Effects of Soybean Supplementation on Performance and Reproduction of Beef Cows and their Calves

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Story in Brief

This experiment was conducted to determine performance and reproductive responses of gestating beef cows of varying age (2-, 3-yr-old, and mature) to whole soybean supplementation. During last gestation, 166 spring calving beef cows were individually fed one of two supplements for an average of 80 d. Supplements (dry matter basis) included: 1) 3.00 lb/d of whole raw soybean grain (Soybean) and 2) 3.43 lb/d of a soybean meal/hull supplement (Positive). Supplements were formulated to provide similar amounts of protein and energy. There were no relevant interactions between supplement composition and cow age class. During supplementation, cows fed Positive gained more body weight (21 lb) and body condition (.18) than cows fed Soybean. However, weight change (-41 lb) and BCS change (-.60) during the 296-d experiment were not different between supplements. Additionally, BCS at weaning (4.6) was not different between supplements. Although calves from cows fed Positive were 3 lb heavier at birth, there was no difference in calf weight at branding (265 lb) or weaning (481 lb) between supplements. Additionally, cows cycling at the start of the breeding season (26%), first service conception rate (68%), and pregnancy rate (73%) were not different between supplements.

Key words: Beef, Cows, Fat Supplementation

Introduction

Optimizing reproductive efficiency is critical to maintain a viable cow/calf enterprise. Consequently, fat supplements have been proposed as nutraceuticals to improve reproductive efficiency through increased functional capability of the ovary and/or alterations in PGF2α synthesis by the uterus (Williams and Stanko, 2000). Effect of fat supplementation on reproduction of beef cows has been inconsistent (Hess et al., 2002).

Whole soybeans have several characteristics that make them desirable as a fat supplement including: a moderate fat concentration, a high protein concentration, good storage and handling characteristics, and excellent palatability. Previous research with whole sunflower seed has resulted in palatability problems (Banta et al., 2003). The objective of this experiment was to determine the effects of feeding whole soybeans to cows of varying age during late gestation on cow performance and reproduction as well as performance of their progeny.

Materials and Methods

A 2 x 3 factorial treatment design with two supplements and three age classes of cows (2-yr-old, 3-yr-old, and mature cows) was utilized in this experiment. During the winter of 2003 and 2004, 166 spring calving Angus and Angus x Hereford crossbred beef cows were assigned to one of six different treatment combinations in a completely randomized design. Cows were assigned to treatments so that initial body weight (BW) and BCS would be similar. Additionally, cows were assigned to supplements so that cow age class and age of cow within the mature age class (average = 7.2 yr; range = 5 to 12 yr) would be similar. Supplementation started on December 22, 2003, and continued until calving or April 6, 2004, whichever came first (average supplementation = 80 d; range = 52 to 108 d). Supplementation was terminated on the 18 cows that had not calved by April 6, 2004, because of the growth of green grass. During the supplementation period, cows were managed as a contemporary group in a single pasture and had free choice access to bermudagrass hay (CP, 8.4%; TDN, 55%; DM) and a mineral supplement (NaCl, 28.6%; Ca, 12.8%; P, 8.5%; Mg, 1.2%; Cu, 1044 ppm; Se, 12 ppm; Zn, 3117 ppm; DM). At calving, treatment supplementation was terminated and cow/calf pairs were moved to an adjacent pasture where they were also managed as a contemporary group. Cow/calf pairs had free choice access to the same bermudagrass hay and mineral supplement and were fed 40% protein cubes as needed. Diets were formulated to meet or exceed CP requirements.

Supplements (dry matter basis) included: 1) 3.00 lb/d of whole raw soybean grain (Soybean) and 2) 3.43 lb/d of soybean meal/hull supplement (Positive; 54.43% soybean meal, 45.57% soybean hulls). Supplements were formulated to provide similar amounts of TDN and protein (Table 1). Each cow was fed its appropriate supplement in an individual stall on Monday, Tuesday, Thursday, and Saturday mornings. The amount of supplement fed on each of these 4 d was determined by calculating the amount of supplement needed per week (daily supplement amount x 7 d) and dividing that amount by 4 (i.e., cows receiving Soybean were fed 5.25 lb/feeding). Following the supplementation period, all cows were managed as a contemporary group and were given access to either bermudagrass pasture or tall-grass prairie pasture and a mineral supplement.

