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Role of feed additives in ruminant's production: A review

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Abstract

With the growing demand of animal products with growing human population constant need for feed additives in ruminants diet is also increasing for better animal production, efficient utilization of available feed resources and to maximize the gain of farmers from producing animals. A variety of feed additives are been used for various purposes in variety of livestock. In many countries use of feed additives which impose high risk to the consumers or environment, like antibiotics, hormone etc. is banned in ruminant diets. Therefore, ruminant feed industry is becoming more interested in other valuable alternatives feed additives which could be accepted preferable by the consumers without any health risk. Probiotics, prebiotics, essential oils, enzymes and ionophores etc. can be seen as alternative feed additives for modifying the digestion kinetics in the ruminant animals leading to accelerated production efficiency.

Keywords: Ruminant, feed additives, probiotics, prebiotics, enzymes, essential oils

Introduction

Mankind has been utilizing different animal species from the dawn of civilization for a variety of purposes viz. production of milk, meat, wool, egg and leather. Apart from all these, different animal species are also been used for security, companionship, draught power, entertainment, research experimentation, sports, etc. Livestock also serves as an insurance substitute, especially for poor rural households; it can easily be sold during time of distress. Livestock production, in particularly buffalo, cattle and small ruminants, is an integral part of food production systems, making important contributions to the quality and diversity of the human food supply. Large increases in per capita and total demand for meat, milk and eggs are forecast for most developing countries for the next few decades (FAO, 2009) [10]. Therefore, the increase in animal production and productivity is urgently needed to reduce the gap between demand and supply. These widespread efforts to produce human food from animals have led to the use of a wide range of feed additives.

What are feed additives.?

These are ingredients or combination of ingredients to be used in micro quantity in animal nutrition. Although, these feed additives are not nutrients and cannot be considered as dietary essential to the animal, they have been reported to improve the efficiency of feed acceptance, nutrient utilization, growth and health of the animals. There are different types of feed additives which can be broadly classified into –

Nutrient feed additive: amino acids, minerals, vitamins

Non nutrient feed additive: probiotics, prebiotics, hormones, enzymes etc

Currently, ruminant nutritionists are at battle with several issues when formulating diets to minimize cost while still meeting the animals' requirements to allow for maximal performance. One of the biggest issues at hand has been the price of feed ingredients in animal diet formulations. One can reduce the cost of feed is by increasing nutrient utilization by the animals, feed additives helps us in this by modifying the digestion kinetics of various feed components resulting in enhanced nutrient utilization. In this review we will discuss need, utilization and effects of various feed additives on various aspects of animal health.

Probiotics (also known as Direct Fed Microbials) as feed additives: Probiotics are live culture of non- pathogenic organisms which are administered orally, which beneficially affects

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host animal by improving its intestinal microbial balance e.g. *Lactobacillus acidophilus*, *L. bifidus*, *L. casei*, *Streptococcus thermophilus*.

Characters of a good Probiotic

- The microbial culture should exert a positive effect on the host.
- It should be gram positive and acid resistant and bile resistant
- The adhesive capacity should be firm and faster
- It should enhance digestion of nutrients and help in improving feed utilization by the animal.

The improved performance of animals due to probiotics application is oftenly due to the improved digestibility of nutrients. Bacterial population in the silage is also a good source of probiotics to the ruminants [20]. Probiotics have also been found to effective in alleviating the acidosis. But, prolonged establishment of probiotic bacterial species in rumen has constantly been a challenge for the ruminant nutritionists.

Prebiotics as feed additives for ruminants

These are organic compounds that cannot be digested by the host animal, but can be utilized by some specific micro-organisms in the GIT of animals for the good of host. Some oligosaccharides like MOS, FOS, XOS and other organic compounds like inulin are “colonic food” for the beneficial microbes in the small and large intestine [12, 14]. But pre-gastric breakdown and huge rumen volume inhibits usage of prebiotics so some rumen-protective technologies are used for utilization of these compounds in dairy animals [2].

Synbiotics: a synergistic approach to modify microbial ecosystem Simultaneous use of probiotics and prebiotics together is known as “synbiotics” [5, 7]. These two products support each other in a highly targeted fashion, which has been reported the most likely approach to reduce pathogens in dairy animals [19]. Bomba *et al.* (2002) [4] showed a synergistic effect in reduction of food borne pathogenic bacteria populations in food animals when fed synbiotics.

Role of Enzymes as feed additives

Enzymes are natural biocatalysts in living system which regulate different biochemical reaction in animal body. They can also be employed as feed additives for improving the deragation reaction during feed digestion. Cellulases, xylanases, β -glucanases, pectinases, amylases, proteases, phytases and enzymes that degrade specific plant toxins like tannases, arise from the diversity of the microbial population established in the rumen [11, 1, 22]. Protected enzymes for Ruminants Exogenous fibrolytic enzymes like cellulases or xylanases are used as protected enzymes by attaching carbohydrate moiety to protein of the enzyme can alter feed utilization either through their effects on the feed before ingestion, or through improvement in the digestion in rumen or post-ruminally. Extracellular enzymes produced by certain fungi can also be protected by this manner.

