Feedstuffs Reprint

Corn processing may affect growth, rumen

Bottom Line

with
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THERE are a variety of opinions as to what is the best form of processed corn used in calf starters. So, it is helpful to have a recent study address that subject (Lesmeister and Heinrichs, J. Dairy Sci. 87:3439-3450).

This is not a simple issue to address for there are several parameters involved. These include mechanical and chemical alterations through processing, palatability and intake of the starter(s) and ruminal effects.

Two experiments were conducted with 92 Holstein calves (52 male and 40 female) started at 2 ± 1 days of age in the first trial and 12 male ruminally cannulated Holstein calves in the second trial. Calves were separated after birth from their dams, blocked by birth date and placed on experiment at two days of age.

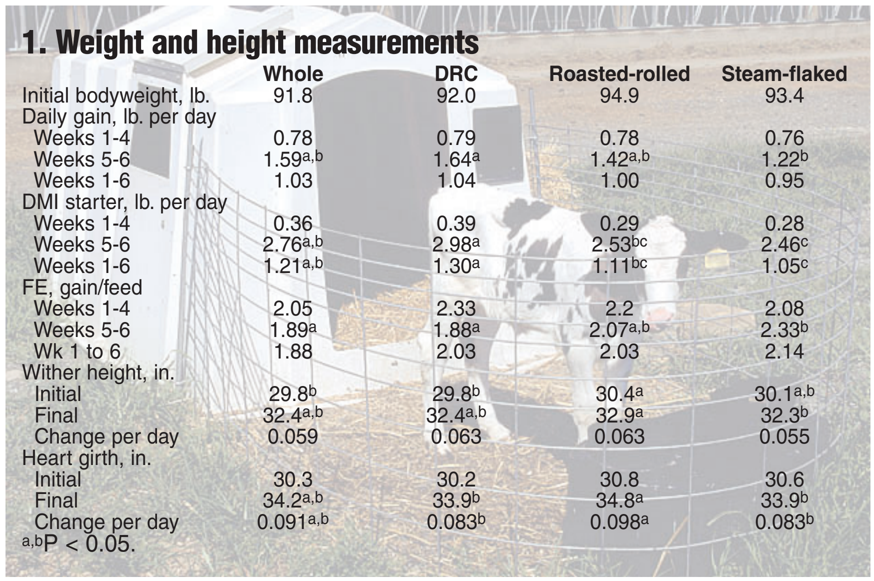
All calves received 4 L of colostrum within 12 hours of birth, followed by four feedings of colostrum. Then, calves received a 20% protein and 20% fat milk replacer from three days until abrupt weaning at 28 ± 1 day of age, although calves continued on the study until 42 ± 1 days.

Milk replacer was fed twice daily in equal feedings at 10% of birth weight and mixed at 12.5% dry matter. Calf starters were fed *ad libitum*, intake was measured daily and water was provided free choice while changed twice daily.

A subset of 12 male calves (three per treatment) was slaughtered at four weeks of age for sampling of rumen tissue development.

In the second trial, ruminal cannulation occurred at 7 ± 1 days of age. The feeding regime was the same as for the first experiment, but starter was manually inserted into the rumen in an amount equal to the calf within the block having the highest intake until voluntary intake occurred. This was done to equalize starter intake.

Composition of the starter was 33.29% corn, 5.08% cane molasses, 15.54% whole oats and the same 17.09% premix pellet comprised mostly of soybean meal and wheat midds. Nutrient composition was similar among starters and averaged about 90% dry matter, 21% crude protein (19% as fed) and calculated total digestible nutrients of 75.6%.



1. Weight and height measurements

	Whole	DRC	Roasted-rolled	Steam-flaked
Initial bodyweight, lb.	91.8	92.0	94.9	93.4
Daily gain, lb. per day				
Weeks 1-4	0.78	0.79	0.78	0.76
Weeks 5-6	1.59[a,b]	1.64[a]	1.42[a,b]	1.22[b]
Weeks 1-6	1.03	1.04	1.00	0.95
DMI starter, lb. per day				
Weeks 1-4	0.36	0.39	0.29	0.28
Weeks 5-6	2.76[a,b]	2.98[a]	2.53[bc]	2.46[c]
Weeks 1-6	1.21[a,b]	1.30[a]	1.11[bc]	1.05[c]
FE, gain/feed				
Weeks 1-4	2.05	2.33	2.2	2.08
Weeks 5-6	1.89[a]	1.88[a]	2.07[a,b]	2.33[b]
Wk 1 to 6	1.88	2.03	2.03	2.14
Wither height, in.				
Initial	29.8[b]	29.8[b]	30.4[a]	30.1[a,b]
Final	32.4[a,b]	32.4[a,b]	32.9[a]	32.3[b]
Change per day	0.059	0.063	0.063	0.055
Heart girth, in.				
Initial	30.3	30.2	30.8	30.6
Final	34.2[a,b]	33.9[b]	34.8[a]	33.9[b]
Change per day	0.091[a,b]	0.083[b]	0.098[a]	0.083[b]

[a,b]$P < 0.05$.

