GENETIC MANIPULATION OF RUMEN MICROBES

Ruminants are fore gut fermenters and their stomach has four distinct compartments consisting of rumen, reticulum, omasum and abomasum. The rumen, which is located at the beginning of the tract, plays a major role as at least 50% of the total digestion occurs there. Although a myriad of microorganisms are found throughout the digestive tract of ruminant, still only the microbiota inhabiting in the rumen have true symbiotic relationship with the host. Individual rumen microbial species have developed in a complex process of evolution extending over long period and provide nature's best example of microbial symbioses. These rumen microorganisms are predominantly bacteria, protozoa and phycomycete fungi. The mammalian system is devoid of enzymes to degrade structural carbohydrate and hence the symbiotic microbes inhabiting in rumen elaborate enzymes for fermentative digestion of large amounts of fibrous feed consumed by the ruminants. By providing a suitable habitat for these microorganisms, the ruminants are able to utilize the end products of microbial fermentation to meet their own nutritional need. Rumen is an open, self-contained ecosystem in which feed consumed by the ruminant is fermented by rumen microbes to volatile fatty acids and microbial biomass those serve as source of energy and protein for the host animals.

The rumen microbial ecosystem is an efficient anaerobic fermentation system that confers added advantages on ruminants over monogastric or non-ruminants animals and these are:

a. Ruminants can digest large amount of fibrous feeds (ligno-cellulosic materials) efficiently,

b. They can use non protein nitrogen sources like urea as a source of nitrogen to meet part of their protein requirement,

c. They can detoxify many toxic ingredients present in feeds of plant origin.

What is the need of manipulation of rumen microbes?

The rumen microbial ecosystem is not so efficient for digestion of ingested feed as evident from the presence of sizable portion of undigested feeds in the faeces and production of large amount of methane gas in the rumen which could be otherwise utilized as source of energy by the animals.

Tropical/developing countries are poorest in the world on economic ground whereas richest area in terms of vegetation content.

Ruminants of the region are mainly maintained/fed on poor quality roughage or lignocellulosic agroindustrial by products with or without concentrate supplementation resulting in poor productivity of the animals. Additionally tropical forages have some important limitation for animals feeding like:

1. Tropical forges have low energy value because their cell walls contain higher amount of lignin, silica and cutin resulting in lower fermentation of structural carbohydrate. Tropical forages in comparison to temperate produces less amount of VFA and microbial biomass (microbial protein) after ruminal fermentation.
2. Intake of tropical forages by the animals is low due to their poor ruminal digestion and prolonged retention time.
3. They are deficient of essential nutrients: contain lower amount of energy, protein (Egan et al., 1986) and minerals.
4. Feeding of tropical forages to the animals results in imbalance in digestive end products (high acetate and low propionate) which causes inefficient utilization of metabolizable energy.

5. Many plant species, particularly legumes and tree leaves contain anti nutritional compound.

Some of the major objectives of rumen manipulation are:

a. Enhance fibrolytic activity: To increase the fibre degradation mainly through manipulation of lignocellulosic bonds in high lignocellulosic feeds as the rumen microbes are the only degraders of cellulose and hemicellulose,
b. Increase microbial protein synthesis: A major portion of the amino acid reaching the duodenum are of microbial protein origin. Therefore, attempts should be made to maximize microbial protein synthesis in the rumen,
c. Reduction in proteolysis: Hydrolysis of feed protein, deamination of amino acids and reutilization of ammonia for microbial protein synthesis are all energy consuming process, hence the degradation of protein and deamination of aminoacids in the rumen should be discouraged,
d. Reduction in methanogenesis: Methane generation in the rumen is a wasteful process as 5-10% of GE intake of ruminants is converted in to methane. The provision of an alternate hydrogen sink in the rumen may help in increasing digestible energy (DE) availability for production,
e. Prevention of acidosis: In high grain fed animals, the level of lactic acid can be controlled to avoid acidosis and inhibition of feed utilization due to lowered pH of the rumen liquor,
f. Shifting acetate to propionate production: In fattening beef/lambs the production of propionate in the rumen at the expense of acetate may be helpful,
g. Novel microbes: The quality of protein is important in high producing ruminants. Microbes, can be tailored to synthesize the amino acids in the form of the peptides and supply to the animals in the intestine,
h. Metabolism of plant toxins: Rumen fermentation can be manipulated for efficient utilization of feeds which contain anti nutritional factors viz. tannin, saponin, mimosine etc, i. Synthesis of useful secondary metabolites.

Broadly the methods of rumen manipulation can be classified in two i.e., genetic manipulation and non genetic manipulation. In genetic manipulation, attempts were made to develop genetically engineered rumen microbes by gene transfer/manipulation technique to enhance the animal productivity.

GENETIC RUMEN MANIPULATION

In genetic manipulation of rumen microbes two approaches are taken:

First approach: the desired gene that is required for digestion of feed is introduced into a rumen microbe enhancing its capability to digest feeds. The genetically modified microorganisms are either able to digest fibrous components and lignins of forage, or degrade toxins, synthesize essential amino acids, reduce ruminal methane production and tolerate acids.

Second approach: The second approach would be to introduce new species or strains of microorganisms into the gut (Stewart et al., 1988). Application of the said two approaches has a great potential to increase digestibilities of feedstuffs and to improve animal production.

NON GENETIC RUMEN MANIPULATION

This approach includes the use of microbial feed additives (probiotics) and defaunation.

The probiotic includes the bacterial organism *Lactobacillus* species and *Saccharomyces cerevisiae*. The process of making the rumen of animals free of rumen protozoa is called

defaunation and the animal is called defaunated animal. The increased rumen protozoa has negative impact on the digestibility of feed.