THE USE OF NPN IN RATIONS FOR MILK PRODUCTION

BY

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C O N T E N T S

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INTRODUCTION

The problem of replacing proteins, as the main natural source of nitrogen in feeding dairy cattle, by the addition of urea to the feed of those animals, is of interest not only from the scientific but also from the economic point of view. This is because nitrogen is much cheaper if supplied in the form of urea, while proteins are among the most expensive constituents of natural feedstuffs.

On the other hand, the requirement of proteins is especially high in the dairy farm animals. A cow producing 4000 Kg. of milk per year, for example requires about 380 Kg. of proteins. Thus partial replacement of dietary protein by cheaper sources of nitrogen like urea seems to be of economical value in milk production.

Moreover, the use of urea enables economy to be practised in utilizing the natural proteins; this seems to be a problem of great importance considering the fact that human populations are constantly growing in numbers. If urea proves suitable for this purpose, its industrial production could be easily increased so as to cover entirely the demands of animal production.

At present, however, the value of urea for the physiological processes resulting in the formation of milk is an open question. There are some contradictions in the views of many authors on the value of urea for milk production. As far as the writer is aware, very little work has been reported on the value of urea in the rations of dairy Buffaloes.

Furthermore, it seemed of importance to use other sources of energy in the rations containing-urea taking into consideration the struggle between man and farm animals for feed.

The present work included the incorporation of urea into the rations of dairy Buffaloes to replace 35 or 50% of their protein requirements.

Also, rations containing high level of urea with crushed date stones or high level of molasses as energy sources for dairy Buffaloes were studied.

REVIEW OF LITERATURE

1. Fate of Dietary Nitrogen Compounds in the Rumen

There is no doubt that the rumen microorganisms play an important role in ruminant nutrition, particularly the utilization of non- protein nitrogen (NPN).

It is a well established fact that when urea enters the rumen, it is rapidly dissolved and hydrolysed to ammonia by the bacterial enzyme urease. The ammonia can then be utilized by the rumen microorganisms for synthesis of amino acids into microbial protein which are in turn available for digestion by the host animal. Amino groups are also split from amino acids and from intact proteins and used by the ruminal bacteria in the same manner (Reid 1953 and F.A.O. book 1968)

The extent of dietary protein breakdown in the rumen depends upon a number of factors of which the chemical and physical properties of the protein with special reference to its solubility in rumen fluid appear particularly important. Values found for the breakdown of dietary protein in vivo in the range from 40 % of the amount fed in the case of zein, which is sparingly soluble (Mc Donald, 1954) , to over 90 % for readily soluble casein (Mc Donald and Hall, 1957).

Moreover, it was found that up to 30% of the herbage nitrogen may be in the form of NPN (Ferguson and Terry, 1954). Thus, considerable amounts of the protein nitrogen fed to ruminants are, in fact, serving as a source of non-protein nitrogen for rumen microorganisms.

When ammonia is produced too rapidly in the rumen, it's concentration becomes too high and appreciable amounts are absorbed directly into the blood stream, reconverted to urea in the liver, excreted through the kidneys in the urine.

There is, however, always a small amount of urea in the blood stream and other body fluids. This urea finds its way into the saliva and re-enters the rumen (Fig.2.1). In sheep it has been estimated that 0.5gm. urea -N per day is introduced into the rumen with the saliva (Mc Donald, 1948). Very much larger amounts pass directly through the ruminal wall from the blood stream (Houpt, 1959 and 1970; Decker, Gartner, Hornicka and Hill, 1961). A result of the secretion and hydrolysis of endogenous urea is that the animal is able to maintain a low but significant concentration of NH_3 in the rumen, even when it is starved. This is to advantage in aiding the survival of the ruminal bacteria until food is available again.

Samples of rumen ingesta taken from the gastric fistula of a steer were used in studies in vitro to invistigate its action on urea (Pearson and Smith , 1943). They concluded that all of the urea which would ever be likely to be fed to a cow will be converted to ammonia within an hour. The urease preparation derived from the rumen contents was found very similar to that from soya or jack beans in its behaviour to temperature, P H and enzyme inhibitors.

Agrewala, Duncan and Huffman (1953) fed to calves a purified diet with urea as the only source of nitrogen;

