A Comparison of Biuret and Soybean Meal to Support Nitrogen Balance in Growing Lambs

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Story in Brief

Previous studies have shown that rumen microorganisms can hydrolyze biuret to ammonia. Development of this ability requires a variable adaptation period affected by nature of the ration, level and regularity of exposure to biuret.

In the present study, a new nitrogen depletion-repletion technique was utilized to determine the biological value of biuret-N for growing lambs. Soybean meal (SBM) supported the highest N-balance (3.9 g/day) but this trait was also positive for biuret (2.4 g/day). Small additions of dehydrated alfalfa meal or SBM to the biuret rations appeared to improve N-balance from this NPN source but not significantly so. N-balance increased with time on all rations but most notably on the biuret rations, indicating an adaptation phenomenon.

Introduction

Previous studies in this laboratory have shown that the microbial population in the rumen of sheep and cattle undergo an adaptation when exposed to biuret in the ration which enables them to hydrolyze the biuret to ammonia. Thus, biuret represents an NPN source which is more slowly hydrolyzed and less toxic than urea. Numerous factors affect the length of time required to complete this adaptation including proportion of grain in the ration, level of biuret feeding and frequency of biuret feeding. Limited studies suggested the presence of some dehydrated alfalfa meal also might decrease the time required for adaptation.

The previous trials were conducted with fistulated animals using laboratory or *in vitro* techniques to demonstrate the adaptation. The study reported here was designed to compare the ability of biuret and soybean meal to support nitrogen balance in growing lambs. Further, the influence of low levels of dehydrated alfalfa meal (Dehy) on N-balance with biuret was studied.

Materials and Methods

A procedure of depletion-repletion, recently tested in ruminants by Dr. J. E. Evans in New Jersey, was utilized for this study. This procedure involves placing a growing animal on a severely N-deficient ration for several weeks followed by several weeks of repletion on the N-adequate or test diets. Nitrogen balance and digestibilities are monitored continuously throughout the trial.

Sixteen growing ram lambs weighing approximately 60 lbs. at the initiation of the trial were placed in metabolism crates equipped for separate collection of urine and feces. Prior to their placement in the crates, all lambs had been fed a standard laboratory carrying ration adequate in known nutrients. A nitrogen depletion ration shown in Table 1 was fed to all lambs for three weeks. During this depletion phase, three 7 day urine and fecal collection periods were conducted consecutively to monitor N-balance. Following the depletion phase, the lambs were allotted randomly to the four repletion rations also shown in Table 1. The soybean meal ration served as a positive control (Ration 1).

In ration 2, pure biuret was substituted entirely for the SBM on an isonitrogenous basis. Ration 3 contained 10 percent dehy with the remainder of the supplementary-N coming from biuret. To determine whether a dehy effect might simply be due to the additional natural protein provided, ration 4 contained an amount of N equivalent to the

Table 1. Composition of Rations

Ingredient	Depletion Ration	SBM	Biuret	Biuret + Dehy	Biuret + SBM
		%, as is basis			
Cottonseed hulls	35.0	35.0	35.0	30.0	35.0
Molasses, dried	10.0	10.0	10.0	10.0	10.0
Corn Starch	20.0	20.0	20.0	20.0	20.0
Ground corn	33.5	20.5	31.2	26.7	27.9
Soybean meal	–	13.0	–	–	3.9
Dehydrated alfalfa	–	–	–	10.0	–
Biuret	–	–	2.3	1.8	1.7
Dicalcium Phos.	0.5	0.5	0.5	0.5	0.5
Limestone	0.5	0.5	0.5	0.5	0.5
T.M. salt	0.5	0.5	0.5	0.5	0.5
Vitamin A	1.25 g/100 lb →				
Vitamin D	0.5 g/100 lb →				

dehy in ration 3 as SBM, with the remaining N as biuret. During the repletion phase, 5 consecutive seven-day collection trials were conducted.

Feed, feces and urine were collected, stored, sampled and analyzed by standard techniques for moisture, ash, cellulose and nitrogen. Blood samples were also collected weekly from each lamb for determination of serum protein.

Results and Discussion

Digestibilities of ration constituents and nitrogen balance during the depletion phase are shown in Table 2. There were no significant changes in any of these traits during the progress of the depletion. Digestibilities of both cellulose and nitrogen were low (about 24 percent) which would be expected with this type of ration. Serum protein did not decrease during the depletion.

Data for the same measurements determined during the repletion phase are presented by period for the five seven-day periods in Tables 3 and 4. There were no significant effects due to N-source or to period in either dry matter or organic matter digestibilities even though digestibility of the SBM appeared to be higher than the others. Digestibility of cellulose was significantly higher ($P<.05$) in the SBM ration than in the other rations, however. In considering this effect it should be noted that all rations contained equal amounts of N. Thus, the N in the biuret rations was apparently not supporting cellulose digestion to the extent that was supported by SBM. Although it is known that a variable period of time is required for the rumen microorganisms to adapt to biuret, no adaptation is apparent in this cellulose digestion data since there was no

Table 2. Digestibilities, N-balances and Serum Proteins During the Depletion Phase.

	DMD[1]	OMD	CD	ND	N-Bal	Ser-Pro
	%	%	%	%	g/day	g %
Period 1	65.6	66.9	30.2	23.5	0.005	5.19
Period 2	64.8	65.7	21.5	23.2	—0.010	5.19
Period 3	64.4	64.9	22.4	23.4	0.163	5.54
$\bar{x}$	65.0	65.9	24.3	23.4	0.054	5.30

[1] Abbreviations used in this and subsequent tables are DMD=dry matter digestibility, OMD=organic matter digestibility, CD=cellulose digestibility, ND=nitrogen digestibility, N–bal=nitrogen balance, Ser – Pro=serum protein.

