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Review Article

Synchronization of Energy and Protein on Supply Synthesis Microbial Protein

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ABSTRACT

Synchronization of rumen available protein and energy is one of the conceptual methods to increase the efficiency of utilization of nutrients by the ruminants. The concept of synchronization energy and protein was first by Jhonson, Implying that maximum microbial protein synthesis could be achieved by matching the rate of Organic Matter and protein degradation. Synchronization of rumen available protein and energy is one of the conceptual methods to increase the efficiency of utilization of nutrients by the ruminants. Feed protein are degraded by microorganism in the rumen via amino acids into ammonia and branched chain fatty acids. Non-protein nitrogen (NPN) from feed and urea recycled from saliva and from the blood across the rumen wall also contribute to the ammonia pool. Microbial protein synthesis is important for ruminant. Current concepts of ruminant nutrition focus on maximizing ruminal microbial protein production. Animal agricultural production systems are major sources of nonpoint pollution affecting quality of water sources. The major nutrients that are considered pollutants from agricultural systems are nitrogen (N), phosphorus, and methane. Therefore, the goal of this discussion is to provide information to aid in reducing N excretion from animals while maintaining a high level of production that is economically efficient.

Introduction

The concept of synchronization energy and protein was first by Jhonson(1976), Implying that maximum microbial protein synthesis could be achieved by matching the rate of Organic Matter and protein degradation . He proposed that by suspending that rate supply of ammonia in the rumen pool by feeding the ruminants from protein source whith various solubility, could sustain the relase of ammonia and match them it cabrbyhdrates fermentation , would Increase microbial synthesis. Synchronization means the both energy in the form of carbohydrats or OM and protein in the form of nor peptids are available in the rumen thought the whole day, and neither OM nor N is exceeded or limited for maximal microbial synthesis at any time(chamberlain and choung 1995). Synchronization of rumen available protein and energy is one of the conceptual methods to increase the efficiency of utilization of nutrients by the ruminants. Sinclair et al (1993) reported that the formulation of diets that are synchronous for energy and nitrogen release in the rumen has been shown to increase the efficiency of MP synthesis in the rumen. Bayati zadeh et al. (2012) reported that the usage of discarded dates as supply energy was increased synthesis microbial protein.

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Contrary to these results, Henning et al. (1993), reported unaffected MP synthesis by the synchronization of energy and nitrogen release in the rumen. These contradictory findings may be the result of the different experimental methods and animals. There are at least three methods in which the synchronization experiments were usually conducted, (1) changing dietary ingredients (2) dosing the specific form of energy and nitrogen directly into the rumen, and (3) altering the relative times of feeding the different ingredients. Some researchers (Richardson et al. 2003; Sinclair et al. 1993) used a term of index to determine the degree of the synchrony of energy and protein supply for MP synthesis. An index of 1.0 means a perfect synchrony of energy and protein availability in the rumen for MP synthesis and an index close to 0.0 means imperfect synchronization. Until now, it has not been clear whether the observed or not observed effects of synchronization with respect to the index were associated with the synchrony of feed degradation of the ingredients or to the methods used.