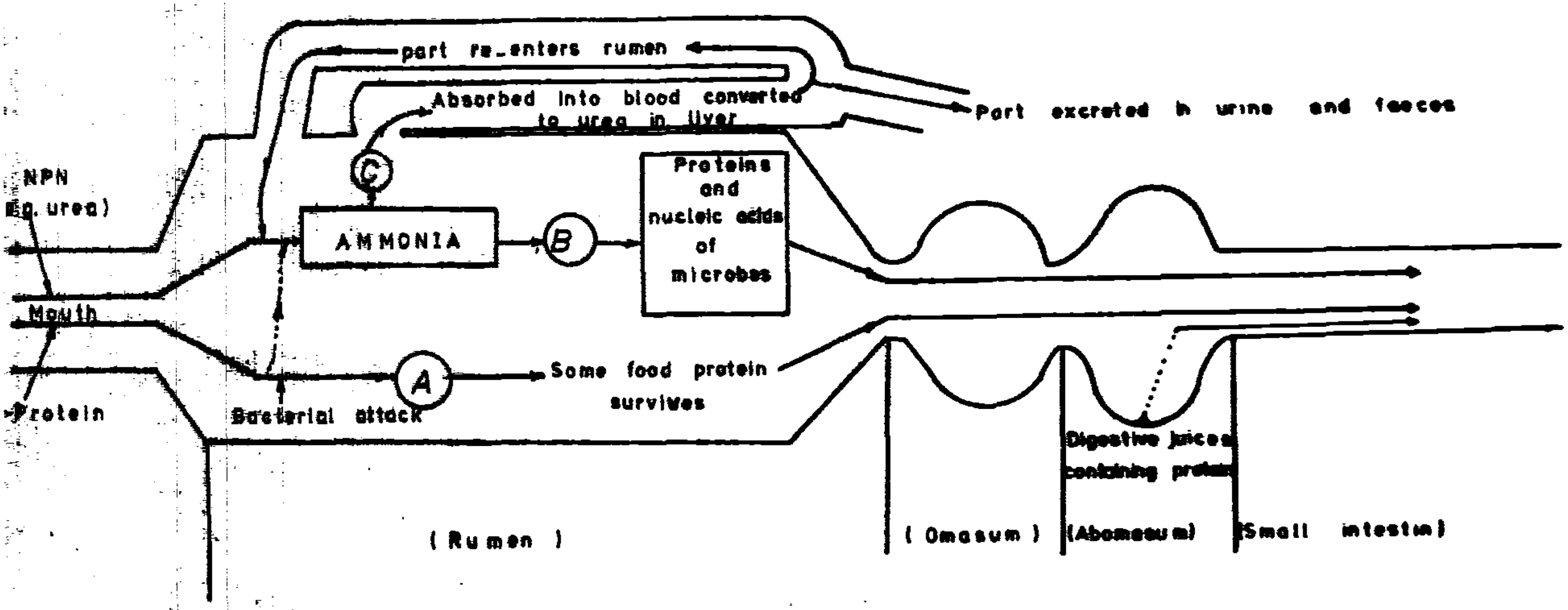

Fig. 2.1. *Diagramuratic representation of ruminant stomacks and fate of dietary nitrogein compounds.*
(From Fonnesbeck ,Kearl and Harris ,1975)

within 6 hr. after feeding, about 55-109 gm. of protein were synthesized in the rumen. Bryant (1968) found that high producing Holstein cows might produce 3.5 - 4.0 Ib of microbial protein daily; any remaining requirement of protein would have to be met from dietary protein passing directly through the rumen without being broken down by microbial attack .

11. Factors Affecting Urea Utilization

1. Influence of Carbohydrates

The ability of ruminal bacteria to utilize NH_3 depends on the simultaneous availability of other nutrients required for the synthesis of their cellular constituents. The most important are suitable and easily available sources of carbon and energy. These are normally provided mainly by the carbohydrates in the diet. A readily fermentable carbohydrate is required for the utilization of N P N and that cellulose and the other carbohydrates present in roughage will not serve the purpose (Mills, Booth, Bohstedt and Hart 1942, Mc Naught and Smith, 1947 ; Reid, 1953; Loosli, 1958).

When glucose or starch is added, the uptake of NH_3 by the bacteria is very much more rapid than when roughage alone is present. This makes the addition of readily fermentable carbohydrate desirable when NPN supplements are fed in a form in which large amount of NH_3 are rapidly produced in the rumen. By increasing the rate of utilization of NH_3 so that it matches the rate of amino acids formation, the carbohydrate reduces the concentration of NH_3 in the ruminal fluid and so decreases the amount lost from the rumen and lessens the danger of toxicity to the animal. If, however, NPN can be given in such a way that NH_3 is released slowly (as NPN in biuret form), the need for supplementation with readily fermentable carbohydrate is greatly reduced, as shown by Hemsley and Moir (1963). Mc Donald (1952); Wetterau Schlegel and Kolssohuh (1964) found that when starch and cereal grains are included in the ration with urea, a rapid reduction of rumen ammonia concentration was observed, suggesting that the starch and cereal grains provided energy needed by the rumen flora to utilize the ammonia.

When labled ammonium sulphate (N^{-15}) and urea were the only sources of N in an experimental diet which consisted of 46 to 62% of total carbohydrates as potate starch, 24 to 38% cellulose and 15 to 23% sucrose, the milk yield was not affected and the efficient utilization of ammonia and urea in the rumen of these cows was related to the presence of large amount of soluble carbohydrate in the NPN diet (Virtanen 1968).

