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Supplementation of exogenous fibrolytic enzyme in livestock nutrition

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Abstract
Livestock plays an important role in Indian economy. There is gap between the availability and demand of feed. To meet the demand of feed and to increase the production of animal alternative feed resourcses are needed. Exogenous fibrolytic enzymes can be used to increase utilization of feed and increase production of the animals. Exogenous enzyme help in degradation of specific bond, anti nutritional factors present in the feed, changes in the micro flora profile in the small and large intestine. In livestock feed amylase, protease, phytase, cellulose, xylanase are used to improve the performance of the animals.

Keywords: Livestock, exogenous fibrolytic enzyme, nutrition

Introduction
The shortage of feeds and forages is the major constraint in accelerating the growth of livestock production in India. The feed stuff available is of poor quality and their nutrients are poorly utilized by animals. India has 190.9, 108.7, 135.2, 65.1 and 10.3 million of cattle, buffalo, goat, sheep and pig population (19th livestock census). Availability of dry fodder, green fodder and concentrate are deficient in India which is presently 433, 600 and 60 million tones. There is a gap between the availability and demand of feed. The requirement of dry fodder, green fodder and concentrate is 550, 1000 and 105 million tones [1]. The country is facing a severe shortage of feed and fodder to feed the present livestock population. As per estimates, the dificits of dry fodder, concentrate and green fodder currently are 40, 57 and 66% respectively [2]. Due to huge population pressure both in human and livestock, there is a severe shortage of feed and fodder in the country for which animals suffer from the malnutrition. In order to meet the gap between availability and requirement of feed and to increase the production of animal different feed additives like growth promoter and antibiotic can be used. Increasing consumer concern about the use of feed additives such as growth promoters and antibiotics in livestock production, therefore exogenous enzyme can become better alternative to the conventional feed additives. The forages which are available are of poor quality and not utilize properly by the animals. Various strategies have been attempted to improve forage quality for livestock. To improve the poor quality roughages, treatment with physical agents (heat, steam and pressure), chemicals (acids, alkalis and ammonia), biological agents (white rot fungi) via natural selection, breeding or molecular engineering and enzyme technology [3]. However, none of these methods give good result for improving forage quality and animal performance. In recent years, exogenous fibrolytic enzymes are increasingly considered as cost-effective feed additives for improving feed efficiency because of their non corrosive and non hazardous nature [4]. Supplementation of exogenous fibrolytic enzyme in dairy cow diets improve plant cellwall digestibility and therefore, improve the efficiency of feed utilization [5]. Most exogenous fibrolytic enzyme mainly xylanases andcellulases of fungal or bacterial origin supplementation in ration before consumption improved feed efficiency and animal performance [6]. Supplementation of exogenous fibrolytic enzyme improve the energy balance in early lactation by the gastro-intestinal degradation of fiber components in the [7]. Enzymatic activity depends on several factors including the microorganism of origin (fungal or bacterial), the type and stability of the enzyme, the type of forage and livestock animal to be used, the pH, temperature and conditions of solution in the gastrointestinal tract, the dose, substrate, enzyme degradation in tract (rumen, stomach acid, and inhibitors) and handling conditions of the product including application method [8].

Applying fibrolytic exogenous enzymes in a liquid form to feeds prior to consumption have a positive effect on animal performance due to association of enzymes with feed which may lead to pre-ingestive attack of the enzymes upon the plant fiber and enhance binding of the enzymes to the feed [9]. Enzyme addition to feeds may create a stable enzyme-feed complex that protects free enzymes from proteolysis in the rumen [10]. Dietary application of exogenous fibrolytic enzyme increase milk production, improve dry matter digestibility [11]. Exogenous fibrolytic enzyme supplementation improves plant cell wall digestibility and efficiency of feed utilization. Exo-enzymes reduced environmental pollution by proper utilization of nitrogen, phosphorus. The aim of this study is to discuss the effect of supplementatation of exogenous fibrolytic enzyme in livestock and how suuplementation of exogenous fibrolytic enzyme improve productivity of the animals.

