The Technical Edge

Biuret has Practical Applications in Beef and Dairy Rations

Biuret

Feed grade biuret, an economical source of non-protein nitrogen (NPN), is an ADM Alliance Nutrition® exclusive. It can be used in ruminant diets and is approved for use in dairy lactation diets. Prior to May 2003, biuret was not approved for use in dairy rations. ADM was instrumental in getting biuret approved for use in dairy rations. Numerous research articles were reviewed and summarized. On May 27, 2003, ADM received an approval letter from the Food and Drug Administration (FDA) allowing biuret to be formulated into dairy rations.

Biuret is formed by the controlled decomposition of urea, condensing two molecules of urea into a single molecule of biuret, which retains three of the nitrogen atoms (see Figure 1). Feed-grade biuret is a mixture containing biuret and urea (maximum of 14%) with small amounts of triuret and cyanuric acid. Typically, biuret contains a minimum of 35% nitrogen with a crude protein value of 246% (See Table 1).

Biuret is less soluble than urea. The combination of structural and physical characteristics slows the rumen digestion of biuret. The *in vitro* ammonia release for biuret was similar to that of soybean meal (SBM); whereas, ammonia production from urea was markedly more rapid (see Figure 2; Bartle, et al.,1998). Similar results were observed for blood serum ammonia, when biuret and urea were compared with SBM in beef feedlot diets (Bartle, et al., 2000).

The slower release of ammonia from biuret makes it a safe source of nitrogen for ruminants grazing forages and for cattle fed in confinement. The slower degradation and physical properties assist in forming a high-quality, self-fed supplement. Biuret is at least 7.3 times less toxic than urea, making it ideal when using higher levels of NPN and in self-fed applications. Up to 15 g/lb of body weight of biuret supplementation have not produced toxic effects, while much lower levels of urea supplementation have resulted in death (Table 2 on the next page). Another advantage of biuret is that it is less hydroscopic (attracts less water) compared with urea. Pellets containing biuret are less likely to cake and bridge compared with pellets containing high amounts of urea.

Table 1 Nutrient Composition of Biuret

Item	% AF	% DM
DM, %	99	–
Protein, %	246	248.5
RDP, % CP	100	100
SIP[1], % CP	100	100
NPN, % SIP	100	100
NRC, 2001 A Protein, % CP	100	100

[1]For use in formulation; biuret is slowly soluble.

Figure 1 Chemical Composition of Biuret

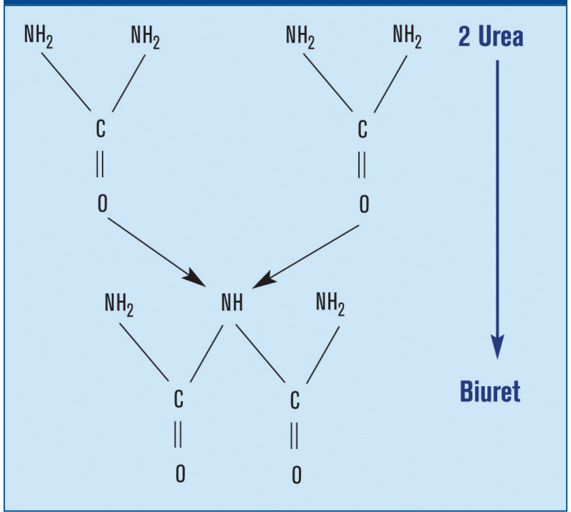
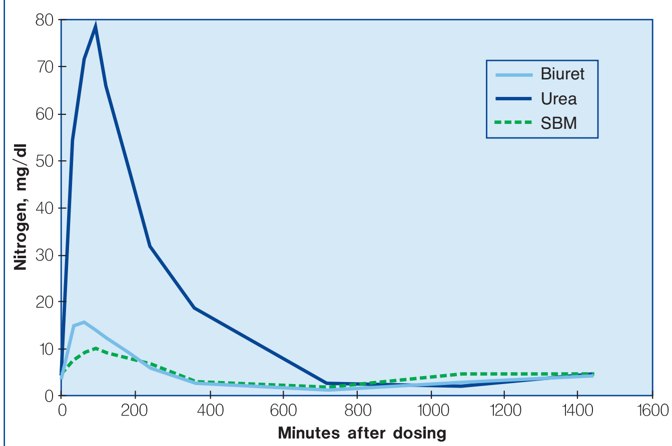


Figure 2 Rumen Nitrogen Release from Biuret, Urea, and Soybean Meal



Source: Bartle (ADM Alliance Nutrition), Ludden, and Kerley (University of Missouri), 1998.