Ruminal degradation of protein

The first step of protein degradation in the rumen involves attachment of bacteria to feed particles, followed by activity of cellbound microbial proteases (Brock et al., 1982). Approximately 70 to 80% of ruminal microorganisms attach to undigested feed particles in the rumen (Craig et al., 1987), and 30 to 50% of those have proteolytic activity (Prins et al., 1983). A large number of different microbial species form a consortium that attaches to a feed particle, acting symbiotically to degrade and ferment nutrients, including protein. Products resulting from this process are peptides and AA. Because the number of different bonds within a single protein is large, the synergistic action of different proteases is necessary for complete protein degradation (Wallace et al., 1997). The rate and extent at which protein degradation occurs will depend on proteolytic activity of the ruminal microflora and the type of protein (susceptibility and accessibility of peptide bonds). Feed protein are degraded by microorganism in the rumen via amino acids into ammonia and branched chain fatty acids. Non-protein nitrogen (NPN) from feed and urea recycled from saliva and from the blood across the rumen wall also contribute to the ammonia pool (Figure 1.1). Because of the central role of ammonia in the N transactions in the rumen, research has focused for long time on ammonia content in rumen fluid. If ammonia levels in the rumen are too low, there will be a shortage of N for microbes. Failure to meet the N requirement of rumen microbes can have serious consequences on the feed utilization and protein synthesis. It has been clearly shown that rumen fermentation can supply 70-100% of a ruminant animal's amino acid supply (AFRC, 1992) and 70-85% of the energy supply can be absorbed as volatile fatty acids, the main end products of microbial fermentation (Dewhurst et al., 2000). As microbial fermentation is such a major component of digestion in ruminants, optimizing microbial growth is obviously important. Microbial protein synthesis in the rumen provides the majority of protein supplied to the small intestine of ruminants, accounting for 50 to 80% of total absorbable protein (Storm and Ørskov, 1983).The total amount of microbial protein flowing to the small intestine depends on nutrient availability and efficiency of use of these nutrients by ruminal bacteria. The basic structure of all of the models is similar with N inputs provided by dietary, recycled, and endogenous N. Dietary protein is divided into rumen-degradable and undegradable protein with RDP composed of nonprotein and true protein N. True protein is degraded to peptides and AA and eventually deaminated into ammonia N or incorporated into microbial protein. Nonprotein N is composed of N present in DNA, RNA, ammonia, AA, and small peptides with the N from peptides, AA, and ammonia being used for microbial growth. Rumen output consists of ammonia N, undegraded protein (dietary or endogenous), and microbial protein. When dietary RDP is in excess of the amount required by ruminal microorganisms, the protein is degraded to ammonia N, absorbed, metabolized to urea in the liver, and lost in the urine. Under typical dairy cattle feeding conditions, manipulation of rumen protein degradation or the efficiency of N use (ENU) in the rumenis the most effective strategy to reduce N losses (Tamminga, 1996).

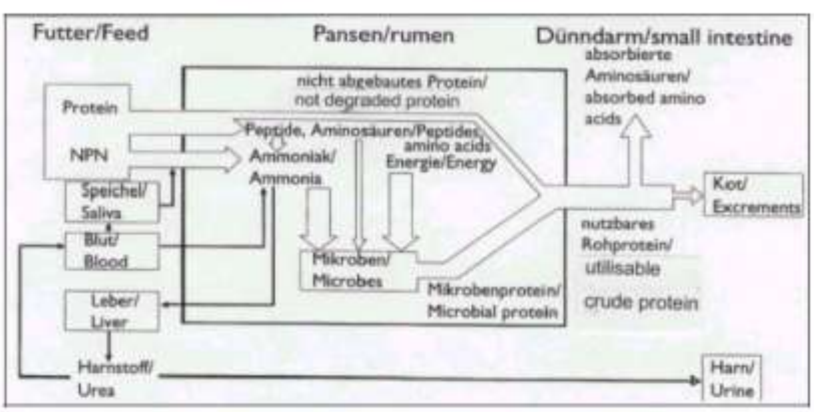

Figure 1. Schematic representation of nitrogen conversion in domestic animal

Various factors affecting microbial protein synthesis in the rumen

Microbial protein contributes about two thirds of the amino acids absorbed by ruminants. Although it is characterized by arelatively high proportion of non-protein nitrogen (25%, AFRC 1992) it has an invaluablerole in the nutrition of ruminant animals. Daily microbial protein synthesis is different from the efficiency of microbial protein synthesis. A major energy source of organic matter is carbohydrate for microbial protein synthesis; some researchers have suggested that it would be more appropriate if the efficiency of microbial protein synthesis is expressed as a function of carbohydrate digested rather than organic matter digested in the rumen (Nocek and Russell, 1988). The efficiency of microbial protein synthesis greatly differs in animals fed different diets, even within similar diets. The average efficiency of microbial protein synthesis was 13.0 for forage based diets, 17.6 for forage-concentrate mix diets, and 13.2 g MCP/100g for concentrate diets of OM truly digested in the rumen. Overall, the average efficiency of microbial protein synthesis was 14.8 g MCP/100g of OM truly digested in the rumen. The rumen is a complex environment inhabited by different microbial species, each of them with different nutrient requirements and metabolisms. Therefore, considering the nutrient requirements of ruminal microorganisms is crucial to understanding N metabolism in the rumen as well as the factors that may modify it.

Dry matter intake: Data from the literature indicate that there is a strong positive correlation between DMI and microbial growth (Gomes et al., 1994). Although increasing the level of intake decreased the percentage of organic matter digested in the rumen. Therefore, more nutrients were supplied for microbial growth. Increasing the DMI with the addition of straw to barleybased diets significantly increased microbial protein synthesis in the rumen.Similarly,thesupplementation of straw with starch linearly increased the amounts of OM digested and solid and liquid outflow rates.

