Kansas Agricultural Experiment Station Research Reports

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

Article 121

2008

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Recommended Citation

May, M.L.; Quinn, M.J.; Depenbusch, Brandon E.; and Drouillard, James S. (2008) "Determining optimum flake density for feedlot heifers," *Kansas Agricultural Experiment Station Research Reports*: Vol. 0: Iss. 1. https://doi.org/10.4148/2378-5977.1524

Determining optimum flake density for feedlot heifers

Abstract

Escalating costs of natural gas and electrical utilities have greatly increased the cost of flaking grain for feedlots. Energy demand for flaking is inversely related to bulk density of flaked grain; the lighter, more highly processed flakes typically require longer steaming times and greater roll pressures, which ultimately decreases mill. Corn is most commonly flaked to a density of about 28 lb/bushel, and published research results indicate that levels less than 28 lb/bushel afford no further advantage with respect to animal performance. Little information is available concerning the relative feed value of grains flaked to heavier bulk densities. Flaking grains to heavier bulk densities could make it possible to increase mill throughput and reduce energy costs associated with flaking. In this study, our objective was to evaluate milling efficiency and cattle performance when grains were flaked to densities of 28, 32, and 36 lb/bushel.

Keywords

Cattlemen's Day, 2008; Kansas Agricultural Experiment Station contribution; no. 08-212-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 995; Beef; Cattle; Heifers; Flaking grains

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DETERMINING OPTIMUM FLAKE DENSITY FOR FEEDLOT HEIFERS

M. L. May, M. J. Quinn, B. E. Depenbusch, and J. S. Drouillard

Introduction

Escalating costs of natural gas and electrical utilities have greatly increased the cost of flaking grain for feedlots. Energy demand for flaking is inversely related to bulk density of flaked grain; the lighter, more highly processed flakes typically require longer steaming times and greater roll pressures, which ultimately decreases mill. Corn is most commonly flaked to a density of about 28 lb/bushel, and published research results indicate that levels less than 28 lb/bushel afford no further advantage with respect to animal performance. Little information is available concerning the relative feed value of grains flaked to heavier bulk densities. Flaking grains to heavier bulk densities could make it possible to increase mill throughput and reduce energy costs associated with flaking. In this study, our objective was to evaluate milling efficiency and cattle performance when grains were flaked to densities of 28, 32, and 36 lb/bushel.

Experimental Procedures

Heifers (n = 358) were allocated to 48 feedlot pens, each containing six to eight cattle. Pens were assigned to one of three treatments (16 pens per treatment), which consisted of finishing diets made from steam-flaked corn processed to densities of 28, 32, or 36 lb/bushel. Cattle were fed once daily throughout the 115-day finishing trial. At the termination of the study, cattle were weighed as pens and subsequently transported to a commercial abattoir in Emporia, KS, for harvest. Information was collected for severity and incidence of liver abscesses; hot carcass weight; back fat over the 12th rib; kidney, pelvic, and heart fat percentage; yield grade; marbling score; and quality grade.

In addition to animal performance and carcass quality attributes, data also were collected to evaluate milling efficiency when corn was processed to the three different densities. Total mill throughput in tons per hour was determined for each grain, and this information was used to calculate energy expenditure associated with processing grains to different densities. Particle size was measured daily for flaked grain samples and weekly for total mixed rations using a Ro-Tap (W. S. Tyler, Mentor, OH) sieving machine equipped with a series of seven sieves with openings ranging from 9,500 to 1,180 μm.