Table 2 Biuret and Urea Toxicity

	Animal	Dosage (g/lb BW)	Result	Source
Urea	Sheep	0.49	Death	Clark et al., 1951
Urea	Sheep	1.94	Death	Repp et al., 1955
Urea	Cattle	0.68	Death	Davis and Roberts, 1959
Biuret	Sheep	15.2	None	Clark et al., 1963
Biuret	Sheep	12.1	None	Clark et al, 1965

Range Feeding

Biuret's slow-release of nitrogen provides a safe and sustained supply of ammonia that is well suited for microbial digestion of lower quality forages. *In vitro* work conducted by ADM Alliance Nutrition research showed biuret improved cellulose digestion from 36.7% for the controls (no supplemental nitrogen) to 53.78% for biuret. These observations are supported by Loest and coworkers (Kansas State University) who evaluated the effects of non-protein nitrogen on the intake and digestion of steers fed prairie hay. Steers fed a cooked molasses block containing 60% crude protein (83% from urea or 42% from urea and 42% from biuret) had a 22% increase in forage intake and a 52% increase in digestible organic matter intake compared with non-supplemented cattle. These improvements in forage digestion and intake should result in better cattle performance.

In a 105-day winter feeding trial, researchers at Montana State University (1996) compared cooked molasses blocks containing 18% crude protein versus blocks containing 42% crude protein with the additional crude protein supplied by biuret. Cows receiving the 18% cooked molasses blocks lost an average 62 lb/hd and body condition score (BCS) decreased by half a point. Cows receiving the biuret supplement maintained body weight and BCS.

Feedlot Feeding

Biuret's physical properties enable it to be utilized in situations where a NPN "safety" factor is desired in the feedlot. Ammonia toxicity most often occurs when hungry cattle are fed high-urea supplements for the first time. Mixing and weighing errors when using high-urea supplements can also increase the likelihood of urea toxicity. Work conducted at the University of Minnesota on feedlot finishing diets indicated that biuret supported gains equal to urea supplemented cattle. A study at ADM Alliance Nutrition facilities confirmed these studies – cattle supplemented with biuret gained 3.15 lb/hd/day compared to urea supplemented cattle that gained 3.09 lb/hd/day.

Biuret Usage in Beef Summary

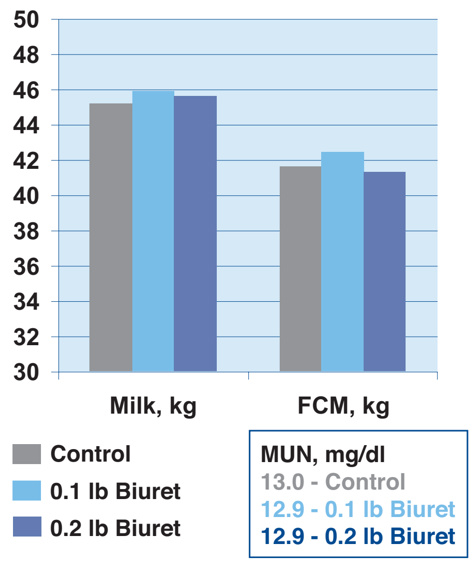
Biuret's physical properties enable it to be utilized in situations where grazing cattle are fed low-quality, low-energy forages or in feedlot situations where a NPN "safety" factor is desired. The slow-release of nitrogen from biuret is better matched to the energy in the diets of cattle consuming low-quality forages, thus improving the utilization of forage and reducing the metabolic cost of eliminating excess nitrogen in urea-based diets.

Biuret Usage in Dairy

Research on biuret as a feed ingredient was performed in the late 1950s through the 1970s, mostly in beef cattle diets, where biuret has been used for many years. A small amount of work involved biuret in dairy feeds where biuret was substituted for true protein. This was before the concepts of rumen degradable protein (RDP) and rumen undegradable protein (RUP) were in practice, and at lower production than is common today, but milk production was unaffected by use of biuret (Fonnesbeck et al., 1975).

