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Role of NSP-Degrading Multi-Enzymes in Optimizing Performance in Laying Hens

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Introduction

In animal nutrition, improving feed efficiency is essential for ensuring optimal growth, health, and productivity in poultry. One major challenge is the presence of non-starch polysaccharides (NSPs) in plant-based feed ingredients such as wheat, barley, oats, and soybeans. These NSPs including compounds like cellulose, hemicellulose, beta-glucans, xylan, and pectin are poorly digested by poultry, leading to reduced nutrient availability and energy utilization. Consequently, a significant portion of the feed's nutritional potential remains untapped. To address this issue, the use of multi-enzyme complexes specifically designed to break down NSPs has emerged as an effective nutritional strategy. By enhancing digestion and improving nutrient absorption, these enzyme blends are revolutionizing poultry feeding practices and contributing to more efficient and sustainable production.

Overview of non-starch polysaccharides (NSPs)

Non-starch polysaccharides (NSPs) are complex carbohydrates commonly found in plant-based poultry feeds, yet they are indigestible by the natural enzymes produced in the gastrointestinal tract of poultry. Unlike starch, which is readily broken down into glucose for energy, NSPs largely remain undigested as they pass through the digestive system. This undigested matter can significantly impair feed efficiency and nutrient absorption. Approximately 30% of the main plant-derived ingredients in poultry diets contain NSPs (Baker et al., 2021). In addition, phytate-bound phosphorus (Phytate-P) which poultry also struggle to utilize accounts for nearly 70% of the total phosphorus in grains, seeds, and their by-products (Vieira et al., 2016).

When present in high amounts, NSPs create a viscous environment in the gut, increasing digesta thickness, slowing nutrient transport, and reducing the efficiency of digestion and absorption. To counter these effects, exogenous multi-enzyme complexes are often added to poultry diets. These enzymes help break down NSPs, reducing viscosity and improving nutrient utilization. Common non-starch polysaccharides (NSPs) in poultry diets include cellulose, hemicellulose, pectin, and beta-glucans. Cellulose is a linear, unbranched chain of glucose molecules that is insoluble in water, alkalis, and dilute acids. It is a tough polysaccharide found in plant cell walls. Hemicellulose is a group of heteropolysaccharides that also form part of the plant cell wall structure. It contains various sugars like xylose and mannose and is often referred to as non-cellulosic polysaccharides. Pectin is a linear polysaccharide composed of D-galacturonic acid and some L-rhamnose groups. This natural heteropolysaccharide is abundant in fruits and vegetables such as apples, pears, citrus fruits, carrots, and citrus peels. Beta-glucans are polysaccharides made up of glucose molecules linked into long chains, which poultry struggle to digest. These glucans are found in feed ingredients like barley, wheat, and rye, commonly used in commercial diets, but they increase the viscosity of the ingesta, reducing the availability of nutrients needed for growth. Other NSPs include gums, mucilage, and chitin, which also contribute to digestive challenges in poultry (Whitcomb and Lowe, 2007). These NSPs can negatively impact feed efficiency by creating a viscous environment in the gut, limiting nutrient absorption and growth.

Impact of multi-enzymes for effective utilization of NSPs

To counter the negative impacts of non-starch polysaccharides (NSPs) in poultry diets, feed manufacturers are increasingly turning to enzyme supplementation. Traditionally, single enzymes such as cellulase, xylanase, or phytase have been used to target specific NSP components. However, recent research indicates that multi-enzyme blends which combine several NSP-degrading enzymes are more effective in improving nutrient digestibility and feed efficiency. The NSPs enzymes used is as follows;

Cellulase: Breaks down cellulose into glucose units, improving energy availability.

Xylanase: Targets xylans found in hemicellulose, reducing gut viscosity and enhancing nutrient absorption.

Phytase: Degrades phytate, improving phosphorus availability and reducing its anti-nutritional effects.

Beta-glucanase: Breaks down beta-glucans, reducing feed viscosity and allowing better nutrient absorption.

Mannanase: Degrades mannans, improving digestion and nutrient uptake.

Pectinase: Breaks down pectins, improving feed digestibility.

By acting synergistically, these enzyme blends help break down complex fiber structures, reduce gut viscosity, release trapped nutrients, and ultimately enhance growth performance, feed conversion, and nutrient uptake in poultry.

