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Influence of flake fragmentation on the feeding value of steam-flaked corn in finishing diets for feedlot cattle

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ABSTRACT

Two trials were conducted to evaluate the influence of fines on the feeding value of steam-flaked corn (SFC) in finishing diets for feedlot cattle. Three levels (0, 333 and 667 g/kg) of re-rolled SFC replaced standard SFC (0.31 kg/L) in a corn-based finishing diet (DM basis). Diets were offered as total mixed rations. Re-rolled SFC consisted of standard air-dry SFC that was passed through the rollers a second time to simulate loss of flake integrity which can occur during feed-handling. In experiment one, the influence of fines in SFC on growth performance was evaluated in eighteen crossbred steers (294 ± 5 kg) in a replicated 3 × 3 Latin square design. Daily weight gain was similar (P>0.10) among treatments, averaging 1.31 kg/d. Dry matter intake tended to be greater (quadratic effect, P=0.06) for diets containing re-rolled steam-flaked corn. Gain efficiency and dietary NE were not influenced by dietary treatments (P>0.10). In experiment two, six Holstein steers (308 ± 17 kg) with cannulas in the rumen and proximal duodenum were used in a replicated 3 × 3 Latin square design to evaluate treatment effects on characteristics of digestion. Reductions in particle size of SFC due to rerolling did not influence ruminal or total tract digestion of OM, NDF, N, or starch (P>0.10). Likewise, there were no treatment effects (P>0.10) on ruminal microbial efficiency, ruminal pH, or ruminal VFA molar proportions. It is concluded that the impact of flake disintegration during conveyance and handling on feedlot cattle growth performance and characteristics of digestion will be marginal, if appreciable.

1. Introduction

Conveyance and mixing may result in breakdown of steam-flaked corn after it leaves the rolls, resulting in variable production of smaller flake particles or “fines”. The influence of this loss of flake integrity on overall palatability of the diet and cattle performance has received limited research attention. Sindt et al. (2006) assessed the idea of flake disintegration and production of fines during mixing on resulting feeding value. Allowing flaked corn to mix in a stationary horizontal ribbon mixer for 0 vs 15 min before addition of the other dietary ingredients caused a 29% reduction in mean particle size of steam-flaked corn. However, this reduction in flake particle size did not affect 108-d growth-performance of feedlot

Abbreviations: ADG, average daily gain; aNDFom, neutral detergent fiber assayed with amylase and expressed exclusive of residual ash; CP, crude protein; DM, dry matter; DMI, dry matter intake; NE, net energy; NE_m, net energy for maintenance; NE_g, net energy for gain; OM, organic matter; SFC, steam-flaked corn; VFA, volatile fatty acids.

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Table 1
Dry sieve characteristics of standard whole and rerolled steam-flaked corn.[a]

Item	Sieve diameter (mm)						MPS[b] (mm)
	<3.2	3.2	4.8	6.4	8.0	9.6	
Percentage retained							
Steam-flaked corn							
Whole[c]	1.6	2.8	4.5	7.8	10.1	73.2	9.5
Re-rolled[c]	39.0	28.4	18.7	10.1	2.9	0.9	3.9

[a] Samples were oven-dried prior to sieving.
[b] MPS, mean particle size.
[c] "Whole" refers to standard 0.31 kg/L (24 lb/bushel) steam-flaked corn. "re-rolled" refers to steam-flaked corn that was allowed to air-dry and then dry-rolled a second time.

heifers. The objective of this study was to evaluate the influence of flake fragmentation on feeding value of a conventional steam-flaked corn-based finishing diet.

2. Materials and methods

All procedures involving animal care and management were in accordance with and approved by the University of California, Davis, Animal Use and Care Committee.

