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Abstract
Dry rolled corn, ensiled high moisture corn, and high moisture corn that was rolled and ensiled with urea or left whole and ensiled with urea were compared in two cattle trials. Dry corn gave the poorest cattle performance; rolled, ensiled high moisture corn gave the best. When corn was left whole, adding urea prior to ensiling increased dry matter losses in the silo and produced a butyric acid fermentation. Urea increased the bunk life of the ensiled high moisture corn.

Keywords
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High Moisture Corn Ensiled With Urea for Cattle Finishing Rations

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Summary

Dry rolled corn, ensiled high moisture corn, and high moisture corn that was rolled and ensiled with urea or left whole and ensiled with urea were compared in two cattle trials. Dry corn gave the poorest cattle performance; rolled, ensiled high moisture corn gave the best. When corn was left whole, adding urea prior to ensiling increased dry matter losses in the silo and produced a butyric acid fermentation. Urea increased the bunk life of the ensiled high moisture corn.

Introduction

High moisture grains are fed in large quantities to cattle on high energy finishing rations with supplemental nitrogen from urea. In our trials here, urea additions were made to whole and coarsely rolled high moisture corn prior to ensiling in concrete stave silos. These treatments were compared to coarsely rolled dry corn and ensiled high moisture corn fed with urea supplements to yearling steers and heifers. The ensiling and storage characteristics also were monitored.

Experimental Procedures

Thirteen hundred bushels of high moisture (HM) corn harvested at 74% dry matter (DM) were stored in three 10 x 50 ft concrete stave silos. Treatments were: 1) rolled with no additive (HMR), 2) rolled with 40 lb of a urea-water solution (50:50 wt./wt.) per ton added at ensiling (HMRU), and 3) whole (fed whole) with 40 lb of a urea-water solution (50:50 wt./wt.) per ton added at ensiling (HMWU). The urea-water solution was mixed with the high moisture corn in a Harsh Mobile Mixer® for 10 minutes before it was discharged to the silo. All corn was of the same variety and from the same field. Eleven hundred bushels of solar-dried corn were stored in an aerated bin and coarsely cracked by a roller mill prior to feeding (DR). It served as the control.

The three structures were opened after 220 days and complete mixed rations were full-fed for 112 days to 64 yearling mixed breed steers (16 pens of 4 steers per pen). Additionally, 20 Hereford heifers were individually fed each ration for 145 days (five heifers per ration).

Rations were formulated to contain 86% of the respective corn, 9% alfalfa, and 5% supplement (DM basis). Rumensin was included in the supplement (Table 13.1) at 550 g per ton and Tylan at 180 g per ton. Cattle were implanted at the beginning of the trial with 36 mg of Ralgro and received the final finishing ration on day 7.

Ingredient samples were collected weekly and feed consumed was recorded daily. The quantity of complete ration offered was adjusted according to the amount cattle consumed. Feed was always present in the feed bunks. Feed not consumed was removed, weighed, and discarded as necessary.

At the start and again at the end of the feeding trial, all cattle were weighed individually after 16 hr without feed or water on 2 consecutive days and the averages of the two weights were used for initial and final live weights. Intermediate full weights were taken before the a.m. feeding at 28-day intervals. Final weights for cattle performance calculations were derived from hot-carcass weights adjusted by the average dressing percentage.

Aerobic stability of the HM corns were evaluated on June 18 and August 5 using 5.5 lb of corn per expanded polystyrene container as described on page 28 of this report. Twelve containers per corn treatment were monitored initially for temperature increases, with three containers per treatment removed on days 3, 5, 9 and 14 for DM loss determinations.

Dry matter losses from fermentation, storage, and feedout for each stave silo were calculated. In addition, nine nylon bags were filled with about 30 lb of corn for each silo and three bags were buried at each of three depths in the HM corn stored within the concrete silos. These bags were recovered during feedout but prior to any aerobic deterioration. Prior to ensiling, nine plastic container laboratory silos (5 gallon capacity) were filled with each treatment using a hydraulic press. The containers were sealed by lids fitted with rubber O-ring seals and Bunson valves and stored in a room at about 30 C. Dry matters were determined on all corns by oven drying at 55 C.

