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Feed additives in Animal Nutrition

H.P. Chanda, K. Sethy*, S. N. Jadhav, S. L. Kolhe
Department of Animal Nutrition, C.V.Sc and AH, Odisha University of Agriculture and Technology, Bhubaneswar, 751003, Odisha
*Corresponding author: **ksethy@ouat.ac.in**
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Introduction

The livestock sector not only contributes significantly to essential food proteins but also plays a crucial role in food security and economic development. Within this sector, nutrition is vital for animal health, productivity, and product quality. Feed additives, which are not nutritional elements or compounds, are incorporated into animal diets to improve their health, feed efficiency, and overall well-being. They are particularly significant for optimizing feed conversion efficiency, reducing nutrient waste, and decreasing antibiotic usage in animal production systems (Huyghebaert *et al*., 2011). Recent innovations, like next-generation additives including probiotics and prebiotics, have gained attention for their ability to sustain a healthy gut microbiota. The recent rise in demand for meat and dairy products globally, along with increasing consumer awareness regarding food quality and safety, has underscored the importance of feed additives. They not only aid in disease prevention and modulation of immune responses but also improve carcass quality. Thus, feed additives are integral to modern livestock feeding, fostering productivity, profitability, and overall animal welfare.

Classification of Feed Additives

Feed additives are categorized into three groups based on their purpose and usage, according to the framework laid out by the European Food Safety Authority (EFSA).

Nutritional Additives

Nutritional additives comprise vitamins, provitamins, minerals, and amino acids essential for maintaining health and supporting growth and metabolism. Important amino acids such as lysine, methionine, and threonine are typically added to animals' diets to ensure a balanced protein content, which is crucial for growth, reproduction, and overall performance.

Technological Additives

Technological additives aim to improve the physical and hygienic attributes of feed. While they do not directly affect metabolism, they can enhance animal performance indirectly by ensuring feed remains fresh, stable, and digestible (Adeola and Cowieson, 2011). This category includes preservatives and antioxidants to guard against microbial infection and feed oxidation, such as propionic acid (which acts as an anti-fungal) and vitamin E and BHT. Pellet binders are used to create denser, more durable pellets that minimize dust and feed loss during handling. Emulsifiers facilitate a consistent mixture of ingredients that may be difficult to combine, like fats and water, thereby enhancing nutrient absorption. Mycotoxin binders prevent the absorption of harmful toxins produced by moulds in the feed within the animal's digestive tract.

Sensory Additives

Sensory additives enhance the palatability and attractiveness of feed, encouraging greater consumption and improving acceptance among animals. Flavors especially improve taste and aroma in young animals or during stressful situations. Color additives can enhance the visual appeal of feed or influence the color of animal products, such as egg yolks or poultry skin, with xanthophylls being a well-known example.

Benefits of Feed Additives

Feed additives comprise a wide range of non-nutritive substances included in animal feed to enhance feed quality, improve animal performance, and influence metabolism and product characteristics. Their benefits span animal welfare, productivity, cost-effectiveness, and environmental sustainability.

Enhanced Productivity and Economic Viability

For producers, utilizing feed additives represents a strategic approach to improving efficiency and profitability. A key benefit is the improved feed-to-gain ratio, indicating the relationship between weight gain and feed consumption by animals. Digestive enzymes (e.g., phytase, xylanase) are additives that boost nutrient bioavailability, allowing animals to derive greater value from each pound of feed. This means that the feed can fulfill growth requirements, directly lowering feed costs, which represent the largest expense in livestock production. Additionally, certain additives such as probiotics and amino acid supplements enhance nutrient absorption and foster gut health, facilitating quicker weight gain, increased productivity, and higher yields. This leads to faster growth rates in poultry and increased milk production in dairy cattle. Healthier animals result in fewer deaths and reduced veterinary care costs, further improving economic outcomes.

Environmental Advantages and Sustainability

The use of feed additives also promotes environmental sustainability in livestock production. Enzymes like phytase for pigs and poultry improve phosphorus digestibility, leading to reduced phosphorus levels in manure and decreasing the likelihood of nutrient runoff, which can cause water pollution and algal blooms. Additives such as ionophores and methane inhibitors can modify the gut microbiome to lower methane emissions in ruminants, making beef and dairy production less carbon-intensive (Hassan *et al*., 2020). These additives enable the production of more meat, milk, or eggs with fewer resources.

Challenges in Use of Feed Additives

The primary challenge in use of feed additives is the cost and inconsistent efficacy. Another critical factor is determining the appropriate dosage, as both under-dosing and over-dosing can negatively impact animal health and nutrient balance. The variability in manufacturing processes also leads to challenges in achieving reliable and consistent results in animal nutrition. Beyond economic and technical concerns, there are environmental implications associated with feed additives. These additives can be linked to the generation and transportation of greenhouse gases that contribute to climate change. Moreover, additives that are not fully metabolized by livestock are expelled in manure, causing nitrogen and phosphorus runoff into water bodies. This runoff can trigger eutrophication, promoting algal blooms that deprive aquatic ecosystems of oxygen and threaten marine life and overall ecosystem health (Jones, 2011).

Future Directions

The livestock feed additives sector is moving towards more sustainable and innovative practices. This shift is influenced by rising consumer awareness, and international demands for environmentally friendly food production methods. A significant trend is the reduction in the preventive use of antibiotics to address antimicrobial resistance (AMR), a pressing global health issue. Instead of antibiotics, there is a growing interest in a new generation of natural, non-residual feed additives, including probiotics and prebiotics that enhance gut health and nutrient absorption, as well as phytogenics, which are plant-derived compounds that possess antimicrobial and anti-inflammatory properties (Gadde *et al*., 2017). Other innovations aim to optimize nutrient utilization, thus minimizing the excretion of excess nitrogen and phosphorus while preventing water contamination.

Conclusion

Feed additives have become essential in modern livestock diets, bridging the gap between productivity, health, and sustainability. They encompass traditional supplements like phytobiotics, as well as advanced solutions such as probiotics, prebiotics and nanotechnology

applications. With the continuous rise in global demand for animal protein, feed additives will play an increasingly vital role in developing efficient, sustainable, and welfare-oriented livestock production systems.

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