Significance of multi-enzyme supplementation in poultry ration

- Enhanced nutrient digestibility: By breaking down NSPs, multi-enzyme solutions release trapped nutrients like starches, proteins, and fats, allowing poultry to extract more energy and nutrients from the same amount of feed. This leads to better feed efficiency.
- Improved growth performance: With enhanced nutrient absorption, birds can grow more quickly and efficiently. This is especially critical in poultry production, where feed costs represent a substantial portion of the overall expense. Better feed utilization directly contributes to improved growth rates and production efficiency.
- Gut health improvement: Xylanase helps hydrolyze 1,4-beta-D-xylopyranosyl linkages in xylan, generating fermented NSP-compounds like xylo-oligosaccharides (XOS) and arabino-xylo-oligosaccharides (AXOS), which act as prebiotics. These compounds promote beneficial gut bacteria and improve the composition and diversity of the intestinal microbiota, contributing to better gut health.
- Sustainability and cost savings: By making feed ingredients more digestible, multi-enzyme solutions allow producers to use lower-cost feed ingredients without sacrificing performance. This reduces the need for expensive feed additives, resulting in overall cost savings in production while maintaining or even improving poultry performance.
- Environmental impact: Although phytase activity exists in the brush border membrane of poultry's digestive tract, poultry poorly utilizes phytate-bound phosphorus (P). As a result, inorganic phosphorus must be added to poultry diets to achieve optimal growth, leading to the excretion of large amounts of P in feces. Exogenous phytase can be included in diets to hydrolyze phytate, making more phytate-bound P available for absorption. This reduces the need for inorganic P supplementation, decreases phosphorus excretion, and helps lower the environmental impact of intensive poultry production.

Upcoming prospects of multi-enzyme in poultry nutrition

With the global demand for poultry products on the rise, advancements in feed technology are essential to ensure sustainable and efficient production. Among these innovations, multi-enzyme solutions targeting non-starch polysaccharides (NSPs) have emerged as a powerful tool. By improving feed efficiency, reducing production costs, and enhancing both egg and meat yields, these enzyme blends play a critical role in supporting the future of high-performance, cost-effective, and environmentally sustainable poultry farming.

- Looking ahead, enzyme solutions are expected to become increasingly customized and precise, tailored

specifically to the composition of feed ingredients and the nutritional needs of poultry. With the aid of advanced feed analytics and characterization tools, manufacturers will be able to formulate enzyme blends that are optimized for particular feedstuffs such as wheat, barley, corn, or soybeans and their associated non-starch polysaccharide (NSP) profiles. Unlike current multi-enzyme supplements that broadly target common NSPs, next-generation formulations will focus on creating more synergistic enzyme combinations. These blends will be designed to work in concert, enhancing the breakdown of a wider array of anti-nutritional factors. Enzyme synergies for example, between xylanase, cellulase, phytase, and protease are expected to significantly improve feed digestion, nutrient release, and overall bird performance. This precision-based approach will not only boost feed efficiency and productivity, but also support sustainable poultry production by minimizing nutrient waste and environmental impact.

- Multi-enzyme supplements are likely to be further developed to support not only nutrient digestion but also gut health. By generating bioactive compounds like oligosaccharides, enzymes such as xylanase will continue to act as prebiotics, promoting beneficial microbiota. Future enzyme supplements may also be combined with probiotics, postbiotics, or other gut health-promoting additives, enhancing their role in supporting animal health and reducing the need for antibiotics.
- As sustainability becomes a growing concern in animal agriculture, multi-enzyme supplementation will play a pivotal role in reducing environmental impacts. By improving nutrient digestibility and reducing nutrient excretion (e.g., phosphorus and nitrogen), enzyme solutions will help mitigate the environmental footprint of intensive poultry production. In particular, the use of phytase to decrease phosphorus pollution will likely become even more essential as regulations surrounding environmental protection tighten.
- The future of multi-enzyme supplementation will continue to enhance the economic viability of poultry production by enabling the use of lower-cost, alternative feed ingredients. As enzyme technologies advance, producers will be able to include a wider range of feedstuffs such as byproducts, lower-quality grains, or unconventional feed sources without compromising performance. This will allow for more flexibility in formulating cost-effective, sustainable diets.
- The integration of digital technologies and precision agriculture tools will allow for real-time monitoring of enzyme effectiveness in animal feed. Sensors, data analytics, and machine learning could be used to track feed digestion, nutrient absorption, and animal growth, providing feedback to optimize enzyme supplementation and feed formulation. This would ensure that animals receive the most efficient diet, tailored to their specific needs and conditions.
- As the poultry industry increasingly focuses on reducing antibiotic use, multi-enzyme supplementation may also gain more regulatory and consumer support as a natural, non-chemical alternative to promote gut health and feed efficiency. Continued research and validation of enzyme benefits will strengthen consumer confidence in this technology, supporting its wider adoption.
- Advances in biotechnology and enzyme engineering are likely to produce next-generation enzymes with improved stability, activity, and resistance to harsh digestive conditions. These enzymes will function more effectively in the acidic and high-temperature environments of the digestive tract, allowing for greater efficiency in breaking down NSPs and other anti-nutritional factors.

Conclusions

The use of multi-enzyme solutions targeting non-starch polysaccharides (NSPs) represents a major advancement in modern poultry

nutrition. By breaking down complex carbohydrates that poultry cannot digest on their own, these enzyme blends significantly enhance feed efficiency, improve gut health, reduce production costs, and support sustainable farming practices. As enzyme technology continues to advance, its role in poultry production will become increasingly critical not only in boosting productivity and profitability, but also in addressing global challenges such as environmental sustainability, resource optimization, and food security. Ultimately, enzyme-based nutritional strategies offer a promising pathway toward more efficient, resilient, and eco-friendly poultry systems capable of meeting the growing global demand for eggs and meat.

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