ENERGY SUPPLEMENTATION OF UNTREATED AND AMMONIATED WHEAT STRAW DIETS FOR SHEEP

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Story in Brief

Sixteen yearling lambs (84 lb) housed in metabolism cages were used to study the effect of ammoniation of wheat straw and energy supplementation as 0, 10 or 20 g of whole shelled corn per kg of metabolic body weight/day on voluntary intake of untreated or ammoniated wheat straw, apparent digestibility of total dietary dry matter, organic matter, neutral detergent fiber and nitrogen, retention of nitrogen, ruminal ammonia-nitrogen concentrations and pH. Sheep consuming untreated straw diets were supplemented with 15 g of urea/head/day.

Ammoniation increased ($P<.01$) intake of straw organic matter and total dietary organic matter apparent digestibility but the apparent digestibility of dietary nitrogen decreased ($P<.01$). There was a tendency to reduced nitrogen retention with ammoniation. Energy supplementation resulted in a linear increase ($P<.01$) in daily intake of digestible organic matter and nitrogen and the retention of nitrogen.

The beneficial effect observed in sheep consuming diets based on straw plus nonprotein nitrogen, in terms of total digestible organic matter intake and retention of nitrogen with the supplementation of energy in the form of whole shelled corn, emphasizes the nature of the first limiting nutrient in such type of regimes.

(Key Words: Wheat Straw, Ammoniation, Energy Supplementation, Digestibility, Nitrogen Retention.)

Introduction

Ammoniation of low quality roughages increases voluntary intake and improves the apparent digestibility of organic matter. The net benefit obtained from the added nitrogen with regard to meeting the crude protein requirements of ruminant livestock is still a subject of research.

The faster ruminal availability of nitrogen than energy in ammoniated straw diets may not be optimal for microbial utilization of the increased nitrogen. Supplementation with a source of energy that would match ruminal nitrogen release may improve microbial fermentation and therefore, diet utilization.

The objective of the present experiment was to obtain additional information relative to nutritive value of the added nitrogen of ammoniated straw, and to evaluate the effect of using whole shelled corn as a source of energy in low quality roughage-nonprotein nitrogen diets.

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Materials and Methods

An experiment was conducted with sixteen rumen fistulated yearling lambs (average weight 60 lb), housed in metabolism pens, to study the effects of ammoniation of wheat straw and level of energy supplementation in the form of whole shelled corn (WSC), on voluntary intake of untreated (US) or ammoniated wheat straw (AS), total intake of dietary nutrients, apparent digestibility, nitrogen balance, and rate of passage of ruminal particulate matter, pH and ammonia nitrogen concentration (NH_3-N). Wheat straw was ammoniated with 35 g NH_3/kg of straw dry matter by the stack method. Supplementary WSC was fed to lambs receiving US and AS at levels of 0, 10 or 20 g per day per kilogram of metabolic body weight ($kg^{.75}$). Untreated straw based diets were supplemented with 15 g urea/head.d^{-1}. All animals received a supplement of trace minerals and salt during the trial and were dosed via intramuscular injection, with vitamins A, D and E at the beginning of the experiment. Feed was offered once a day and refusals weighed every morning. Daily output of total feces and urine were measured for each lamb during three consecutive periods of 7 days each, each period preceded by 15-20 days during which voluntary intake of straw was recorded. At the end of each period, samples of rumen fluid were obtained at 0, 1, 2, 4, 8 and 12 h after feeding for pH and NH_3-N measurements. Rate of passage and mean retention time (MRT) of ruminal particulate matter were measured each period by means of a pulse dose of Yb-labeled straw followed by fecal sampling at 36, 48, 60 and 72 h post-dosing.

Results and Discussion

Effects of Ammoniation

Ammoniation of wheat straw resulted in a 33 and 9 percent increase in straw OM intake and total diet OM digestibility, respectively ($P<.01$; Table 1). Ammoniation of straw had no effect on apparent digestibility of total fiber (NDF) of the diet, and decreased in 29 percent the apparent digestibility of total dietary N ($P<.01$). The net effect of the above factors was a 41 percent increase in total digestible organic matter intake/$kg^{.75}$ (TDOMI; $P<.01$), but N balance/$kg^{.75}$ was only 85.5 percent of that observed in the untreated straw plus urea diets, though not significantly different. The reduced apparent digestibility of nitrogen by lambs fed the AS diets may have resulted from increased microbial fermentation in the caecum of a more potentially digestible straw OM that escaped rumen fermentation. The reduction in MRT of ruminal particulate matter of AS diets supports this suggestion. Therefore, more nitrogen from the ammonia pool in the caecum may have been incorporated into caecal microorganisms, most of which will pass undigested in the feces. Indeed, fecal nitrogen output was significantly increased (2.3 times, $P<.01$) in lambs consuming AS diets, while urinary nitrogen output was similar among US and AS. This increased caecal fermentation and the resultant loss of nitrogen may adversely effect the nitrogen economy of ruminants fed ammoniated roughages.

Rumen pH values were always above 6, regardless of the type of straw, level of energy supplementation or time of sampling after feeding (Table 2). Therefore, microbial activity apparently was not impaired at any time by an unfavorable pH in the rumen.

Table 1. Daily intake and apparent digestibility of nutrients and nitrogen balance in sheep fed untreated (US) or ammoniated wheat straw (AS), supplemented with different levels of whole shelled corn (WSC).

