EVALUATION OF ROASTED SOYBEANS FOR DAIRY CALVES

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Summary

Diets containing soybeans roasted at different temperatures were fed to calves to investigate effects on growth and feed consumption. A growth trial was conducted using 84 Holstein calves from birth to 8 wk of age. The diets were formulated to contain 18% CP using soybeans roasted at 270 degrees F, 295 degrees F, or 325 degrees F. The overall feed consumption was greater for calves fed the diet containing beans roasted at either 270 or 295 degrees F than those fed the diet containing 325 degrees F beans. A similar trend was observed in weekly feed consumption. Gains were higher for calves fed the diet containing 295 degrees F beans, and these calves were more efficient in converting feed and energy to gain than the others. Rumen undegradable intake protein increased with increasing roasting temperature, but unavailable protein was high for 325 degrees F beans. Superior calf performance resulted when corrected undegradable intake protein (undegradable intake protein "minus" indigestible intake protein) was 56% and trace lipase activity remained.

(Key Words: Calves, Starter Diets, Soybeans, Roasting Temperatures.)

Introduction

Young calves, like high milk-producing cows in early lactation, require a feed high in protein and energy. Full fat soybeans contain, on a dry basis, approximately 19% fat and 39% CP, but raw soybeans contain several antinutritional factors (trypsin inhibitors, urease, hemaglutinins, etc.) that may lower their feed value. Heat treatment is the most commonly used method to minimize activity of these factors and can be accomplished by extrusion or by roasting. Results of our previous studies indicated that when roasting temperature was increased up to 290 degrees F, calf performance was increased. However, we did not have information on beans roasted at temperatures above 290 degrees F. The industry needs a simple, reliable method for determining when soybeans have been properly processed. This experiment was conducted to answer some of these questions.

Procedures

Performance Trial

Eighty-four Holstein calves were used from birth to 8 wk of age. They were fed colostrum for 3 d, then whole milk at 8% of birth weight daily in two equal feedings. All calves were housed in outdoor hutches and bedded on straw.

Calves were blocked by date of birth, then calves within blocks were assigned randomly to each of three pelleted calf starter diets (Table 1). The diets were formulated to contain 18% CP using soybeans roasted at 270 degrees F, 295 degrees F or 325 degrees F with a Jet-Pro Roaster® (Jet-Pro Co., Atchison, KS). Calves could consume calf starter and water free choice and were weaned when they consumed at least 1.5 lb starter per day for 2 consecutive days.

Amount of starter consumed and body weight of calves were recorded weekly. Calves were observed daily for deviations from normal health. At birth and at 8 wk of age, wither height,

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body length (from point of shoulder to posterior edge of pin bone), and heart girth were recorded.

In Vitro Evaluation of Roasted Soybeans

A laboratory method was used to determine the extent of protein degradation in the roasted soybeans. Indigestible intake protein content of roasted soybeans was calculated from analyzed values of acid detergent insoluble nitrogen. Lipase activity of the soybeans roasted at different temperatures was determined by using a PRO-CHEK test kit (ALTECA Ltd., Manhattan, KS).

Results and Discussion

Feed consumption and weight gains are presented in Table 2. The overall feed consumption was greater for calves fed the 270 or 295 degrees F diets than those fed 325 degrees F roasted beans. A similar trend of weekly feed consumptions was observed from wk 4 through 8. However, the weight gains of calves fed the 295 degrees F diet were higher than those of calves fed the 270 or 325 degrees F diets.

Average daily gain, gain to feed ratio, and energy efficiencies were calculated using the data for calves (n = 80) from 6 to 8 wk of age (Table 3). Calves fed the diet containing beans roasted at 295 degrees F gained more weight and tended to be more efficient in converting feed and energy to gain than those fed the 270 or 325 degrees F diets.

The increases in height for the 8-wk period were 3.4, 4.1, and 2.6 inches, and the increases in length were 4.0, 4.6, and 3.3 inches for the 270, 295, and 325 degrees F diets, respectively. Calves fed the 295 degrees F diet grew more than calves in other groups.

