Probiotics: Potential Alternative to Antibiotics in Ruminant Feeding

Vivek K. Bidarkar1, Partha Sarathi Swain2*, Subhasish Ray3 and George Dominic2

1Assistant Professor, Extension Education Centre, Veterinary College, KVAFSU, Bidar-585401 (KA), India.
2DCN Division, NDRI, Karnal-132001 (HR), India.
3Department of Animal Nutrition, C.V.Sc & A.H., OUAT, Bhubaneswar, Odisha, India.

*Corresponding Author:
Partha Sarathi Swain
Email: parthavet@yahoo.com

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Abstract
Probiotics are being considered as an alternative to antibiotics and are already had been used in preference over antibiotics, whose use as a feed additive has been banned by the European Union since 1st January 2006. In ruminant feeds, probiotics are included as feed additives for stabilizing the microbial communities of the digestive tract. Various probiotic bacterial species used in ruminants includes Lactobacillus, Pediococcus, Streptococcus, Bacillus, Bifidobacterium and Saccharomyces spp. These serve many beneficial effects like stabilizing beneficial microbial population, stimulate immunity, produce antimicrobial substances, competitive exclusion of pathogens, prevent some feed allergies by reducing concentration of circulating CD4 and T lymphocytes and restore TG1/TG2 balance in feed allergies, antioxidant, anticarcinogenic etc. In ruminants they have also found to have substantial effect on fibre degradation, reducing methane production, improving productive performances and reduction in the occurrence of metabolic disorders like acidosis. Thus, Probiotics can be expected with a promising future in ruminant nutrition due to its beneficial effects, no residual effect on animal products and reconstitution of equilibrium of intestinal microflora.

Keywords: Probiotics, Antibiotic resistance, Ruminants, Feed additive.

1. Introduction
The discovery and development of antibiotics led to an increased treatment of infectious diseases and improvement in food animal production. In recent years, there has been an increased resistance of pathogens towards various antibiotics or antimicrobial agents due to continuous or indiscriminate use as chemical feed additives (antibiotics, antimicrobial agents) or as a livestock growth promoters or feed supplements. The use of antibiotic as feed additive might contribute to an increase of bacterial antibiotic resistant which is a matter of concern when they are used as therapeutic agents, so the European Union has decided to ban the antibiotics as feed additives from 1st January 2006 onwards. This made a way for further alternative agents as growth promoter and antimicrobials. Probiotics are being considered to fill this gap and are already used in preference to antibiotics. Probiotics or direct-fed microbial (DFMs) are live microorganisms that when administered in adequate amounts confer a health benefit to the host (FAO/WHO, 2001). Nutritionists are continually putting their efforts into producing better and more economical feed. Good feed alone will not serve the purpose but its better utilization is also essential.

The term “probiotics” was first introduced in 1953 by Kollath (Hamilton-Miller et al., 2003). Among the proposed definitions, widely accepted one is “live microorganisms which, when administered in adequate amounts, confer a health benefit on the host” (FAO/WHO, 2002). According to Fuller (1989) probiotic is a live microbial feed supplement, which beneficially affects the host animal by improving its intestinal microbial balance.

Feed is the nutritional basis of the microorganisms. The feeding aspects have a pivotal role in maintaining the animal’s physiological and production status. It directly affects milk as well as meat production. Supplementation of probiotics as an alternative to antibiotics is one of the approaches to improve animal health and production. They are friendly microbes playing a vital role in improving productivity of animals which include bacteria and some fungus like yeast. They influence the digestive microflora of the host animal in a beneficial way and develop their activity exclusively in the digestive tract.
In ruminant feeds, probiotics are included as feed additives for stabilising the microbial communities of the digestive tract. They are also known as direct-fed microbials (DFMs). They are animal feed supplements with beneficial effect on the animal by affecting its gut and ensures effective establishment of intestinal populations of both beneficial and pathogenic organisms. Various probiotic bacteria species belonging to *Lactobacillus*, *Pediococcus*, *Streptococcus*, *Bacillus*, *Bifidobacterium* and *Saccharomyces* spp. have a beneficial effect on ruminants in a number of ways like modulation of intestinal microflora, pathogen inhibition and adaptive histological changes in intestine. Probiotics is generally believed to improve performance in farm animal by improving the intestinal health and maintenance of the microbial balance.