2.1. Experiment 1, influence of flake fragmentation on growth performance and dietary energetics

2.1.1. Animals and diets

Eighteen crossbred steers (294 ± 5 kg) were used in a replicated 3 × 3 Latin square design experiment to evaluate the influence of flake fragmentation (increased fines) of steam-flaked corn (SFC) on feed intake and growth-performance. Treatments consisted of a finishing diet with 880 g/kg of concentrate in which the SFC was provided as (1) whole; (2) 2/3 whole, 1/3 re-rolled or (3) 1/3 whole, 2/3 re-rolled. "Whole" refers to standard 0.31 kg/l (24 lb/bushel) steam-flaked corn. "Re-rolled" refers to "whole" SFC which was allowed to air-dry and then passed through the rollers a second time. The intent of re-rolling was to simulate loss of flake integrity which can occur during handling. The particle size in sieve of dry "whole" and "re-rolled" steam-flaked corn is shown in Table 1. Steam-flaked corn was prepared as follows: a chest situated directly above the rollers (46 cm × 61 cm, corrugated) was filled to capacity (440 kg) with whole corn and brought to a constant temperature (102 °C) at atmospheric pressure using steam. The corn was steamed for 20 min before starting the rollers. Approximately 440 kg of the initial steam-processed grain that exited the rolls during warm-up was not fed to steers on this study. Tension of the rollers was adjusted to provide the indicated flake density (0.31 kg/L). Retention time of grain in steam chamber was approximately 18 min. The SFC was allowed to air-dry (5 d) before use in diet preparation. Yellow corn used was a commercial blend of US #2 dent. The only difference in diets was the substitution of whole by re-rolled SFC (*T*1 had 773 + 0; *T*2 had 515.3 + 257.7; and *T*3 had 257.7 + 515.3, for whole and re-rolled SFC, respectively). The ingredient composition (g/kg, DM basis) of basal diet (experiments 1 and 2) was: 80.0 alfalfa hay, 40.0 Sudangrass hay, 773.0 steam-flaked corn, 25.0 blended animal vegetable fat (predominantly soap stock), 40.0 cane molasses, 17.8 limestone, 11.7 urea, 7.5 sodium bicarbonate, and 5.0 trace mineral salt (containing g/kg: $CoSO_4$, 0.68; $CuSO_4$, 10.4; $FeSO_4$, 35.7; ZnO, 7.5; $MnSO_4$, 10.7; KI, 0.52; and NaCl, 934). Nutrient composition of basal diet on DM basis was: 9.2 and 6.4 MJ/kg of NE maintenance and gain, 130 g/kg of crude protein, 60.3 g/kg of ether extract, 8.0 g/kg of calcium, 2.8 g/kg of phosphorus, and 6.4 g/kg of potassium. This composition was estimated based on tabular values for individual feed ingredients (NRC, 1996) with exception of supplemental fat which was assigned NE_m and NE_g values of 25.2 and 19.8 MJ/kg, respectively (Zinn, 1988). Steers were blocked by weight and randomly assigned to 6 pens (3 steers/pen). Pens were 15 m^2 with 15 m^2 of overhead shade, automatic waterers, and 2.4 m fence-line feed bunks. Animals were weighed at the start and end of the study, and at each changeover between periods. Experimental periods were of 42-d duration. Steers were allowed *ad libitum* access to experimental diets, fresh feed was provided twice daily.

2.1.2. Estimation of dietary NE

Energy gain (EG) was calculated by the equation: $EG = ADG^{1.097}\ 0.0557\ W^{0.75}$, where EG is the daily energy deposited (Mcal/d), W is the mean shrunk BW (kg; NRC, 1984). Maintenance energy (EM) was calculated by the equation: $EM = 0.077\ W^{0.75}$ (NRC, 1996). Dietary NE_g was derived from NE_m by the equation: $NE_g = 0.877\ NE_m - 0.41$ (Zinn and Shen, 1996). Dry matter intake is related to energy requirements and dietary NE_m according to the equation: $DMI = EG/(0.877NE_m - 0.41)$, and can be resolved for estimation of dietary NE by means of the quadratic formula: $x = [-b \pm (b^2 - 4ac)^{0.5}]/2a$, where $x = NE_m$, $a = -0.877DMI$, $b = 0.877\ EM + 0.41\ DMI + EG$, and $c = -0.42\ EM$ (Zinn and Shen, 1996).