Results and Discussion:

Starch availability ranged from a high of 47% for corn flaked to a density of 28 lb/bushel down to 35% for corn flaked to a density of 36 lb/bushel. As bulk density increased, mill throughput increased fairly dramatically. Increasing flake density also increased the average particle size of flakes and improved durability of the flaked grain throughout the mixing process, as evidenced by the decreased proportion of small particles that tend to accumulate in feed bunks. However, these improvements in flake integrity did not positively improve cattle performance. Processing corn to heavier bulk densities resulted in small decreases in gain, as well as slightly higher feed intakes. Carcass traits were mostly unaffected by degree of grain processing. Overall, efficiency tended to improve with more rigorous processing of the grain. Compared with cattle fed 28-lb flakes, feeding corn flaked to densities of 32 or 36 lb/bushel yielded gain efficiencies that were 2 to 5% poorer than those of cattle fed the 28-lb flakes. Using an estimated feed cost of $200/ton (dry basis), the poorer efficiency of under-processed flakes increased cost of production by $0.01 to $0.03 per pound of gain, equating to approximately $0.03 to $0.08 per animal daily.

Implications:

Improvements in mill efficiency that are attributable to flaking grain to heavier bulk densities do not offset increased costs associated with poorer feed conversion efficiency.

Table 1. Composition of Steam-flaked Corn-based Finishing Diets Containing Different Flaked Densities Fed to Yearling Heifers

	Flake Density, lb/bushel		
Item, % dry matter	28	32	36
Steam-flaked corn	83.0	83.0	83.0
Alfalfa hay	6.4	6.4	6.4
Corn steep	3.9	3.9	3.9
Limestone	1.9	1.9	1.9
Urea	1.4	1.4	1.4
Mineral/vitamin premix[1]	1.2	1.2	1.2
Feed additive premix[2]	2.2	2.2	2.2
Nutrient Analyses			
Crude protein, %	13.86	13.80	13.85
Calcium, %	0.71	0.71	0.71
Phosphorus, %	0.25	0.25	0.25
Potassium, %	0.30	0.30	0.30
Net Energy, Mcal/100 lb			
Maintenance	111	110	108
Gain	79	78	76

[1] Formulated to provide (dry matter basis) 0.15 ppm cobalt; 10 ppm copper; 0.6 ppm iodine; 60 ppm zinc; 60 ppm manganese, 0.25 ppm selenium; and 1,200 IU/lb of vitamin A.

[2] Provided 300 mg/day Rumensin, 90 mg/day Tylan, and 0.5 mg/day MGA.

Table 2. Influence of Bulk Density on Dry Matter and Available Starch of Flaked Grain and Mill Efficiency

	Flake Density, lb/bushel					
Item	28	32	36	SEM	Lin	Quad
Dry matter, %	84.54	84.39	84.22	0.27	0.39	0.99
Starch availability, %[1]	46.73	39.27	34.87	0.32	<0.01	<0.01
Rate, tons/hour	2.22	2.45	3.40	0.13	<0.01	0.13
Mill efficiency, %[2]	100	114	152.8	---	---	---

[1] Measured by incubating 25 g of intact flakes in 100 mL of a 2.5% (wt/vol) amyloglucosidase enzyme solution for 15 minutes, and subsequently determining percentage of solubles on a refractive index scale.

[2] Efficiency is expressed as a percentage relative to grain flaked to a density of 28 lb/bushel.

Table 3. Growth Performance of Yearling Heifers Fed Finishing Diets Containing Corn Flaked to Different Densities

	Flake Density, lb/bushel					
Item	28	32	36	SEM	Lin	Quad
Number of pens	16	16	16	-	-	-
Number of heifers	116	118	121	-	-	-
Initial weight, lbs	740	742	745	5.36	0.51	0.85
Final weight, lbs[1]	1069	1065	1060	7.89	0.43	0.92
Dry matter intake, lb/day	16.82	16.91	16.98	0.18	0.52	0.95
Daily gain, lb[1]	2.85	2.81	2.73	0.08	0.29	0.85
Feed:gain[1,2]	5.90	6.02	6.22	0.15	0.13	0.83

[1] Final live weight was computed as hot carcass weight divided by a common dresses yield of 0.635.

[2] Statistics were performed as gain:feed, reported as feed:gain.

