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ROLE OF BYPASS PROTEINS IN RUMINANT PRODUCTION

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Introduction

The field of Animal Science developed with the domestication of Animals. Today, the primary importance of domestic animals for people is a source of food and other products. These animals provide a regular source of income from the sale of milk, meat, skin, draught power and dung. In the developing countries like India, the feed inadequacy is the major impediment in the development of livestock industry, especially dairy. The problem is quit acute in India, where the bovine population is largest; and increasing at the rate of more than 1 percent annually. This constant increase in the bovine population dilutes any efforts made towards increasing the feed/ nutrient supply achieved by nutritionists. More than this, there is a shortage of about 30-32 percent of energy (feed) availability for livestock in the country.

Crop residues, which form the bulk of feed resources in India, are of inferior quality. Oil seed cakes are in short supply, partly due to lower production of oil seeds and partly due to its export to rich countries. We have made remarkable progress in grain production (through green revolution), but the first preference for their use goes to human beings. We have to look for alternate ways of increasing the nutrient supply to bovines from existing as well as newer feeds. This can be achieved by modifying the feeds and the feeding conditions, and by the manipulating the digestive tract, especially rumen. Many of these manipulations are aimed at increasing the nutrient utilization within the ruminant system. In recent years, several feeding technologies have been developed through the intensive efforts of Animal Nutrition research. In fact several more technologies are in the process of being developed. By increasing, the efficiency of nutrient utilization we can thus achieve the twin objective of increasing the production of dairy and also reduces the cost of production

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Bypass Nutrient Technology

In the feed
fraction of nutrients, which are low or non-degradable in the rumen by the microbes
and they are digestible and absorbable at lower tract and become available to animal
called as Bypass Nutrient Fraction. Bypass nutrient mean that the essential and more important nutrient (high BV) should be escape from the rumen or face minimum fermentation. The reasons for protecting different nutrients are different based on their mode of utilization in the rumen.

Various Bypass Nutrients

1.
Bypass Proteins
2. Bypass Starch
3. Bypass Fats

4. Bypass/ Chelated Minerals
5. Vitamins can also be protected

BYPASS PROTEINS

RDP (Rumen Degradable Proteins) and
UDP (Undegradable Dietary Proteins)

In India, there is a shortage of both energy as well as proteinacious feeds. Protein supplements are more expensive and increase the feed cost. By optimizing the use of protein supplement within the ruminant system, we can either reduce the quantity of protein in the diet or can enhance the production of the animals.
The protein can be divided in two parts, for the ruminant animals, in most of the feed, major part is degradable in rumen 'Rumen Degradable Protein' (RDP) and a small but variable amount of dietary protein escape rumen degradation ' Un-degradable Dietary Protein (UDP). UDP which enters the lower tract is absorbed mostly as amino acids following enzymatic digestion. Of the RDP fraction, substantial part is utilized as the N source for rumen microbes, for protein synthesis, while the rest is absorbed as ammonia. Only part of absorbed ammonia is recycled back to rumen as urea via saliva, the rest excreted out through urine.
The host animal gets amino acids requirement from two sources i.e. microbial protein and UDP, both flowing to lower tract. Although in the case of low yielder, the microbial protein synthesized in the rumen is sufficient. In some cases microbial protein and UDP is sufficient to meet animal's requirement. In high growing animal and high yielding animals microbial supply is limited (Table 1), then the demand of amino acids at the tissue level, so to support the demand, it is necessary to provide proteins in the form of UDP or escape proteins or protected proteins. The protection of protein can be achieved by various methods. Few are following:

Table1. Nutrient Requirement for Lactating Cow of 400kg B. Wt. Producing Milk with 4% Fat

Milk Yield, kg (4%fat)	ME (MJ/d)	CP (g/d)	CP by Microbes; RDP (8.34xME (MJ/d))	UDP required CP require-RDP)
0	50.44	318	420.66	Nil
1	55.65	408	464.12	Nil
2	60.86	498	507.57	Nil
3	66.07	588	551.02	36.98
4	71.27	678	594.47	83.61
5	76.48	768	637.84	130.16
6	81.7	858	681.37	176.63
7	86.91	948	724.82	223.18
8	92.12	1038	768.27	269.73
9	97.12	1128	811.72	316.28
10	102.54	1218	855.17	362.83

(NRC, 1989)

Protection can be achieved by Various Methods i.e. Naturally, Physically and chemically

1. Naturally Protected Proteins

The protein of most of the feed resources is bypass to some extent, but some bypass more than others (Table 2). The_natural protection depends upon the following properties of feeds.