Essential oils as feed additives

Essential oils are a secondary metabolite present in herbal plants leaves, spices also in bulbs of certain plants. These are aromatic volatile in nature with a oily apperance extracted from plants by steam distillation. They are highly potent

compounds hence used cautiously. They can work great with organic acids in improving performance of animals by reducing methane production. Essential oils (EOs) are gaining importance in ruminant nutrition for reducing enteric methanogenesis and improvement in health and productivity of animals. The antimicrobial effect of EOs suggests their relevance as antimethanogenic feed additive (Krishan Kumar, 2017) [13] but challenge is to maintain feed digestibility. It is indicated that essential oils reduces methane production either by inhibiting methanogenic archaea, changes in the phylogenetic distribution of archeal population or activity of methane producing genes [15]. As the mode of action of various feed additives including plant bioactive compounds in reducing enteric methane production are different, a blend of such compounds might have synergistic effect at very low individual doses without affecting feed degradability. Synergistic effect of blends of reetha (soapnut), eucalyptus oil and bargad leaves (*Ficus bengalensis*) were observed to reduce methane production both *in-vitro* and *in-vivo* with improvement in body weight gain and feed efficiency in buffalo calves [17].

Antioxidants as feed additives

Oxidation of feed fat causes rancidity spoiling of feed through lipid peroxidation which imparts off flavor to animal products, hence use of antioxidants as feed additive limits this oxidative spoilage and rancidity of feed. Primary antioxidants can stop propagation of free radicals while the secondary antioxidants can stop formation of free radicals. Naturally occurring antioxidants are:- vitamin E, rosemary extract, carotenoids, thiocyanates etc. most commonly synthetic antioxidants are ethoxyquin, terbutyl hydroxyquinone, propyl gallate, butylated hudroxytoluene etc. Main secondary antioxidants are metal chelators and reducing agents like ascorbates and sulfites.

A variety of feed additives have been in use to gain maximum benefits from the animals. Various combinations of different feed additives have been studied to study the effect on different production aspects of the animals.

Effect of different feed additives on digestibility and nutrient utilization

Nutrient utilization and digestibility in animals depends on many factors. With enormously vivid qualities of different feed additives are zealously attracting researchers for more exploration of their qualities in terms of their effect on nutrient utilization, feed digestibility and reduction in methane production in ruminants. Response of every feed additive is different even at different dose rate of same compound. Many feed additives such as EO, tannins in combination with saponins or alone have been used by many researchers to study their effect on digestibility and nutrient utilization. Ueda *et al.* (2003) [18] reported that feeding of linseed oil in dairy cows increases overall digestibility in case of forage-based diet but it is reverse in case of concentrate-based diet. Singh *et al.* (2016) [17] studied the effect of some plant bio-active compounds on methane production, growth and nutrient utilization in buffaloes and found that digestibility of all the nutrients were comparable among all the treatment groups. Krishan Kumar (2017) reported no change in digestibility coefficient of nutrients (DM, NDF, ADF, EE and CP) among the various treatments fed with feed additives rich in essential oils in growing buffaloes.

Effect of different feed additives on DM intake

Different feed additives have different effect on feed intake in animals. It also varies with the quantity, quality and physiological state of the animal. Different workers have tried different feed additives to increase the production level of lactating animals and also studied their effect on DM intake to calculate the feed conversion efficiency. In case of EO mixed observations on feed intake have been reported depending upon the type of EO and doses. Proper doses of EO is required because at low doses they may increase the feed intake while on the other hand at higher doses, EO have been reported to lower down the DM intake in animals. Cardozo *et al.* (2006)^[6] studied the effect of supplementing a mixture of EO composed of cinnamaldehyde and eugenol in beef cattle and reported adverse effects on DM intake. On the other hand, Yang *et al.* (2007)^[21] studied the effect of feeding of EO from garlic and juniper berry, or monensin reported that DM intake was not affected by dietary additives^[17]. reported no effect on DMI in buffaloes fed with some plant bio-active compounds when compared to unsupplemented group. Same results were reported by^[13].

Effect of different feed additives on enteric methane production in ruminants

Many feed additives have also been used in recent past for reducing methane production from ruminants. Out of these, ionophore antibiotics (monensin, lasalocids) and organic acids (malate, fumarate) were extensively used to reduce methane production and improvement of animal performance^[3]. Nitrate and sulphate either separately or in combination were used as alternate hydrogen sink^[23] and reduced methane production by stimulating sulphate reducing bacteria (SRB) in the rumen^[16]. There is a growing interest in the use of plant bio-active compounds (condensed tannins, saponins, essential oils) as a CH₄ mitigation strategy because of their natural origin in opposition to chemicals additives. For tannin-containing plants, the anti-methanogenic activity has been attributed mainly to condensed tannins^[9] a direct effect on ruminal methanogens and an indirect effect on hydrogen production due to lower feed degradation^[8].

Conclusion

It can be concluded that variety of feed additives can be used in animal health care for enhancing their feed utilization and milk production and minimizing the adverse effect of diets on animal health and the environment. However some of them may be harmful in higher doses. Hence, a careful and justified level of feed additives should be added in animal diet to enhance animal health aspects and benefits to the farmers.

Application of review: This review presents the use of various feed additives used in animal diet which will help dairy farmers update themselves for gaining maximum possible economic return from their dairy animals.

Abbreviation used:

MOS: Mannan oligosaccharides

FOS: Fructooligosaccharides

XOS: Xylooligosaccharides

EO: Essential oils

DMI: Dry matter intake

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