Table 1. Supplement composition and amount of nutrients supplied daily[a]

	Supplement	
Item, (DM)	Positive	Soybean
Whole soybeans, lb/d	-	3.00
Soybean hulls, lb/d	1.56	-
Soybean meal, lb/d	1.87	-
Dry matter, lb/d	3.43	3.00
CP supplied, lb/d	1.20	1.21
NE_m, Mcal/d	3.20	3.20

Fat, lb/d	.05	.55
[a]Compostion is based off of tabular values		

Individual cow BW and BCS was determined at the start of the supplementation period (12/22/03), after the first 50 d of supplementation before any cows had calved (2/10/04), at the onset of breeding (5/4/04), and at weaning (10/13/04). Cows were weighed 16 h after withdrawal from feed and water. Body condition scores were assigned by two independent evaluators (1 = emaciated, 9 = obese). The same evaluators assigned condition scores throughout the experiment.

The 79-d calving season lasted from February 12, to May 1, 2004, (average calving date: March 13, 2003). The 2-yr-old cows were bred to start calving at the same time as the 3-yr-old and mature cows. The percentage of cows cycling at the start of the breeding season was determined by measuring progesterone concentration in plasma samples obtained via tail venipuncture 7 d before and again on the first day of the breeding season. Cows were artificially inseminated according to the AM/PM rule from May 4 through June 14, followed by natural mating from June 14 through July 6, which resulted in a 63-d breeding season. First service conception rate (FSC) was determined using transrectal ultrasonography approximately 30 d after AI; pregnancy rate was determined by rectal palpation at weaning. Birth weight of each calf was determined within 24 h of birth. Branding weight and weaning weight were determined on June 14, and October 12, 2004 (average age = 94 and 214 d, respectively). At branding and weaning, calves were weighed directly off the cow without any restriction from feed or water.

Statistical Analysis

Cow was considered to be the experimental unit because supplements were individually fed to each cow. All non-categorical data was analyzed using MIXED MODEL procedures of SAS (SAS Inst. Inc., Cary, NC) and the Satterthwaite approximation for degrees of freedom. All interactions and covariates remained in the model regardless of significance. When the P-value for the F-statistic was $\leq .05$, least squares means were separated using the LSD procedure of SAS ($\alpha = .05$). Least square means are reported in all tables and overall means in the text represent the simple average of the least square means, except for percent of cows cycling, pregnancy rate, and first service conception rate which are raw means. For various reasons (failure to calve, n=2; calf death, n=7; injury, n=2; miscellaneous, n=3) data from14 cows and their calves were removed from the experiment. No relationship was apparent between any of these factors and late-gestation supplement composition. Only data from the 152 cows that weaned a calf in October were used for statistical analysis. Cow sire and calf sire were not included in any of the models because they were partially confounded with cow age class.

Cow and Calf Performance. Supplement and cow age class were included as fixed effects in the model for cow performance. The models for calf performance included supplement, cow age class, and calf sex as fixed effects. Calf age was also used as a covariate in the branding and weaning weight models.

Cow Reproductive Performance. The model for days from calving to the start of the breeding season and days from calving to first AI date included supplement and cow age class as fixed effects. Categorical modeling procedures (PROC CATMOD) were used to test for interactions between supplement and cow age class. If an interaction was not detected, contingency tables were developed for proportional differences among main effects for percent cycling, first service conception rate, and pregnancy rate and tested using a chi-square test. Data were analyzed using FREQ procedures of SAS.

Results and Discussion

Main Effect of Supplement

Cow Weight and BCS. No significant interactions were detected for any of the BW or BCS measurements. Length of the supplementation period was not different between supplements (80 d; Table 2). During the first 50 d of treatment supplementation, cows fed Positive gained 21 lb more BW than cows fed Soybean (Table 2). Supplement composition did not influence BW change during any of the subsequent weigh periods (Table 2). Additionally, final BW at weaning and BW change over the 296-d experiment (-41 lb; Table 2) were not different between treatments. Body condition score change followed the same pattern as weight change. During the first 50 d of treatment supplementation, cows fed Positive gained more body condition than cows fed Soybeans (Table 2). However, BCS at the start of the breeding season (4.86; P=.58) and final BCS at weaning (4.60; Table 2) were not different between treatments.

