EFFECT OF MICROBIAL INOCULANTS ON THE STORAGE CHARACTERISTICS AND NUTRITIONAL VALUE OF HIGH MOISTURE CORN FOR FINISHING PIGS

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Summary

High moisture corn (23% moisture) was harvested in September, 1988, and stored in concrete silos until March, 1989. As the corn was harvested, it was divided into four treatment silos: high moisture corn (HMC) and HMC treated with inoculants containing lactobacillus, serratia, or streptococcus organisms. As a positive control, some of the corn was allowed to "field dry" to 14% moisture before being harvested. Two hundred forty finishing pigs were fed the corn treatments. Approximately mid-experiment, samples of the corn and mixed diets were collected and evaluated for aerobic stability. At the end of the experiment, chromic oxide was added to the diets (.25%), and the indirect method was used to calculate apparent dry matter and nitrogen digestibilities. Results from the experiment indicated that the mixed diets were stable for a longer period of time than the ground corn (132 h vs 103 h until heating occurred). The HMC treatment was the least stable, and lactobacillus-treated corn was less stable than corn treated with the serratia and streptococcus inoculants. Also, corn treated with the serratia inoculant was more stable than corn treated with the streptococcus inoculant. Average daily gain of pigs was not affected by corn treatment. There were no differences in dry matter intake or feed efficiency expressed on a dry matter basis. Apparent digestibilities of dry matter and nitrogen were similar among the treatment groups. From these data, we conclude that new experimental inoculants (serratia and streptococcus) improve the storage characteristics of high moisture corn. However, an improvement in storage characteristics does not necessarily indicate improved nutritional value of the treated corn.

(Key Words: Microbial Inoculants, Aerobic Stability, Performance, Digestibility, Finishing Pigs.)

Introduction

Weather conditions in the fall and early winter can make it difficult to harvest crops. Long delays in harvest dates, coupled with wet conditions, can result in increased incidence of moldy grain and marked reductions in grain quality. To avoid problems caused by unusual weather conditions, some farmers have opted to harvest their corn crops earlier in the fall, at moisture contents of 20 to 30%. This practice of harvesting "high-moisture corn" allows the farmer much more flexibility in harvest dates. However, there are problems inherent to the use of high-moisture corn, including the potential for spoilage and loss of protein quality, if the grain "heats" during the initial ensiling process.

Chemical grain preservatives (e.g., propionic acid) have been used to prevent spoilage of high-moisture corn, but those preservatives are caustic to metal equipment and tend to be expensive. As an alternative, microbial products are being developed to help preserve high-moisture grain. The objectives of the experiment reported herein were to evaluate three microbial inoculants for their ability to prevent spoilage in high moisture corn and to determine the nutritional value of the treated corn.

Experimental Procedures

High moisture corn (23% moisture) was harvested in September, 1988, and stored in concrete silos until the feeding experiment was started in March, 1989. As the corn was harvested, each truck-load was divided evenly among four treatment silos. The microbial inoculants were sprayed onto the corn as it was put into the silos. For a positive control, some of the corn was left in the field and allowed to dry to 14% moisture before harvesting. Treatments were: 1) the dry-corn control; 2) high moisture corn (HMC); 3) HMC treated with lactobacillus[1]; 4) HMC treated with serratia[2]; and 5) HMC treated with streptococcus[3]. The treatment corns were ground through a hammermill equipped with a 1/4 in. screen before being added to the basal diet given in Table 1. All diets contained 14% crude protein, .65% Ca and .55% P. The HMC treatments were added to replace the dry-corn on a dry matter basis.

The diets were fed to 240 finishing pigs (avg initial wt of 116 lb), with rate of gain (ADG) and feed intake (ADFI) measured bi-weekly. Approximately mid-experiment, samples of the freshly ground HMC treatments were collected before and after being mixed into the diets. The corn and feed samples were loosely packed into one-gallon styrofoam buckets. Thermocouple wires were inserted into the corn and feed samples, and temperatures were recorded every 6 h for 7 d. After the temperatures had stabilized at or near room temperature (usually about 24 h later), a 5°F rise in temperature was assumed to indicate "heating" of the grain. At the end of the growth experiment, chromic oxide was added to the diets (.25%). After a 4-d adjustment period, fecal samples were collected from eight pigs on each treatment, for two consecutive days. The samples were dried, ground, and analyzed for chromium, dry matter, and nitrogen contents so that apparent dry matter and nitrogen digestibilities could be determined.

Table 1. Composition of Basal Diet[a]

Ingredient	Amount, %
Dry-corn treatment[b]	81.14
Soybean meal (44%)	16.15
Monocalcium phosphate	1.04
Limestone	1.02
Salt	.25
Vitamins and minerals	.40

[a]All diets were formulated to contain 14% crude protein, .65% Ca and .55% P.
[b]The high moisture corn treatments were analyzed for dry matter content and substituted for corn on a dry matter basis.