Supply of nitrogen compounds: The crude protein content of many practical diets may be greater than the 11% CP required to support optimal microbial growth; the resistance of proteins to microbial degradation may limit microbial protein synthesis. Protein degradation in the rumen is one of the main reasons for the inefficient utilization of protein in ruminants. The efficiency of microbial protein synthesis was greater in forages containing saponin and tannins, which reduce ruminal N degradability.

Rumen environment: An important factor, which may alter the microbial protein yield in the rumen, is pH value. Low pH value can be deleterious to rumen microbes, and especially sensitive are protozoa. A low pH value is also expected to reduce the digestibility of fibrous plant tissues. Due to low pH value, energy within the rumen is diverted to non-growth functions, i.e. maintaining neutral pH in bacterial cells (Strobel and Russel, 1986).

Synchronized release of nitrogen and energy from diets: Matching the release of ammonia-N from dietary protein with the release of usable energy may improve N utilization (Salter et al, 1979). Sinclair et al. (1993) found that wheat straw and barley diets containing rapeseed meal as a slow release N source, or urea as a rapid release N source, contained equal amounts of rumen degradable protein and OM truly degraded in the rumen.

Efficiency utilization of nitrogen

Although the high producing dairy cows are more efficient converting dietary nitrogen (N) in the feed to milk protein and contribute less emissions per kg milk to the environment than those who produce less milk (Flachowsky, 2002), they are not particularly efficient compared with other animals, especially pigs where the efficiency of N utilization could reach 40% (Nieto et al. 2002) and 48% in broilers (Nguyen et al. 2003). In dairy cows, the efficiency of conversion of feed N into milk N, ranging from 23 to 32% (Børsting et al. 2003; Castillo et al. 2000), depends largely on the stage of lactation. The N efficiency of cows at daily production levels of 30 - 50 kg milk, is generally around 30%, whereas cows with lower milk yields, cows in late lactation or dry cows have lower N efficiency (Kalscheur et al. 1997). Low efficiency of N utilization in dairy cows is largely due to the losses of N in urine and faeces (Castillo et al. 2001; Van Soest, 1994). Losses of N in urine are mainly caused by an oversupply of crude protein and/or an imbalance in the supply of amino acids. The amount of N excreted in faeces, however, is reported to be relatively constant in proportion to dry matter intake (DMI), about 7.5 g/kg DMI (Castillo et al. 2001) or 0.6% of dietary DMI (Van Soest, 1994). In some cases, increase of N in faeces might be a result of high amounts of undigestible feed protein (UDP) or undigested microbial N (microbial protein : 6.25) from the large intestine. Moreover, in normal practical rations for dairy cows both true digestibility of UDP and of microbial protein (MP) are high, suggesting that reduction of N excretion in the faeces does not appear to be a promising way for substantially reducing N losses from ruminants (Tamminga, 1992). Therefore, a more promising way to reduce N output is by reducing urinary N excretion (Castillo *et al*. 2001).

Environment pollution

Animal agricultural production systems are major sources of nonpoint pollution affecting quality of water sources (Williams, 1995). The major nutrients that are considered pollutants from agricultural systems are nitrogen (N), phosphorus, and methane (Kohn et al., 1997). Nitrogen has been identified as the foremost source of nonpoint water pollution (Thomann et al., 1994) and the potential negative impacts of N have become an area of public concern. Substantial efforts have gone into managing nutrients on dairy farms to maximize profit while reducing the risk of pollution to protect water resources (Lanyon, 1994). Nitrogen losses from dairy farming can be reduced through improvements in diet formulation (Tamminga, 1992; Kohn et al., 1995). Reducing dietary protein and increasing the efficiency of protein use within the cow can lead to reductions in N loss from dairy cows (Tamminga, 1992). The environmental impact of farming is of great public concern. As urban expansion continues to increase, farm land is turned into housing developments and shopping malls. Additionally, the human population continues to increase in size, in consequence, increasing the demand for agricultural commodities such as meat, milk, fruits and vegetables. However, as urban sprawl increases developments on fertile farm land, producers are left to generate high-quality products in less space. In the animal industry, this trend has lead to confined animal feeding operations where a large number of animals are housed in a relatively small area. A large amount of waste is generated from these feeding operations which must be handled in a safe and effective way as nutrients such as phosphorus and N contained in the waste may contribute to potential air and water pollution.

Conclusion

Synchronization of rumen available protein and energy is one of the conceptual methods to increase the efficiency of utilization of nutrients by the ruminants. A major energy source of organic matter is carbohydrate for microbial protein synthesis. The environmental impact of farming is of great public concern. As urban expansion continues to increase, farm land is turned into housing developments and shopping malls.

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