

# Particle Size of Roasted Soybeans and Its Effect on Milk Production of Dairy Cows

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## Introduction

Heat treatment of soybeans increases the amount of rumen undegraded protein, and use of roasted soybeans as a dietary supplement for dairy cows has gained wide spread acceptance. A question remains, however, as to optimum particle size for the roasted soybeans. The protein in small soybean particles is likely to be degraded more rapidly than the protein in large particles. Therefore, the objective of this experiment was to quantify the effect of particle size of roasted soybeans on milk production of high producing dairy cows.

## Materials and Methods

Fifteen multiparous cows were used in a 5 x 5 Latin square design experiment with a 2 wk pretrial and five experimental periods of 2 wks each. At the end of the pretrial period, cows were blocked according to their milk yield and randomly assigned to one of the five treatments. The first week in each period was used as adaptation time, and measurements were made during the last week in each period. At the beginning of the experimental period, cows were between 126 to 171 days in milk. The diet contained (% of DM): alfalfa silage, 33.0; corn silage, 17.0; high moisture ear corn, 30.6; soybeans, 18.0; and mineral and vitamin supplement, 1.4. The five treatments had soybeans in the diet as: raw whole soybeans (RAWSB), and roasted soybeans in four different particle sizes [whole and half (RSBWH), half and quarter (RSBHQ), quarter and smaller (RSBQ), and coarsely ground soybeans (RSBG)]. Roasted soybeans of different particle size were prepared by passing through a roller mill and then screening to different sizes. Particle size distribution of soybeans is given in Table 1. Soybeans were roasted at 146°C using a Jet Pro Roaster and steeped for 30 min before cooling.

Diets were fed as a total mixed ration once daily. Daily feed offered and refused was recorded. Cows in all the treatments were injected with rBST biweekly.

During the last two days in each period, milk samples were collected from four consecutive a.m. and p.m. milkings and analyzed for composition. Feed DM digestibility was determined using acid detergent lignin as an internal marker. During the last week in each period, six fecal grab samples were collected within 48 h from two cows in each treatment. Composite fecal samples of each cow during each period were analyzed for acid detergent lignin. During the last week in each period, fecal grab samples (500 g on fresh basis) from each cow were washed with water through different screens for visible soybean particles. Soybean particles were dried at 60°C and expressed as g soybean particles excreted/ 100 g of dried feces.

## Results

Feed intake did not differ among treatments. Cows fed RSBWH and RSBHQ produced more 3.5% FCM compared with RAWSB, RSBQ, and RSBG (Table 2). Milk yield of cows fed RSBWH and RSBHQ was not different. Normal handling of properly roasted soybeans will result in a large number of seeds being broken into halves (36% on w/w basis in the present experiment). Milk fat, protein, lactose, and SNF percent were similar across treatments. Higher milk yield of cows fed RSBWH and RSBHQ resulted in increased milk fat and protein yield compared with other treatments. Feed DM digestibility was similar in all soybean treatments. Cows fed RAWSB excreted the highest amount of soybeans in the feces, whereas cows fed RSBG excreted the least amount of soybeans in the feces.

## Conclusion

Results suggest that the benefit of reducing the particle size of properly roasted soybeans beyond wholes and halves was minimum. Grinding of roasted soybeans is definitely not recommended.

Table 1. Particle size distribution of different soybean treatments.

Treatment <sup>1</sup>	Screen size, mm				
	4.75	3.35	2.36	1.18	Pan
	% retained on the screen				
RAWSB	92.6	6.1	.9	.3	.07
RSBWH	90.6	8.0	.8	.3	.3
RSBHQ	21.2	36.9	23.9	10.7	7.3
RSBQ	30.5	21.1	17.7	16.7	14.0
RSBG	5.1	10.4	23.5	32.1	28.9

<sup>1</sup>Five treatments had soybeans in the diet as raw whole soybeans (RAWSB), and roasted soybeans in four different particle sizes [whole and half (RSBWH), half and quarter (RSBHQ), quarter and smaller (RSBQ), and coarsely ground soybeans (RSBG)].

Table 2. Dry matter intake, milk production, and feed digestibility of cows fed soybeans of different particle sizes.

Measurement	Treatment <sup>1</sup>					SEM	P =
	RAWSB	RSBWH	RSBHQ	RSBQ	RSBG		
DMI, kg/d	24.3	24.0	23.7	23.6	23.9	.6	.9
Milk, kg/d	36.2 <sup>c</sup>	38.1 <sup>ab</sup>	38.7 <sup>a</sup>	37.4 <sup>ac</sup>	37.0 <sup>bc</sup>	.5	.03
3.5% FCM <sup>2</sup> , kg/d	35.4 <sup>b</sup>	37.7 <sup>a</sup>	37.2 <sup>ab</sup>	35.1 <sup>b</sup>	35.4 <sup>b</sup>	.8	.08
Milk fat, %	3.37	3.43	3.27	3.16	3.25	.08	.2
Milk protein, %	3.04	3.04	3.02	3.04	3.08	.03	.6
Fat yield, kg/d	1.22 <sup>ab</sup>	1.31 <sup>a</sup>	1.27 <sup>ab</sup>	1.17 <sup>b</sup>	1.20 <sup>b</sup>	.04	.1
Protein yield, kg/d	1.10 <sup>b</sup>	1.15 <sup>a</sup>	1.17 <sup>a</sup>	1.13 <sup>ab</sup>	1.14 <sup>ab</sup>	.02	.08
Feed DM digestibility, %	63.6	64.0	64.6	64.3	64.0	1.5	.5
Soybean excretion, g/100g feces	6.13 <sup>a</sup>	3.10 <sup>b</sup>	3.34 <sup>b</sup>	2.27 <sup>bc</sup>	1.06 <sup>c</sup>	.5	.001

<sup>abc</sup>Means in the same row with different superscript differ, *P* as indicated.

<sup>1</sup>Five treatments had soybeans in the diet as raw whole soybeans (RAWSB), and roasted soybeans in four different particle sizes [whole and half (RSBWH), half and quarter (RSBHQ), quarter and smaller (RSBQ), and coarsely ground soybeans (RSBG)].

<sup>2</sup>3.5% FCM = .432(kg milk) + 16.2 (kg fat).