Success Story of Bypass Protein

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Introduction

The very concept of feeding Bypass protein to ruminants was proposed by the renowned Australian Scientist from CSIRO, Dr. W.T. Scott in late 70s. However, when it was thought of conducting research on this feeding technology in India, there was a

lot of objection from many quarters. Incidentally, during that period, NDRI received many foreign experts under several International Programs. All of them without any exception totally rejected the idea of doing research on bypass protein. The reason being the low yielding dairy animals in India don't need bypass protein, since the microbial protein synthesized in their rumen may be quite sufficient to take care of their protein needs. Notwithstanding the fact that during the last 3 decades, a lot of research has been conducted on bypass protein in the different Indian universities and research institutes, including NDDB which is the pioneer organization for the commercialization of this feed technology in India. However, NDRI was the first research institute to undertake research on bypass protein. In fact, it virtually delineated most of the research aspects of this technology, and finally NDDB made it a successful commercial technology.

How the new perspective bypassed the earlier apprehensions on the Bypass Prot concept?

During the literature search, a research paper by Satter and Slyter (1975) published in Journal of Dairy Sci. (US) mentioned that only 5 mg of ammonia/100 ml of rumen liquor are optimally required for maximum protein s me while a series of experiments conducted on cattle and buffaloes fitted with rumen cannula earlier showed that the rumen ammonia levels varied from above 5 to 20 mg/100 ml of rumen liquor.

Satter and Slyter (1975) publication surprised in two ways:

a) only a low level of ammonia is required to maximize protein synthesis in rumen

b) why the ammonia level in the rumen of cows and buffaloes in India is generally much higher than actually required for microbial protein synthesis in rumen

After giving some thought it was realized that under rural conditions of the country, grains are mostly consumed by humans and non-edible oilcake are fed to ruminants. Oil cakes fed to animals are generally highly degradable in the rumen, with some exceptions, and thus, produce excess ammonia in rumen. For efficient use of ammonia with respect to Amino Acid synthesis in the rumen, a matching soluble carbohydrate, like grains, are required to provide CO_2 after its degradation. In the absence of sufficient availability of carbon skeleton as CO_2, to trap excess ammonia, ammonia gets accumulated in the rumen.

Since Amino Acids are like bricks for protein synthesis, its degradation/ conversion to ammonia in the rumen is akin to the production. This excess ammonia has to be cleared off from the rumen, as it has no use to the animal. The recycling of N is least needed in such a situation. After absorption from the rumen, ammonia is transported to the liver for conversion to urea,

before its excretion through urine. But for urea synthesis, the animal has to spend its own energy, thus, rather the animal has to pay a price to clear this ammonia.

Thus, feeding of Bypass protein offers triple benefit to the animal. It saves feed protein, saves animal's own energy and there is less urea excretion through urine. This last point has a bearing on protecting the environment, through less Nitrous Oxide emission into the atmosphere.

The mechanism behind the feeding bypass protein

Testing the protein degradability of several Proteinous feeds: Several oilseed cakes and other proteinous feeds were subjected to in vivo dacron bag technique for estimation of protein degradability and also to calculate the RDP (Rumen Degradable Protein) and UDP (Undegraded Dietary Protein) values of these feeds. Proteins of Mustard, rapeseed, and GN cake are highly degradable in the rumen, (80-85%), and need protection. However, proteins of Cottonseed cake, Maize gluten meal and guar meal are least degradable in the rumen, are naturally occurring Bypass Protein, and thus do not protect. Protein from Soybean cake has a medium degradability (around 50 %), and needs protection.

Measuring the flow rates of various Nitrogen Fractions at Abomasun fed Bypass Protein: A feeding trial was conducted on 12 cow calves fitted with the abomasal cannula. Two groups of animals were fed isonitrogenous diets [redacted] naturally occurring Bypass Protein in concentrate. Flow rates at abomasum were measured, using chromic oxide as digesta marker and RNA as a microbial marker. Flow rates of Microbial N, Urea/Ammonia N rates/24 h were significantly reduced on the higher Bypass Protein level.

