THE UTILIZATION OF SIMPLE COMPOUNDS OF NITROGEN BY RUMINANTS

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The utilization of dietary nonprotein nitrogen by ruminants is generally believed to take place through the symbiotic activity of micro-organisms in the rumen. Apparently the bacteria are the most active of the organisms in the rumen that utilize nonprotein nitrogen for the synthesis of their own cellular proteins. It has been suggested (Johnson *et al.* 1944) that protozoa normally present in the rumen feed upon the bacteria and finally that the host digests the micro-organismal protein derived from dead bacteria and protozoa. Thus, nonprotein nitrogen in the diet is changed to protein nitrogen that can be used by the animal for growth and production. Nonprotein nitrogen in excess of that required to nourish the rumen organisms is probably inefficiently utilized; some of it may be used in the synthesis of "dispensable" amino acids and other nitrogen compounds required for maintenance.

It has been further suggested that in addition to nonprotein nitrogen, a considerable amount of true-protein nitrogen of the diet is also converted to micro-organismal protein. The initial step in this conversion is probably hydrolysis of the dietary protein to simple compounds of nitrogen. Synthesis of protein from these compounds by micro-organisms would complete the transformation. As a result, the protein actually digested by the animal, therefore, would consist of this micro-organismal protein plus any dietary protein which escaped decomposition in the rumen. Possibly, when low-protein diets are fed, all of the protein that reaches the true stomach is of the former type.

Such a theory of protein metabolism, supported by experimental evidence of an indirect nature, has been offered to account for the fact that various feed proteins, regardless of quality, show about the same biological value when fed to ruminants. The same proteins when fed to animals with simple stomachs show different biological values.

In experimental studies, and recently in practice, urea and ammonium salts have been fed to ruminants as sources of dietary nitrogen (protein). As shown by analysis of rumen contents the first step in the conversion of urea to protein by rumen organisms is its breakdown to NH_3 (Mills *et al.* 1944). Experiments by English workers have shown that under proper conditions of incubation 100 g of rumen contents can convert 100 mg of urea to NH_3 in 1 hour (Pearson and Smith 1943). The enzyme urease appears to be involved. Attempts to separate urease from the bacteria of the rumen have been unsuccessful. Nevertheless, its presence is indicated by changes in activity with changes in temperature and pH, and by decreased activity in the presence of such inhibitors as quinone and NaF.

Evidence of the synthesis of protein from the NH_3 derived from urea has been obtained in experiments with animals with rumen fistulas. Equally good evidence of protein synthesis has been obtained by incubating rumen contents with urea for periods of from 2 to 4 hours. In the latter experiments conducted *in vitro* there was a rapid disappearance of urea and an accumulation of NH_3 during the first 30 minutes. This was followed by a gradual decrease in nonprotein nitrogen with a parallel decrease in NH_3 nitrogen. Total nitrogen remained unchanged during the period and protein nitrogen, computed by difference, increased. Protein synthesis, however, was accompanied by hydrolysis and under unfavorable conditions of temperature and pH the

amount of protein hydrolyzed exceeded that synthesized. The conditions of incubation and the presence of various substances determined which process predominated. The presence of starch in relatively large amounts was favorable for protein synthesis; other carbohydrates were less effective. Variable and incomplete results were obtained with additions of amino acids and protein. In general, these and other results indicate that synthesis of protein from urea nitrogen in the rumen is markedly affected by the composition of the entire ration.

In recent steer-feeding experiments conducted by the Department of Animal Husbandry urea has been fed by itself and in combination with hominy and molasses as a supplement to prairie hay. The apparent digestibility of the ration nutrients and the amount of nitrogen (protein) stored by the animals were determined during 10-day periods. The average value for nitrogen storage was negative, -14.4 g per day, when hay was fed alone and -0.8 g when urea was fed as a supplement at the rate of 89.4 g per day. In some instances nitrogen balances were positive during urea feeding. There was practically no change in the digestibility of hay constituents when urea was fed, consequently it appears that this improvement in nitrogen balance resulted from utilization of urea nitrogen, either directly or through the interaction of rumen organisms. There is the possibility, however, that the nitrogen of the hay was utilized in metabolism more efficiently when urea formed a part of the ration.

When approximately 89.4 g of urea were fed daily in combination with carbohydrates (hominy feed and molasses) nitrogen storage was further increased to about +3.4 g per day. However, the addition of this combination of urea and carbohydrates increased the digestibility of dry matter and crude fiber of the hay. It is possible, therefore, that when this supplement was fed a part of the observed increase in nitrogen storage resulted from increased digestion of nitrogen from the hay. Further studies of this problem are in progress.

LITERATURE CITED

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