High-moisture Corn With Additives for Finishing Rations[1,2,3]

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Summary

Dry corn (dry), Harvestore ensiled high-moisture corn, stave silo ensiled high-moisture corn (stave H.M.C.) and stave H.M.C. ensiled with NaOH, Cold-flo ammonia, or Silo-Best additives were evaluated in steer and heifer finishing trials. Cold-flo and NaOH H.M.C. gave slowest gains; NaOH had the highest intake and Harvestore H.M.C. the lowest, efficiency of gain favored the Harvestore H.M.C.

All H.M.C. corn except NaOH was unstable in air because of high dry matter at ensiling, slow corn use, and warm temperatures. Dry matter losses and temperature rises during air exposure were highest for Cold-flo and Harvestore H.M.C.

Experimental Procedure

Four concrete stave silos (10 ft x 50 ft) and one oxygen-limiting Harvestore were used to store about 1,000 bushels per structure of high-moisture corn (H.M.C.) at 77.7% to 82.1% dry matter, harvested September ll-13, 1979.

Stave silo H.M.C. treatments were: 1) no additive (stave), 2) 80 lb of NaOH, 3) 2.0 lb of Silo-Best,[1] and 4) 19.3 lb of Cold-flo[2] ammonia. For treatment 5, H.M.C. corn ensiled in a Harvestore was used and for 6, artificially dried corn (dry). Additive rates were per ton of wet corn harvested of the same variety and from the same field. NaOH and Harvestore H.M.C. were ensiled whole; others were coarsely cracked by a roller mill before ensiling. Harvestore and dry corns were coarsely rolled before feeding; NaOH H.M.C. was fed whole.

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[1] Silo-Best ® is an enzyme product of Cadco, Inc., Des Moines, Iowa. Partial financial assistance provided by Cadco, Inc.

[2] Cold-flo ® is a non-protein nitrogen product of USS Agri-Chemicals, Division of United States Steel, Atlanta, Georgia. Partial financial assistance provided by United States Steel.

[3] Mention of products and companies is made with the understanding that no discrimination is intended and no endorsement implied.

Silos were opened after 210 days and a complete mixed ration of each corn was full-fed for 93 days (April 9 to July II, 1979) to 78 cattle (five individually fed steers/ration and two pens of four heifers/ration). The rations contained 83.2% corn, 4.5% forage sorghum silage, 4.5% alfalfa hay and 7.8% supplement (dry basis) (Table. 10.1). All rations were formulated to 12% crude protein, .80% calcium and .32% phosphorus. Cattle were adjusted to full feed over 24 days, implanted with 36 mg of Ralgro, and wormed with an oral paste.

At the start and again at the end of the feeding trial, all cattle were weighed individually after 16 hr without feed or water. Intermediate full weights were taken before the a.m. feeding on days 28, 56, and 84. Steer performance was based on beginning and ending live weights. Heifer final weights were derived from hot-carcass weights and a dressing percentage of 62.

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

Aerobic stability (bunk life) of each H.M.C. was measured with samples taken on May 13 and July 1, 1980 (details are described on page 7 of this report).

Results

The Cold-flo H.M.C. was 9.36% crude protein (CP) before treatment and 9.95% CP when fed. The 19.3 lb of Cold-flo added per ton should have raised the CP to 14.32%, so only 12% of the Cold-flo nitrogen added was retained. Ammonia loss at the silo blower and during silo filling were enhanced by the low moisture of the ensiled corn.

Adding NaOH to whole H.M.C. quickly turned the corn a carmel yellow and the mixture was very difficult to blow into the silo. NaOH-treated corn at feeding was dark brown to black; it caked and was extremely difficult to remove from the silo.

Chemical analyses of the corn treatments are shown in Table 10.2. The pH values for ensiled H.M.C.'s were higher than expected. NaOH (pH, 8.8) and Cold-flo (pH, 7.8) remained basic due to the alkaline nature of the additives. High pH's for the other H.M.C.'s indicated minimum fermentation because of high dry matter of the pre-ensiled corn. Volatile fatty acid and lactic acid levels confirmed the pH measurements. Acid detergent nitrogen, which represents bound and undigestible nitrogen (probably due to heating), was highest for the NaOH treatment.

