Evaluation of Reproduction and Blood Metabolites in Beef Heifers Fed Dried Distillers Grains Plus Solubles and Soybean Hulls During Late Gestation[1]

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Summary

Dried distillers grains plus solubles (DDGS) contain a significant amount of both undegradable intake protein and fat, which have both been shown to increase reproductive performance when supplemented to heifers during gestation. The mechanisms leading to enhanced reproduction when fat or UIP are supplemented have not been fully defined. The objective of this experiment was to evaluate DDGS or soybean hulls (SBH) fed during the last trimester of gestation on circulating concentrations of growth hormone (GH) and insulin-like growth factor-I (IGF-I) and reproductive efficiency. Ninety-five crossbred heifers were grouped by expected calving date, BW, BCS, and randomly assigned to DDGS or SBH (n = 6 pens per treatment). Diets were formulated to be isoenergetic and meet the nutrient requirements at d 240 of gestation. Diets were limit fed during the last trimester of gestation until parturition. Blood samples were collected prior to calving and once per week for 4 weeks following calving . Treatment had no effect on circulating concentrations of GH or IGF-I. Time influenced both GH and IGF-I. Circulating concentrations of GH were elevated at calving and decreased by 4 d after calving. Circulating concentrations of IGF-I rose for the first 2 d following calving and then decreased through d 6. At the start of the breeding season there was no difference between DDGS and SBH in the percent of heifers that had initiated estrous cycles (74% and 70%, respectively). There was a tendency for more DDGS treated heifers to become pregnant during a 64 d natural service breeding season compared to SBH treated heifers (92% vs 80%, respectively). There was no difference in the distribution of pregnancies throughout the breeding season between treatments. In summary, DDGS and SBH fed during the last trimester of pregnancy to heifers resulted in similar patterns of circulating concentrations of GH and IGF, but DDGS treated heifers tended to have improved pregnancy rates during a defined breeding season.

Introduction

Prepartum nutrition has a major effect on postpartum reproduction. Supplementation with fat and/or undegradable intake protein (UIP) may provide a nutritional mechanism to optimize reproduction in young beef cows. Pregnant heifers supplemented with UIP (Patterson et al., 2002) or fat (Bellows et al., 2001), had increased pregnancy rates without differences in BW or body condition score (BCS), however the mechanism by which either fat or UIP supplementation function to enhance reproduction has yet to be fully elucidated. Dried distillers grains plus solubles (DDGS) contain both UIP (up to 60% of the CP) and fat (12 %), and are an economical and readily available feedstuff in many areas of the United States.

Changes in insulin-like growth factor-I (IGF-I) and the components of the IGF system have been demonstrated to influence reproductive function (Zulu et al., 2002). Subsequently, under nutrition of beef cows caused decreased circulating concentrations of IGF-I and prolonged the postpartum anestrous period (Roberts et al., 1997). We hypothesized the effects of increased fat and UIP to enhance reproductive function may be associated with

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altering the somatotropic axis in well fed pregnant beef heifers. Therefore, our objective was to evaluate the effects of DDGS (increased UIP and fat) or soybean hulls (low fat and UIP) during the last trimester of gestation on circulating concentrations of growth hormone (GH) and IGF-I and subsequent reproductive efficiency.

Materials and Methods

Ninety-five crossbred pregnant beef heifers were allotted to one of two prepartum dietary treatments (**DDGS or SBH**). The heifers were blocked by previous heifer development strategy and stratified by expected calving date, BW, and BCS. Heifers were randomly allotted to one of twelve dry-lot pens at the SDSU Cottonwood Research Station. Diets were limit fed and consisted of similar amounts of grass hay (8.90 lb/hd/d) plus a supplement (0.69 lb/hd/d) formulated for each respective diet and either DDGS (6.80 lb/hd/d) or SBH (7.60 lb/hd/d). Dietary treatments were applied from the mean gestation of 190 d until parturition, for a mean dietary treatment application of 96 d. Both DDGS and SBH diets were formulated to offer similar amounts of energy and to meet or exceed the degradable intake protein (DIP) requirement for an 1120 lb heifer at the mean day of gestation during dietary treatment application of 240 d (Table 1; NRC Model, 1996).