1 Surface Area Available for Microbial Attack
2 Chemical Nature of Proteins
3 Physical Consistency of Proteins
4 Presence of other Dietary Components
5 Passage Rate from Rumen

Table 2. Percentage of UDP in Common Feed and Fodder.

Feed	UDP %	Feed	UDP %
Maize (grain)	65	Blood meal	76 – 82
Barley	21(11-27)	Fish meal	71 – 80
Sorghum	52	Meat meal	53 – 76
Bajra	68	Brewers dried	53
Oat grain	14–20	Corn gluten	53
Wheat grain	20–36	Wheat bread	29
Cotton seed meal	41–50	Corn silage	27
Linseed meal	11–45	Rice straw	63
Ground nut meal	30	Wheat straw	45
Rapeseed meal	23	Para grass	52
Soybean meal	28 (15–45)	Cow pea	32 – 45
Sunflower meal	24	Berseem	37 – 52
Subabul	51 – 70	Alfa-Alfa	28

(NRC, 1985; Dutta *et. al*., 1997)

2. Heat Treatment

The drying of forage is known to increase the protection of the proteins. During the process of manufacturing oil seed meals, they are subjected to different degree of heating which partly explains differences in the degree of protection. Thorough heating of protein supplement causes denaturation of protein; it provides effective protection against microbial fermentation in the rumen. Heat treatment at 125- 150^0 C for 2-4 hours could protect proteins very efficiently. High pressure steam treatment with extrusion has shown promising results.

3. Esophageal Groove

This is normal function in young one. It is done/ good for liquid proteins. Groove closer is influenced by various factors such as age, temperature of liquid, posture of animal while drinking, site of delivery into esophagus, and chemical composition of liquid. More over commonly used chemical influencing the closer are Salts of Sodium, Copper, Silver and Zinc.

4. Formaldehyde Treatment

It is most widely used chemical treatment for the protection of protein. Normally we add 3-4 kg of commercial formalin (37-40% HCHO) per 100 kg of CP or 1-1.2 g HCHO/ 100 g CP. The most successful procedure, developed by Ferguson *et al.* (1967). Generally there is increased fecal nitrogen and decreased urinary nitrogen which indicates effectiveness of protection. The use of formaldehyde to protect dietary protein for ruminants is based on the premise that bound formaldehyde markedly reduces the solubility of the protein at pH 6.0, thereby rendering it highly resistant to microbial attack in the rumen, without significantly reducing its digestibility in the small intestine. Other aldehydes like, acetaldehyde, glutaraldehyde, glyoxal are also effective but they don't possess any advantage over formaldehyde which is comparatively cheaper and easily available.

5. Post Rumen Infusion (Fistula)

Surgically fitted fistula after the rumen in the lower tract of intestine is an easy method to avoid rumen microbial degradation of proteins, so proteins/ amino acids are available in the intestine. This method is only used at research level to generate the data and rumen degredation pattern.

6. Encapsulation of Proteins

Encapsulation of Proteins is usually done for good Biological value proteins and for individual amino acids. Methionine and lysine are limiting amino acids in microbial proteins on feed intake, plasma amino acids and milk production. So they can be given the form of capsule with a combination of fats or fatty acids sometimes by addition of carbonate, kaolin, lecithin, glucose etc.