ADM Alliance Nutrition research has evaluated the use of biuret in lactating diets (see Figure 3). Approximately 0.5 and 1 lb/head/day of soybean meal was replaced by about 0.1 and 0.2 lb/head/day of biuret. Diets were equal in crude protein and predicted RUP. Feeding biuret did not affect milk production or milk composition of the higher production animals. Milk urea nitrogen (MUN) was similar for each treatment. In the lower producing cows, milk production was unaffected by biuret use, but when receiving 0.2 lb/head/day biuret, MUN was elevated and fat content was reduced. The connection between the high MUN and depressed fat is unclear, but is sporadically reported in the literature in studies focused on RDP feeding. With appropriate balancing of RDP and RUP, biuret was an effective substitute for degradable true protein in these lactation diets.

Figure 3 Lactation Performance of Dairy Cows Receiving Biuret



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Dairy Recommendations

Nutritional Models: Biuret is unique as a slowly soluble source of NPN. Biuret has a slightly greater ammonia release rate than SBM. Using biuret in NRC 2001 CPM or CNCPS models presents descriptive challenges. As a source of NPN, it fits biologically into the definition of the "A fraction" as a source of ammonia. However, the assumption is made that NPN is immediately available to the rumen, which is incorrect for biuret. The "B fractions" of the models characterize a true protein that supports rumen peptide effects in the CPM and CNCPS models. The "B fractions" also predict the dietary RUP and, thus, metabolizable protein available to the animal. While ammonia release rates of biuret are similar to SBM, the NPN conversion to urea and ammonia does not fit the assumptions of true protein within the models.

Currently, biuret is best incorporated in models as an NPN ingredient. In the case of NRC, this means inclusion into the vitamin-mineral category to avoid affecting energy equations. Within the CPM and CNCPS models, the nitrogen would be 100% SIP and 100% NPN to avoid affecting bacterial efficiency via the peptide equations.

Rumen Balance: Because of the broad spectrum of forages and ingredients available, recommendations for RDP are general guidelines. In general, RDP should be from 10.5% to 12% of diet dry matter (DM) to maximize rumen bacterial yield. To meet the demands beyond ruminal supply of metabolizable protein (MP), the remainder of the protein delivered will be RUP (6-7% of DM). Below 10.2%, RDP may limit rumen efficiency. Soluble protein will typically range from 5.5 to 6.5% of DM. Protein fractions may also be expressed as a percentage of total dietary crude protein (CP), in which case, RUP will range from 32-40% of CP and soluble intake protein (SIP) from 20-30% of CP. Practically, RUP balance will be most beneficial from 34-38% of CP. Biuret should be included in the SIP fraction, and the SIP values can float towards the upper end of the range. Historical recommendations for dietary NPN levels are 1% of diet DM to avoid intake concerns.

Intake: Biuret should be treated as a source of NPN relative to intake. There is little data to support improved palatability of biuret compared with urea. Levels of NPN should not exceed about 1% of the diet to avoid intake concerns. In practice, this will be affected by the balance of RDP in the diet and management. Within concentrates, the recommendation is typically 1.5% NPN to avoid palatability concerns.

Carbohydrates: Biuret will be less sensitive to inclusion of rapidly fermented carbohydrates than urea. Use of NPN is typically most effective when balanced against rapidly fermenting carbohydrates to capture the nitrogen in bacterial protein. Molasses and sugar supplements and refined starches (bakery waste, ground high-moisture corn, etc.) have typically been increased with urea feeding. With a slower release, biuret will be effective with ground corn and non-forage fiber sources as well.

With Urea: Combinations of biuret and urea will likely be desired to maximize NPN in diets to reduce protein cost when faced with combinations of sugar, finely ground high-moisture corn, and the more rapidly fermented, processed corn silages. In field practice, for diets having more fermentable energy sources, a 50:50 ratio of urea and biuret may be reasonable, with the amount of biuret rising as the level of NPN is increased and SIP raised beyond 33% CP (see Table 3).

Minerals: The level of sulfur needs to be reviewed in rations with added NPN. A dietary ratio of between 10:1 and 12:1 of nitrogen:sulfur is commonly recommended (target 11:1), which would equate to about 0.23-0.25% sulfur. With a longer time for rumen availability, there is the potential to impact digestion of non-forage fiber sources, such as soyhulls as well, so supplemental cobalt should be considered to maximize the efficiency of the cellulolytic bacteria.

Table 3 Maximum Levels of Added Urea and Biuret in Lactation Diets

Ration SIP, % CP	lb/cow/day	
Before NPN Addition	Urea	Biuret
> 38	0.00	0.00
36 to 38	0.00	0.05 to 0.15
33 to 36	0.05	0.10 to 0.20
30 to 33	0.10	0.10 to 0.25
27 to 30	0.15	0.15 to 0.25
< 27	0.20	0.15 to 0.25