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OPTIMIZING NUTRITIONAL EFFICIENCY IN RUMINANTS THROUGH RUMEN BYPASS PROTEINS AND BYPASS FATS

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ABSTRACT

High-yielding animals need a larger percentage of nutrients in their diet that do not degrade in the rumen and instead provide the intestinally required amino acids. The efficiency of protein utilization is reduced when proteins are fermented in the rumen prior to enzymatic digestion. Feed ingredients that include proteins with a greater bypass value can be used to supply ruminants with bypass proteins. Supplementing with rumen-protected protein, fat, and vitamins increases immunity, lowers heat stress, and increases milk output. Therefore, using protected/by-pass dietary nutrients can be a potential technique for improving both the quality and quantity of animal production in order to supply dairy animals with precise and high-quality nutrition during times of high nutrient demand.

Keywords: Rumen, amino acids, peak yield, optimal production, microorganisms, metabolism

I. INTRODUCTION

In theory, there seem to be valid reasons to administer bypass nutrients to ruminants in order to improve their nutrient use efficiency, particularly at greater production levels. In actuality, though, the animals' reactions vary widely. Fast-growing or high-yielding animals in the early stages of lactation are likely to respond more favorably. These are common circumstances when there is a strong demand for nutrients and the animal may have a poorer body condition score due to a negative protein and energy balance.

Therefore, rumen-protected nutritional supplements can increase ruminant production in both quantity and quality, particularly in stressful situations. The nutritional needs of high-yielding dairy animals, particularly in the early stages of lactation, transition, and heat stress, are frequently greater than those met by rumen fermentation and microbial biomass synthesis. Additionally, in milch animals, a higher milk output during the early stages of lactation is frequently linked to a reduced feed intake. While maximum feed intake is several weeks behind peak milk yield, peak milk yield happens 6 to 8 weeks after delivery. Farm animals experience varied degrees of negative energy balance due to the disparity between the timing of their maximum energy output as milk yield, and their feed intake during the first 60 days of lactation. Animals in such circumstances use their body reserves to support production, which eventually leads to sterility, weight loss, and metabolic problems such milk fever and ketosis. In light of the aforementioned facts, transition nutrition has become increasingly significant to researchers around the world because of the different metabolic abnormalities that are linked to this period and influence the ensuing economic and productive losses. Dairy cows need better energy supplements during transition to counteract the negative impacts of decreased nutritional intake and body weight loss (Katiyar et al., 2019). Additionally, the rumen's significant breakdown of high-quality nutrients frequently renders them unavailable to the host, resulting in nutrient waste.

Proteins produce amino acids, which are used for development, maintenance, reproduction, and milk production. Based on how easily it breaks down during fermentation, crude protein in ruminant diets can be categorized into two groups: a. Protein degradable intake (DIP) b. Undegradable intake protein (UIP) becomes a limiting factor when there are high yielders and physiological stressors like pregnancy, lactation, transition, etc. In the aforementioned situations, rumen-protected or bypass nutrients are efficient at supplying nutrients in an efficient and usable form straight to the intestine.

Initially, as dietary proteins are the costliest nutrient in ruminant diets, they were protected. To achieve optimal production, however, nutrients such as lipids, vitamins, amino acids, and probiotics are now also fed to the animals in rumen-protected form.

II. AMINO ACIDS

Amino acids (AA) are generally essential for protein synthesis, animal maintenance, growth, reproduction, and production. As a result, rumen-protected limiting AAs provide a more accurate way to balance the diet's protein composition, which can save feed costs and enhance the body's total protein consumption. The most limiting necessary amino acids for high-yielding dairy animals are methionine and lysine, which are followed by arginine, histidine, phenylalanine, isoleucine, and threonine. Methionine and lysine are thought to be the first two co-limiting amino acids in tropical field circumstances, when animals primarily eat diets high in roughage and maize. As a result, feeds that are balanced for these AA, either separately or in combination, improve the ratio of milk to DM intake, milk energy and yield, milk protein percentage, and the percentage of dietary N that is collected as milk N.

III. PROTEIN

When cattle are given poor-quality forages, protein is typically the first limiting nutrient. In India, particularly in rural communities, isolated areas, and mountainous regions, farmers feed dairy cows locally sourced protein meals in addition to other components. A large portion of these protein-rich meals are converted to ammonia in the rumen, the ruminant's first stomach, which has a 50–60 liter capacity. The term "bypass nutrient fraction" refers to the portion of nutrients in the feed that are either low or not broken down by bacteria in the rumen but are digested and absorbed in the lower tract and made available to the animal. Protein meals typically undergo 65–70% degradation in the rumen, which results in nitrogen waste via excretion in urine and feces.

