Calcium Oxide and Ammoniated Whey Treatment of Cornstalks, Oat Hulls, Wheat Straw and Drought Stressed Corn Plants

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Summary and Implications

Calcium Oxide (CaO) treatment of cornstalks, oat hulls, wheat straw or drought stressed corn plants when added at five percent of the feed dry matter will reduced neutral detergent fiber (NDF) levels of these feedstuffs and improve NDF digestibility and in-vitro digestibility to varying degrees due to the strong base reacting with the plant fiber. Ammoniated whey when added to the above mentioned feedstuffs likewise improves these same measures but does so in an additive manner since the ammonia level in these products is not high enough to initiate the desired reaction seen with the CaO. Therefore the rate at which the ammoniated product is added should be done so based on final desired outcome in terms of crude protein.

Introduction

Grain is a valuable commodity that is not always available or economical to feed to livestock. The ruminant can utilize forage quite well however there are times when the animal has a higher nutrient demand than what the available forage may provide. Generally poor quality forage has excessive fiber and a treatment that would facilitate fiber digestibility could allow the animal to glean more energy and other nutrients from this feedstuff. A strong base can break down the fiber fraction and release glucose and other shorter chain carbohydrate derivatives that can provide energy to the animal. Previous research on calcium oxide treatment of corn stalks or wheat straw used in finishing cattle diets has generated many questions about using the treatment on other forages including corn silage. One producer who has access to various feed products asked about using other types of products that would contain a strong base to treat forages. The producer was able to provide four types or higher fiber feedstuffs and two types of ammoniated whey from the cheese making industry. The point of this trial was to treat four high fiber feedstuffs with alkali in the attempt to increase the digestibility of these feedstuffs and quantify the effect. In addition it was of interest to see if using the base treatment would affect ensiling of corn silage. The alkali used was CaO, an ammoniated whey product -pH 6.5 (AW7) and an ammoniated whey product -pH 10 (AW10). The analysis of the products is shown in Table 1.

Material and Methods

Cornstalks, oat hulls, wheat straw or drought stressed corn plants (no ears) were obtained and divided into four treatment categories. The first was left as-is and sampled as such, the second was treated by mixing CaO at five percent of the forage weight on a dry matter basis with the forage in a feed mixing wagon. Water also was added to the cornstalks, oat hulls and wheat straw to make the forage used in this treatment 50 percent moisture. This was done to ensure a proper reaction but also provide a heat sink in order to prevent combustion since the CaO treatment produces heat. It should be noted that the drought stressed corn plants were quite wet as-is and this treatment did not have any water added. The corn was cut in late July and processed with a bale processor before treatment. The third treatment mixed the AW7 with forage at 25 percent of the forage weight on a dry matter basis. This mixing was also done in the feed mixing wagon, but no water was added. The final treatment mixed AW10 with forage at 25 percent of the forage weight on a dry matter basis and like the AW7, the mixing occurred in the feed mixing wagon and no water was added. A pH measure was taken on the samples and the untreated and treated samples were packed into 50 gallon barrels, 3 barrels per treatment, and the tops were sealed with water bags to exclude air.

Table 1. Analysis of ammoniated whey and calcium oxide.

	AW7*	CaO
Dry Matter	61.5	99
Cr.Protein (dm basis)	71.5%	0
NDF	0	0
Ca	0.29%	71%

*AW10 is the same product as AW7 with added ammonia to raise the pH to 10

After one week samples of each treatment were taken and the material sent to Dairyland Laboratories of Arcadia WI for an in-vitro digestibility evaluation. Samples were also taken one month later and also sent to Dairyland Laboratories as well for both fermentation and in-vitro digestibility evaluations. The in-vitro digestibility evaluation was performed using a 48 hour incubation period