	Wheat straw							Level of significance			
	Untreated (US)			Ammoniated (AS)				US			
WSC[1]:	0	10	20	0	10	20	Std Error	vs AS	WSC	WSC LIN	WSC QUAD
Daily intake (g):											
Straw OM	555	555	444	736	728	609	27.4	.01	.01	.01	.04
Total diet OM	590	709	728	750	861	870	27.0	.01	.01	.01	.05
Total diet N	10.1	11.3	12.8	13.5	15.8	16.4	.64	.01	.01	.01	NS
Total diet apparent digestibility (%):											
OM	53.9	59.5	62.1	58.7	62.6	63.7	1.1	.01	.01	.01	NS
NDF	53.2	50.9	42.0	52.5	53.2	45.2	2.3	NS	.01	.01	.08
N	73.3	70.1	70.1	51.9	54.3	56.7	1.6	--[2]	--	--	--
Daily intake of digestible nutrients (g/kg$^{.75}$):											
OM	22.09	29.72	32.49	31.19	38.48	39.78	1.24	.01	.01	.01	.03
N	.519	.562	.644	.500	.626	.664	.033	NS	.01	.01	NS
N balance	.145	.202	.276	.124	.221	.333	.035	NS	.01	.01	NS

[1] Supplementary whole shelled corn: 0, 10, 20 g DM/kg$^{.75}$.
[2] Significant interaction type of straw * linear effect from grain supplementation (P<.03).
NS = Not significant (P>.10).

Table 2. Post feeding pattern in rumen pH and ammonia nitrogen concentrations (mg NH_3-N/dl), in sheep consuming untreated (US) or ammoniated (AS) wheat straw, supplemented with whole shelled corn (WSC)(n=6).

Hr	Variable	WSC[1]:	Type of straw: Untreated (US) 0	Untreated (US) 10	Untreated (US) 20	Ammoniated (AS) 0	Ammoniated (AS) 10	Ammoniated (AS) 20	SE	Level Sig. US vs AS	Level Sig. WSC Lin
0	pH		6.8	6.9	6.9	6.9	6.9	6.9	.05	NS	NS
	NH_3-N		7.43	5.81	4.61	6.95	7.51	6.24	.56	.04	.01
1	pH		7.0	7.0	7.0	6.7	6.7	6.7	.05	.01	NS
	NH_3-N		31.8	34.8	26.8	24.6	25.1	19.4	4.1	.01	NS
2	pH		6.9	6.8	6.9	6.6	6.5	6.5	.07	.01	NS
	NH_3-N		39.4	36.3	27.5	29.8	25.6	22.3	3.4	.01	.01
4	pH		6.8	6.5	6.4	6.6	6.3	6.3	.08	.03	.01
	NH_3-N		36.7	18.0	19.0	23.9	17.0	14.8	2.3	.01	.01
8	pH		6.4	6.2	6.4	6.2	6.2	6.2	.10	NS	.04
	NH_3-N		17.7	5.1	1.8	9.6	8.2	5.8	1.8	NS	.01
12	pH		6.5	6.5	6.2	6.5	6.4	6.2	.08	NS	.01
	NH_3-N		8.8	6.5	3.6	9.6	7.9	6.6	1.4	NS	.01

[1]Whole shelled corn supplementation = 0, 10 or 20 g DM/$kg^{.75}$.d^{-1}.

During the first four hours after feeding, rumen NH_3-N concentrations in lambs fed AS diets was lower as compared to US fed lambs ($P<.01$). At 8 and 12 h postfeeding, the differences were nonsignificant ($P>.10$). For both types of straw diets, NH_3-N increased after feeding and reached maximum concentrations at 2 h postfeeding (Table 2). In most instances, NH_3-N was above 5 mg/dl, a concentration considered adequate for growth of ruminal microorganisms.

Effects of Energy Supplementation

Supplementation (Table 1) with WSC resulted in a net increase in TDOMI ($g/kg^{.75}$) of 34 and 47 percent for US and AS, respectively, at the low level of supplementation, and of 23 and 28 percent at the higher level as compared with unsupplemented diets. Intake of AS and US straw OM was maintained with the low level of WSC supplementation but reduced by 17 and 20 percent, respectively, at the higher level of WSC supplementation (quadratic response, $P<.04$). A linear interaction ($P<.03$) was found for apparent digestibility of dietary N between type of straw and level of WSC supplementation with an increase for AS diets.

Nitrogen balance ($g\ N/kg^{.75}$) of lambs fed US diets was increased linearly ($P<.01$) due to supplementation with WSC by 39 and 178 percent, and by 90 and 169 percent for AS diets. This marked increase in nitrogen retention as a result of WSC supplementation supports the concept of energy being the first limiting nutrient in low quality roughage diets (Zorrilla-Rios et al., 1984). Therefore, to achieve an efficient utilization of the increased crude protein of ammoniated low quality roughages, it is required that the supplemental energy will become available to the rumen microflora as synchronously as possible with the nitrogen.

In both types of straw, except for the first hour after feeding, ruminal NH_3-N concentration decreased linearly ($P<.01$) with the increase in energy. No consistent interaction ($P>.10$) between type of straw and level of energy supplementation was found (Table 2). The consistent lower levels of ruminal NH_3-N observed with AS as compared to US plus urea diets at all sampling times after feeding, suggests a greater uptake of nitrogen by the rumen microflora, and therefore a more efficient utilization of N at the rumen level. The reduction in ruminal NH_3-N found as the level of WSC supplementation increased with both types of straws supports the concept of energy being the first limiting nutrient for an efficient utilization of dietary nitrogen at the rumen level. The further reduction observed in ruminal NH_3 in the AS diets, emphasizes a greater benefit to be expected in terms of proximal microbial fermentation, when AS diets are supplemented with energy.

Literature Cited

Zorrilla-Rios, J. et al. 1984. Nutritive value of ammoniated wheat straw for ruminants. Can. J. Anim. Sci. 64(Suppl.):158.