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Intestinal Oxidative Stress and its Impact of Unconventional Feed Fermentation

Bağırsak Oksidatif Stresi ve Geleneksel Olmayan Yem Fermantasyonunun Etkisi

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ABSTRACT

Unconventional feed contains anti-nutritional factors and toxins. Still, microbial fermentation can effectively mitigate these issues, leading to enhanced nutrient composition in the feed. This process can stimulate animal appetites and ultimately result in substantial improvements in intestinal health and growth performance. Researchers have found that fermented feed effectively mitigates oxidative stress effects on the gastrointestinal system. Observations show it expedites the elimination of gastrointestinal abnormalities, enhances intestinal stress resistance, and promotes ideal animal output. Non-traditional fermented feeds are a growing practice in animal farming, and a variety of studies have been conducted to evaluate the efficacy of non-traditional fermented feeds in animals exhibiting oxidative stress symptoms. To offer a theoretical framework for non-traditional fermented feed's advancement and implementation in mitigating oxidative stress, this paper aims to provide a framework for the advancement and implementation of these feeds.

Keywords: Unconventional feed; Fermented probiotics; Oxidative stress; Antioxidant

ÖZ

Geleneksel olmayan yemler anti-besinsel faktörler ve toksinler içerir. Yine de mikrobiyal fermantasyon bu sorunları etkili bir şekilde azaltabilir ve yemdeki besin bileşiminin artmasını sağlayabilir. Bu süreç hayvanların iştahını açabilir ve sonuçta bağırsak sağlığı ve büyüme performansında önemli iyileşmeler sağlayabilir. Araştırmacılar, fermente yemin gastrointestinal sistem üzerindeki oksidatif stres etkilerini etkili bir şekilde azalttığını bulmuşlardır. Gözlemler, gastrointestinal anormalliklerin ortadan kaldırılmasını hızlandırdığını, bağırsak stres direncini artırdığını ve ideal hayvan verimini desteklediğini göstermektedir. Geleneksel olmayan fermente yemler, hayvan yetiştiriciliğinde büyüyen bir uygulamadır ve oksidatif stres semptomları gösteren hayvanlarda geleneksel olmayan fermente yemlerin etkinliğini değerlendirmek için çeşitli çalışmalar yapılmıştır. Bu makale, oksidatif stresin azaltılmasında geleneksel olmayan fermente yemlerin ilerlemesi ve uygulanması için teorik bir çerçeve sunmayı amaçlamaktadır.

Anahtar Kelimeler: Geleneksel olmayan yem; Fermente probiyotik; Oksidatif stres; Antioksidan

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INTRODUCTION

Unlike conventional feed, unconventional feed uses raw materials or methods differently from conventional feed. A variety of raw materials are used to produce this type of feed, such as agricultural products, ancillary goods, aquatic products by-products, and industrial wastes. The acquisition of these resources is aided by certain processing and treatment methods. However, non-traditional feed has a complicated mix of nutrients, and it has problems, such as an unpleasant taste, changing nutrients, and noticeable changes in quality. In consequence, non-traditional feed is used insufficiently, causing resource waste and contamination of the environment. Alternative feed, or special feed, refers to unconventional feed that undergoes various processing techniques, including microbial fermentation technology, crushing, heating, hydrolysis, and drying. Through these methods, we are able to break down antinutritional factors, toxins, crude fiber, lignin, and other substances found in feed (Abd El-Hack et al,. 2018). As a result of these processes, the feed gains a higher protein, mineral, and trace element content, which is essential for supplementing livestock. Consequently, people often substitute unconventional feed for traditional feed to reduce feeding costs, boost economic value, and foster sustainable growth. It has become increasingly popular to consume unorthodox feeds in recent years (Sugiharto and Ranjitkar, 2019).