Results and Discussion

Table 2 provides a summary of the in-vitro digestibility (in-vitro d) of the feedstuffs before treatment, one week post treatment and one month post treatment. In all cases the NDF was reduced from the treatment. In the case of the CaO treatment, this reduction was brought about by the reaction occurring between the strong base and the H bonds of feedstuff. In the case of the ammoniated whey, the reduction occurs from the additive effect of mixing the AW7 or AW10 with the feedstuff. It was postulated that the ammonia in these products would also react to some degree with the feedstuff fiber since ammonia has been used for this purpose in the past. The use of ammonia has shown in historical work to reduce the NDF concentration and improve digestibility as the CaO did in this trial. However, in this trial concentration of ammonia did not seem high enough in the AW7 or AW10 product to affect NDF beyond the additive of effect of whey at 0 % NDF. It should be noted when considering in-vitro digestibility that the CaO treatment seems to have the largest positive impact on oat hulls and then cornstalks and wheat straw and these results seem to be in line with previous trials using cornstalks. With the corn plant, there was a definite decrease in NDF but the in-vitro d was not improved and may have even decreased. It would be interesting to conduct a feeding trial to see if these resulting in-vitro digestibility do relate to animal performance, but at this point it seems that high quality forage like corn silage, one with an in-vitro digestibility above 70%, does not benefit from increased digestibility with treatment.

Table 2a – Cornstalks.

	Control	AW7 - 1week	AW10 – 1week	CaO – 1week	CaO -1month
NDF %	75.8	63.3	60.5	64.7	58.2
NDFd %	35.6	40.3	38.9	46.4	43.4
In-vitro d %	51.1	62.2	63.1	65.3	67.1

Table 2b – Oat hulls.

	Control	AW7 - 1week	AW10 – 1week	CaO – 1week	CaO -1month
NDF %	56.0	42.4	39.1	43.0	37.8
NDFd %	28.3	23.5	16.4	68.4	73.4
In-vitro d %	59.8	67.6	67.3	86.4	90.0

Table 2a – Wheat straw.

	Control	AW7 - 1week	AW10 – 1week	CaO – 1week	CaO -1month
NDF %	73.7	57.0	58.2	55.7	-
NDFd %	44.1	50.3	47.1	50.5	-
In-vitro d %	58.8	71.7	69.2	72.4	-

Table 2a – Drought stressed corn plant.

	Control inital	Control-1 month	AW7 - 1week	AW10 – 1week	CaO -1month
NDF %	62.4	60.9	53.9	46.6	49.6
NDFd %	57.5	60.8	52.1	56.6	45.2
In-vitro d %	73.5	76.1	74.2	79.8	72.8

Table 3 provides a summary of the fermentation that occurred in the barrel ensiled samples after one month. It should be noted that all the feedstuffs except for the drought stressed corn plants were very dry going into the trial and would not have ensiled if left as they were without the addition of water. They also would have been quite low in fermentable carbohydrates such as sugar and starch and therefore would be limited in their potential to ferment as well from this standpoint. The alkali treatment does free up some fermentable carbohydrates and the material does start to ferment after time. The fermentation is slow, the pH is still quite high after one month and there is relatively little acid produced with the resulting acetic to lactic acid ratio being quite high. The ammonia levels also increase with the treatment as is shown with the drought stressed corn plants. It was observed that the crude protein did increase with the CaO treatment. Why this increase occurs may be from a dry matter loss due to the reaction or maybe the reaction is capable of binding some N from the air trapped in the ensiled forage. In any case this fraction consistently increases when CaO is added and the material is stored in an air tight environment. The crude protein levels from the AW treatments seem to be mathematically predictable from calculating the weighted average between the forage DM and the quantity of AW added.

Table 3a. Fermentation results after one month of ensiling.

	Cornstalks		Oat Hulls		Wheat Straw	
	initial	CaO	initial	CaO	initial	CaO
pH	-	8.8	-	10.4	-	8.4
CP %	4.8	5.8	4.1	8.5	3.5	9.2
Ammonia % of CP	-	4.37	-	1.61	-	8.1
Lactic acid %	-	0.36	-	0.41	-	0.25
Acetic acid %	-	2.30	-	1.43	-	1.27
Total acid %	-	2.65	-	1.85	-	2.40

Table 3b. Treated drought stressed corn silage fermentation effects one month after treatment.

	Control	AW7	AW10	CaO
pH	3.7	5.3	5	4.3
CP %	12.8	19.8	20.3	16.9
Ammonia % of CP	9.06	60.49	67.58	28.64
Lactic acid %	9.11	9.13	12.99	10.96
Acetic acid %	3.77	2.2	1.65	3.00
Total acid %	12.88	11.32	13.75	14.18

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