However, the flow rates of protein N, Non-Ammonia Non-Urea N, and Amino acid N showed significantly higher flow rates on the higher bypass Protein levels. This clearly proved that when Bypass Protein is fed to ruminants, there is an overall increase in the flow of Amino Acids to the lower tract, and thus, making more Amino Acids available for the absorption in the intestines of the animal.

Methods for protection of proteins in highly degradable cakes: There are two ways to protect the proteins in highly degradable cakes in the rumen, and to convert these into Bypass Protein.

Heat Treatment: Heat treatment of oil cakes can be done through roasting at 140 degrees C for 30 minutes. It was found that the above time/temperature combination was quite sufficient to protect soybean cake protein, having protected its protein from rumen degradation up to 70-80 %. However, the problem with this method is that it is not a cost-effective technology.

Formaldehyde (HCHO) Treatment: Groundnut Cake was subjected to HCHO treatment using different levels of

formaldehyde, viz. 0.5, 0.8, 1.0, 1.2, and 1.5 g HCHO/100 g cake protein. The protein degradability in the rumen was measured by in vivo Dacron bag technique. It was observed that the level of 1.0 g HCHO/100g of cake protein caused 70-80 % protection of its protein in the rumen. Accordingly, this level was considered as the optimum level of HCHO for protecting proteins from highly degradable cakes. Formalin is easily available in the market in liquid form. It is 40% HCHO, and accordingly, 2.5 ml of Formalin shall provide 1 g of HCHO. Formalin is a cheap chemical, thus making HCHO treatment quite a very cheap method of protein protection for making it a Bypass protein. However, at the time of Formalin application, precautions have to be observed due to its volatile and corrosive nature.

Results of the Growth trial on feeding Bypass Protein

Growth trials on goat kids fed two types of Cakes treated with HCHO: A growth trial was conducted on 12 goat kids divided into 2 groups fed untreated or HCHO treated GN Cake (60% BPP in concentrate) for 3 months. At the end of the trial, it was found that it gave 30-35% increase in growth rate in the treated group over the control group. The feed conversion efficiency was found to be much higher in the treated group.

Similarly, in another trial conducted on 14 goat kid, the animals were divided into 2 groups and fed either untreated or HCHO treated mustard Cake (60% BPP in concentrate) for a period of 3 months. The result in this experiment was similar observed in kids fed HCHO G.N. cake There was a 30-35% increase in growth in the treated group over the control group. Feed conversion efficiency too was much higher in the treated group as in the first case.

Growth trial on buffalo calves fed HCHO treated G.N. Cake: Another growth trial was conducted on 12 buffalo calves divided into 2 groups fed either untreated GN cake or HCHO treated GN Cake (60% BPP in concentrate) for a period of 4 months. In this particular experiment as well, the growth rate recorded was 30-35% in the HCHO treated mustard cake group, over the control group. The higher feed conversion efficiency also seen in this experiment makes it an attractive and cheaper technology.

Additional benefits of HCHO treatment on both types of cakes: HCHO Treatment of GN Cake: After finishing the growth trial on kids, the Aflatoxin level was measured in leftover untreated and as well as treated cake samples. Interestingly, it was found that the aflatoxin level was 3 times more in the untreated cake. This suggests that apart from protecting cake protein, HCHO treatment does not allow the fungus to grow on the cake. Thus, the HCHO treatment of GN Cake arrests the further growth of fungi, and no further increase in Aflatoxin level in the cake happens, while in the untreated cake the fungus grew unchecked and this increased its aflatoxin content.

HCHO treatment of Mustard Cake: After the growth trial on kids, these animals were slaughtered and the organs were

subjected to histopathological examination. Results showed that there was a massive cellular degeneration of most of the organs in animals fed untreated cake, while in the treated group all the organs were intact. This proved that HCHO treatment prevents the conversion of glucosinolate, present in the mustard cake to thiocyanate in the rumen. Thus, feeding of Mustard Cake treated with HCHO has no toxic effect on ruminants, suggesting that its feeding is safer in two ways: does not cause any organ damage to the animal and it also prevents Thiocynate Poisoning in ruminants.