2. Beneficial Effects of Probiotics in Animal Body

2.1 Stabilizing Beneficial Microbial Population: Their role on balancing and multiplication of beneficial microbial population in gastrointestinal tract which has a very important role in digestive health. This feed supplement has shown alterations in pre existing intestinal flora so as to provide advantage to host.

2.2 Host Immune Stimulation: Probiotics have the ability to stimulate immunity mainly by their physiological action in intestine. With probiotic feeding, there is an increase in concentration of IgG and higher macrophagic activity may be due to increase in WBC. Upon colonising in gut, they trigger an immune response since intestinal cells can produce different immune regulatory cells when stimulated by bacteria. Probiotic *Lactobacillus acidophilus* and *Bifidobacterium bifidum* appear to enhance non-specific immune phagocytic activity of circulating blood granulocytes.

2.3 Production of Antimicrobial Substances: Inhibition of pathogenic bacteria by producing variety of inhibitory substances for both gram positive and gram negative bacteria. These inhibitory substances include organic acids like acetic acid, hydrogen peroxide, lactic acid and bacteriocins.

2.4 Competitive Exclusion of Pathogens: By colonising probiotics in gut in large numbers, the probiotic bacteria exclude pathogen and prevent them from causing infection.

2.5 Antiallergic Effect: Probiotics colonize in intestines of calves may prevent some feed allergies by reducing concentration of circulating CD4 and T lymphocytes and restore TG1/TG2 balance in feed allergies.

2.6 Antioxidant Effect: Some probiotics like *Lactobacillus* spp. are having antioxidant effect which scavenge superoxide radicals, inhibit lipid peroxidation and chelate Fe.

2.7 Anticarcinogenic Effect: Bacteria produce some enzymes that are potent carcinogen in lower intestines. Probiotic (*Lactobacillus* spp.) feeding reduces the risk of colon cancer in animals (Friend and Sahani, 1984).

2.8 Reducing Inflammation: Probiotics like LAB have been found to modulate inflammatory and hypersensitivity responses by the regulation of cytokine. They can prevent reoccurrences of inflammatory bowel disease and also improve milk allergies.

2.9 Improving Mineral Absorption: Most ruminant feeds are rich in forage and roughages. It is hypothesized that probiotic (*Lactobacilli*) can enhance the absorption of trace minerals particularly while using high phyate containing feeds.

3. Mode of Action of Probiotics

The main aim of probiotic feeding is to eliminate the harmful microbial population in the GIT, to stabilize and enhance the beneficial microbial populations. This is achieved with probiotics by following any of the following mechanisms.

- Principle of competitive exclusion: competition for site of attachment, substrate and feed resources leads to elimination of the pathogens called as competitive exclusion.
- Production of antimicrobial compounds like bacteriocins.
- Production of antibacterial metabolites like hydroxyperoxides and organic acids (lactic acid and VFA) which leads to reduction of pH in intestine thus inhibit the growth and multiplication of pathogenic microorganisms.
• Competition for nutrients (available carbohydrate) between favourable and unfavourable microorganisms.
• Competitions for sites of attachment on the intestinal wall- the microbes retain in the GIT due to their attachment in the GIT which resist them from peristaltic removal of organisms. Due attachment of beneficial bacteria there is a decrease in the binding sites for pathogenic organisms leading to their peristaltic removal. Mostly *Lactobacillus spp* act through this mechanism.
• Neutralization of bacterial Enterotoxins: Lactic acid bacteria inhibits the growth of coliforms and production of toxic amines which prevents growth *Salmonella spp.*, *Coliforms, Campylobactor fetus, Clostridium perfringens* etc.

4. Characteristic of Good Probiotics

Fuller (1989) listed that following as features of a good probiotic:
• It should be a strain, which is capable of exerting a beneficial effect on the host animal.
• It should be non-pathogenic and non toxic.
• It should be present as viable cells preferably in large numbers.
• It should be a capable of surviving and metabolizing in gut environment eg. Resistant to low pH and organic acids.
• It should be stable and capable of remaining viable for periods under storage and field condition.
• Ability to colonize in GIT.