The rapid expansion of the economy and the subsequent improvement in living conditions have led to significant advancements in agricultural and animal husbandry. However, the issue of "humans and livestock competing for food" remains a pressing concern, mostly due to the escalating demand for feed and the inadequate supply. Currently, the prohibition of antibiotics in animal feed has emerged as a significant trend in the advancement of the livestock and poultry sectors. Research is exploring alternative additives to antibiotics, such as probiotics, antimicrobial peptides, Chinese herbal additives, plant-derived phytochemicals, functional amino acids, organic acids, and other beneficial additives that won't compromise livestock quality. Research on these options mostly concentrates on the use of probiotics in fermented feed and the methods to preserve and enhance animal gut health and production performance through fermented feed (Zhang et al, 2024). According to reports, the introduction of beneficial microorganisms into raw feed materials can lead to the fermentation of organic macromolecules, such as proteins and lipids, resulting in the formation of smaller molecules like organic acids. This process enhances the nutritional composition of the feed, helps with its absorption by livestock and poultry, and contributes to the improvement of animal intestinal health. This process enhances the growth performance and overall health of livestock and poultry (Wang et al., 2018). Oxidative stress happens when too many highly reactive molecules, like reactive oxygen species (ROS) and reactive nitrogen radicals (RNS), are made, and antioxidants can't get rid of them fast enough (Zhang et al,. 2024). This imbalance undermines the equilibrium between the oxidative and antioxidant systems, leading to cellular and tissue damage. Animals may undergo oxidative stress when exposed to external environmental pressure, disease, feed discomfort, transportation, or other adverse stimuli (Yiannikouris et al., 2021). This stress can lead to various physiological and pathological changes, including damage to cell membranes, abnormal organelle functions, oxidation of DNA, proteins, and lipids, and the start of inflammatory reactions (Ma et al., 2023). These reactions then impact the animal's health and performance through mechanisms such as diminished immune response, decelerated growth rates, and decreased reproductive potential. Hence, the proficient management of oxidative stress is imperative to preserve animal well-being and the enhancement of breeding efficacy (Adisa et al., 2024). Many studies have demonstrated that the inclusion of fermented feed as a dietary supplement can be efficacious in preserving the stability of the intestinal milieu and mitigating the harmful consequences of oxidative stress. As an illustration, Jairath et al. (2023) observed that fermentation led to a notable augmentation in antioxidant activity. These results from Liu et al. show that feeding finishing pigs with fermented mixed feed changes the gut microbiome and metabolic processes in a good way. Hu et al.(2023) observed a substantial enhancement in the antioxidant capacity of a juvenile largemouth bass when exposed to fermented tea residue.

Fermentation and other methods can convert low nutritional value and anti-nutritional elements in unconventional feed raw materials into high-quality fermented feed (Sabour et al., 2019). After the fermentation process, using unconventional feed not only improves the nutritional composition and digestibility of traditional feed but also reduces oxidative stress in animals. Additionally, it facilitates advancements in livestock and poultry health and production (Ge et al., 2018). Unconventional fermented feed maintains intestinal health through antioxidants and probiotics, as well as enhances immune function with bioactive substances, which is a crucial part of unconventional fermented feed. This holds significant importance in antibiotic-free animal husbandry, as well as in mitigating resource scarcity and addressing oxidative stress (Wang et al., 2018). Researchers have found that enhancing feed diversity positively affects the overall growth performance of livestock and poultry, reduces environmental pollution, and promotes sustainable practices in animal husbandry (Qiu et al., 2023). The presence of antioxidants in non-traditional fermented feeds has the potential to enhance the antioxidant capacity of animals and mitigate the harmful effects of free radicals (Li et al., 2021). This can lead to enhanced animal health and increased production efficiency. Antioxidants encompass a variety of substances, such as vitamins, enzymes, peptides, and other small-molecule compounds. By counteracting free radicals in the body, mitigating oxidative stress, and protecting cells against harm, these chemicals counter the damaging effects of free radicals. Insufficient research has been conducted to understand how fermented feed affects digestion's oxidative stress. Furthermore, it is necessary to improve the evaluation system for assessing these consequences. Various fermentation strains, methods, and conditions can influence the quality of feed, growth performance, and meat quality of animals (Liang et al., 2021). So it is imperative to optimize the fermentation process and conduct further research on its effects on intestinal health. Thus, scientific validation and advancement of unconventional fermented feed will be contributed.

Classification and Utilization of Unconventional Feed

There is a wide range of sources for unconventional feed, encompassing various by-products derived from grain and oil processing, animal and poultry processing, aquatic product processing, and other industrial processing. Despite their abundance as resources, the elevated levels of anti-nutritional elements and toxins constrain the use of unconventional raw materials in animal feeding. Hence, enhancing the caliber of non-traditional raw materials and increasing their efficiency in animal nutrition are important subjects of ongoing scientific feed investigation (Shah et al., 2021). Suppose you want to use common raw materials like wheat bran, rice bran, bean dregs, distiller grains, sweet potatoes, straw, and other processing wastes. In that case, you need to use techniques like physical processing, chemical treatment, or microbial fermentation to help the crude fiber break down and increase its feed value (Wang et al., 2019). There are several methods available to mitigate the presence of anti-nutritional elements and toxins in unusually fermented feed. Fermentation generates microbes and enzymes that break down antinutritional components like phytic acid and cellulose. Additionally, the application of high temperatures aids in the degradation of some toxins by disrupting their structural integrity. Furthermore, regulating pH and microbial metabolism throughout fermentation has the potential to decrease toxic content in feed. Physical treatments like filtration and sedimentation can reduce toxin levels. By integrating these approaches, it is possible to safely administer non-traditional fermented feed to animals, thus enhancing their nutritional accessibility and overall well-being (Sun et al., 2023).