Corn was the treatment variable and was either whole shelled (density of 1.50 lb. per quart), dry rolled (DRC, 1.59 lb. per quart), roasted rolled (0.90 lb. per quart) or steam flaked (0.81 lb. per quart). Large particle size (percent retained on screen of 6.70 mm) was considerably greater for both whole (20.7%) and roasted-rolled (21.9%) corns compared to DRC (0.9%) and steam-flaked corn (10.5%).

Initial body weights were similar (Table 1). Average daily gains (ADG) did not differ before weaning but were greater ($P < 0.05$) for DRC versus steam flaked postweaning. Dry matter intake (DMI) for milk replacer was about 1.2 lb. per day and was similar among treatments. Starter DMI did not differ among treatments before weaning but after weaning was lower ($P < 0.05$) for roasted-rolled corn than DRC and steam-flaked corn than for DRC and whole corn. This similar pattern carried over for the entire six-week average.

These intake and performance data are similar to the summary reported by Kertz et al. (1979), which used starters made with cracked corn. The somewhat lower starter intake in this study (Lesmeister and Heinrichs, 2004) would likely be due to 20% fat in the milk replacer versus 12% in the former study.

The key element, irrespective of corn physical form, appears to be the importance of particle size in starters, as noted by Warner et al. (1973).

Structural growth among treatments was not different for hip height, and the rate of change was similar for wither height (Table 1). Hip width (not shown) and heart girth rate of change indicated some significant differences ($P < 0.05$). These differences appeared to favor the roasted-rolled treatment. The authors speculated that this may have been due to nutrient partitioning to bone or fat deposition, most likely post-ruminally as a consequence of processing methods. On the other hand, they also said these differences were biologically quite small.

Blood parameters measured in these calves did not differ in plasma total protein, beta hydroxybutyrate and hematocrit. However, there was a consistent pattern in total blood volatile fatty acids (VFAs) and acetate, propionate and butyrate being higher ($P < 0.05$) for steam-flaked corn compared to the other treatments, which did not differ amongst themselves. This may reflect more rumen epithelial activity or more rumen VFA production on the steam-flaked treatment.

Calves were healthy, with no differences in scouring, respiratory or general appearance evaluations.

In the second study, there were no differences in starter intake, but intakes were equalized during the first two weeks through the rumen fistula. Rumen pH did differ somewhat but not consistently and with significant treatment by week interactions. Rumen pH did decrease linearly ($P < 0.05$) with age in this study. Similarly, there were some significant rumen ammonia differences, but changes were inconsistent and highly variable. Rumen ammonia actually changed quadratically ($P < 0.01$) with age.

Total rumen VFA along with acetate and propionate concentrations were generally lowest in calves on the whole corn treatment and highest for the steam-flaked treatment. The changes seemed to be related to the degree of corn processing. Rumen butyrate was higher ($P < 0.05$) in calves during week 5 on the roasted-rolled treatment than in calves receiving DRC or steam-flaked treatments.

If this were related to processing alone, why would steam-flaked corn-fed calves not have had higher butyrate? Possibly, because as the authors speculated, more butyrate may have been used for epithelial growth and/or an increased uptake of rumen butyrate as associated with higher blood butyrate for these calves. During week 6, plasma beta hydroxybutyrate was higher in calves on whole corn or DRC than in calves receiving roasted-rolled or steam-flaked treatments.

Table 2 shows that DRC treatment calves had greater ($P < 0.05$) rumen papillae length than the steam-flaked treatment, with the other two treatments being intermediate. No differences were noted in pappillae width. The rumen wall was thicker ($P < 0.05$) for steam-flaked compared to whole corn, with the other treatments being intermediate.

The steam-flaked starter treatment exhibited a pattern of being lower in DMI, ADG and feed efficiency as well as higher in blood and rumen VFAs, particularly propionate. Why? This treatment had the lowest density and the most processing, which would tend to increase its fermentability and fragility. The latter may also have tended to produce more fines and most likely would have reduced particle size effect in the rumen.

2. Rumen tissue parameters

	Whole	DRC	Roasted	Steam-flaked
Papillae length, cm	$0.87^{a,b}$	0.71^{b}	$0.80^{a,b}$	0.89^{a}
Papillae length, cm	0.57	0.54	0.51	0.61
Rumen wall thickness, cm	1.06^{b}	$1.10^{a,b}$	$1.14^{a,b}$	1.21^{a}

$^{a,b}P < 0.05$.

The Bottom Line

The Lesmeister and Heinrichs (2004) study indicated that properly processed corn by various methods for use in a calf starter resulted in essentially equivalent calf performance, with some concern about steam-flaked corn. Starter limitations may often have more to do with proper corn processing, the final physical properties of calf starters and then proper feeding management practices on the dairy or calf operation.

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