Table 1. Nutrient composition, intake, and modeled balances of prepartum diets containing either dried distillers grains plus solubles (DDGS) or soybean hulls (SBH) fed to beef heifers during the last trimester of gestation.

Diet Nutrient Composition[a]	DDGS[b]	SBH[b]
Ether extract, %[c]	6.7	3.08
CP, %[c]	17.2	12.0
DIP, % of CP[d,e]	59.4	80.3
ADF, %[c]	24.5	40.1
NEm, Mcal/lb[d]	0.74	0.70
IVDMD, %[c]	63.4	68.9
Nutrient Intake[a]		
DM Intake, lb[c]	16.4	17.2
Nem, Mcal/d[d]	12.1	12.0
CP, lb/d[c]	2.82	2.06
DIP, lb/d[d]	1.68	1.65
MP, lb/d[d]	1.87	1.29
Modeled Nutrient Balance[a]		
NEm, Mcal/d[d]	0.2	0.1
CP balance, lb/d[c]	1.22	0.46
DIP balance, lb/d[d]	0.18	0.14
MP balance, lb/d[d]	0.67	0.09

[a] DM basis.
[b] Formulated using NRC computer model (1996) to be isocaloric and adequate in DIP and meet nutrient requirements of 1120 lb heifer at 240 d of gestation.
[c] Based on assayed values for individual feed ingredients
[d] Based on tabular values for individual feed ingredients
[e] Degradable intake protein
[f] Invitro dry matter disappearance

Following parturition heifers were removed from treatment diets, placed on pasture and managed as one group until July. In July lactating heifers were grouped by treatment and previous development and split into four pastures. Heifer BW and BCS was measured using a 9 point scale (1=emaciated; 9 = obese) by half score increments and the average of two individual trained scorers, at the start of the feeding period, just prior to parturition, and monthly until weaning. Calving ease score was recorded at parturition. Calf BW were measured at birth and monthly until weaning. Cows were exposed to bulls for a 64 d natural service breeding season. On d 5 of the breeding season all cows received an injection of prostaglandin $F_{2\alpha}$ (25mg as 5mL of ProstaMate i.m., IVX Animal Health, St. Joseph, MO). Pregnancy was detected by transrectal ultrasonography 86 d and 117 d following the start of the breeding season.

Blood samples were collected by jugular venipuncture into 10 mL Vacutainer tubes on d 71 of the feeding period (1 week prior to start of calving) and weekly for 4 weeks following calving for determination of plasma concentrations of GH and IGF-I. Blood samples were also collected 7 d prior to the start of the breeding season and 11 d later (d 5 of the breeding season) for analysis of progesterone (P4) concentrations. Animals were determined to be cycling at the start of the breeding season if P4 concentrations were ≥ 1ng/mL in 1 of the 2 samples. Animals were determined to be anestrous if P4 concentrations were < 1ng/mL in both samples.

Mean BW and BCS were compared using GLM procedure of SAS for a randomized complete block with treatment x block as the error term and pen as the experimental unit. Cyclicity and pregnancy rate were analyzed by Chi-square analysis using the frequency procedure of SAS. Pregnancy distribution was analyzed by analysis of repeated measures of categorical data, and concentrations of GH and IGF-I were analyzed by repeated measures using the Mixed procedure of SAS. Cows that had lost calves prior to the start of the breeding season were omitted from pregnancy and cycling data.

Results and Discussion

There were no differences between DDGS or SBH treated heifers in initial (*P* = 0.56; *P* = 0.34), calving (*P* = 0.60; *P* = 0.36), or weaning (*P* = 0.40; *P* = 0.14) BW or BCS (Table 2). All heifers maintained a BCS of ≥5.5 from intiation of the feeding period until weaning. Furthermore, there was no difference between treatment in calving ease (*P* = 0.90), calf birth weight (*P* = 0.48), calf ADG (*P* = 0.90) or weaning weight (*P* = 0.70; Table 3).

Table 2. Effect of dried distillers grains plus solubles (DDGS) and soybean hull (SBH) dietary treatments on heifer BW and BCS at the start of the feeding period, at calving, and at weaning.