[1]Lactobacillus was Ecosyl®, CIL, Inc., Ontario, Canada.
[2]Serratia was an experimental inoculant, CIL, Inc., Ontario, Canada.
[3]Streptococcus was an experimental inoculant, ICI, PLC, London, England.

Treatment comparisons were: 1) the HMC treatments (HMC, lactobacillus-inoculated, serratia-inoculated, and streptococcus-inoculated) vs the dry-corn control; 2) HMC vs HMC treated with the microbial inoculants; 3) the commercially available inoculant (lactobacillus) vs the experimental inoculants (serratia and streptococcus experimentals); 4) serratia experimental vs streptococcus experimental.

Results and Discussion

Hours until a 5°F rise in temperature for the HMC treatments are given in Table 2. On average, the mixed diets were more stable than the ground corns ($P<.001$), as indicated by an additional 30 h before heating occurred. Corn treated with the microbial inoculants was more stable than the untreated HMC ($P<.001$). Corn treated with both experimental inoculants was more stable ($P<.001$) than corn treated with the commercially available inoculant. Finally, the corn treated with the serratia experimental inoculant was more stable than the corn treated with the streptococcus experimental inoculant ($P<.03$). The treatment effects were consistent in the ground corn and mixed diets.

Table 2. Effect of Microbial Inoculants on Aerobic Stability of High Moisture Corn

	Ground corn[a]				Mixed diet[b]				
Item	HMC[c]	Lacto-bacillus	Serratia	Strepto-coccus	HMC	Lacto-bacillus	Serratia	Strepto-coccus	CV
Hours to 5°F rise in temperature[c]	92	82	124	112	118	122	150	138	7.2

[a]Corn was collected from the silos, ground through a 1/4 in. screen, placed in a one-gallon styrofoam bucket, and monitored for temperature rise (n=3).
[b]Samples of the treatment diets made from the ground corn were collected, placed in one gallon styrofoam buckets, and monitored for temperature rise (n=3).
[c]Ground corn vs mixed diets ($P<.001$); HMC vs lactobacillus + serratia + streptococcus ($P<.001$); lactobacillus vs serratia + streptococcus ($P<.001$); serratia vs streptococcus ($P<.03$).

The effects of feeding the corn treatments to finishing pigs are shown in Table 3. Average daily gain was not affected by treatment ($P>.23$). Feed intake was 11% greater ($P<.001$) for pigs fed the HMC treatments than pigs fed the dry-corn control diet. Feed to gain ratio (as-fed basis) was also 11% higher ($P<.001$) for pigs fed the HMC treatments than pigs fed the dry-corn control diet. However, dry matter intake was not different ($P>.49$) for pigs fed the HMC treatments than pigs fed the dry-corn control diet, and F/G ratio (when expressed as dry matter intake ÷ gain) also was not different ($P>.36$). It appears that the greater feed intakes for pigs fed the HMC treatments than pigs fed the dry-corn control diet were due to the lower energy density of the HMC diets rather than increased palatability.

Table 3. Effect of Microbial Inoculants on the Nutritional Value of High Moisture Corn[a]

Item	Corn treatments					CV
	Dry-corn control	HMC	Lacto-bacillus	Serratia	Strepto-coccus	
Performance						
ADG, lb[b]	1.89	1.87	1.85	1.91	1.88	3.6
ADFI, lb[c]	6.50	7.28	7.12	7.33	7.02	5.0
F/G (as-fed basis)[d]	3.45	3.91	3.85	3.86	3.74	5.0
Dry matter intake, lb/d[e]	5.51	5.59	5.47	5.57	5.46	5.0
F/G (dry matter basis)[f]	2.93	3.00	2.96	2.93	2.91	5.0
Apparent digestibility						
Dry matter, %[g]	80.2	83.8	81.7	83.9	79.3	4.1
Nitrogen, %[h]	76.6	77.9	75.5	77.5	75.2	7.9

[a]Six pens per treatment (eight pigs per pen), avg initial wt of 116 lb and avg final wt of 223 lb.
[b]No treatment effect (P>.23).
[c]Dry control vs HMC + lactobacillus + serratia + streptococcus (P<.001).
[d]Dry control vs HMC + lactobacillus + serratia + streptococcus (P<.001).
[e]No treatment effect (P>.49).
[f]No treatment effect (P>.36).
[g]Serratia vs streptococcus (P<.02).
[h]No treatment effect (P>.46).

Apparent digestibility of dry matter was greater for corn treated with serratia than corn treated with streptococcus (P<.02). However, the dry matter digestibility of corn treated with serratia was not different than the dry matter digestibility of the HMC (83.9% vs 83.8%, respectively). The corn treatments did not affect nitrogen digestibility (P>.46).

In conclusion, the data in this report indicate that microbial inoculants do enhance the storage characteristics of high moisture corn. Aerobic stability of corn treated with the serratia experimental inoculant was improved by 32 h (124 h vs 92 h), when compared to HMC. The use of microbial inoculants did not affect nutrient digestibility or performance of finishing pigs fed diets containing the treated corn.