Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 1 *Cattleman's Day (1993-2014)*

Article 271

2003

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A.B. Broce

C.M. Gordon

J.J. Sindt

See next page for additional authors

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Abstract

Tempered and non-tempered steam-flaked corn samples along with total mixed rations containing either tempered or non-tempered steam-flaked corn were exposed to flies and the environment for 21 hours. Exposure to flies and the environment increased (P<0.05) generic E. coli, non-E. coli coliforms, total coliforms, and total plate count for the steamflaked corn samples independent of tempering. Tempering corn before steam-flaking increased total plate counts. Exposure to the environment and flies did not significantly (P>0.05) alter microbial counts of total mixed rations regardless of tempering (Table 1). Generic E. coli coliforms were greater in total mixed rations when the corn was tempered, both before and after exposure to flies and the environment (P<0.05). Similarly, total microbial plate counts were higher in steam-flaked corn samples when the corn was tempered (P<0.05). A significant increase in response to grain tempering was also noted in non-E. coli coliforms and total microbial plate counts for the total mixed ration samples after exposure (Table 1). Following the initial experiments, 96 finishing beef steers were used to evaluate the effects of tempering steam-flaked corn on acid-resistant E. coli and total fecal coliforms. On day 56 of the feeding period, fecal samples were collected and analyzed for total and acidresistant E. coli and coliforms. No significant treatment difference was observed in the total fecal coliforms (P>0.05), but acid-resistant (pH 2) non-E. coli and total fecal coliforms (Table 2) were lower in feces of cattle fed the tempered grain than those fed non-tempered grain.

Keywords

Cattlemen's Day, 2003; Kansas Agricultural Experiment Station contribution; no. 03-272-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 908; Beef; Corn; Flaking; Houseflies; Fecal matter; Finishing cattle; Coliforms

Authors

A.B. Broce, C.M. Gordon, J.J. Sindt, Brandon E. Depenbusch, James S. Drouillard, and Randall K. Phebus

HIGH MOISTURE TEMPERING OF CORN BEFORE FLAKING: EFFECTS ON BACTERIAL CONTAMINATION FROM HOUSEFLIES AND FECAL SHEDDING IN FINISHING CATTLE

B. E. Depenbusch, J. S. Drouillard, R. K. Phebus, A. B. Broce, C. M. Gordon, and J. J. Sindt

Summary

Tempered and non-tempered steam-flaked corn samples along with total mixed rations containing either tempered or non-tempered steam-flaked corn were exposed to flies and the environment for 21 hours. Exposure to flies and the environment increased ($P<0.05$) generic *E. coli*, non-*E. coli* coliforms, total coliforms, and total plate count for the steam-flaked corn samples independent of tempering. Tempering corn before steam-flaking increased total plate counts. Exposure to the environment and flies did not significantly ($P>0.05$) alter microbial counts of total mixed rations regardless of tempering (Table 1). Generic *E. coli* coliforms were greater in total mixed rations when the corn was tempered, both before and after exposure to flies and the environment ($P<0.05$). Similarly, total microbial plate counts were higher in steam-flaked corn samples when the corn was tempered ($P<0.05$). A significant increase in response to grain tempering was also noted in non-*E. coli* coliforms and total microbial plate counts for the total mixed ration samples after exposure (Table 1).

Following the initial experiments, 96 finishing beef steers were used to evaluate the effects of tempering steam-flaked corn on acid-resistant *E. coli* and total fecal coliforms. On day 56 of the feeding period, fecal samples were collected and analyzed for total and acid-resistant *E. coli* and coliforms. No significant treatment difference was observed in the total fecal coliforms ($P>0.05$), but acid-resistant (pH 2) non-*E. coli* and total fecal coliforms (Table 2) were lower in feces of cattle fed the tempered grain than those fed non-tempered grain.

Introduction

Visual observations at the Beef Cattle Research Center suggest that houseflies (*Musca domestica*) have an affinity for tempered steam-flaked corn as compared to non-tempered steam-flaked corn. High moisture tempering of whole shelled corn prior to flaking resulted in significantly higher moisture content (37%) of the flaked corn as compared to industry standards (20%). The end product of the tempering process that attracts the flies is not known. Recent research indicates that houseflies are a common carrier of pathogens such as *Salmonella* and *Escherichia coli* (*E. coli*) O157:H7. Considering both issues, one might conclude that tempering steam-flaked corn may attract more flies and pathogens resulting in higher number of food-borne pathogens shed by the cattle. We hypothesized that the tempered steam-flaked corn would have higher levels of *E. coli* coliforms and that the cattle receiving the tempered total mixed ration would shed higher numbers of fecal coliforms.