7. Amino Acids Analogs

Structural manipulation of amino acids to create resistance to ruminal degradation is another potential method for rumen bypass of amino acids. In addition to being absorbable from the small intestine, the analog must have biological potency in metabolism by tissue. Analogs such as Methionine hydroxy, N-acetyl-DL-Metionine, DL-

Homocysteine thiolactone-Hcl, DL-Homocysteine, etc. have given satisfactory results. Reacting amino acids to produce imides, produced materials which survival ruminal conditions, yielded free amino acids at abomasal pH, and increased amino acids concentration in the ruminants.

8. Feed Processing

Normal procedure in the manufacture of feed ingredients can influence the magnitude of protein degradation in the rumen. Certain grain processing can either increase or decrease rumen degradation of Proteins. Increased ruminal degradation may be the result of disruption of the protein matrix, whereas heat applied or generated during grain processing can decrease ruminal degradation of proteins.

9. Lowering Ruminal Protease Activity

By depressing the proteolysis activity of the rumen microbes (not Urease) we can slow down the protein degradation within the rumen. Bacteria are the mainly responsible for proetolytic degradation. So antibiotics can be used to reduce the protein degradation within the rumen.

10. Metal Amino Acid Complex

Metal complexes commonly available such as Zinc Methionine, Zinc Lysine, Copper Lysine, Manganese Metionine, Iron Methionine etc. their usefulness lies in the fact to assume that they must be stable in the rumen environment and abomasum and be delivered to the small intestine intact, secondly, there is some evidence that mineral chelates are considerably better absorbed than inorganic forms.

11. Plant Secondary Compounds

These are mainly secondary metabolism compounds these are generally not utilized in metabolic process these include lignin, tannin, terpenenoids, volatile essential oils, alkaloids etc. these have potential to be used as protein protectant in the rumen. Tannin has got good attention, although it is considered as antinutritional factor but as it is a protein suppresser or decreasing is digestibility so it can be used in the ruminant animal at lower level; for monogastric it is toxic.

12. Decreasing Retention Time in Rumen

Less stay in rumen environment mean less degradation because feed or protein is getting less exposure to enzymatic action. Faster pass of feed in the rumen is the explanation. Factors influencing the rate of passage include food intake, specific gravity, particle size, Concentrate to roughage ratio, rate of rumen degradation etc.

Additional Benefits of Formaldehyde Treatment over Others.

1. Arrests the growth of mycotoxin forming fungus so can be used as preservatives
2. Protecting from Glucosinolates found in Mustard Cake as it lowers its activity
3. It is Cheap, 1 kg Oil Cake Treatment have a invetment of 0.7 Rs (**Walli, 2004)**
4. Starch protection can also be achived (Table 3, Mehta and Srivastava, **2001)**
5. Fat Protection can also be done at satisfactory level (Table 4, Gulati *et al*. **2001)**

Table3. Nutrient Intake and Performance of Crossbred Calve fed by Bypass starch

Parameter	**Control**	**Treatment**
Nutrient intake (kg)		
DMI/head/day	2.84	2.98
DMI/100kg b.wt./day	2.94	2.89
DCP/head/day	0.33	0.34
DCP/100kg b.wt./day	0.348	0.338
TDNI/head/day	2.02	2.11
TDNI/100kg b.wt./day	2.08	2.04
Body Wt. Changes (kg)		
Initial body wt.	69.71	71
Final body wt.	130.57	142.85
B. wt. chang in 150 day	60.86	71.85
Body wt. gain /day	0.406	0.479

The Ground Barley, Treated with Formaldehyde for Bypassing Starch **(Metha and Srivastava, 2001)**

Table 4 Nutrient Profile of HCHO Treated Soybean Oil Seeds

Parameter	Unprotected (g/kg)	Protected (g/kg)
A. Total Fat	**323**	**323**
Rumen Un-degradable Fat	16	255.17
Rumen Degradable Fat	307	67.83
Fatty Acids Available for Absorption at the Aomasum		
Oleic	8.4	133.2
Linoleic	4.2	66.3
Linolenic	1.4	21.9
B. Total Protein	**285**	**285**
Rumen Un-degradable Protein	57 (20 %)	228 (80 %)
Rumen degradable protein	228	57
Amino Acids Available for Absorption at the Abomasum		
Cysteine	0.27	2.09
Methionine	0.25	0.98
Isoleucine	0.71	2.85
Leucine	1.21	4.86
Phenylalanine	0.74	2.96
Lysine	0.78	3.12
Histidine	0.46	1.85

Arginine	1.12	4.47

(Gulati *et al.*2000; Gulati *et al.* 2001)

Effects of Bypass Proteins on Animal Performance

Biochemical and nutritional basis by which bypass protein show its effect on animal performance.

