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Mini Review

Biotechnological Application in Animal Nutrition and Feed Technology: Mini Review

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Abstract

India's livestock production is expected to reach its peak in 2020-21 and rapidly increase by 2027, necessitating a rise in feed production. Biotechnology can help with this issue by providing nutrients, improving feed quality, and evaluating the optimal diet. The various biotechnological applications are discussed in this review.

Keywords: Biotechnology; Animal Nutrition; Feed Technology

Introduction

In India, livestock production is expected to reach its peak in 2020-21 and then rapidly increase by 2027 [4]. This rise in output necessitates a rise in feed production. Even while we were able to increase food production for human consumption, it had no immediate positive effects on animal feed. There is very little space available to produce fodder because more area is being used for crop cultivation. Also employed in the last year to increase livestock output in order to fulfil the demand were the conventional methods of livestock development. However, this technique can no longer support production. The use of biotechnology can help with these issues to some extent.

The availability of nutrients to the animals (via the use of enzymes, prebiotics, and probiotics, etc.), feed quality (protection of protein, amino acids, and fat; reduction of anti-nutritional agents, etc.), and subsequently animal output have all been greatly improved through biotechnology. By assessing the gene expression for a specific attribute (meat production, milk production, etc.), biotechnological tools can also be used to evaluate the optimal diet [1].

Biotechnology: general aspects

Due to the rapid population growth and economic expansion, there is a need to adjust to the growing demand for more food from livestock products, and biotechnology plays important roles in many ways in this regard. According to Salem., *et al.* (2007), biotechnology plays a specific role in the production of livestock and may be divided into three categories: biological, chemical, and physical procedures that affect animal health, nutrition, breeding, and reproduction [8]. Today, the economic growth of developing countries is increasingly dependent on livestock, and the adoption of biotechnology is primarily motivated by commercial and socio-economic goals. It will present fresh and unexpected opportunities to boost animal productivity through increased growth, improved carcass quality and reproduction, improved nutrition and feed utilisation, better quality and safety of animal feed, improved health and welfare of animals, and decreased waste as a result of more efficient resource use.

Biotechnology in animal nutrition

The main contribution of biotechnology to the production of livestock is the use of various chemicals, such as feed additives, to increase the nutrient value and content of animal feeds as well as the digestibility of low-quality feeds, including roughage. By safeguarding protein, amino acids, and fat, biotechnology can raise the nutritional value of animal nutrition. Using different enzymes to increase nutrient availability from feed and reduce waste from feed and fodder, immune stimulants to stop harmful bacteria from infecting animals, plant biotechnology to produce feed and fodder with high nutritional values, adding antibodies to feeds to protect animals from disease, and genetic engineering of rumen microorganisms to improve animal gut health and performance are all examples of such techniques.

Improvement of roughage quality

Most ruminant animals raised by smallholder farmers in impoverished nations are fed with fibrous, poorly digestible diets. Some microbes may degrade the lignin found in the cell walls of fibrous feed, such as the cellulose enzymes made by anaerobic bacteria and white rot fungi (*Pleurotus ostreatus*). Numerous fungi, such as *Asprigullus niger*, *A. terreus*, *Fusarium moniliforme* and *Chaetomium celluloyticum* have been employed for lingo cellulosic hydrolysis. However, it has been noted that among the many kinds of fungi, white rot fungi are more efficient than others for treating fibrous material. These organisms can attack lignin polymers, split apart aromatic rings, and release low-molecular-weight fragments, just like the white rot fungi can.

The other techniques for enhancing low quality forages, like cereal straws, include mechanical processes like grinding, physical processes like heating and cooling, temperature and pressure treatment, or a variety of chemical processes. Additionally, by breaking ligno-cellulosic linkages, these techniques enhance the rumen's ability to microbially break down roughage.

Improvement of gut health

By adding biotechnological items to improve the gut environment and genetically manipulating the naturally occurring microbes in the gut to increase their capacity for designated roles, biotechnology can be utilised to improve the metabolism and activity of gut microorganisms. The genetically altered microorganisms can either digest the lignin and fibrous parts of forages, or they can break down toxins, produce necessary amino acids, stop methane from forming, or tolerate acids.

The third method is to change the bacteria already present in the gut. Compared to the two applications previously mentioned, this one has a greater potential to improve animal health and growth as well as the digestibility of feed ingredients.

Biotechnology products for feed additives

Antibiotics

In order to increase the animals' growth and feed conversion efficiency, certain antibiotics are added to their feed. The class of antibiotics known as ionophores. In ruminant animals, such as cattle, ionophores are used to increase feed efficiency by directing rumen fermentation towards the creation of more propionic acid, which the animal may consume, and less methane, which is wasted. Ionophores alter the rumen microbes' production patterns by producing less acetate, butyrate, and methane and more propionate.

When compared to the chickens receiving the other nutritional treatments, those receiving the diet supplemented with antibiotics had a considerably reduced total aerobic bacterial number in the small intestines. In comparison to the energy diet and other dietary treatments, the combined supplementation of the antibiotic and enzyme led to a much-decreased *E. coli* concentration in the small intestines [9].

Enzymes

The main function of enzymes is to increase the nutritional content of existing diets, particularly when low-quality nutrients, like roughage and typically less expensive ones, are included. Supplemental phytase enzyme improves the digestion of amino acids. Since native mammalian enzymes do not digest cellulose, cellulase enzymes can be employed to dissolve it. It takes enzymes to break down the carbohydrates in cell walls and release the sugars that the lactic acid bacteria need to develop. Cellulase is added to a diet that contains wheat byproducts to improve the digestion of non-starch polysaccharides.

