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dairy guidelines

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ORGANIC ACID PRESERVATION OF HIGH MOISTURE CORN

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In the 1970's another method became available for the preservation of high moisture grains. Organic acid treatment involves the application of acid (i.e., propionic, acetic, formic, ammonium isobutyric, etc.) at time of harvest, followed by storage in a pile. Commercial applicators have been developed whereby the grain flows into a hopper and is sprayed with acid during spiral action of exposed auger flights. The acid flow rate is adjustable and is dependent on auger throughput and moisture content of the grain. The acid is adsorbed onto the kernel surface, giving it a shiny or glazed appearance, and becomes absorbed into the kernel. Properly treated high moisture corn has the same appearance after 18 months as it has immediately after treatment.

Acid treatment inhibits the growth of molds and bacteria. Research has shown that propionic acid alone or acetic plus 25% propionic acids are quite effective. Acetic acid should not be used alone. Limited research indicates that sodium propionate, formalin, ammonium isobutyrate and citric acids have been successful, as well as combinations of propionic acid and formic acid or formalin.

Successful preservation demands that dairymen follow directions of the acid supplier and treat at the suggested level. Although recommended application rates include "safety factors," undertreatment could result in moldy grain. High moisture shelled corn has stored well when 22 lb. of propionic acid was added to a ton of 28% moisture corn (1.1% rate) or 34% moisture corn was treated with 30 lb. per ton (1.5%). In contrast to ensiled grain, corn can be harvested at less than 25% moisture. The drier the grain, the cheaper the treatment as less acid is used. Overtreatment does not affect livestock performance; but it costs money. An example of minimum application rates, as used in Germany, are shown in Table 1.

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Table 1. Minimum application rates for propionic acid, with no apparent margin of safety (Germany, 1971).

Kernel moisture (%)	Propionic acid by wet weight			
	6-month storage+		1-month storage	
	(lb./ton)	(%)	(lb./ton)	(%)
18	9	0.45	7	0.35
20	10	0.50	8	0.40
22	12	0.60	9	0.45
24	14	0.70	10	0.50
26	16	0.80	11	0.55
28	19	0.95	13	0.65
30	22	1.10	16	0.80
35	28	1.40	23	1.15

+The amount of propionic acid should be increased by 3% for each additional month of storage over 6 months.

The preservation of high moisture ear corn by acid treatment has not been as successful. Application rates which are recommended for shelled corn should not be used; they are too low as considerable acid appears to be absorbed by the cob. Ground ear corn at 43% moisture was successfully preserved with 30 lb. acid (80% propionic:20% acetic acid, 1.5% rate) per ton, while small batches of 27% moisture ear corn were preserved with 20 lb. propionic acid per ton. The following guidelines may be appropriate for ear corn of varying moisture corn, although these have not been confirmed experimentally.

Moisture content ear corn (%)	Acid treatment (lb. per ton)
25	18
30	22
35	26
40	30

Acid-treated high moisture corn supports high levels of milk production with no apparent effect on milk composition or animal health (Table 2). No evidence can be found that acid treatment either raises or lowers milk fat test, provided the ration crude fiber content is within acceptable limits. Acid-treated grain should be coarsely ground; use at least a 1/2" screen. Gradually adjust cows to the ration at start of feeding.

Storage. Acid-treated grains cause extensive rusting of galvanized steel bins; it has been estimated that bin life could be reduced from 30 to 3 years. Bins can be protected by coating with high build chlorinated rubber over polyolefin primer. Other resistant materials include urethanes, and films of polyethylene or polyvinyl chloride, but coatings should be primed and cured for 2-3 days, with good ventilation, before filling the bins. The simplest method of storage is to lay plastic down on a barn floor and along sides or walls, and then put the corn on top. Treated corn should be protected from rain, water, etc., especially in high rainfall areas, to prevent leaching of the acid. Plastic is essential over a concrete floor; however, grain preferably should not be sealed between layers of plastic sheets.

One feedlot has stored 1.3 million bushels of treated corn in two bunker silos; they treated 5,000 bu. per hour and lost a total of 400 bu. due to a snow drift. Other feedlots have reported the treatment of 120,000, 180,000, 37,000 and 5,000 bu., which ranged from 19 to 36% moisture and cost 11-13¢ per bushel. Various cost estimates suggest that acid treatment is comparable to other storage methods, depending upon moisture content and type of storage structure.

Table 2. Effect of acid treatment of high moisture corn on milk production and composition (Jones, 1973; Jones et al., 1973).

	Experiment I		Experiment II		
	Acid-treated HMSC[+]	Dry SC[+]	Acid-treated HMSC	Ensiled HMSC	Commercial Concentrate
Milk (lb/day)	50.8	50.2	38.7	38.3	38.5
Fat test (%)	4.0	3.8	3.9	4.2	4.1
Soluble protein (% of total)[‡]	-	-	25.0	41.8	-
Lactic acid (% of dry matter)[§]	-	-	0.6	1.1	-

[+]HMSC = high moisture shelled corn; SC = shelled corn.

[‡]Soluble protein levels in ensiled grain (specifically prolamins and reduced forms of nonprotein nitrogen) have been correlated with depressed appetite and ammonia toxicity symptoms.

[§]Lactic acid analyses suggests little bacterial fermentation occurred in treated grains.

Organic acid preservation provides another alternative method for handling corn. Its use should be based upon cost of handling, and availability and cost of storage facilities and feeding equipment rather than feeding value. One advantage of the acid system is that dairymen can store high moisture grain without high initial investments and this provides small grain producers the opportunity to make use of this feedstuff or allows for expanding grain acreages. Acid preservation overcomes three disadvantages that restrict the use of ensiled high moisture grain:

1. A minimum feeding rate to prevent top-spoilage is not necessary.

2. Treated grain can be transported over long distances without risk of spoilage and thus animals need not be located in close proximity to feed.

3. Complete concentrates containing the high moisture grain can be mixed in larger volumes and stored without risk of heating and molding. Also, the treated grain can be made available in complete rations for longer periods of time.

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