The Mechanism of Unconventional Feed Quality

We derive unconventional feeds from a diverse array of readily available sources. The exploration and application of non-traditional raw materials have the potential to address the issue of food security and contribute to the overall impact of poverty alleviation (Wang et al., 2018). As previously said, unconventional raw materials have several advantages, including fewer environmental demands, a broad spectrum of development potential, substantial nutritional content, and a substantial overall yield. These days, using microbial fermentation technology has made it easier to break down chemicals and other substances that aren't good for you and are in unconventional raw materials (Sabour et al., 2019). This makes those resources more nutritious. Using unusual fermented feed in animal production is an important method of enhancing antioxidant activity. The aforementioned feed variant safeguards animal cells against oxidative harm by providing a substantial reservoir of antioxidants, including vitamin C, vitamin E, and polyphenolic substances. These antioxidants successfully impede the generation of free radicals. Also, making non-traditional fermented feed might help break down harmful chemicals and antinutritional parts that are in the feed (Sugiharto and Ranjitkar, 2019).This would lower oxidative stress animals experience, which would then lower the chance of oxidative damage happening. These antioxidants have the capability to augment the immunological function of animals, bolstering their resistance and thereby mitigating their susceptibility to diseases (Terzioğlu et al., 2019). It is noteworthy to mention that, after undergoing fermentation treatment, unconventional feed shows enhanced antioxidant activity. This not only preserves the nutrient integrity of the feed and prolongs its shelf life, but also enhances its palatability, digestion, and absorption efficiency. These improvements contribute to the overall health and production performance of animals. Hence, the use of nontraditional fermented feed as an antioxidant in animal production holds immense importance in enhancing the sustainable growth of the aquaculture sector (Ren et al., 2023).

Unconventional Fermented Feed Improves Oxidative Stress

The rapid advancement of contemporary animal husbandry practices has the potential to induce oxidative stress in animals, leading to harmful effects on their intestinal well-being (Shah et al., 2021). This can manifest as the destruction of intestinal mucosal structures and impairment of intestinal absorption function, ultimately affecting the growth performance of animals. Animal husbandry has acknowledged and extensively employed probiotic-fermented feed for animal nutrition (Olukomaiya et al., 2021). In a study Liang et al. (2023) have demonstrated that fermented feed can affect the stability of the gut microbiota and the efficient functioning of the gut. Fermented feed's dietary fiber plays an important role in regulating lipid metabolism and the body's reaction to antioxidant stress. It also has notable effects on enhancing cardiovascular and cerebrovascular diseases, changing the composition of intestinal microorganisms, and influencing energy balance through the gut microbiota-gut-brain axis (Pan et al., 2024). It has a beneficial influence on overall health. Fermented feed is significantly important in terms of its antioxidant activity due to its high content of antioxidants like vitamin C, vitamin E, and polyphenols. Additionally, certain microbial metabolites generated during fermentation possess antioxidant properties, hence contributing to the maintenance of redox equilibrium within the body (Sugiharto and Ranjitkar, 2019).Fermented feed has several notable benefits, including an enhanced utilization rate of feed components, improved nutritional status of animals, and increased resistance to oxidative stress. Using fermented feed has various advantages, including the provision of antioxidants and microbial metabolites as well as the facilitation of nutrient absorption. This breeding method holds significant importance for promoting animal health and maintaining physiological equilibrium (Nag et al., 2020).

Prospects

The usage of non-traditional fermented feed yields favorable outcomes for sustainable and ecologically conscious livestock management across various dimensions. The feed-in question uses a variety of raw materials, including agricultural and ancillary products, aquatic by-products, and industrial by-products. This approach demonstrates efficient resource utilization and reduces resource waste. This characteristic contributes to the reduction of the overall environmental burden. It is worth noting that unconventional fermented feed has the potential to include a greater abundance of nutrients and bioactive compounds compared to conventional feed. This, in turn, can enhance the growth, development rate, immunology, and disease resistance of animals, ultimately leading to improved breeding efficiency. The utilization of unconventional fermented feed plays an important role in advancing the principles of the circular economy. Using and reusing waste resources, we can effectively pursue the objectives of waste reduction, resource conservation, and ecological and environmental protection. This approach contributes to the establishment of a livestock system that is both sustainable and environmentally conscious.

CONCLUSIONS

A situation of oxidative stress occurs when an animal's antioxidant system cannot eliminate enough oxidative chemicals. This can negatively affect animal health, including impairing the integrity of the intestinal barrier and triggering an inflammatory response. A fermented feed that is unconventionally produced can reduce oxidative stress levels in animals, thereby improving their health. In addition to its high antioxidant content, it provides essential nutrients and maintains a healthy gut microbiota. In spite of this, it is crucial that they are carefully selected and overseen to ensure that they have a positive effect on animals, and they should be inspected closely and changed individually as necessary.

Therefore, it is of great significance to investigate the utilization of non-traditional fermented feeds to maintain animals' gastrointestinal well-being. A future research focus should be on improving the quality of fermented feed and optimizing the production process. It is also possible to generate substantial evidence for the advancement of scientifically based feeding methods by examining the mechanisms by which fermented feed regulates gut health and enhances antioxidant capacity at the same time. Therefore, animals can be offered holistic well-being and performance.

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