Table 4. Carcass Characteristics for Yearling Heifers Fed Finishing Diets Containing Corn Flaked to Different Densities

	Flake Density, lb/bu					
Item	28	32	36	SEM	Lin	Quad
Hot carcass weight, lb	679	676	673	5.01	0.43	0.92
USDA quality grade						
Prime, %	3.7	1.7	3.3	1.80	0.88	0.40
Upper 2/3 Choice, %	21.1	18.0	22.6	3.11	0.73	0.33
Choice, %	61.0	54.5	58.2	4.98	0.69	0.41
Select, %	33.3	42.2	37.6	4.74	0.53	0.25
No roll, %	1.0	0.8	0.9	0.91	0.91	0.87
Dark cutter, %	0.9	0.9	0.0	0.73	0.39	0.62
Marbling score[1]	536	516	536	11.57	0.99	0.17
Average yield grade	2.69	2.62	2.75	0.06	0.50	0.16
Yield grade 1, %	5.98	2.45	4.02	2.12	0.51	0.33
Yield grade 2, %	31.0	39.8	24.2	3.98	0.24	0.02
Yield grade 3, %	51.4	51.2	65.2	4.54	0.04	0.21
Yield grade 4 %	11.7	6.6	5.8	2.09	0.06	0.40
Liver Abscess, %	3.6	4.9	5.0	1.89	0.62	0.79
Kidney, pelvic, heart fat, %	2.33	2.40	2.39	0.04	0.26	0.40
Ribeye area, square inches	12.96	12.89	12.24	0.16	0.01	0.15
Back fat 12th-rib, inches	0.57	0.58	0.59	0.02	0.57	0.80

[1] Marble Score 500=Small.

Table 5. Particle Size Distribution, Geometric Mean Diameter, and Geometric Mean Diameter Standard Deviation of Steam-flaked Corn Where Flake Densities were 28, 32, or 36 lb/bushel

	Flake Density, lb/bushel					
Item	28	32	36			
Screen size, µm	Particle size distribution, %[1]			SEM	Lin	Quad
9,500	52.15	43.54	24.40	12.57	<0.01	0.04
6,700	32.97	45.80	64.61	15.92	<0.01	0.12
4,750	6.63	4.79	3.77	1.45	<0.01	0.52
3,350	2.94	2.23	1.98	0.50	<0.01	0.56
2,360	1.51	1.01	0.58	0.47	<0.01	0.82
1,700	0.76	0.48	0.22	0.27	<0.01	0.98
1,180	0.62	0.36	0.19	0.22	<0.01	0.40
< 1,180	2.41	1.79	1.25	0.58	<0.01	0.82
GMD, µm[2]	6,163	6,565	7,000	55.23	<0.01	0.81
GSD[3]	3.47	2.90	2.75	0.11	<0.01	0.13

[1] Percentage of sample remaining on screen.
[2] GMD = geometric mean diameter.
[3] GSD = geometric standard deviation.

Table 6. Particle Size Distribution, Geometric Mean Diameter, and Geometric Mean Diameter Standard Deviation of Complete Diets Where Flake Densities were 28, 32, or 36 lb/bushel

	Flake Density, lb/bushel					
Item	28	32	36	SEM	Lin	Quad
Screen size, µm	Particle size distribution, %[1]					
9,500	4.56	12.15	12.34	4.44	<0.01	<0.01
6,700	22.87	36.01	45.71	11.46	<0.01	0.41
4,750	22.21	16.47	12.70	4.79	<0.01	0.37
3,350	15.07	11.26	9.61	2.80	<0.01	0.16
2,360	9.26	6.12	5.38	2.06	<0.01	0.01
1,700	6.04	4.19	3.50	1.32	<0.01	0.14
1,180	14.58	9.98	7.75	3.48	<0.01	0.24
< 1,180	5.41	3.82	3.01	1.22	<0.01	0.33
GMD, µm[2]	2,990	4,420	4,565	284.47	<0.01	0.07
GSD[3]	1.80	1.66	1.53	0.03	<0.01	0.78

[1] Percentage of sample remaining on screen.
[2] GMD = geometric mean diameter.
[3] GSD = geometric standard deviation.