THE USE OF HIGH FAT PREBREEDING SUPPLEMENTATION TO INFLUENCE REPRODUCTIVE EFFICIENCY IN BEEF COWS AND HEIFERS

by

NATHAN M. LONG

(Under the Direction of G. M. Hill)

ABSTRACT

Reproductive efficiency or the percent of cows bred at the end of breeding season is a primary factor affecting profitability of a cow calf producers. There are several factors that hamper the efforts of producers to get there cows and heifers bred. Theses factors are both physiological and nutritional. The objective of this research was to evaluate the effects of a high-fat supplements fed to cows and heifers 60 days prebreeding, on cow and calf gain, estrual activity, and blood metabolites associated with reproductive efficiency. Calcium soaps of fatty acids (CSFA) were fed to heifers, and whole soybeans were fed to primiparous and multiparous cows as supplemental fat sources. The CSFA tended to improve reproductive performance while whole soybeans did not result in statistical difference. Cows and heifers used in this research were on a exceptionally high plane of nutrition, and we observed differences in reproductive levels and blood metabolites resulting from fat supplementation. Even higher reproductive performance might have occurred if the high-fat supplements were fed to cattle maintained on lower nutritional planes, and if the cattle had lower body condition..

INDEX WORDS: Postpartum supplementation, Leptin, Cholesterol, Reproduction, Megalac, Soybeans, Heifers, Cows

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Chapter 1

INTRODUCTION

It is a challenge for herd managers to improve reproductive efficiency by manipulating postpartum reproduction. Cows are under significant nutritional and physiological demands at this point in the production cycle. Dietary energy is one of the most limiting requirements for the cow producing milk for a calf as well as maintaining body condition, while completing restoration her reproductive tract for rebreeding. These demands contribute to postpartum anestrus, which is defined as the interval from parturition to estrus. There are several physiological mechanisms that are involved with postpartum anestrus to account for the events during this period. First, uterine involution occurs, and it often plays a relatively small part, however it is still a barrier to fertility. Short estrus cycles are the second factor that contribute to anestrus, and these usually occur during the first 30 to 40 days postpartum. Short cycles result from either a corpus luteum (CL) that is not functioning normally, or a CL that is regressed due to regression signals that are released too early in the cycle. Postpartum anestrus is the next problem, which can include silent heat or in some instances estrus without ovulation. This condition is caused by several factors including season of the year, cow breed, cow age, dystocia, and presence of a bull. However, suckling and nutritional factors are two primary factors causing postpartum anestrus. There is also a general infertility part on this problem it is a general 20% to 30% decrease in fertility that is associated with normal fertility regardless of time or season.

There are nutritional and management practices that can affect postpartum reproductive problems (Short et al., 1990). This review of literature includes discussion of many aspects of manipulation of estrual activity with the goal of enhancing bovine reproductive performance, including management practices and different nutritional supplementation strategies relative to reproductive stage of the cow.

Body Condition Score at Calving and Postpartum Nutrition

Logically if a cow had an above average body condition score (BCS) at calving she should be better able to handle the stress associated with calving, initiation of lactation, and return to estrual activity occurring in the postpartum period. This theory was tested recently (Morrison et al., 1999), as part of a three-state joint research project that utilized 250 multiparous cows over a 3-yr period. Six months before the beginning of calving season cows were assigned to two groups: supplemented (fed to gain 1 to 2 BCS units) and restricted (nutritional management designed to allow cows to loose 1 to 2 BCS units). All cows were then regrouped at 90 d pre-calving and managed to achieve a BCS of 5-6 at calving. After calving, the cows were managed together as a single group. Results indicated that the percent of cows with luteal activity, indicative of a normal estrous cycle, was not affected by prepartum BCS, and there were no differences in pregnancy rate or mean conception date between groups. A trend was reported for previously fleshy cows to show postpartum intervals that were 11 d shorter than cows with lower BCS. Prebreeding treatment did not affect calf birthweight or weaning weight.

A similar study to that conducted by Morrison et al. (1999) was conducted by Looper et al. (2003), in which 77 Hereford x Angus cows were grouped at 3.5 months before initiation of calving season. One group was fed to maintain a BCS of 5 (moderate), or lose BCS to become a BCS of 4 (thin). After parturition, all cows were managed as a single herd. They reported a shortened interval from parturition to normal luteal activity and first estrus for moderate BCS cows compared to the thin cows.The interval from parturition to conception was 24 days shorter for the moderate BCS cows than for the thin cows. The interval from first normal luteal activity to conception was also shorter for the moderate BCS cows. The BCS did not influence the incidence of estrus associated with first normal luteal activity. They observed that increased levels of progesterone before first estrus influenced subsequent luteal function.