Aerobic deterioration of H.M.C., which can occur in the silo (at the surface) or in the feed bunk, results from aerobic organism growth (yeasts, molds, or bacteria). In this experiment the structures were open for feeding April 8 through July 15, 1980. NaOH-treated corn did not heat extensively at the feeding surface, but some spoilage occurred near the inside wall of the silo. Stave, Silo-Best, Cold-flo, and Harvestore H.M.C.'s heated at the feedout surface, in addition to showing organism growth. Mold and yeast

growth were apparent. Slow corn use and warm ambient temperature undoubtedly contributed to the aerobic deterioration at the surface. Instability in the Harvestore could have been increased because only 20% of the structure was filled originally.

Aerobic stability measurements (Table 10.3) confirmed the unstable nature of all H.M.C.'s except NaOH. Cold-flo and Harvestore H.M.C. heated nearly as soon as they were exposed to air, and they reached the highest temperatures and had the greatest accumulated temperatures in each measurement. Stave and Silo-Best H.M.C. heated at an intermediate rate. Dry matter and lactic acid disappeared and pH values increased during exposure to air; changes were most pronounced in Harvestore and Cold-flo H.M.C. Ammonia accumulation, particularly in Harvestore H.M.C., indicated protein breakdown.

Performance of all steers and heifers are shown in Table 10.4.
Individually fed steers: Intakes were similar among treatments, but rates of gain for Cold-flo and NaOH H.M.C. were less ($P<.05$) than for other corns. NaOH H.M.C. was used the least efficiently ($P<.05$).
Heifer groups: Daily feed consumption was higher for Silo-Best and NaOH H.M.C. ($P<.05$) than for Harvestore; consumption was similar for other corns. Rates of gain were all statistically similar, but gains were lowest for Cold-flo and NaOH H.M.C. Harvestore H.M.C. was used the most efficiently; NaOH, the least ($P<.05$).

For both steers and heifers, NaOH addition increased intake but performance was reduced. The high sodium content of NaOH rations caused high water intake and urine excretion, which could explain the lowered performance. Although the stave, Silo-Best, and Harvestore H.M.C.'s were unstable in air, cattle performance for these rations was similar to that for dry corn.

Table 10.1. Composition of the supplements fed in the six rations.

Ingredient	Dry, stave, Harvestore, and Silo-Best	NaOH	Cold-flo
	lb per ton		
Corn, rolled	---	---	1042.0
Soybean meal, 44% CP	900.00	900.00	---
Tallow	20.00	20.00	20.00
Urea, 281% CP	178.00	178.0	---
Limestone	520.00	520.0	520.0
Dicalcium phosphate	60.00	60.0	60.00
Salt	120.00	---	120.00
Potassium chloride	110.00	230.00	146.00
Ammonium sulfate	40.00	40.00	40.00
Vitamin A (10,000 IU/gm)	17.80	17.80	17.80
Vitamin D (15,000 IU/gm)	1.20	1.20	1.20
Rumensin 60	5.00	5.00	5.00
Tylan 10	18.00	18.00	18.00
Trace mineral (CCC-Z10)	10.0	10.0	10.0

Table 10.2. Chemical analyses of the corn treatments.[1]

Corn treatment	Dry matter	pH	NH_3-N_2	Crude protein	ADN[3]	Lactic acid	Acetic acid	Valeric acid
	%			% of the DM				
Dry	89.6	5.5	.47	9.49	.046	.194	.014	.030
Stave	82.0	6.4	5.14	8.96	.110	.433	.096	.021
NaOH	82.1	8.8	1.81	8.68	.177	.264	.379	.087
Silo-Best	81.4	6.4	4.19	9.15	.070	.350	.140	.015
Cold-flo	79.0	7.8	18.66	9.95	.092	.754	.117	.027
Harvestore	77.7	7.6	11.96	9.04	.047	.579	.121	.015

[1] Each value is the mean of a composite sample.

[2] NH_3-N means amnonia-nitrogen expressed as a % of total nitrogen.

[3] Acid-detergent nitrogen

Table 10.3. Changes in temperature, and pH and losses of dry matter and lactic acid during air exposure by five high-moisture grains.

Samples taken May 13.

