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Popular Article

Protected Nutrient Technology: An Efficient Way for Optimization of Feed Sources in Ruminant Production

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Abstract

In high producing dairy animals, especially during early lactation, the amount of energy and protein required for maintenance of body tissues and milk production often exceeds the amount of energy available from diet which results in a negative energy balance. This deficit condition can be altered by feeding of protected nutrients to such animals. Generally, protected fat, protein, starch, chelated minerals and vitamins are incorporated in animal ration. Several methods are available for protection of proteins like heat treatment, esophageal groove closure, formaldehyde treatment, encapsulation of proteins etc. and for fat like hydrogenation of fat, formaldehyde treatment of oil seeds, calcium salts of long chain fatty acids obtained by fusion or double decomposition method. All such methods employed for bypassing the rumen results in improved productivity and reproductive performance of animal.

Introduction

Livestock production contributes significantly to rural economy and could be cash crops in many small holder mixed farming systems. In tropical countries, there is horizontal growth in terms of animal numbers and now needs to achieve vertical growth in terms of improving productivity, so that future demand of milk would be met. This can be achieved, if the early lactating high yielding and genetically improved cows and buffaloes were fed according to the nutrient requirement with high energy diet. In early lactating cows and buffaloes, the energy intake through ration doesn't meet the requirement for higher milk production, resulting in a Negative Energy Balance (NEB), which is

closely related to reproductive performance. Hence, an effective solution can be provided by using "protected nutrient or bypass nutrient technology" that prevents the dietary nutrients from hydrolysis, allowing these nutrients to bypass rumen and gets digested and absorbed from the lower tract. The protected nutrients mainly included protected fat, protein, starch, chelated minerals and vitamins.

Types of nutrients that could bypass rumen fermentation to certain degree:

1.) Bypass proteins/ amino acids

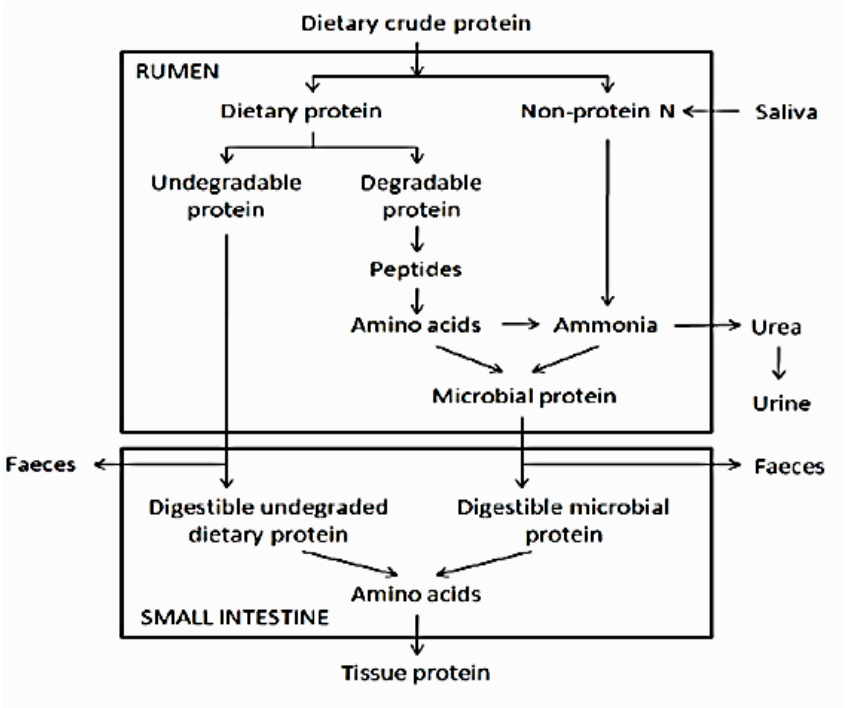
Out of the total dietary protein taken by animal, 40% escapes rumen digestion and goes to intestine while rest of 60% and all other dietary non protein nitrogen (NPN) along with recycled nitrogen through saliva and amount entering across wall contribute to ammonia pool and synthesize microbial protein whereas, the remaining part of ammonia get absorbed in rumen and reticulum. The dietary protein which is taken by animal is acted by the rumen microbes for the synthesis of microbial protein which are enough to meet the production and maintenance requirements of low yielders but if the demand is high and animal is actively growing then they are required to be provided with extra undegradable protein source that will meet the requirement of animal are called as rumen undegradable protein or rumen escape protein or by-pass protein.