5. Probiotics in Different Species of Animals

5.1 Probiotics in Calves

Supplementation of probiotic bacteria like *Lactobacillus spp.* is beneficial to calves. After birth, young ruminants are germ free but by contact with mother’s saliva and faeces, they acquire a microflora rapidly. Establishment of cellulolytic bacteria is faster and more stable in calves receiving *S. cerevisiae*. Protozoa population in rumen appears once bacteria population is present as they feed on rumen bacteria. Protozoa appeared earlier in calves fed with *S. cerevisiae* and microbial ecosystem accelerated. Reduction of calf diarrhoea reduced coliform counts due to probiotic bacterial adhesion and modification of gut in calves fed with probiotics (Galvao *et al.*, 2005). Probiotics modify and balance intestinal microorganisms, adhere to intestinal mucosa and prevent pathogen adherence or activation; influences gut permeability and modulate immune function which reduces calf scour.

5.2 Probiotics in Sheep and Goats

The inclusion of probiotics in lamb’s diet has improved feed utilisation and growth performance of animals (Khalid *et al.*, 2011). It has influenced the rumen ecology and thereby nutrient utilisation in ruminants. Improvement in colonisation of cellulolytic bacteria results in improved digestion process, enhanced nutrient utilisation and growth in the small ruminants (Soren *et al.*, 2013).

5.3 Effect of Probiotics in Ruminants

The rumen is a natural fermentation unit in ruminants with varied microbes in both numbers and types. It includes Bacteria, Protozoa and Fungi. They will function with a proper concentration for the fermentation process. Alteration in any of these microbial levels in rumen will have a hampering effect on animal’s physiological status.

The most commonly used additives for ruminant feeding includes Bacillus, Lactic acid bacteria and yeast. Bacilli have better thermo stability and survive well during feed pelletisation and have a high potential for stimulating local intestinal immunity. Lactic acid bacteria are acid tolerant and their characteristic feature is mainly their metabolic activity in intestine by release of antimicrobial substances and the biofilm formation to protect the intestinal mucous membrane. The fat content in cow milk had increased by supplementing with direct fed microbial containing *E. faecium* and *S. cerevisiae* due to increased volatile fatty acid production (Oetzel *et al.*, 2007).

5.3.1 Yeast as Probiotic

Live yeasts are an important probiotics in ruminant nutrition (Denev *et al.*, 2007). Yeast is largely utilised in ruminant feeds. They include *S. cerevisiae, A. oryzae* being most important. During Ruminal fermentation, yeast is having beneficial effect. Probiotic yeast culture based on *S. Cerevisiae* is currently accepted and widely used in ruminant diet. *S. Cerevisiae* is considered as Generally Regarded As Safe (GRAS) status.

5.3.2 The Effect on Fibre Degradation

They enhance fungal colonisation of plant cell wall mainly by increasing supply of thiamine to fungal rumen microbes (Patra, 2012). Yeast probiotics also stimulate activities of fibrolytic bacteria and help in fibre degradation mainly by scavenging oxygen since rumen microbes are sensitive to oxygen. This
stimulates cellulolytic bacteria, their attachment to fibre particles and increases cellulose digestion and hence increased feed and dry matter intake.

5.3.3. The Effect on Ruminal Acidosis
Due to increased easily digestible carbohydrates consumption, lactic acid accumulation will be there causing acidosis. The lactate producing bacteria like *Streptococcus bovis* will outnumber the lactate utilising bacteria like *Megasphaera* sp. And *Selenomonas* sp. Yeast stimulates lactate users, increase their numbers and serve as a competitor with lactate users and finally stabilise the rumen pH.

5.3.4. The Effect on Methane Gas Production
Yeast reduces methane formation mainly by increasing protozoal population, promote acetogenesis.

5.3.5. The Effect on Milk Production
It has shown an improvement in milk production due to enhanced nutrient supply to mammary gland than mobilisation of body reserves and by improved cellulose digestion, fibre digestion and dry matter intake. The milk fat content has increased by supplementing with direct fed microbial containing *E. faecium* and *S. cerevisiae* due to increased volatile fatty acid production by yeast probiotic supplementation.

6. Conclusion
The inclusion of probiotics in ruminant ration has improved feed utilisation and growth performances, stabilize the rumen ecology and thus nutrient utilisation. Establishment and improvement in colonisation of cellulolytic bacteria by probiotics results in improved digestion process. Thus, probiotics as direct fed microbials can be expected with a promising future in ruminant nutrition due to its beneficial effects, no residual effect on animal products and maintenance, reconstitution of equilibrium of intestinal microflora. Its use in livestock feed as a microbial feed additive will improve, maintains the physiological and production status of domestic animals for their proper health and wellbeing.

References