Plane of nutrition of cows and heifers before the breeding season can have a great influence on reproductive performance. Freetly and Cundiff (1998) selected crossbred beef heifers that were put in drylot when their average age was 186 d. They were given a 42-d adjustment period before initiation of two nutritional treatments: high nutritional level (15.8 Mcal ME/d), or low nutritional level (12.6 Mcal ME/d). Heifers were fed the same basal diet, but at different amounts, to achieve appropriate energy intake, and they were fed these diets until 14 d before the start of breeding season when they were assigned to the same pasture. They found no difference in calving percentage due to nutritional treatment, and there was no difference in age at parturition between nutritional levels. Subsequently, there was no difference in postpartum interval and percent of heifers pregnant with second calf.

The relationship between nutritional plane and reproduction seems to be different for cows and heifers. Reproductive problems in heifers are anticipated when they are not fed enough to attain at least 60 to 65 % of their projected mature weight by the start of breeding season. Heifers use more of the additional nutrients for growth of bone and muscle, and they deposit fat and body reserves last. When the Morrison et al. (1999) and Looper et al. (2003) results are compared, the findings are opposite. Morrison et al. (1999) found no difference in reproduction except for a trend for the fleshier cows to have a shorter postpartum interval. Looper et al. (2003) found differences in almost every reproductive parameter he measured, with cows in greater BCS at calving having better reproductive performance than cows calving at lower BCS. The difference in the results of these two studies is associated with the precalving treatments of the cows. Looper et al. (2003) had a difference in BCS at calving, while Morrison et al. (1999) had already corrected for the previous difference in BCS, and they had the cows at a similar BCS at calving. The types of cows used in the study might have influenced reproductive performance. Cows used by Morrison et al. (1999) were from three different herds made up of different breeds in three different states, compared with Hereford x Angus cows used by Looper et al. (2003).

The issue of BCS and its relationship to reproductive performance has been the primary subject of several regional projects. One study (Spitzer et al., 1995) looked at BCS at calving and postpartum nutritional level effects on reproduction, involving 242 primiparous beef cows during a 3-yr replicated study. Cows calved in a BCS of 4, 5, or 6, and after calving they were allotted to one of two groups: one group was supplemented to gain .45 kg/cow daily (moderate), and a second group was supplemented to gain 0.9 kg/cow daily (high) from parturition to the start of breeding season. Body condition at calving did not affect dystocia scores. Postpartum nutritional level influenced weaning weight, but BCS at calving did not affect preweaning performance. More cows in the high postpartum gain group had luteal activity at the start of breeding season than cows in the low gain group. The BCS at parturition did not affect percent luteal activity at the start of breeding. Increasing BCS and high postpartum nutritional level increased the number of cows exhibiting estrus at 40 or 60 days after the breeding season began. Pregnancy rates were dramatically improved when cows calved at higher BCS, (56, 80, 96% for BCS 4, 5, and 6 respectively). In a study by Vizcarra et al. (1998) blood was collected from the cows in the study of Spitzer et al. (1995) for analysis of insulin, glucose and other metabolic factors. They reported no effects on glucose levels and a BCS by postpartum nutritional level interaction for NEFA concentration in serum.

Prepartum BCS and postpartum nutritional intake and it effects on endocrine and reproductive responses were investigated by Ciccioli et al. (2003). They used 34 Angus x Hereford crossbred primiparous heifers that were fed during the last trimester of pregnancy to either lose condition to a BCS 4 or maintain condition at a BCS of 5. At calving, heifers were fed to gain at either 0.45 (moderate) or 0.9 (high) kg/d for 71 d with an average minimum of 45 d on treatment. Calves on the high dietary treatment had higher BW at the end of the supplemental period and at weaning. Serum IGF-1 was higher in cows on the higher plane of nutrition three weeks before and after the end of supplementation. The cows on the high nutritional treatment had higher levels of leptin, insulin, and glucose three weeks before the end of supplementation. Three weeks after the end of supplementation there were no differences in leptin or insulin levels. Estrual activity, ovarian function, and reproductive performance were not affected by BCS at calving, but were affected by postpartum plane of nutrition. The length of postpartum anestrus was 34 d longer for the moderate as compared to the high nutrition group. The pregnancy rate was greater for the high group compared to the moderate group. When prepartum BCS was compared with postpartum nutritional level, it appears that postpartum nutritional level had a greater effect on the reproductive level of the cow. However, the prepartum BCS can still have a dramatic effect even if it had been corrected, as evidenced by the increased pregnancy rate reported by Spitzer et al. (1995) and the shorter postpartum interval reported by Morrison et al. (1999).