Rumen undegradable intake protein contents of soybeans roasted at 270, 295, and 325 degrees F were 53, 60, and 69% and lipase activities were medium, trace, and none, respectively.

Use of soybeans roasted at 295 degrees F resulted in superior calf performance. This temperature sufficiently increased the protein undegradability and probably allowed more efficient utilization in the small intestine. The low gains on the diet containing 325 degrees F beans may have been related to palatability or heat damaged protein that was indicated by severe scorching and burning of the seed coat and by a high proportion of indigestible intake protein (13%) in comparison to soybeans processed at 270 or 295 degrees F (4%).

In conclusion, performance of calves fed soybeans roasted at 295 degrees F was superior to those fed soybeans roasted at 270 or 325 degrees F. Rumen undegradable intake protein increased with increasing roasting temperature, but unavailable protein was high for 325 degrees F beans. Lipase activity can be used to predict protein undegradability, provided that the beans are uniformly cooked.

Table 1. Ingredient and Chemical Composition of Calf Starters

Item	Diets[1] 270^{0}F	295^{0}F	325^{0}F
Ingredient	---------- % ----------		
Alfalfa, ground	19.4	19.9	19.9
Corn, cracked	40.3	39.4	39.5
Oats, rolled	14.5	15.1	15.1
Molasses, liquid	6.0	6.0	6.0
Soybeans, roasted	18.5	18.3	18.2
Trace-mineralized salt	.22	.22	.22
Dicalcium phosphate	.46	.46	.46
Limestone	.54	.54	.54
Vitamin ADE premix[3]	.05	.05	.05
Coccidiostat[4]	.03	.03	.03
Chemical analysis, %			
DM	89.6	89.8	90.5
CP[5]	17.9	18.2	18.4
ADF[5]	9.9	10.1	9.5
NDF[5]	14.4	14.6	15.0

[1]Diets identified by temperature at which soybeans were roasted.
[2]As-fed basis.
[3]Provided 1000 IU vitamin A, 140 IU vitamin D, and 32 IU vitamin E per lb feed.
[4]Provided 30 mg of decoquinate per lb feed.
[5]DM basis.

Table 2. Average Feed Consumption and Weight Gains of Calves Fed Roasted Soybeans

Item	Diets[1]	Week 1	2	3	4	5	6	7	8	Overall
		---------- lb ----------								
Feed consumption	270^{0}F	.2	.6	2.9	8.5^a	14.8^a	18.7^b	23.3^b	28.1^a	96.3^a
	295^{0}F	.1	.7	2.8	8.1^a	15.7^a	22.2^a	26.1^a	30.5^a	103.3^a
	325^{0}F	.2	.5	2.1	5.4^b	11.1^b	15.0^c	19.9^c	23.1^b	81.3^b
	SEM	.2	.1	.2	.4	.5	.5	.5	.5	1.9
Weight gain	270^{0}F	.6	-.8	5.3	8.3^a	7.6^{ab}	8.2^{ab}	9.9^b	12.3^{ab}	51.3^b
	295^{0}F	1.0	1.0	6.3	6.6^b	9.4^a	10.7^a	12.5^a	14.7^a	61.1^a
	325^{0}F	.7	-.9	5.9	6.0^b	5.4^b	7.6^b	8.1^b	10.5^b	44.2^c
	SEM	.2	.3	.3	.3	.4	.4	.4	.4	1.2

[a,b,c]Means within a column within feed consumption or weight gain with different superscripts differ (P<.05).
[1]Diets identified by temperature at which soybeans were roasted.

Table 3. Average Daily Gain (ADG), Gain to Feed Ratio, and Energy Efficiency of Calves from 6 to 8 wk of Age

Diets	ADG, lb	lb gain/lb feed	Mcal ME/lb gain
270^0F	.22[b]	.33	4.37
295^0F	.27[a]	.36	4.24
325^0F	.18[c]	.36	4.54

[a,b,c]Means within a column within a trial with different superscripts differ (P<.05).
[1]Diets identified by temperature at which soybeans were roasted.