Body weight, lb	DDGS	SBH	SEM[a]	*P*-Value
Initial	1116	1120	1.2	0.56
Calving[b]	1162	1153	4.2	0.60
Weaning	1147	1169	19.0	0.40
Body condition score[c]				
Initial	5.96	5.89	0.04	0.34
Calving[d]	5.95	5.84	0.07	0.36
Weaning	5.70	5.47	0.06	0.14

[a] Standard error of the mean
[b] Body weight was measured within 24 h after parturition
[c] Body condition is the average of two trained individual scorers using half scores on a 9 point scale (1 = emaciated; 9 = obese)
[d] Just prior to parturition

Table 3. Effects of dried distillers grains plus solubles (DDGS) and soybean hull (SBH) on calving ease and calf birth weight, weaning weight, and ADG

Item	DDGS	SBH	SEM[a]	*P*-Value
Calving Ease[b]	1.23	1.21	0.13	0.90
Body weight, lb				
Birth	86	86	1.43	0.48
Weaning[c]	441	437	12.13	0.70
ADG, lb	2.09	2.09	0.04	0.90

[a] Standard error of the mean
[b] 1= no assistance 2= easy pull 3= hard pull requiring calf jack 4= caesarian section 5= malpresentation
[c] The mean age at weaning was 167 d

There was no effect of treatment (*P* = 0.51) or treatment x time (*P* = 0.99), but there was an effect of time (*P* = 0.002) on circulating concentrations of GH (Figure 1). Circulating concentrations of GH were elevated at calving (14.4 ± 1.5 ng/mL) and decreased by d 4 after calving (9.0 + 1.6 ng/mL). Periparturient plasma GH concentrations in beef cattle have been shown to rise around parturition and subsequently decline during early lactation for cows in excellent to moderate nutritional status at parturition (Lalman et al., 2000). Lactation increases the energy demand for cows. In addition to the demand of lactation, first calf heifers also have an energy demand for growth. One of the functions of GH is to stimulate mobilization of fat stores, which may help to alleviate physiological energy deficiencies in periparturient animals.

In the current study there was no effect of treatment (*P* = 0.18) or treatment x time (*P* = 0.63), but there was an effect of time (*P* < 0.001) on circulating concentrations of IGF-I (Figure 2). Concentrations of IGF-I rose for the first 2 d following parturition (57.1 ± 5.2 ng/mL) and then decreased through d 6 (30.5 ± 5.6 ng/mL). This is consistent with the function of GH on the somatotropic axis; under conditions of adequate nutrient intake GH also functions to cause a subsequent rise in hepatic IGF-I secretion in beef cows (Lalman et al., 2000).

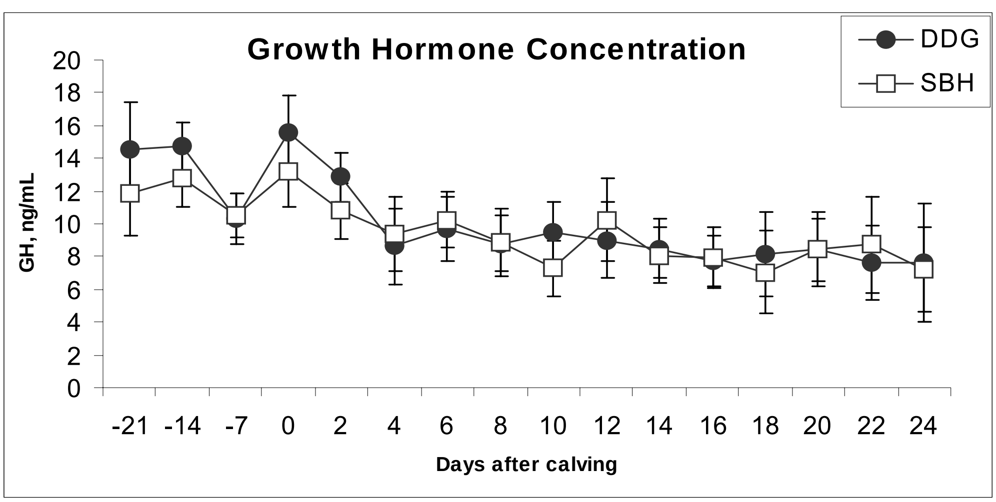

Figure 1. Circulating concentrations of growth hormone by day in pre- and postpartum dried distillers grains plus solubles (DDGS) and soybean hull (SBH)supplemented beef heifers. (Treatment *P* =0.51; Time *P* = 0.002; Treatment * Time *P* = 1.0)