Results and Discussion

Steer performances are shown in Table 13.2. There were no statistically significant differences for average daily gain, feed intake, or feed conversion among corn treatments. Heifer performances are also shown in Table 13.2. Feed efficiency was significantly ($P<.05$) better for the HMR corn than DR corn. Average daily gain was similiar for heifers fed HMR, HMRU, HMWU corns and the lowest for those fed the DR corn. At each 28-day weigh period, DM intake was greatest for the HMWU corn treatment for both steers and heifers.

Ration crude proteins were lower for DR and HMR than HMRU and HMWU (Table 13.3) where urea additions were made prior to ensiling.

The DM lost from farm scale silos during fermentation, storage, and feedout was less for the HMR corn than the urea-treated HM corns (Table 13.4). Nylon bags and laboratory silos showed DM loss patterns similiar to the farm scale silos. HMR corn had the lowest DM loss and HMWU corn had the greatest DM loss.

Chemical analyses of the three ensiled corns from nylon bags are presented in Table 13.5. HMR and HMRU had undergone predominantly lactic acid fermentations whereas HMWU had significantly less lactic acid and a greater quantity of butyric acid. The most efficient fermentation would have occurred with the HMR and HMRU corns, as suggested by the high lactic to acetic acid ratio.

HMWU fermented inefficiently, with the production of butyric acid. That agrees with the high DM losses from silos and nylon bags for the HMWU. The buffering effect of ammonia from the urea allowed production of the most total fermentation acids in the HMRU corn; however, the HMR had the lowest pH. The high pH for HMWU most likely resulted from a buffered environment which was high in oxygen and had only limited access to water soluble carbohydrates from the whole kernel. Nitrogen recovery corrected for DM loss was lowest for HMR (93.8%) and highest for HMRU (85.4%) with HMWU being intermediate (91.4%).

All three ensiled HM corns in the farm scale silos were well preserved and free of mold or visible spoilage. However, the nylon bag chemical analyses reflects the composition of the ensiled corns more accurately than the weekly corn samples (Table 13.5). High ambient temperatures and slow surface removal rates from the silos caused some aerobic deterioration of the weekly samples. More free ammonia was apparent to workers around the HMWU silo than the HMRU silo.

Aerobic stability determinations with the ensiled HM corns showed that HMWU corn was the most stable in air and was the only ensiled corn that did not have a rapid and extensive rise in temperature over 14 days. It also had the highest % of total nitrogen as ammonia. HMR was the only unstable corn in the June 18 determination, heating on day 8 and reaching a maximum temperature of 102 F on day 13, with a 6.0% DM loss after day 14. HMR and HMRU corns were unstable after day 3 and 5, respectively, for the August 5 determination, and maximum temperatures of 113 F and 102 F were reached on day 6 and 14, respectively. Although HMRU corn was slightly unstable, the temperature rise occurred over an extented period of time and the DM loss was small. This is likely a result of ammonia production from urea breakdown.

Urea additions to ensiled HM corn increased the extent of fermentation and increased fermentation, storage, and feedout DM losses; however, urea-treated corn supported cattle performance equal to dry corn in this trial. Aerobic stability of whole HM corn stored with urea in a stave silo during the summer was equal to or better than HM corn stored without urea. Although urea may make it possible to store whole HM corn without oxygen-limiting structures, this practice is not currently recommended.

Table 13.1. Supplement Formulation for Cattle Rations Containing Dry Corn and High Moisture Corns.

Item	HM rolled urea and HM whole urea	Dry rolled and HM rolled
Corn	45.0	35.9
Fat	3.0	3.0
Urea	—	9.0
Limestone	20.7	0.8
Dicalcium phosphate	3.6	3.6
Potassium chloride	11.0	11.0
Ammonium sulfate	1.7	1.7
Salt	10.0	10.0
Premix[1]	5.0	5.0

[1] Included Rumensin, Tylan, trace minerals, and vitamins A, D, and E.

Table 13.2. Performance of Finishing Steers and Heifers Fed the Dry Corn or High Moisture Corn Rations.