Table 2. Effect of late-gestation supplement on cow weight change and BCS change

	Supplement			
Item	Positive	Soybean	SEM	P-Value
n=	74	78		
Length of treatment period, d	80	80	1.9	.95
Initial wt (12/22/03), lb	1114	1108	11.6	.70
Wt change (12/22/03 to 2/10/04), lb	73	52	2.8	<.01
Wt change (2/10 to 5/4/04), lb	-206	-196	4.7	.15
Wt change (5/4 to 10/13/04), lb	93	103	5.0	.16
Wt change (12/22/03 to 10/13/04), lb	-40	-42	5.8	.87
Final wt (10/13/04), lb	1073	1066	11.4	.64

Initial BCS (12/22/03)	5.15	5.23	.07	.35
BCS change (12/22/03 to 2/10/04)	.08	-.10	.05	<.01
BCS change (2/10 to 5/4/04)	-.35	-.29	.04	.31
BCS change (5/4 to 10/13/04)	-.28	-.25	.05	.59
BCS change (12/22/03 to 10/13/04)	-.55	-.64	.06	.25
Final BCS (10/13/04)	4.60	4.60	.06	.97

Calf Performance. No significant interactions were detected for calf birth, branding, or weaning weight. At birth, calves from cows fed Positive were 3 lb heavier than calves from cows fed Soybean (Table 3). Although calves from cows fed Positive were heavier at birth, there were no apparent differences in dystocia. Additionally, supplement composition did not influence fetal mortality (Positive=2; Soybean=0) or calf mortality from birth through weaning (Positive=4; Soybean=3). Furthermore, calf weight at branding (265 lb) and weaning (481 lb; Table 3) were not different between supplements.

Table 3. Effect of late-gestation supplement on calf birth, branding, and weaning weight

	Supplement			
Item	Positive	Soybean	SEM	P-Value
n=	74	78		
Birth wt, lb	73	76	1.2	<.01
Branding wt, lb (avg age=94 d)	267	264	4.0	.65
Weaning wt, lb (avg age=214 d)	481	481	6.2	.94

Cow Reproductive Performance. No differences in days from calving to the start of the breeding season (53 d) or days from calving to first AI date (77 d; Table 4) were detected between supplements. No significant interactions were detected for first service conception or pregnancy rate. However, a supplement by age class interaction was detected for percent cycling at the start of the breeding season. Percent cycling was 79, 11, and 2% for the mature, 3-yr-old, and 2-yr-old cows fed soybeans, respectively; compared with 46, 19, and 0% for the mature, 3-yr-old, and 2-yr-old cows fed soybeans, respectively. Since there were no significant interactions observed for first service conception or pregnancy rate only main effect means for percent cycling at the start of the breeding season will be reported in Tables 4 and 7. Supplement composition did not significantly influence percent of cows cycling at the start of the breeding season (26%), first service conception (68%), or pregnancy rate at weaning (73%; Table 4).

Table 4. Effect of late-gestation supplement on cow reproductive performance				
	Supplement			
Item	Positive	Soybean	SEM	P-Value
n=	74	78		
Calving to start of the breeding season, d	53	53	2.1	.98
Cows cycling, %	22	29	5.2	.27
Pregnancy rate at weaning, %	77	68	5.3	.21
n=	50	45		
Days from calving to first AI date	77	76	2.6	.79
First service conception rate, %	62	73	6.7	.24

Main Effect of Cow Age Class

Some of the differences observed among the different age classes of cows may partly be due to genetic differences, because sires used to produce the mature cows were different than the sires used to produce the 2- and 3-yr-old cows. The 2- and 3-yr-old cows are daughters of the mature cows. Additionally, cow sires are common among the 2- and 3-yr-old cows.

Cow Weight and BCS. Length of the supplementation period was not different among cow age classes (81 d; Table 5). During the first 50 d of treatment supplementation, mature cows gained 23 lb more BW than 3-yr-old cows and 42 lb more BW than the 2-yr-old cows. From before calving to the start of the breeding season the mature cows lost 64 lb more BW than the 3-yr-old cows and 81 lb more BW than the 2-yr-old cows. From the start of the breeding season to weaning the 3-yr-old cows gained 21 and 31 lb more BW than the mature and 2-yr-old cows, respectively. During the 296-d experiment, the 3-yr-old cows lost the least weight and the mature cows lost the most weight (Table 5). Initial BCS was greatest for the 2-yr-old cows (5.49), intermediate for the mature cows (5.17), and least for the 3-yr-old cows (4.90; Table 5). During the supplementation period, 3-yr-old and mature cows showed a slight gain in BCS and the 2-yr-old cows showed a slight loss in BCS (Table 5). During the subsequent periods all age groups lost body condition. Additionally, during the entire experiment the 2-yr-old cows lost the most body condition and the 3-yr-old cows lost the least body condition. Consequently, BCS at weaning was not different among the age classes at weaning (4.59; Table 5).