- Proteins can be divided in two parts:

a) **Rumen degradable protein (rdp):** It is easily degraded in the rumen making the nitrogen available for the microbes in the rumen for microbial synthesis.

b) **Un-degradable dietary protein (udp):** It passes through the rumen unchanged and some of it can be digested in the small intestine as amino acids.

c) **Digestion and absorption of protein and non-protein nitrogenous compound in ruminants**



- Different methods of protein protection

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i. **Naturally protected proteins:** The protein supplements are categorized as

A) High bypass protein feed/ Low protein degradability (60-80%) viz. maize gluten meal, cottonseed cake, fish meal, meat meal, coconut cake.

B) Intermediate bypass protein feed/ Medium protein degradability (30-60%) viz. linseed cake, soyabean meal, leucocephala leaf.

C) Low bypass protein feed/ High protein degradability (10-30%) viz. Mustard cake (MC), Groundnut cake (GNC), sunflower meal, safflower seed meal, rape seed meal.

ii. Heat treatment

Drying forage is known to increase protection of proteins. Heating of protein source leads to denaturation of protein and provides effective protection against microbial fermentation in rumen. Heat treatment at different degree of heating explains difference in degree of protection. At 125-150 ºC for 2-4 hours could protect proteins very effectively by inactivation of enzymes. Disadvantage of this method is excessive heat ~ Maillard reaction.

iii. Esophageal groove closure

It is influenced by various factors such as age, temperature of liquid, site of delivery into esophagus and chemical composition of liquid. The groove through which liquid diet reaches to abomasum forms from extension of esophagus from cardiac to reticulo-omasal orifice. It is a conditional reflex stimulated by act of sucking or drinking in young calves. It can occur in adult animals by feeding of copper sulphate or salts of zinc and sodium.

iv. Formaldehyde treatment

Formaldehyde reduces the degradability of highly degradable protein in rumen. It gets absorbed and form cross links with amino group and protect from microbial proteolytic enzymes. In acidic pH of abomasum these bonds are loosened and proteins are free for digestion.

v. Post rumen infusion (fistula)

Protein or amino acids are directly infused into the duodenum or abomasum by forming a fistula to avoid microbial degradation of proteins. Sulphur containing amino acids or casein is placed in fistula which results in improvement in milk yield and dry matter intake in animal.

vi. Encapsulation of proteins

It is used for good biological value proteins and for individual amino acids. Rumen protected (lysine, niacin, choline) and encapsulated vitamin-C are some of the rumen encapsulated proteins. They can be given in capsule form with a combination of fats or fatty acids and along with carbonate,

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kaolin, lecithin and glucose.

vii. Amino acid analogues/ metal amino complex

Structural manipulation of amino acids can be done to create resistance to ruminal degradation for bypass of amino acid. Methionine is most limiting amino acid of lactating cow. Analogues such as Methionine hydroxy analogue Ca (MHA) N-acetyl-DL-Methionine, etc. have given satisfactory results in high yielders. Metal complexes such as zinc methionine, zinc lysine, etc. are delivered to small intestine intact and remain stable in rumen environment.

viii. Feed processing

Manufacturing of feed ingredients can influence the magnitude of protein degradation in rumen. Different grain processing can either increase or decrease degradation of proteins. For e.g., heat application can decrease ruminal degradation.

ix. Lowering ruminal protease activity

By depressing the proteolytic activity of rumen microbes' protein degradation can be slow down. Antibiotics can be used to reduce protein degradation within the rumen.

x. Decreasing retention time in rumen

Less stay means lesser degradation and the protein gets less exposure to enzymatic action.

❖ **Effects of bypass protein**

It reduces dietary amino acid loss as ammonia and urea and conserves the energy through less urea synthesis in rumen. Increases availability of amino acids and results in efficient protein synthesis. Increases growth rate by 25-30%, milk yield to about 10% and contents of milk.