Sources of exogenous enzyme

Commercial ruminant enzymes are produced by micro-organisms (bacteria and fungi). Bacteria (*Bacillus subtilis*, *Lactobacillus acidophilus*, *Lactobacillus plantarum* and *Streptococcus faecium*) and fungus (*Aspergillus oryzae*, *Trichoderma reesei*, and *Saccharomyces cerevisiae*) species produced enzymes [12]. Solid state fermentation and submerged fermentation are the major methods used for enzyme preparation [13]. Exoenzymes are available as dry, liquid and encapsulated form. Now a days cocktail enzymes are also available which are more efficient.

Microencapsulation is a process in which tiny particles are surrounded by a coating to give small capsule. It helps in controlled release of enzyme at appropiate site.it improves shell life of the micro organisms, mask the odour and prevent degradative reaction.

Methods of application of enzymes

Enzymes can be applied to total mixed rations, hay, ensiled forages, concentrate, as a supplement or infused directly to the rumen. Exogenous enzymes are more effective when applied to high moisture feeds (such as silages) compared to dry feeds due to higher moisture content [14]. Supplementation of EFE combinations at low doses @ 10 g/Holstein cow/day intra-ruminally had no effect on nutrient digestibility and rumen fermentation pattern [15].Supplementation of fibrolytic enzyme @ 12 g/d directly into the rumen increased the fibrolytic activity in ruminal fluid, without pre-feeding feed-enzyme interaction, when sheep were fed on grass hay: concentrate (70:30; DM basis) diet [16].

Modes of action of fibrolytic enzymes

The exogenous fibrolytic enzymes are most effective when applied in liquid form into the dry feed prior to ingestion. This may partially digest feed or weaken cell wall barriers. The EFE releases reducing sugars from the feedstuffs before feed consumption which increase available carbohydrates in the rumen and also enhance the rapid microbial attachment and growth.

In the rumen exogenous fibrolytic enzymes hydrolyse feed directly or work synergistically with ruminal microbes to enhance feed digestion. They are actively stable to continue hydrolysis of feed in the rumen fluid. In sub rumen conditions (pH $\leq$ 5.9) effectiveness of exogenous fibrolytic enzymes reduced as compare to higher rumen pH conditions [17]. Application of exogenous fibrolytic enzymes in ruminants increase the attachment and numbers of cellobiose- and glucose- utilizing bacteria in the rumen [18].

In the large and small intestine also exogenous fibrolytic enzyme work [6]. In the small intestine, exogenous fibrous enzyme survive for a sufficient period of time with sufficient effects on substrate particles when applied to wet feeds and concentrate premix [19].

Effect of exogenous fibrolytic enzyme in livestock

Forages are the major source of energy for ruminants but many types of forage are of low quality because of poor digestibility and limited amount of energy available to animals, so there is more excretion of nutrients and incomplete use of fractions of the cell wall in the rumen which limits the degradation of nutritional compounds. Matured plant contains tannin and lignin which reduce feed intake, digestibility of feed. Leguminous herbage, shrubs contain anti-nutritional factors which reduce the digestibility of the feed. Therefore there is poor utilization of feed and animal performance and productivity is decrease. Ruminants obtain energy from plant polysaccharides and in turn produce high quality meat and milk protein to meet the demand of consumer [5]. Various strategies have been attempted to improve forage quality for ruminant including treatment with physical agents such as heat, steam and pressure, with chemicals such as acids, alkaliand ammonia, with biological agents such as white rot fungi, via breeding or molecular engineering [4]. But these methods are not used widely for improve the quality of feed. In recent years exogenous fibrolytic enzymes are considered as cost effective, improve feed efficiency [20]. EFE work in synergy with the endogenous rumen microbial enzymes to enhance the digestibility and nutritive value of high fibrous diet. Enzyme activity depend on several factors: type of enzyme, species and age of the animal, p^H, temperature and gastrointestinal condition, dosage, substrate, degradation of the exogenous enzyme along the tract (rumen, stomach acid and inhibitors) management condition (mode of application, application rate).