Protein Supplementation

The use of a protein supplement has been evaluated by numerous investigators, both preparturition and postparturition, to manipulate reproduction in beef cows. A review by Randel (1990) discussed research in the area of nutrition and reproduction interactions. He reported that there was some common issues regarding protein supplementation and reproduction. He found that heifers and cows that received inadequate protein with a variety of energy sources during gestation had lower pregnancy rates than herdmates. The fact that inadequate protein intake decreases reproduction was found to be true during the postpartum period. The problem with research reported with protein supplementation is that the diets were not isocaloric, so differences in energy intake were confounded with level of protein being fed. Randel (1990) discussed results of another study that used isocaloric treatments which produced similar results to the prementioned studies. He determined that inadequate protein negatively affected first-service conception rate.

Two experiments were conducted (Wiley et al., 1991) to observe differences in protein degradability and consequent results on reproductive performance. In one experiment 71 primiparous beef heifers were divided into two groups before parturition. One group was fed a restricted diet, designed to allow heifers to lose BW until calving. The second group was fed a diet with a barley supplement designed to maintain BW until calving. After calving heifers were assigned to one of two postpartum treatments within prepartum energy groups. The treatments were isocaloric and isonitrogenous, but differed in that one was ruminally undegradeable and the other was ruminally degradeable. The second experiment used different feed ingredients for the prepartum period, and was conducted a year later but followed the same experimental design as the first experiment, and the postpartum supplements were the same in both experiments. The investigators found no interaction between prepartum nutritional level and postpartum protein supplementation. They reported that weight was affected by prepartum nutritional level, with heifers on the ruminally undegradeable protein supplement having a higher rate of gain during the postpartum period. They found that calf BW, vigor and dystocia were not influenced by prepartum nutrient level, and that milk production, measured by weigh-suckle-weigh technique, was unaffected by either pre- or post-partum treatment. Heifer blood urea nitrogen (BUN) was affected by both prepartum and postpartum treatments. Glucose was not influenced by treatment, but serum albumin increased by maintenance level of prepartum nutrient level. Cholesterol was the opposite of serum albumin and was affected by postpartum supplementation with a ruminally digestible protein source increasing cholesterol level. Low prepartum nutrient heifers had decreased levels of insulin postpartum. The percent of heifers displaying estrual activity before breeding season was affected by prepartum group, with fewer heifers on the low nutrient prepartum diet exhibiting estrus before the start of breeding season The percent of heifers bred during the first 21 days of the breeding season was affected by postpartum protein source, with more cows being bred on the ruminally undegradeable protein supplement. However, pregnancy rate was not different between prepartum or postpartum groups.

Additional research in the area of protein supplementation on cow reproductive performance was published by Dhuyvetter et al. (1993). They used crossbred multiparous cows that had been fed either alfalfa cubes or canola meal as a prepartum supplement. The cows were then divided into two studies based on early or late calving dates within the calving season. The first study used the late calving cows and they were fed either a 50 % ruminally undegradable or a 25% ruminally undegradeble protein (RUP) supplement that was isonitrogenous and almost isoenergetic. The early-calving cows were assigned to the same treatments as the late-calving cows. Researchers did not intensely observe these cows, and they took fewer samples from this group due to the belief that these cows would be cycling normally at the start of breeding season because of the increased time between calving and the start of breeding season. In the first study postpartum protein supplement did not affect BW, but BUN was higher for the 50% ruminally protected protein. The interval from calving to first observed estrus was shorter by nine days for the group fed the 25% ruminally indigestible protein supplement. In the second study the cows on 50% ruminally protected protein supplement lost 39 kg less BW than cows fed the 25% ruminally protected protein. There was, however, no difference in percentage of cows pregnant in the second study.

Rusche et al. (1993) published a paper on protein supplementation in which primiparous Angus x Hereford heifers were either fed a low RUP (soybean meal) or a high RUP (equal parts corn gluten meal and blood meal) fed at either 100 % or 150% of the recommended level (NRC, 1984). The cows and calves were maintained in a drylot and fed supplements for 100 days, or until first estrus was observed, whichever came first. There was no difference in BCS between the four groups, but ADG of the calves was increased by both the level of protein and the high RUP protein. Differences in luteinizing hormone level were not observed along with days until progesterone concentration was greater then 1 ng/ml, indicating beginning of ovarian luteal activity. Plasma urea nitrogen showed no difference between the level or source of RUP. A conception rate of 56% was low for the 100 % low escape group while cows on other treatments had a conception rate of 83%, but conception rate differences were not statistically different. Cows fed the lower level of protein tended (p=0.14) to calve earlier the following year.