It is also frequently stated that starch is more effective in promoting NH_3 utilization than are soluble sugars. The evidence for this rests largely on the in vivo experiments of Mills, et al; (1942), Mills, Lardinois, Rupel and Hart, (1944) and Lewis and Mc Donald (1958), and the in vitro studies of Pearson and Smith (1943) and Mc Naught (1951). The superiority of starch is attributed to the fact that it is less rapidly fermented than sugars, which disappear from the rumen so quickly that they are unavailable to the bacteria except for a very short time.

2. Level of Protein Intake

The efficiency with which urea is utilized by ruminants and the amount of protein that can be replaced by urea have been found to depend on the protein level of the ration. It has been found that if the protein content of the feed is too high, NPN supplements are utilized poorly or not at all. Krebs(1936) found that when the ration contains an ample amount of true protein, urea utilization is lower than with rations low in protein, as far as the synthesis of bacterial protein from NPN in the rumen is apparent only when protein intake is low. This is explainable on the basis that the protein alone provides more than sufficient NH_3 for the requirements of the bacteria .

On the other hand, protein type can affect urea utilization. Mc Naught and Smith (1947) pointed out that when insoluble protein is fed to ruminants, the amount of ammonia formed from this protein is small and this might favour a more efficient utilization of urea. Mc Donald(1952), demonstrated that when zein was fed, there was very little increase in the ammonia content in the rumen, but when casein or gelatin was fed, large amounts of ammonia were liberated.

3. Effect of Sulphur

An adequate supply of sulphur is required for the incorporation of NH_3 into sulphur-containing amino acids. Thomas, Loosli, Williams and Maynard (1951) found that urea nitrogen was not retained by sheep on a sulphur-deficient diet. Addition of sulphate to the ration resulted in a positive nitrogen balance.

Davis, Williams and Loosli (1954) reported that, on rations low in sulphur and high in urea content, the addition of sulphate can be desirable. When lambs were fed a purified diet containing urea as the only source of nitrogen, without sulphur supplementation, animals lost body weight and were in a negative balance for both nitrogen and sulphur. The same diet supplemented with sulphates supported positive balances and weight gains (Thomas et al. 1951). Kuganev and Rasnokhnin (1970,1971) found that the addition of 10 gm. methionine to a daily winter ration containing 216 gm. urea fed to dairy cattle resulted in an increase in casein and fat content of the milk, due to the increased numbers and activity of bacteria in the rumen.

On the other hand, Matruo and Ushizima(1957) concluded that the addition of 10gM. sulphur /cow/day fed 130 or 150gm. urea daily, did not significantly increase milk yield, butterfat content or liveweight, but the addition of 5gm. methionine did significantly increase the milk yield. Similarly, Burgess and Nicholson(1971) fed 24 lactating Holstein and Ayrshire cows for 120 days on an average quality roughage containing 127mg S/gm. and three grain mixtures(2,82,4.08 and 5.48 mg S/gm)containing 2% urea . They found that mean daily intakes of hay D.M were 2.73,2.51 and 3.44 kg /100kg bodyweight, respectively. The corresponding values of 4% FCM yield were, 14.6 and 14,8 kg/cow/day. Differences among values of feed intake and FCM yield were not significant. Averages of bodyweight gain were 0.28,0.20 and0.22kg/cow daily. A nutrient balance trials with 4 cows ineach treatment indicated no consistent relationship between in-amount of dietary S and N or S balance. They concluded that sulphur supplementation was not required for dairy cattle fed locally grown hay and grain mixtures containing 2% urea.

It is now accepted that the bacterial protein found in the rumen is deficient, at least quantitatively, in sulphur amino acids such as methionine. Thus, the addition of sulphur of methionine increased the nitrogen retention of urea fed animals(Starks,Hale,Garrigus,Forbes,and James 1954 anddThomas et al.,1951)

4. Frequancy of Feeding

It is theorisdd that more frequent feeding maintains a constant level of available energy in the rumen thus parallel the release of ammonia from urea with the synthesis of a mino acids in the rumen. Another approach for the proper utilisation of urea has been to delay feeding of the urea portion of the ration to coincide the period of energy released in the rumen.

The effect of frequency of feeding on NPN utilisation could be illustrated by the experiment of Broom (1968). He fed five groups of ten animals each on ad lib. a basal barley/mineral/vitamin diet throughout the day to provide a backgroud of constant energy in the rumen. Against this background the same amount of supplementary nitrogen in the form either of soyabean meal or urea (2%) was provided; continously(by incorporation into the barley) or at a single limited period each day(as a protein of the concentrate). Results(Table 2.I) indicate significantty higher levels of protein nitrogen in the rumen liquor of animals receiving supplementary nitrogen throughout the day. Also of interest is the fact that urea gave rise to similar amounts of protein in the rumen liquor as did soyabean meal.