Effect of feeding Bypass Protein on Reproductive aspects of dairy animals

Some experiments on the feeding of bypass protein were conducted by the LPM Division of NDRI Karnal, on the reproductive aspects of the animals. It demonstrated that Bypass Protein feeding has some positive effect on reproduction. Because of higher growth rate and feed conversion efficiency, it leads to early maturity, resulting in a slight decrease in age at first calving, an improved conception rate, and a decreased inter-calving period in females. In addition to that, the lower ammonia level in circulation has a positive effect on foetal growth, because the higher ammonia levels in circulation can also ca damage to the foetus. Furthermore, in young bulls, due to more supply of Amino Acids on feeding bypass protein, it c lso lead to a better libido as well as better semen quality.

Feeding Bypass Protein to lactating animals

Effect on milk yield of buffaloes on feeding bypass protein: 12 lactating buffaloes were divided into 2 groups and fed either untreated GN cake or HCHO treated G.N. Cake (@1g HCHO/100g cake protein). The bypass protein level in the concentrate was 60% of total protein. After 4 months of the feeding trial, the average milk yield in the treated group was 12-14% higher. The FCM yield was still better in the treated group because there was a slight increase in the fat percentage of milk from treated cows. The increase in fat percent after feeding Bypass Protein has been very consistently seen in a number of other experiments. Perhaps the increased Methionine supply on feeding Bypass Protein provides Methyl donor for Fat synthesis, resulting in more fat in milk.

Effect on milk yield of goats on feeding bypass protein: A trial on 14 lactating goats divided into two groups was conducted. While the control group was fed concentrate which contained untreated mustard cake, the experimental group was fed concentrate having HCHO treated mustard cake, forming 60% bypass protein in the concentrate. The trend regarding the increase in milk yield was just similar in the HCHO treated group as in other experiments, along with higher fat content, as observed in the case of lactating buffaloes.

Milk samples from goats fed HCHO treated mustard cake showed no trace of either Formalin or Thiocyanate, Thus, such milk is absolutely safe for human consumption, apart from the fact that HCHO treatment of this cake is also safe for animals, as

demonstrated earlier in goat kids, through histopathological studies.

Effect on milk yield of crossbred cows on feeding bypass protein:

A) Under NDRI- American Soybean Association Collaborative Project: A trial was conducted on 12 Lactating Cross Bred cows divided into two groups, fed either Roasted Soybean cake (140 deg C for 30 Min), or Soyabean cake as such, for 3 months, to make bypass protein as 60% in concentrate. At the end of the trial, the treated group showed 12-14% higher milk yield than the untreated group. Though the results were quite encouraging, it has been already mentioned that this is not a cost effective technology. As compared to roasting, the HCHO treatment of cake is a much cheaper technology to convert highly degradable oil cakes into Bypass Protein.

B) Under NDRI-NDDB collaborative project: A trial was conducted at NDRI on 12 lactating crossbred cows divided into two groups. The experimental group was fed Bypass Protein feed having HCHO treated G N Cake, while the control group was fed feed containing untreated G.N. cake. After the 3 months of trial, the increase in milk yield was recorded to be around 14% in the group fed bypass protein over the control group, along with better feed conversion efficiency and cost-effectiveness.

Simultaneously a similar trial was conducted by NDDB, using the same bypass protein feed, in the nd d. However, the increase in milk yield in the rural area was still higher than recorded at NDRI. The yield varied from 15-20%. After getting convinced, then NDDB Chairman Dr. Amrita Patel decided to go for large scale production of Bypass protein.

The biochemical explanation for the increase in milk yield:

A) Quantum of Lactose synthesis decides the quantum of milk to be synthesized in Mammary Gland

B) Lactose regulates the osmotic pressure of milk. More the lactose synthesis, more amount of water Mammary Gland has to suck from blood, which increases milk volume.

C) Lactose synthesis in Mammary Gland depends upon the supply of glucose, part of which is also converted to galactose, for lactose synthesis.

D) More supply of glucose to Mammary Gland, means more Lactose synthesis.

E) Bypass Protein feeding provides extra supply of AA to liver for more Gluconeogenesis, as propionate supply is not sufficient, due to less ingestion of soluble carbohydrates.

F) Since, the other two milk constituents viz. Protein and Fat have to keep pace, to match the lactose level in milk. This results in more Milk Volume or in other words more Milk yield.

The first commercial plant for manufacture of Bypass Protein was commissioned at Baroda, under Indo-Australian

Collaborative Project in 2004.

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