Corn treatment	Day of initial rise above ambient	Maximum temp.*	Days exposed to air: 0	2	5	7	16
		°F	Accumulated temp. above ambient °F				
Stave	5.7	88.9		29.9	50.7	84.6	136.2
Silo-Best	7.2	88.3		28.5	42.3	49.3	96.9
NaOH	Stable	69.0		**	4.8	9.3	35.3
Cold-flo	1.4	111.5		43.8	204.6	329.3	633.9
Harvestore	1.0	104.3		67	155.7	207.3	493.0
Dry	Stable	66.7		**	**	**	**
			Loss of DM (% of DM exposed to air)				
Stave				.9	1.3	1.6	2.7
NaOH				. 8	1.1	1.2	3.6
Silo-Best				1.2	1.6	1.8	2.1
Cold-flo				13.4	14.3	16.6	26.70
Harvestore				1.7	2.3	3.6	11.8
Dry				1.1	1.1	1.00	.9
			pH				
Stave			4.72	4.87	5.26	5.73	5.99
Silo-Best			4.87	4.95	5.09	5.32	5.88
NaOH			8.83	9.03	9.15	9.11	9.19
Cold-flo			5.61	5.92	6.80	6.67	6.59
Harvestore			5.14	5.78	6.39	6.39	6.19
Dry			5.53	5.55	5.97	5.50	5.66
			Lactic acid				
Stave			.32	.40	.34	.24	.13
Silo-Best			.23	.21	.26	.19	.08
NaOH			.06	.06	.07	.08	.06
Cold-flo			.85	.72	.43	.41	.15
Harvestore			.30	.27	.14	.13	.11
Dry			.12	.05	.06	.05	.04

Samples taken July 1.

Corn treatment	Day of initial rise above ambient	Maximum temp.*	Days exposed to air: 0	2	5	7	16
		°F	Accumulated temp. above ambient °F				
Stave	5.5	84.8		5.0	30.8	41.3	56.9
Silo-Best	4.5	93.00		19.0	62.3	69.8	143.8
NaOH	Stable	71.3		**	**	**	**
Coldflow	2.0	116.9		91.7	262.7	338.1	475.l
Harvestore	1.0	118.4		163.3	284.2	340.7	459.1
Dry	Stable	71.2		**	**	**	**
			Loss of DM (% of DM exposed to air)				
Stave				2.69	3.05	3.17	2.77
Silo-Best				.84	1.70	2.19	4.04
NaOH				.3 0	0	0	0
Cold-flo				1.50	5.46	9.79	14.44
Harvestore				3.88	7.78	10.40	15.27
Dry				0	0	0	0
			pH				
Stave			5.08	5.01	5.63	6.03	6.07
Silo-Best			5.26	5.25	6.27	6.21	6.08
NaOH			8.35	8.67	8.76	8.52	8.87
Cold-flo			5.13	6.08	6.61	6.43	6.69
Harvestore			5.76	6.65	6.54	6.48	6.74
Dry			5.80	5.62	5.56	5.51	5.48
			Lactic acid				
Stave			.25	.39	.30	.13	.16
Silo-Best			.33	.39	.18	.16	.15
NaOH			.06	.13	.12	.14	.13
Cold-flo			1.31	.77	.30	.25	.26
Harvestore			.27	.14	.15	.14	.10
Dry			.09	.07	.09	.08	.08

*6.0 F rise above ambient temperature

** No rise in temperature.

Table 10.4. Performance by steers and heifers fed the six corn rations.

	Dry	Harvestore[1]	Stave	NaOH	Silo-Best	Cold-flo
No. of steers	5	4	5	5	5	5
Initial weight, lb	641	630	648	640	652	655
Final weight, lb	930	914	942	860	956	915
Avg. daily gain, lb	3.18^{a}	3.12^{a}	3.23^{a}	2.42^{b}	3.35^{a}	2.86^{ab}
Total daily feed, lb[2]	18.08	17.06	18.44	18.95	18.89	16.99
Feed/lb of gain, lb[2]	5.72^{a}	5.50^{a}	5.78^{a}	8.07^{b}	5.62^{a}	6.08^{a}
Number of heifers	8	8	8	8	8	8
Initial wt., lb	552	557	548	553	557	555
Final wt., lb	816	822	804	807	826	801
Avg. daily gain, lb	2.90	2.92	2.81	2.79	2.96	2.71
Total daily feed, lb[2]	17.20^{ab}	16.50^{b}	17.67^{ab}	18.76^{a}	18.19^{a}	17.29^{ab}
Feed/lb of gain, lb[2]	5.93^{bc}	5.66^{c}	6.29^{abc}	6.72^{a}	6.16^{abc}	6.40^{ab}

[1]One steer died.

[2]100% dry matter basis.

^{a,b,c}Values with different superscripts differ significantly ($P<.05$).