Probiotics and prebiotics feed additives

They are feed supplements that can be used in farm animals' diets to help maintain a healthy balance of gut microbes. The addition of probiotics in foods is intended to promote specific strains of bacteria in the gut at the expense of less desirable ones, in contrast to the use of antibiotics as nutritional modifiers, which eradicate bacteria. As there is no interference with the rumen bacteria, they are becoming more and more successful in ruminants in treating illnesses of the gastrointestinal tract in young animals. Yeasts can be utilised as probiotics in adult ruminants to enhance rumen fermentation. Oligosaccharides, which are non-digestible carbohydrates, are the most typical prebiotics.

Protection of protein, amino acids and fat

The ruminal microorganisms utilise this non-proteinous nitrogen to synthesise the microbial protein after rumen enzymes break down the protein to create ammonia. Degradable protein should be safeguarded against ruminal breakdown by chemical treatments like formaldehyde and physical treatments like heat treatment and extrusion frying, in order to increase its utilisation. According to several researchers, treating groundnut cake with formaldehyde reduces the protein degradability by 33%.

Fat can be preserved by being saponified using calcium salts. Giving negative energy balance animals calcium soaps of fatty acids, which are inert in the rumen, increases dietary energy density and, consequently, energy intake without impairing the activity of rumen bacteria. In this way, negative energy balance's harmful effects on animals can be mitigated.

Removing anti-nutritive factors from available feeds

Protease inhibitors, tannin, and cyanogen in legumes, as well as glucosinolates, tannins, and saponin in rapeseed meal and other substances in feeds, are antinutritive elements found in plant tissues. The negative effects of these substances are more pronounced in non-ruminants than in ruminants, similar to deficits in amino acids. Such anti-nutritive elements have been lessened and, in some cases, eliminated from feed through conventional plant breeding. An illustration is the development of oilseed rape cultivars that are free or low in erucic acid and glucosinolates. The main anti-nutritive elements in important plant species used as animal feeds should be significantly reduced or eliminated by a mix of genetic engineering and conventional plant breeding.

Improving nutritive value of conserved feed

The preservation of plant matter as silage depends on the anaerobic fermentation of sugars in the material, which is influenced by the naturally occurring lactic acid bacteria's capacity to grow quickly on the available nutrients under the current environmental conditions. Lactic acid bacteria are always present, no matter how the ensiled material is sterilised. However, the ensiling circumstances might not always be best for their growth. The quality of conserved silage may also be influenced by other elements in addition to the quantity and type of bacteria, such as the presence of water-soluble carbohydrates, the amount of dry matter present, pH, etc.

By wilting the material, it is possible to increase the dry matter to a point where less acid is needed to stabilise the fermentation and overcome the lack of water-soluble carbohydrates. To accelerate the synthesis of lactic acid, the bacterial culture can also be added.

Metabolic modifiers

Researchers have also developed porcine somatotropin, which increases muscle growth and reduces body-fat deposition, resulting in swine that are leaner and of greater market value. Metabolic modifiers, such as recombinant bovine somatotropin, have been used to increase production efficiency, such as weight gain and improve carcass composition. A class of substances known as metabolic modifiers alter animal metabolism in targeted and particular ways. In addition to enhancing carcass composition (lean to fat ratio) in developing animals, raising milk yield in nursing animals, and reducing animal waste per production unit, they also have an overall positive impact on productive efficiency (weight gain or milk yield per feed unit) [7].

Antimicrobial peptides

Bacterial antibiotic resistance and antibiotic residues in meat and eggs are results of the improper use of antibiotics for the stimulation of growth in poultry. Numerous researchers have looked into possible antibiotic replacements. The greatest antibiotic substitute may be antimicrobial peptides. Antimicrobial peptides (AMPs) are tiny biological molecules with molecular weights less than 10 kDa and amino acid counts below 100. They are present in all species, from plants and animals to insects and exhibit a wide range of antibacterial, antiviral, and antifungal action [6].

Important families of avian AMPs include the cathelicidin and defensin groups. Defensins are hydrophobic, cystine-rich, cationic antimicrobial peptides that are involved in immunological signalling systems and have the ability to directly kill a variety of microorganisms, including bacteria, fungi, some enveloped viruses, and the majority of non-enveloped viruses.

Electronic nose

The electronic nose is a piece of technology that imitates the human olfactory system to detect flavours and scents. By using a sample delivery system, detecting system (different sensors like MOS, CP, PCS, MOSFET, etc.), and computation system (different computer algorithms), it simulates the functioning of the human olfactory system. The volatile substances are the main focus of the electronic nose. By analysing the volatile chemicals present in the sample, it can be utilised for silage evaluation, animal protein evaluation, mycotoxin detection, and pet food evaluation [2,3,5].

Nutrigenomics

The genetic consequences of eating are studied by the emerging fields of nutrigenomics and nutrigenetics. The domains of nutrition, bioinformatics, molecular biology, genomics, functional genomics, epidemiology, and epigenomics all work together to understand how bioactive substances in food and supplements alter gene expression, which in turn affects animal metabolism. The application of multidisciplinary technologies enables the examination of the complex relationships between the food and the genome. The importance of genetic-nutritional interactions on various physiological and metabolic processes, which have a big impact on traits that are economically significant, like the quality of milk and meat, is highlighted by these new methods. They also highlight the interest in multidisciplinary studies to address these brand-new, complex issues.

Conclusion

The biotechnology is one of the best tools which plays important role in the field of animal nutrition. Although there are various applications of it, which is being used, continuous research is required to improve its efficiency.

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