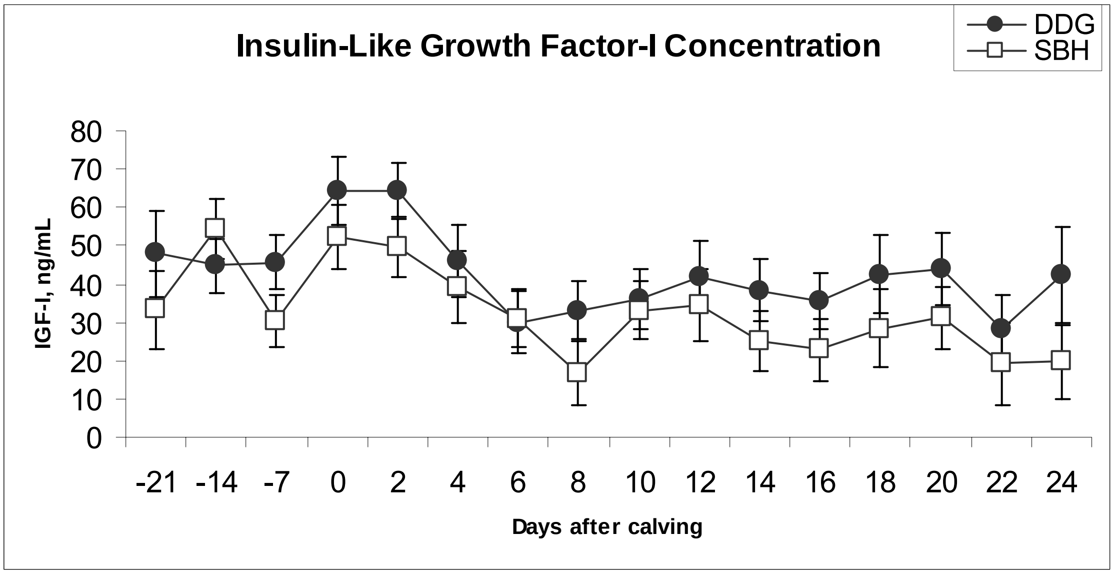

Figure 2. Circulating concentrations of insulin-like growth factor-I by day in pre- and postpartum dried distillers grains plus solubeles (DDGS) and soybean hull (SBH) supplemented beef heifers. (Treatment P = 0.18; Time P = < 0.001; Treatment * Time P = 0.63)

At the start of the breeding season there was no difference (P = 0.75) between DDGS and SBH in the percentage of heifers that had initiated estrous cycles (Figure 3, 74% and 70%, respectively). In addition, there was no difference (P = 0.30) in the distribution of pregnancies (Figure 4) during the breeding season between treatments. However, there was a tendency (P = 0.11) for more DDGS treated heifers to become pregnant during a 64 d natural service breeding season compared to SBH treated heifers (Figure 3; 92% vs 80%, respectively).