Experimental Procedures

Trial 1

High moisture tempering of the whole shelled corn was achieved by mixing corn with water in a stationary mixer periodically for 24 hours. The tempered corn was then

flaked to a bulk density of 26 lb/bushel resulting in final moisture content of 37%. Non-tempered whole shelled corn was also flaked to the same bulk density as the tempered steam-flaked corn samples. To determine initial bacterial counts, 250-gram aliquots of tempered and non-tempered corn were sampled directly from the steam flaker following completion of the flaking process and immediately refrigerated. An additional 70 lb sample of each corn treatment was acquired and left exposed to the environment and flies for the next 21 hours, samples were then aseptically mixed completely and thoroughly by hand. Random grab samples were used to acquire a 250-gram aliquot, which was refrigerated prior to enumeration of microbial populations. Samples of the total mixed ration were taken directly from the unloading chute of the feed truck mixer following mixing of the ration. Samples of the total mixed rations were collected and refrigerated immediately in order to determine the initial bacterial counts. Five pounds of each of the tempered and non-tempered rations were also exposed to the environment and flies for 21 hours. Samples were then serially diluted in 0.1% peptone water and plated onto both Petrifilm™ and Tryptic Soy Agar petri plates. All plates were incubated for 48 hours at 37°C and enumerated.

Trial 2

Twelve pens with eight steers each received total mixed rations containing either tempered or non-tempered steam-flaked corn. Fecal samples were collected on day 56 of the feeding period. Composite pen samples made using fecal grab samples from individual animals were mixed thoroughly and refrigerated. Fecal samples from each pen were adjusted to pH 2 or 7 for 15 minutes to ascertain total and acid-resistant coliforms and *E. coli.* The pH 2 samples were then neutralized to pH 7 with 1 M NaOH. Serial dilutions were made and plated on Petrifilm. The plates were incubated for 48 hours at 37ºC and enumerated.

Results and Discussion

Trial 1

Generic *E. coli* coliforms, total coliforms, and total plate counts were all numerically higher for the tempered steam-flaked corn samples than for their non-tempered counterparts (Table 1). Non-*E. coli* coliforms, generic *E. coli* coliforms, total coliforms, and total plate counts were all numerically higher for the tempered total mixed rations than for their non-tempered counterparts (Table 1). Exposure to flies and environment significantly increased non-*E. coli* coliforms, generic *E. coli*, total coliforms, and total plate counts for the tempered and non-tempered steam-flaked corn samples ($P<0.05$). Exposure of tempered and non-tempered total mixed rations did not significantly change the microbial counts. Higher background microbial counts of the other ingredients in the ration are probably the reason the differences were not significant.

Trial 2

According to the data from Trial 1, cattle fed the tempered ration would consume more microorganisms than the cattle receiving the non-tempered ration. This is in agreement with our original hypothesis. The pH 7 fecal coliforms shed by the cattle were not significantly different between the rations containing tempered and non-tempered steam-flaked corn (Table 2). However, contrary to our hypothesis cattle receiving the non-tempered rations actually shed more acid-resistant coliforms than the cattle fed the rations containing the tempered steam-flaked corn (Table 2).

Competitive exclusion organisms and/or changes in the ruminal environment would be possible causes for the significant differences in the shedding of acid-resistant coliforms. Possibly the higher moisture contents of the tempered rations fostered the growth of competitive organisms that reduced the acid-

resistant coliforms. Perhaps less substrate was passed on to the large intestine of the cattle fed the ration containing tempered steam-flaked corn resulting in less substrate for the proliferation of acid resistant coliforms.

Table 1. Bacterial Counts in Steam-Flaked Corn and Total Mixed Rations Before (Initial) and After (Final) Environmental Exposure (Trial 1)

Steam-Flaked Corn	Initial	Final
Non-*E. coli* coliforms	------- Log_{10} colony forming units/gram -------	
Non-Tempered	0.47	2.65†
Tempered	0.20	2.32†
Generic *E. coli*		
Non-Tempered	0.20	2.00†
Tempered	0.87	3.19†
Total coliforms		
Non-Tempered	0.20	2.44†
Tempered	0.88	3.33†
Total Plate Count[a]		
Non-Tempered	3.86	5.49†
Tempered	5.78*	8.19*†
Total Mixed Ration		
Non-*E. coli* coliforms		
Non-Tempered	3.22	3.05
Tempered	4.07	4.67*
Generic *E. coli*		
Non-Tempered	1.88	2.16
Tempered	3.46*	4.03*
Total coliforms		
Non-Tempered	3.26	3.16
Tempered	4.19	4.76
Total Plate Count[a]		
Non-Tempered	7.02	6.44
Tempered	7.63	8.60*

[a]Total aerobic fastidious and non-fastidious microorganisms.
*Value for tempered product is significantly greater than value for corresponding non-tempered product ($P<0.05$).
†Value after exposure is significantly greater than value for corresponding initial value ($P<0.05$).

Table 2. Fecal Coliform Levels from Steers Receiving Total Mixed Rations Containing Either Tempered or Non-tempered Steam-Flaked Corn (Trial 2)

Fecal Coliforms	Non-tempered	Tempered	P-value[a]
Total Coliforms (pH 7)	---- Log_{10} colony forming units/gram ----		
E. coli	6.29	6.18	0.70
Non-*E. coli*	5.60	5.57	0.96
Total	6.45	6.33	0.80
Acid-resistant Coliforms (pH 2)			
E. coli	1.33	0.85	0.09
Non-*E. coli*	2.29	0.85	0.01
Total	2.49	0.85	0.002

[a]Probability that differences of the magnitude observed were due to random chance.