Table 5. Effect of cow age class on cow weight change and BCS change					
	Cow age class				
Item	Two	Three	Mature	SEM	P-Value
n=	50	54	48		
Length of treatment period, d	81	83	78	2.3	.31
Initial wt (12/22/03), lb	965^{z}	1084^{y}	1283^{x}	14.4	<.01
Wt change (12/22/03 to 2/10/04), lb	42^{z}	61^{y}	84^{x}	3.5	<.01
Wt change (2/10 to 5/4/04), lb	-168^{x}	-185^{y}	-249^{z}	5.9	<.01
Wt change (5/4 to 10/13/04), lb	84^{y}	115^{x}	94^{y}	6.2	<.01
Wt change (12/22/03 to 10/13/04), lb	-42^{y}	-9^{x}	-71^{z}	7.2	<.01
Final wt (10/13/04), lb	923^{z}	1075^{y}	1211^{x}	14.2	<.01
Initial BCS (12/22/03)	5.49^{x}	4.90^{z}	5.17^{y}	.08	<.01
BCS change (12/22/03 to 2/10/04)	$-.15^{y}$	$.05^{x}$	$.07^{x}$	.06	<.01
BCS change (2/10 to 5/4/04)	$-.42^{y}$	$-.20^{x}$	$-.33^{xy}$	.05	<.01
BCS change (5/4 to 10/13/04)	$-.42^{y}$	$-.14^{x}$	$-.24^{x}$	.06	<.01
BCS change (12/22/03 to 10/13/04)	$-.99^{z}$	$-.29^{x}$	$-.51^{y}$	.07	<.01
Final BCS (10/13/04)	4.51	4.61	4.66	.07	.27
^{xyz}Within a row means without a common superscript differ (P≤.05).					

Calf Performance. Birth, branding, and weaning weight were least for the 2-yr-old cows and greatest for the mature cows (Table 6). These differences are probably due to both age of cow and calf sire. There was a tendency for male calves to be heavier at birth than female calves (73 vs 76 lb; P=.05). Additionally, steer calves tended to be heavier at branding time (260 vs 270 lb; P=.08) and were heavier at weaning (471 vs 491; P=.03) than heifer calves.

Table 6. Effect of cow age class on calf birth, branding, and weaning weight			
	Cow age class		

Item	Two	Three	Mature	SEM	P-Value
n=	50	54	48		
Birth wt, lb	67^{z}	73^{y}	82^{x}	1.4	<.01
Branding wt, lb (avg age = 94 d)	237^{z}	258^{y}	301^{x}	4.9	<.01
Weaning wt, lb (avg age = 214 d)	436^{z}	481^{y}	526^{x}	7.6	<.01
^{xyz}Within a row means without a common superscript differ (P≤.05).					

Cow Reproductive Performance. Days from calving to the start of the breeding season were not significantly different among age groups (53; Table 7). However, only one of the 2-yr-old cows was cycling at the start of the breeding season compared with 15% of the 3-yr-old cows and 63% of the mature cows (Table 7). Pregnancy rates were significantly greater for the 3-yr-old (83%) and mature cows (83%) compared with the 2-yr-old cows (50%). Days from calving to first AI date were greatest for the 2-yr-old cows and least for the mature cows, however, no significant difference was detected for first service conception rate among the age groups (68%; Table 7).

Table 7. Effect of cow age class on cow reproductive performance					
	Cow age class				
Item	Two	Three	Mature	SEM	P-Value
n=	50	54	48		
Calving to start of the breeding season, d	52	50	56	2.6	.31
Cows cycling, %	2^{z}	15^{y}	63^{x}	7.0	<.01
Pregnancy rate at weaning, %	50y	83x	83x	7.1	<.01
n=	13	37	45		
Days from calving to first AI date	84^{x}	75^{xy}	71^{y}	4.3	.04
First service conception rate, %	69	73	62	12.8	.58
^{xyz}Within a row means without a common superscript differ (P≤.05).					

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