Cattle and buffalo

Supplementation of fibrolytic enzymes to cattle improves utilization of feed, weight gain, milk productionand carcass yield. Fibrozyme supplementation either with either corn silage or berseem hay enhanced milk production and nutrient digestibility [21]. Application of exogenous fibrolytic enzyme to the Bermuda grass based TMR in dairy cattle increased DM intake and milk production without affecting the ruminal DM degradation or ruminal pH, ammonia-N and volatile fatty acid concentration. Fibrolytic enzymes do not affect performance but improve carcass yield and tenderness in steer [22]. Enzyme addition did not affect DM intake, whereas it increased total tract apparent digestibility of nutrients including NDF and ADF, concentrations of rumen ammonia N and total short chain fatty acids (SCFA) and live weight gain [21]. EFE supplementation increased the digestibility of CP, EE and CF, while there was no effect on digestibility of other nutrients in buffalo [23]. Supplementation of exogenous fibrolytic enzyme in total mixed ration decreased Supplementation of cellulase and xylanase mixture at 1.5 g/kg of DM of TMR containing Roughage: concentrate @ 60: 40 on DM basis significantly increased the average daily milk yield and FCM yield in Murrah buffaloes due to improved dietary fiber digestion [17].

Sheep and goat

Total volatile fatty acid and NH3-N concentration was higher in enzyme supplemented group while no effect was observed on pH and total N concentration. The invitro study by using complete feed containing bajra straw supplemented with exogenous fibrolytic enzyme increase in total valatile fatty acid and an unaltered rumen pH, total nitrogen and ammonia N compared to control. The effect of high doses of EFE (@ 0, 5 or 10 gms per 1 kg oat straw) on lamb performance. Athere is decrease in intake with increasing enzyme doses were noticed without changing the weight gain, feed conversion, digestibility and ruminal fermentation variables [24]. Meat quality of growing lambs was improved with the addition of Salix babylonicaL. Extracts and exogenous enzymes alone. Digestibility of DM, OM, CP, NDF, ADF and total carbohydrates in the enzyme supplemented group. Enzyme supplementation with the TMR resulted in 31.25% increase in net profit by improving the average daily weight gain without any effect on feed intake [25].

Pigs

Corn and soyabean are mostly used in pig diet. Non-starch polysaccharides are the main problem in pig and poultry diet because these are present in feed. NSP utilization in non-ruminant diet is very poor. Supplementation of xylanase-based enzymes in corn-soybean based-diet improved the digestibility of energy and NDF and also improved average daily gain of growing pigs [26]. Supplementation of starch with enzyme increased the concentrations of acetic, propionic and butyric acids in both the cecum and colon. Enzyme supplementation significantly increased the population of *Lactobacilli* in the cecum. In the colon, the population of *E. coli* was lower for pigs fed the diets supplemented with enzyme than those without enzyme supplementation. Effect of increased levels of dried coconut meal supplemented with an enzyme cocktail in growing pigs showed that pigs fed with 5, 10 and 15% dried coconut meal in the diet with enzyme cocktail at a level of 0.055 had higher digestible fibre than control diet.

Future prospective and significance

Supplementation of exogenous fibrolytic enzymes to animals diets can potentially improve cell wall digestion, efficiency of feed utilization and productivity of livestock. But due to high cost their use is limited in animal diets. It is important to promote the development of new low-cost enzymatic products that are profitable for livestock production systems.

Conclusion

Supplementation of exogenous fibrolytic enzyme help in utilization of forages more efficiently**,** likewise help in release of bound minerals and other nutrients, increase productivity of the animal, reduce the cost of animal production, improvement of litter quality and use of agro-industrial byproducts. Exogenous fibrolytic enzyme help in clean environment by reduced manure volume and reduced excretion of nitrogen and phosphorus. Thus concept of exogenous fibrolytic enzyme in the animal feed industry is a developing prospect of animal husbandry with the purpose of enhancing digestion, feed utilization & also reduction of environmental pollution.

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