A small but variable amount of dietary protein escapes rumen degradation as "Un-degradable Dietary Protein" (UDP) or "bypass protein." The majority of the protein in most feed for ruminant animals is degradable in the rumen and is known as "Rumen Degradable Protein" (RDP). After enzymatic digestion, the majority of the UDP that enters the lower tract is absorbed as amino acids. A significant portion of the RDP fraction is used by rumen bacteria as a source of nitrogen for protein synthesis, with the remainder being absorbed as ammonia. Saliva only recycles a portion of the absorbed ammonia back to the rumen as urea; the remainder is eliminated through urine. Both UDP and microbial protein, which move down the lower tract, provide the host animal with the amino acids it needs. The microbiological supply of growing and high-yielding animals is less abundant than the tissue-level demand for amino acids; therefore, proteins in the form of UDP, escape proteins, or protected proteins must be supplied to meet the requirement.

Rumen microorganisms hydrolyse dietary protein that is soluble in rumen (RDP) into peptides and amino acids. Ammonia, organic acids, and carbon dioxide are the byproducts of further degradation of the amino acids (AA). The main nitrogenous base for microbial protein synthesis, which supplies over two-thirds to three-quarters of the protein required by host species, is ammonia. According to Mahesh and Thakur (2018), protein is the costliest and one of the main limiting nutrients in dairy animals' diets. This is especially true during transition and summer stress when their intake of dry matter (DM) is insufficient. Additionally, low DM intake reduces the amount of fermentable energy available in the rumen for the synthesis of microbial protein.

IV. RUMEN BYPASS PROTEINS

In high yielding foods, bypass fat or inert fat is essential for maintaining energy density balance. The goal of feeding "bypass" protein is that a high amount of the protein is available immediately at the lower section of gastro-intestinal tract, where it is digested and then absorbed as amino acids for utilisation at tissue level. The digestion of fiber is impacted when "bypass" starch is fed because it lessens the rumen's overproduction of lactic acid, which would otherwise cause acidosis, or low rumen pH. To prevent or lessen nutrient degradation in the rumen, a variety of techniques have been used, including heat treatment, chemical treatment, encapsulation, and specific modulation of rumen metabolic pathways. Bypassing the rumen, these techniques facilitate the movement of nutrients from the rumen to the the intestines.

V. FAT

The most variable component in milk when it comes to dietary changes is fat. When lactating cows are fed dietary bypass fat, their milk fat content rises. The main purpose of feeding "bypass" fat, also known as protected fat, is to prevent ruminal microbes from hydrolysing unsaturated fatty acids by bio-hydrogenation and to increase the feeds' energy density. As a result, the lipids are primarily broken down in the small intestine and absorbed as unsaturated fatty acids, which has no effect on the rumen's ability to ferment fibrous diets.

Without affecting DMI or nutrient digestibility, Tyagi et al. (2009) found that supplementing with bypass fat at a level of 2.5% of DMI enhanced milk output, lactation persistence, and the percentage of unsaturated FA in milk fat. In a tropical feeding scenario, lactating crossbred cows should consume 200–300g of bypass fat per day, while buffalo with a milk yield of 3000 L per lactation should receive 300–500g of bypass fat per day from 10 days before delivery to 30–50 days after delivery. Although supplementing with bypass fat is a sensible strategy, it should only be implemented after carefully weighing the costs and benefits.

VI. RUMEN PROTECTED FAT

In order to meet the energy needs of animals, excessive grain or oil/fat feeding may impact rumen fermentation and result in other metabolic problems. For dairy animals, protected fat can be added to the diet to prevent these issues. In high-yielding dairy animals, bypass fat, also known as inert fat, is essential for maintaining energy density balance. These are the dietary fats that are absorbed in the lower intestine but do not undergo ruminal lipolysis or biohydrogenation. Because of their hard outer seed coat, whole oil seeds, when fed without any processing other than drying, have inherent rumen bypass qualities. However, during mastication, the seed coat physically breaks down, resulting in poor rumen inertness. Certain rumen bypass fatty acids can also increase dairy animal reproduction and milk quality by lowering the amount of saturated fat.

Numerous methods have been developed to obtain rumen inert fatty acids, such as calcium salt of fatty acids, prilled fats, etc. The most common method for obtaining calcium salts of fatty acids is fusion and double decomposition. These calcium soaps are soluble in abomasum (pH 2-3) but insoluble in rumen pH (6.2 6.8). Prilled fat (PF) is made by liquefying and spraying a solution of saturated fatty acids under pressure into a cooled atmosphere. PF is not broken down in the rumen environment because of its higher melting point, which is 50-60°C.

VII. CONCLUSION

The use of bypass nutrients offers significant practical benefits, especially for high yielding, stressed, or lactating animals, but must be strategically managed to maximize productivity while minimizing costs and metabolic issues. By improving nutrient delivery to the intestines and supporting metabolic health during critical periods like lactation and transition, bypass nutrients can help dairy farmers optimize milk production and animal health.

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