NPN AS A WAY OF SAVING PROTEIN FEEDS FOR RUMINANTS, INCLUDING AMMONIA TREATMENT OF FIBROUS RESIDUES

by

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Reduction of the import of high cost protein feeds is an important object for the Hungarian economy as well as for the economy of some developing countries. With this objective in mind I will discuss the research done in our Institute to attempt to increase the efficiency of utilization of protein and non-protein nitrogen by cattle.

In Hungary, beef production is based largely on diets based on corn silage, usually supplemented with urea (the "Unicarb" preparation is the most widely used - see Szentmihályi 1985). Unicarb contains corn meal urea, a small amount of vegetable protein meals, minerals and other additives, such as vitamins, growth stimulants and monensin which are mixed and extruded. The urea is thus thoroughly mixed with the gelatinized corn starch. Urea fed in this way minimizes the risk of ammonia toxicosis. The extruded material is apparently palatable. Heat treatment may also decrease the solubility and ruminal degradation of the proteins of the mixture, which increases the content of bypass protein and the lowered protein degradation in the rumen facilitates the utilization of urea.

In our fattening system, bulls weigh between 200 and 500 kg liveweight and consume an average 6 kg dry matter daily from the corn silage (35% DM). This feed is imbalanced and needs to be supplemented with protein and some energy.

By comparing feed proteins both before and after extrudation, we found 25% reduction in ruminal protein degradation. The value of degradability was used for the calculation of urea fermentation potential. Urea (and Ca, P, S and micro-elements) supplementation of the concentrate was performed according to the urea fermentation potential, by taking into consideration the intake of 18 kg corn silage. By feeding of 2 kg of Unicarb the high quality corn silage is adequately supplemented with fermentable N and minerals. This ration contains nutrients for maintenance plus 1300 g/d average gain during fattening from 200 to 550 kg liveweight. An advantage of the system is the saving of protein meal and cereal grains, the simple and safe use of urea and the economy of fattening.

Table 2 shows the results of an experiment performed in practical conditions. The data indicates that corn silage and Unicarb alone supported 1 300 g daily gain and good feed efficiency. The group consuming 4 kg/d concentrate and 2 kg/d hay had a somewhat lower growth rate and feed conversion rate due primarily to the hay. The cost of the relatively expensive extrudation process should be rapidly returned. The cost of feed required for 1 kg weight gain was 14% lower in the group fed with Unicarb than in the controls. A significant advantage of this fattening technology is that it produces 1 000 kg body weight from a 16% less cultivated area, than the earlier method, and saves 700 g protein feed per kg weight gain.

Another widely used urea preparation which does not require complicated technology is the "Bentocarb-30".

Different amounts of the preparation were administered to fistulated sheep. The well-known "Starea" preparation, containing steam-treated corn with urea, was used as standard.

When Starea was administered, ruminal pH values fell to about 6, after a temporary increase. Urea concentration varied between 8 and 20 mmol/litre. Lactic acid and VFA levels rose markedly; the latter was still elevated after 3 hours.

The Bentocarb-30 preparation uses bentonite for the absorption of ruminal ammonia with a binding capacity of 6 to 12 mg ammonia-N per gram bentonite (Bartos et al, 1982). The bound ammonia is released if the ruminal ammonia concentration begins to decrease. Bentocarb-30 stabilized the rumen pH very well (between 6.2 and 6.6). Urea concentration varied between 20 and 26 mmol/litre and that of ammonia between 20 and 60 mmol/litre. The level of lactic acid and VFA increased moderately. Starea and Bentocarb-30 enhanced the production of propionic acid and increased blood sugar level moderately; the concentration of serum urea nearly doubled. The ammonia level rose from 90 to 250 or 300 umol/litre in the blood in the first 4 hours.

The experiments showed that both preparations meet the needs: ruminal hydrolysis of urea became slower and the ammonia concentration did not reach toxic level in the blood with any of the doses used. Bentocarb-30 is a safe urea preparation which can be mixed with protein-deficient feeds without difficulty.

It is important to note that the fermentative production of acids may be imbalanced with respect to the release of ammonia and the animal tries to compensate with an enhanced excretion of sodium. It is advisable, therefore, to provide the animal with more sodium than usual, if urea preparations are fed.

The results of feeding "Bentocarb-30" 50% corn to growing lambs is shown in Table 3.

Bentocarb-like preparations containing urea adsorbed to bentonite or zeolite may be produced and used for the substitution of protein feeds in the developing countries as well.

Where the climate is adequate for rice production, the large amounts of rice hulls can be used in sheep and cattle nutrition especially in countries with an insufficient feedstuff supply. Rice hulls (RH) are removed from the grain at the mill and represent approximately 20% of the unmilled rice. Three different diets were fed to lambs in three consecutive trials (Table 4). The RH used in this study contained 93% dry matter, 5% crude protein, 0.8% crude fat, 39% crude fibre, 33% nitrogen-free extract, 0.9% silica-free-ash and 14% silica.