Item	Dry rolled	HM rolled	HM rolled urea	HM whole urea
		Steers		
No. of pens	4	4	4	4
No. of steers/pen	4	4	4	4
Final weight, lb[1]	1053	1085	1072	1089
Initial weight, lb	674	673	674	679
Ave. daily gain, lb	3.38	3.68	3.55	3.66
Daily intake, lb[2]	20.08	19.51	20.23	21.76
Feed/gain	5.96	5.33	5.69	5.95
		Heifers		
No. of heifers	5	5	5	5
Final weight, lb[1]	933	999	975	1002
Initial weight, lb	569	573	568	568
Ave. daily gain, lb	2.51	2.94	2.80	3.00
Daily intake, lb[2]	15.23	15.33	15.23	17.31
Feed/gain	6.12[b]	5.27[a]	5.51[ab]	5.79[ab]

[1] Final live weights adjusted to a dressing percentage of 62.

[2] 100% dry matter basis.

[ab] Values with different superscripts differ significantly (P<.05).

Table 13.3. Chemical Composition of the Four Complete Rations.

Item	Dry rolled	HM rolled	HM rolled urea	HM whole urea
Dry matter, %	86.4	76.7	75.4	74.9
	——— % of the DM ration ———			
Crude protein	11.6	11.3	13.5	13.1
	——— % of the total N ———			
HWIN as % TN[1]	60.0	46.5	43.4	48.8
NPN as % TN[2]	12.9	15.6	20.3	18.2

[1] Hot water insoluble-nitrogen.
[2] Non-protein nitrogen.

Table 13.4. Dry Matter Losses From Fermentation, Storage, and Feedout for the Ensiled High Moisture Corns.

Item	HM rolled	HM rolled urea	HM whole urea
	——— % of the DM ensiled ———		
Concrete stave silos:[1]			
Losses from fermentation, storage, and feedout.	4.8	5.8	6.1
Nylon bags:[2]			
Losses from fermentation, and storage	1.78	3.87	4.43
Laboratory scale silos:[3]			
Losses from fermentation, and storage	3.37	4.37	5.45

[1] Each value represents one silo.
[2] Each value is the mean of nine bags, except HM rolled urea which is the mean of seven bags.
[3] Each value is the mean of nine silos.

Table 13.5 Chemical Composition of the Dry Corn and Ensiled High Moisture Corn Weekly and Nylon Bag Samples.

Item	Weekly: Dry rolled	Weekly: HM rolled	Weekly: HM rolled urea	Weekly: HM whole urea	Nylon bag: HM rolled	Nylon bag: HM rolled urea	Nylon bag: HM whole urea
Pre-ensiling DM, %	—	73.8	73.4	74.0	74.6	73.7	73.8
Post-ensiling DM, %	88.3	75.8	75.8	75.1	75.1	74.3	72.2
pH	5.58	4.27	5.63	7.27	3.80	5.59	6.24
Nitrogen fractions:							
	DM basis						
Crude protein, %	9.1	10.3	12.6	12.8	9.6	13.7	13.1
NPN as % of TN[1]	3.15	12.5	21.4	20.0	4.7	26.1	22.9
NH4 as % of TN[2]	1.03	7.3	13.8	11.6	4.2	9.9	15.6
HWIN as % of TN[3]	80.8	52.6	39.5	48.6	46.6	48.7	55.9
Fermentation acids:							
	% of the corn DM						
Lactic acid	—	2.00	2.61	.56	1.86	3.92	.27
Acetic acid	—	.49	.56	.57	.43	.67	.73
Propionic acid	—	.03	.03	.02	.03	.02	.03
Butyric acid	—	.12	.06	.36	.07	.01	1.31
Total acids	—	2.65	3.27	1.54	2.40	4.62	2.45
Ethanol	—	.03	.02	.02	.05	.05	.05
WSC[4]	4.15	11.12	7.53	9.57	7.93	7.96	4.48

1 Non-protein nitrogen as % of total nitrogen.
2 Ammonia nitrogen as % of total nitrogen.
3 Hot water insoluble-nitrogen as % of total nitrogen.
4 Water soluble carbohydrates.