Table 3. Digestibility of dry matter, organic matter and cellulose during the repletion phase.

Item	Period	Ration 1 SBM	Ration 2 Biuret	Ration 3 B-Dehy	Ration 4 B-SBM
		%	%	%	%
Dry matter	4	68.8	56.6	61.7	60.4
	5	68.7	59.9	64.0	65.3
	6	67.1	63.5	68.1	62.1
	7	70.6	65.9	62.8	62.1
	8	66.9	60.0	63.1	63.1
	$\bar{x}$	68.4	60.8	63.9	62.6
Organic matter	4	69.8	56.9	62.5	61.4
	5	65.7	60.1	64.4	66.0
	6	67.8	64.5	68.8	63.3
	7	71.4	61.3	63.7	62.8
	8	67.9	59.6	64.3	65.0
	$\bar{x}$	68.5	60.5	64.7	63.7
Cellulose	4	51.7	15.4	31.2	27.9
	5	51.0	23.7	34.8	37.9
	6	49.7	30.5	43.0	29.9
	7	56.4	26.6	29.8	31.0
	8	49.2	20.3	30.3	36.2
	$\bar{x}$	51.6^1	23.3^2	33.8^2	32.6^2

[1,2] Means with unlike superscripts are significantly different ($P \leq .01$).

significant change due to period in any of the rations.

As shown in Table 4, the nitrogen digestibilities were not different between rations over all periods. However, there was a significant difference between periods. Since the Ration x Period interaction was not significant, the time or period effect was apparently manifested across all rations. This is indicative of an adaptation phenomenon which was expected with biuret but not necessarily with SBM. N-balance data shows a more distinct difference between rations. When the means over all periods are considered, N-balance was significantly higher with the SBM ration than with the biuret ration. N-balances with the B-dehy and B-SBM rations were intermediate.

Period or adaptation effects were observed with all rations. N-balance was much higher during period 4 with the SBM and B-SBM rations than with the B or B-dehy rations. N-balance increased significantly for all rations up to periods 7 or 8. Maximum N-balances achieved were 4.9, 3.7, 4.5 and 3.7 g/day for the SBM, B, B + Dehy and B-SBM rations, respectively. Although there were small differences in total serum protein, the variability was sufficient to make these differences meaningless.

Table 4. Nitrogen Digestibility and Balance and Serum Protein During the Repletion Phase.

Item	Period	Ration 1 SBM	Ration 2 Biuret	Ration 3 B-Dehy	Ration 4 B-SBM
N-Diges.[1] %	4	51.8	48.1	53.4	41.6
	5	57.6	53.2	61.7	61.4
	6	54.5	55.7	55.8	51.6
	7	51.8	57.2	55.1	50.1
	8	56.6	54.4	61.9	56.5
	$\bar{x}$	54.5	53.7	57.6	53.8
N-balance[2] g/day	4	2.30	0.73	0.98	2.44
	5	3.97	2.30	2.91	3.14
	6	3.55	2.39	4.46	3.27
	7	4.78	3.69	4.00	3.08
	8	4.93	2.93	4.52	3.74
	$\bar{x}$	3.91[3]	2.41[4]	3.38[3,4]	3.14[3,4]
Ser-Prot[5] g %	4	–	–	–	–
	5	6.10	5.68	5.90	5.88
	6	6.60	6.82	6.12	6.22
	7	6.23	6.00	6.10	5.85
	8	5.80	5.62	5.70	6.10
	$\bar{x}$	6.10	6.03	5.96	6.01

[1] A significant ($P<.01$) effect due to "Period" was present but both Ration and Ration X Period effects were non-significant.
[2] Effects due to Ration were significant ($P<.05$) and effects due to Period were highly significant ($P<.01$). Ration X Period effects were not significant, however.
[3,4] Means with unlike superscripts are significantly different ($P<.05$).
[5] Effects due to Period were significant ($P<.05$) but effects due to Ration or Ration X Period were not significant.

Although N-digestibility and N-balance are indicators of utilization of a N-source, in recent years researchers have placed more reliability in values for "percent retention of absorbed nitrogen" which is, in effect, a biological value measurement. These values are shown in Table 5. These data also illustrate better utilization of SBM nitrogen (62.4%) than biuret nitrogen (36.8, 45.6 and 46.0 percent for B, B-dehy and B-SBM, respectively). Utilization of biuret-N was considerably lower during period 4, again indicating the adaptation period required to allow utilization of this source. It would appear from these data, however, that this adaptation period was complete somewhere between 7 and 14 days after initiation of biuret feeding.

In this study N-utilization was taking place from all sources of nitrogen. The data for cellulose digestion, N-balance and "percent retention of absorbed-N" show, however, that SBM was superior to biuret as a N-source. In two of the biuret rations there was a strong indication of

Table 5. Percent Retention of Absorbed Nitrogen.

Period	SMB	Biuret	B-Dehy	B-SBM
4	53.3	18.4	17.3	36.9
5	65.8	35.7	39.4	54.6
6	53.5	40.0	61.7	50.7
7	75.7	48.7	58.8	40.9
8	63.5	41.1	50.7	47.1
$\bar{x}$	62.4	36.8	45.6	46.0

a period of adaptation being required for biuret utilization since N-balance was very low during the first repletion period. However, this trait improved with time with all rations.

Although SBM did appear to be the superior source of N it is important to note that excellent N-balance figures were obtained with biuret also. Thus, these results definitely corroberate earlier conclusions that biuret can be utilized by rumen microorganisms after a period of adaptation. Whether this utilization can be improved markedly by additions of small amounts of Dehy or SBM is difficult to say and awaits further testing.