1. Protected/ bypass fats

Dietary fat which is not degraded in rumen but gets digested in lower alimentary tract is known as bypass fat. In early lactation, animal requires very high energy for milk production which results into Negative Energy balance (NEB). This deficit energy can affect both productive and reproductive performance of animal. Supplementation of protected fat in the ration helps to meet this energy gap of high yielding animals. Generally, fatty diets cause disturbance in rumen fermentation by inhibiting fiber digestion. However, protected fat can increase energy density of diet without causing any reduction in fiber digestion in rumen.

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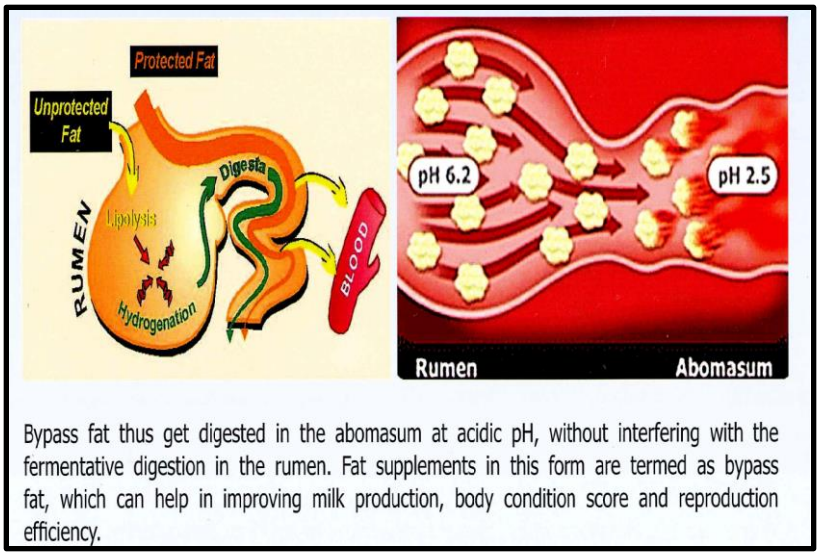
Need of bypass fat



Bypass fat thus get digested in the abomasum at acidic pH, without interfering with the fermentative digestion in the rumen. Fat supplements in this form are termed as bypass fat, which can help in improving milk production, body condition score and reproduction efficiency.

❖ **Methods of fat protection**

i. Naturally protected fat: Whole oil seeds with hard outer coat protect the internal fatty acids from lipolysis and bio-hydrogenation in the rumen. Oil seeds cakes commonly used in the ration of dairy animals are cotton, roasted soybeans, sun flower, and canola.

ii. Crystalline or hydrogenation of fat: Crystalline or prilled fatty acids can be made by liquifying and spraying the saturated fatty acids under pressure into cooled atmosphere causes increase in melting point of the fatty acids which do not melt at ruminal temperature, resisting rumen hydrolysis.

iii. Formaldehyde treatment of oil seeds: Formaldehyde treated protein encapsulated fatty acids is also an effective means of protecting dietary fat from rumen hydrolysis. Oil seeds can be crushed and treated with formaldehyde (1.2 g per 100g protein) in plastic bags or silos and kept for about a week.

iv. Calcium salts of long chain fatty acids: Calcium salts of long chain fatty acids are insoluble soaps produced by reaction of the carboxyl group of long chain fatty acids and calcium salts. This can be done by two methods:

A. **Fusion method** - Fatty acids heated with calcium oxide or calcium hydroxide in the presence of catalyst in closed vessel so a hard mass of calcium saponified salts is obtained. The fatty acids in the form of calcium salts are protected against rumen enzymes and used for protection of lipids.

