11
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Rumen by-pass protein technology for enhancing productivity in dairy animals

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SUMMARY

More than two decades of research involving a number of trials conducted for ruminant production has established the relevance of by-pass protein technology for developing countries, including India. National Dairy Development Board (NDDB) of India has standardized the process of producing rumen by-pass protein supplement by treating the protein meals. Protected proteins were prepared by cross-linking the constituent protein with optimum levels of formaldehyde to enhance the level of constituent amino acids that escape rumen by about 75 percent. By-pass protein technology has emerged as one of the cheapest feeding technologies. It is now a successful commercial feed-technology in India and has led to increases in milk yield of 10 to 15 percent. Feeding by-pass protein protects dietary proteins from excessive degradation to ammonia in the rumen and also supplies more essential amino acids at the intestinal level. With only marginal increase in treatment cost, the efficiency of utilizing scarce protein meals can be increased significantly for growth and milk production in most developing countries. Experiments clearly indicate that farmers feeding by-pass protein can earn about 10 percent more money in case of cows and about 15 percent in case of buffalo.

Key words: *by-pass protein, commercialisation, dairying, economics, patented*

INTRODUCTION

In recent years, several technologies have been developed through intensive animal-nutrition research, one of them being by-pass protein feed technology. By-pass protein refers to dietary protein that escapes rumen degradation. The technology aims at decreasing the wasteful production of ammonia in rumen from highly degradable protein meals, thereby increasing the availability of essential amino acids at the intestinal level. The main aim is to increase the efficiency of protein utilization in ruminants for enhanced milk production. Dairy nutritionists try to enhance nitrogen utilization through dietary manipulation to optimise milk production. Manipulation of protein degradation in the rumen is the most effective strategy to reduce nitrogen losses in dairy animals. Losses of nitrogen can be reduced by balancing the ration to achieve optimum ratio of rumen degradable protein (RDP) to rumen undegradable protein (UDP) and increase nitrogen use by ruminal microorganisms. Optimising RDP:UDP also optimises post-ruminal amino acid supply for productive purposes.

EXPERIENCES OF APPLYING BY-PASS PROTEIN TECHNOLOGY IN THE FIELD

Methods evaluated for enhancing by-pass protein value. Protein meals are normally fed 'as such' to ruminants in India. However the meals have varying degrees of naturally rumen-protected proteins. The fact that solubility of proteins change, when subjected to special treatments, can be exploited to protect good-quality proteins from rumen degradation. A number of treatments to protect proteins have been tried, e.g. alkali, xylose, heat and formaldehyde. Among these formaldehyde treatment has the advantage of being the most cost effective technology for protecting highly-degradable proteins in the rumen and not adversely affecting animal health and milk quality. This method has been extensively used because of the following advantages:

- Desired level of protein protection can be achieved – under- and over-protection of proteins can be avoided;
- The bio-availability of the essential amino acids can be maximized;
- Does not increase contents of acid detergent insoluble nitrogen (ADIN) and neutral detergent insoluble nitrogen (NDIN);
- Less expensive than heat treatment; and
- Helps to control salmonella and reduce mould growth in feedstuffs.

PATENTED TECHNOLOGY BY THE DAIRYBOARD

By-pass protein technology is a new-generation technology, wherein by-pass protein feed is produced by a special chemical treatment, developed and patented by the Dairyboard of India. Regionally-available protein meals are treated appropriately, so as to reduce degradability of the proteins in the rumen from 60–70 percent to 25–30 percent, in a specially designed airtight plant (Photo 1). By-pass protein feed supplements have been developed by screening protein meals for their amino acid composition and then developing suitable chemical treatment procedures.

Protein meal identified for treatment is first ground, treated chemically at an appropriate level and then stored for 9 days under airtight conditions. After 9 days of incubation period, protein meal is ready for feeding to ruminants and can be stored for more than a year, without any deterioration in the quality.

APPLICATION STATUS OF THE BY-PASS PROTEIN TECHNOLOGY

Development of test method. The test method used by the feed industry in India to measure by-pass content of protein meals was based on nitrogen solubility in buffer solutions. However phosphate-buffer solubility values do not compare favourably with *in vitro* or the

photo 1
By-pass protein supplement production plant

in sacco protein degradability values. The Dairyboard, in technical collaboration with the Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia and the Australian Centre for International Agricultural Research (ACIAR), has standardised an *in vitro* ammonia release method which gives more accurate values for protein by-passability. In this method, a known quantity of protein meal is incubated under anaerobic conditions at 38 °C for 24 hours in strained rumen liquor (SRL). Protein degradation is measured by analysing ammonia nitrogen level in SRL at the end of the incubation period (Gulati, Ashes and Scott, 1999).

FARM AND FIELD TRIALS AND ECONOMIC BENEFIT

Studies have shown that the feeding by-pass protein to growing animals increased growth rate (25–30 percent), reduced rearing costs and resulted in earlier maturity of calves. Feeding by-pass protein also improved the reproductive efficiency of breeding bulls (Walli, 2009). Numerous feeding trials were conducted at different laboratories using different protein meals in lactating cows and buffalo. In all these trials, daily milk yield in experimental groups increased by 1.0 to 1.5 litres; milk protein increased by 0.3–0.4 percent and milk fat by 0.2 percent. On average, daily net income (per animal) increased by Rupees 10–11 (1 US$ = ca 45 Indian Rupees) in animals yielding 8–10 litres and Rupees 5–6 in animals yielding 4–5 litres. ACIAR conducted a study to assess the economic benefit of feeding by-pass protein feed in Vadodara district of Gujarat State, India. The study revealed that on feeding by-pass protein , the average increase in net daily income was Rupees 9.20, 6.42 and 12.41 in indigenous cows, crossbred cows and buffalo, respectively. Supplementation with by-pass protein feed was found to be economical in lactating animals yielding on average 5–8 litres of milk daily (Garg *et al.*, 2005; Garg, 2009).

COMMERCIALISATION OF TECHNOLOGY

A commercial by-pass protein production plant was set up in Baroda Milk Union, in Western India, for producing 50 tonnes of by-pass protein feed per day. The demand for the by-pass protein feed produced in this plant has been steadily increasing. Subsequently, the Dairyboard has set up 12 by-pass protein manufacturing plants mainly under the dairy co-operatives network and has thus commercialised the technology.

OPERATIONAL HEALTH AND SAFETY MEASURE

Chemical treatment of protein meal(s) is carried out in a specially-designed airtight plant, so that there is no risk to workers operating the plant. Moreover, workers are advised to wear gloves, masks and safety glasses. The US Food and Drug Administration (FDA) has approved the use of formaldehyde as a feed additive to protect proteins from ruminal degradation, to preserve silages, to maintain animal feeds and feed ingredients free from salmonella and to control fungi. Formaldehyde used in treatment of protein meals is at very low levels and poses no health risk to animals and consumers.

LESSONS LEARNT AND FUTURE OF BY-PASS PROTEIN TECHNOLOGY

Due to the several advantages of by-pass protein technology, including the cost effectiveness of treated meals and increase in milk yield, the technology has been successfully

adopted by the feed industry in India, with NDDB taking the lead in propagating the technology. The Dairyboard is also exploring the possibility for setting up by-pass protein plants in the premises of oil solvent extraction units. The animal nutrition group of Dairyboard is also assessing the amino acid profile of different protein meals available in India, so as to prepare a suitable blend of treated protein meals for improving milk production. The technology could also be employed in other parts of the developing world.

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