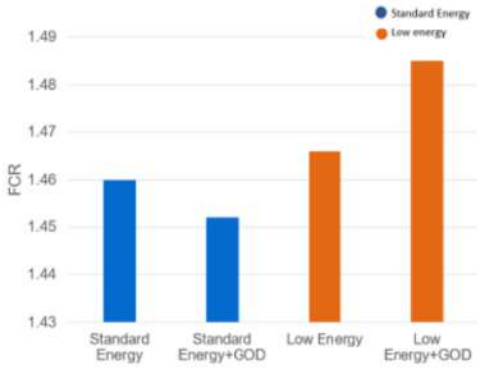


Main Effect
Energy, P=0.107; GOD, P=0.044; Energy*GOD, P=0.421



Main Effect
Energy, P=0.553; GOD, P=0.046; Energy*GOD, P=0.205

Figure 1: Impact of Energy Level and GOD Addition (200 mg/kg) on Broiler Performance



Main Effect
Energy, P=0.051; GOD, P=0.576; Energy*GOD, P=0.177

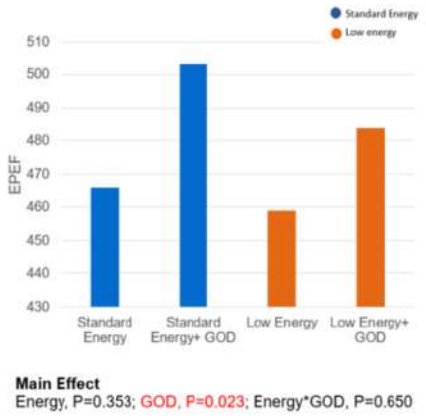


Figure 2: Impact of Dietary Energy Level and GOD Addition (200 mg/kg) on the European Production Efficiency Factor (EPEF) of Broilers

Conclusion

GOD has a wide range of applications in the feed industry. Its multifaceted modes of action render it a valuable feed additive, addressing the challenges of feed quality, animal digestion, and health in modern livestock production. The recent trial in Australia demonstrates its efficacy in broiler production. As research progresses, the application of GOD in poultry industry is expected to be further optimized, bringing additional benefits to the sustainable development of the animal husbandry industry.