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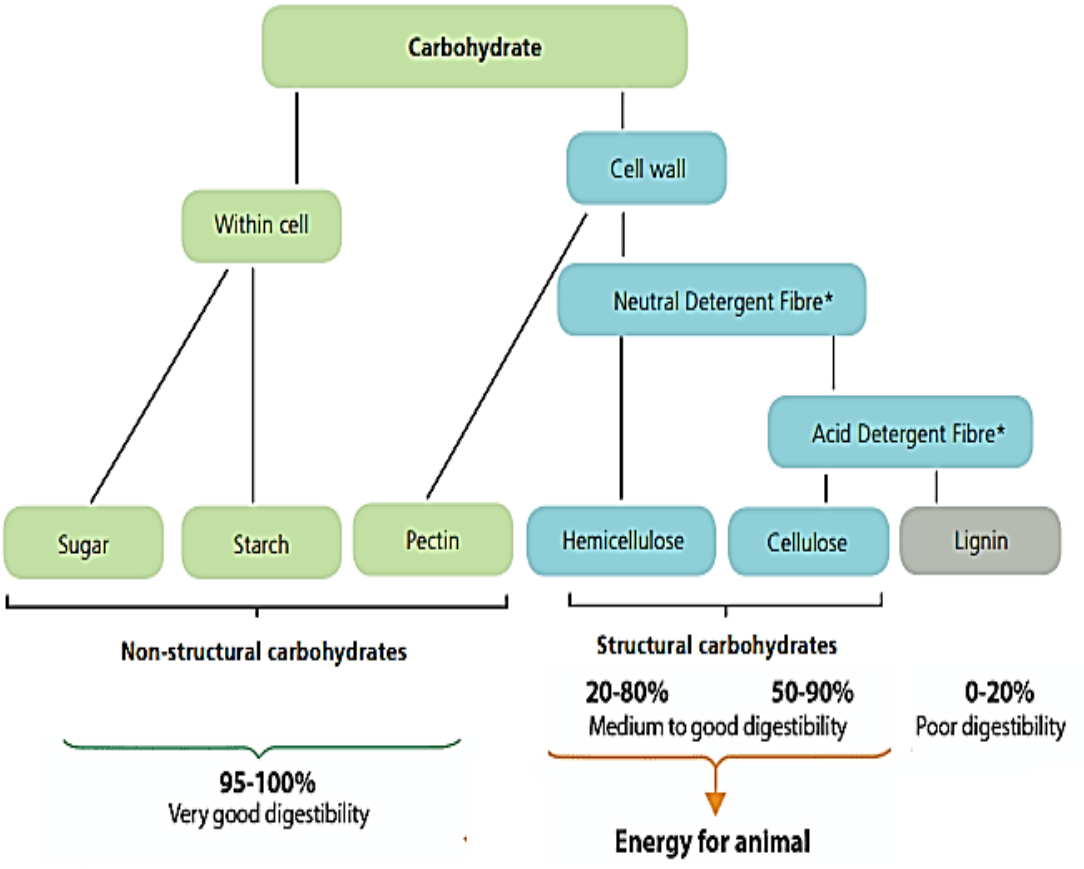
B. **Double decomposition method** - In this method, fat source is heated in a metal container. Aqueous sodium hydroxide solution is added to melted fat source till fatty acid dissolved. Calcium chloride solution is used which cause precipitation of calcium soap. It can be dried at cool temperature and mix in ration.

2. Protected/ bypass starch

Feeding of bypass starch can reduce excess production of lactic acid in rumen, which otherwise inhibits fiber digestion due to acidic pH condition in rumen. Starch which escapes rumen fermentation, is digested in small intestine and produces glucose. Liver glucose production is increased by the infusion of starch into the rumen. After absorption, it is more efficiently used as energy source by the animals than lactic/propionic acid absorbed from rumen. Metabolizable energy would be supplied mainly through the absorption of volatile fatty acid (VFAs) if starch is digested in the rumen; and mainly through the absorption of glucose if it is digested in the small intestine and hindgut. The shifting of the site of starch digestion from the rumen to the small intestine enhances starch digestion and availability of energy for the milk production.

Starch degradation in rumen



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3. Chelated/ bypass minerals

Chelate is cyclic compound which is formed between an organic molecule and metallic ion. Zinc, manganese and chromium chelated minerals are important for dairy cow for optimum production. Chelates and other complex minerals are useful in animal nutrition to protect trace minerals during digestion. The goal is to increase bioavailability of minerals and to support metabolic functions. Chelates and other complexes should be stable in rumen and digestive tract of animals.

Conclusion

In developing countries like India, supplementation of protected proteins and fats is beneficial to medium and high yielding cows and buffaloes but the cost effectiveness of the same needs to be kept in mind. As about the feeding of protected protein, the result of some farm studies and field studies have indicated the usefulness and cost effectiveness of its feeding to cows and buffaloes. In addition, milk fat yield and percentage of unsaturated fatty acids in milk fat was increased, resulting in improved nutritive value of milk from a human health point of view.

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