- Additional supply of amino acids at intestinal and tissue level
- Lower ammonia production in the rumen because proteins are fermented to ammonia and low degradation of protein will lower ammonia
- Lower urea synthesis in liver as ammonia is being absorbed at lower level
- Energy saving process as urea synthesis is at lower level
- Excess amino acids go for Gluconeogenesis

Best Utilization of Protein Resources

Total Protein Available from Concentrate in India is estimated to be around 8.5-9 million tones which can Support production of only 0.45 million tones of Milk Proteins by the present mode of its Utilization. Studies showed that when Protein Degradation in Rumen is controlled and it is made to Bypass, the same can support the production of 1.72 million of Milk Proteins.

Beneficial Effects of Bypass Proteins

1 Growth Performance

Feeding of bypass protein meals generally increase the growth rate of animals and the increase is often significant. A series of experiments conducted at NDRI, Karnal have shown significant increase in growth rates in calves, buffalo calves, and goat kids on feeding bypass protein. These experiments were on HCHO treated GNC and Mustard cake. The increase in growth rate of these animals was registered to the tune of 30 -40 %. Feeding of Bypass protein to growing stock, not only increases growth rate, but also improve feed conversion efficiency feed required per kg gain and feed cost per kg gain. Infact, it not only results in reduction in the cost of rearing, but due to higher growth rate, it also results in attaining early maturity by male or female animals. This is definitely a bigger boon in terms of improvement in reproductive efficiencies of these animals.

2 Lactating Performance

Most of feeding trails resulted in significant increase in m milk yield and FCM yield. The increase in milk yield varied in the range of 8 – 10 percent. The studies conducted on medium producing animals, proved that bypass protein feeding can be beneficial to the animals, producing 8-10 liters of milk per day. Significantly increase in milk yield and FCM yield in cross bred cattle in murrah buffaloes and in Goats.

3 Reproductive efficiency

Because of high growth rate caused through protein feeding, the young stock can attain early maturity to start the reproductive life at an earlier age. It has been shown that bypass protein feeding can improve the reproductive efficiency of breeding buffalo bulls and cross bred bucks, both with respect to sexual behavior, including libido score as well as the seminal attributes like ejaculate volume, mass activity and sperm count per ml, similar positive results were obtained in females, where the number of service per conception decreased after feeding of bypass proteins.

CONCLUSION

1 No Need of Bypass Proteins for Maintenance.
2 Required over Production of 3 l/ d.
3 3-5 l/ d Milking Animal; Naturally Bypass is Sufficient.
4 Medium and High Lactating and Growing Animals Need it.
5 It Increases DM intakes.
6 Increase in Milk production by 10-15 %.
7 Good increase in live weight gain.
8 Essential and Limiting Amino Acids reach to Intestine.
9 HCHO treatment is good over other treatments.
10 Reduces Milk Production cost.

Suggestions by Different Scientists

1 Advantage should be taking of Ruminants Ability to Synthesize Microbial Protein.
2 Microbial Protein Synthesis is Energy Dependent Process so Try to Increase Energy intake.
3 Use of NPN should be Optimized.
4 Indian Conditions Need Naturally Protected Proteins Sources.
5 Need of On-farm Research.
6 Provide Bypass Proteins in Area Low Protein Resources.
7 Use of Protein Banks (Fodder Bank).
8 Potential of Tree Leaves, Seeds and Pods to be utilized.
9 Possibilities of Using Plant-Biotechnology.
10 Possibilities of Using Rumen Manipulation.
11 Commercial Dairy Sector Need to Adopt bypass Protein Manufacturing Tecnology.

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