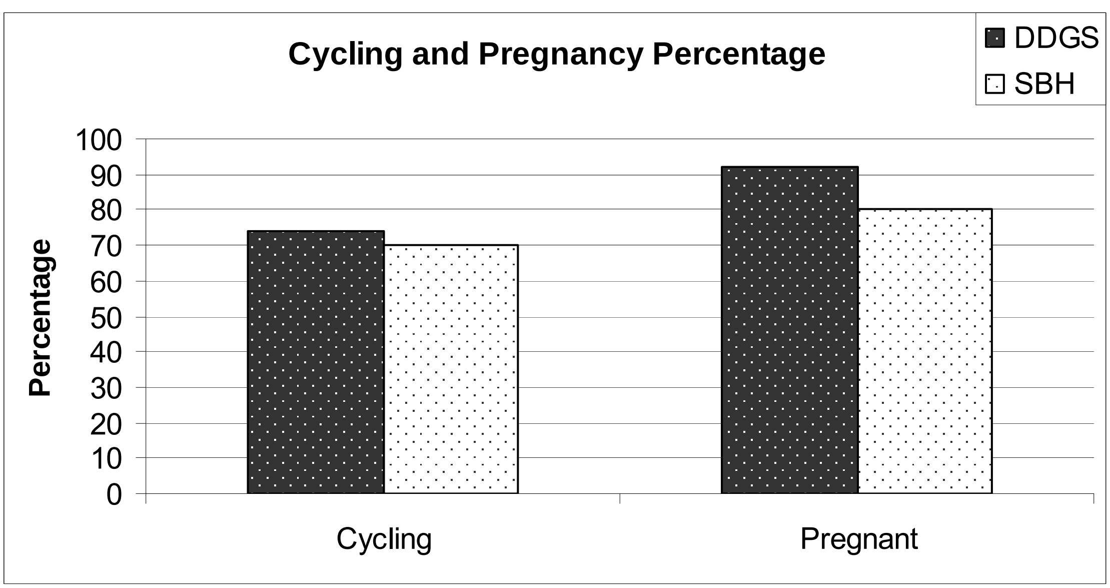

Figure 3. Percentage of dried distillers grains plus solubles (DDGS) and soybean hull (SBH) treated heifers cycling at the start of the breeding season and percentage pregnant following a 64 d breeding season. (DDGS n=44; SBH n=38; Cycling P = 0.75; Pregnant P = 0.11)

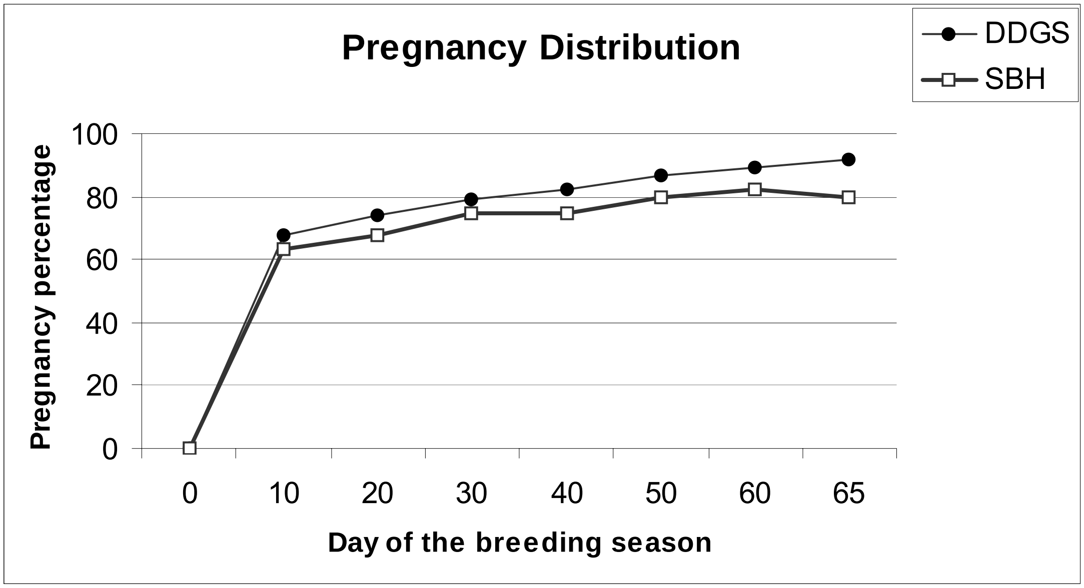

Figure 4. Pregnancy distribution for dried distillers grains plus solubeles (DDGS) and soybean hull (SBH) treated heifers during a 64 d natural service breeding season. (Treatment P = 0.26; Time P < 0.001; Treatment*Time P = 0.98)

Conclusion

In conclusion, both DDGS and SBH caused similar effects to postpartum heifer performance, calving ease, and calf performance, therefore, both can be effectively fed during the last trimester of gestation to replace hay in limit-fed heifer diets. Although there where no detectable differences in circulating concentrations of GH and IGF-I and no difference in the number of heifers cycling at the start of the breeding season or in the pregnancy distribution, DDGS treated heifers tended (P = 0.11) to have a greater pregnancy rate than SBH treated heifers. Therefore, fat and/or UIP sources fed in the last trimester of gestation have the potential to positively impact subsequent reproductive performance in well maintained beef heifers.

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