The increase in the silica content of the diet from 6 to 31 g/day was associated with an increased silica concentration in the rumen. The soluble silica was absorbed and excreted in the urine and the undissolved silica was excreted with the faeces.

After 110 days of feeding RH to lambs, there was no increase in the blood silica concentration. When the urinary tracts of the carcasses were examined no calculi were found.

When 200 g barley straw was substituted by rice hulls, digestibility of the dry matter decreased by 10%, but the addition of urea increased it by 20%, resulting in higher values than for the original ration. The improvement was most marked in the fibre fraction (Table 4). The data in this experiment confirm that RH can be used as a component of the diet of ruminants.

It was concluded that RH was deficient in nitrogen, thus restricting bacterial growth. When supplementary nitrogen (urea) was added, it stimulated bacterial growth in the rumen and increased the utilization of RH.

Ammonia treatment of fibrous residues

The basal feeds available to ruminants in developing countries are largely the fibrous residues of crops. Where the basal feed is of low digestibility, the major constraint to production is usually the feed intake restricted by inadequate rumen function. This is why Preston and Leng (1984) pointed out the importance of an adequate supplementation and discussed several possibilities (e.g. the use of molasses-urea blocks). In Hungary, and in many developing countries, molasses is used for alcohol production. Starch-rich cereal meals supplemented with urea can be used instead to stimulate the growth and cellulolytic function of rumen bacteria.

Another way to solve the dual problem of N-supplementation and the degradation of lignocellulose is to ammoniate the fibrous basic feed.

Direct ammoniation to increase NPN content of straw is not widely used because of the difficulties and hazards of handling anhydrous ammonia and the need to enclose the straw for treatment and subsequent storage. Ammonia is retained mostly in the aqueous phase of the straw and much less is taken up by the drier material. Indirect ammoniation is performed by adding urea to the straw during storage to elevate its NPN content.

Urea is readily available, safe and easy to handle and the non-hydrolyzed residues remain in solid form or in aqueous solution. Urea-treated straw does not need to be covered.

The Hungarian experiments (Table 5) are based partly on earlier GDR experiences. The long straw was piled up in heaps, covered with a plastic sheet and treated with anhydrous ammonia. The treatment resulted in higher intake, better digestibility, more daily gain and the feeding of 30% less concentrate.

Although treatment with urea improved digestibility less readily than did direct ammoniation, it resulted in higher feed intake and, therefore, the daily gains did not much differ. In addition, the chemically treated straw can be stored for a longer period than the untreated one. Similar results were obtained with chopped straw as with long straw. Our results agree quite well with those of Wanapat et al. (1983), who fed water buffaloes with rice straw treated with urea. In their experiment the treatment increased feed intake (4.77 kg to 6.14 kg.), organic matter digestibility (58% to 65%) and daily gain (-383 g to +136 g).

As splitting of urea to ammonia does not require aerobic conditions, urea treatment may be a substitute for ensiling in conservation of feedstuffs not readily compacted or having high buffering capacity (e.g. green leguminose plants). Urea treatment of straw may be used as a simple method for use in the developing countries.

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Table 1: Growing-bull fattening trial

	Control	Experimental
Daily feed intake (Kg/d)		
Corn silage	12.1	19.7
Alfalfa hay	2.0	-
Concentrate	4.0	-
"Unicarb"	-	2.0
Total DM	9.3	8.6
Liveweight (Kg)	15	12
Starting	206	215
Finishing	556	554
Daily gain	1.22	1.30
Used for 1 Kg weight gain		
Feed DM (Kg)	7.6	6.6
Feed cost (%)	100	86

Table 2: Effect of different levels of "Bentocarb-30" on performance of lambs (20 to 30 kg liveweight)

		(g/kg liveweight)		
Urea from Bentocarb-30	0	0.3	0.4	0.5
Daily gain (g)	224	251	254	253
Feed conversion	7.09	6.86	6.82	6.69

Table 3: Rice hulls in the nutrition of lambs*

	Barley straw	Rice hulls	Rice hulls + urea
Silica in feed (g/d)	6.0	31.0	31.0
Silica recovery in faeces (%)	98	99	90
Silica in rumen liquor (mg/100 ml)	9.2	18.0	21.1
Silica in blood SiO_2 (mg/100 ml)	0.40	0.97	0.30
Silica recovery in urine (%)	0.97	0.42	0.39
Digestibility (%)			
Dry matter	71	64	77
ADF	30	3	25

*Each diet contains 600 g barley and 200 g straw or RH

Table 4: Treatment of straw with ammonia or urea (wet ensiling) for the feeding of growing bulls

	Long straw*		Chopped straw*	
	NH_3	urea	NH_3	urea
	Relative values (control = 100)			
OM digestibility	123	115	118	116
DM intake	127	139	125	145
LW gain	150	162	142	171

*On long and chopped straw OM digestibility (%) was: 43 and 45; DM intake (Kg/d): 3.4 and 4.2; daily LW gain (g); 423 and 476; conversion: 4.7 and 4.2