In a 3-yr study in which protein supplementation and energy level during gestation were treatments, Marston et al. (1995) used crossbred primiparous and multiparous cows. The cows were supplemented with either energy (20% CP soyhull-based supplement at 1.22 kg/d) or a protein (40% CP soybean meal at 2.44 kg/d), both provided precalving and postcalving. The cows fed the energy supplement during late gestation had greater BW and BCS throughout the study, and a greater pregnancy rate (90% vs 80 % for the protein supplemented group). The number of days to conception was similar between precalving groups. Milk production was greater in early lactation for the energy supplemented postpartum cows, but pregnancy rate was not affected by postpartum supplementation group.

Breed of beef cows may affect prepatum and postpartum reproductive performance. Many large cow herds contain Brahman derivative cows in the Southern United States. Protein supplementation of Brahman primiparous and multiparous cows was reported by Triplett et al. (1995). Treatments were low, medium, and high undegradable intake protein (UIP) supplements with soybean meal and fish meal as the protein sources that were fed to cows for 112 days. There were no differences in BW or BCS by treatment or parity, there was no difference in milk production related to treatment, but parity affected milk production with primiparous cows producing less milk in the experiment. Treatment had no effect on calf performance (BW or

ADG). Progesterone was higher for the medium UIP group. More females in the low UIP treatment failed to return to estrus, and displayed more silent heats than cows in the other two groups. First service conception rate was higher for the medium UIP group vs low UIP groups. The high UIP group tended to have higher first service conception rate compared with the low UIP group. However, there was no difference in overall pregnancy rate between groups. In a similar study, Kane et al. (2004) used the same experimental procedures as Tripplett et al. (1995), with low, medium and high UIP supplements. Kane et al. (2004) used cottonseed meal and fish meal as the two protein sources that were fed to Angus x Hereford heifers during a 1-wk acclimation period, then fed for 30 to 32 d in a supplementation period. Two heifers were selected from each group and slaughtered to collect anterior pituitary glands, corpora lutea, follicular fluid, cerebral spinal fluid, and blood. Heifers were synchronized for estrus using PGF2α injections 11 d apart. They found no difference in the insulin, IGF-1, cerebral spinal fluid leptin level, or serum leptin level, but there were greater levels of IGFBP 2 and 4 in the group fed high UIP. However, there was no difference in the amount of total IGFBP in the serum. The cerebral spinal fluid and anterior pituitary content did not differ between groups. There was no difference in serum progesterone, estrodial-17β, or the CL weights This study had several problems: one is the extremely short period of time that the supplement was fed, which was apparently too short to cause any differences between the treatments, The other was this experiment examines the endocrinology, but not the physiology of reproduction, which leads to difficulty in making inferences about the reproductive performance that might be expected for the treatment groups

Supplementation of primiparous beef heifers starting 64 days prepartum was reported by Strauch et al. (2001). They used a (UIP) treatment and a control, both of which exceeded metabolizable protein requirements of beef heifers (NRC, 1996). They reported no difference in BW or BCS between treatments, and there was no effect on calf BW at weigh-suckle-weigh periods or at weaning. There was no difference in the postpartum period for either group, and there were no differences in the serum urea nitrogen concentrations for the groups. However, IGF-1 was greater at calving for the group supplemented with UIP protein. They observed that BCS were greater throughout the experiment for cows with short and medium postpartum intervals. In a related study (Patterson et al., 2003) with two supplements, one that met the CP requirement (NRC, 1996),and one that used feather meal to meet the metabolizable protein (MP) requirement (NRC, 1996), were fed to heifers three times a week for approximately five months. They found no difference in BW between groups, but they reported a higher pregnancy rate in 2-yr old cows if they were fed the MP supplement.

When one takes an objective view of protein supplementation effects on reproductive performance there is consensus that protein supplementation improves reproduction in cases where the diets of the cows are deficient in protein. The next question that arises is whether or not certain types of protein (i.e.. ruminally degradeable or undegradeable), have an advantage in meeting requirements for optimum reproductive efficiency. There are two recurring problems associated with most research in this subject area. The first is that protein in the studied of Kane et al. (2004) and Marston et al. (1995) was not fed for more than one month. The question becomes whether or not this was long enough to induce the desired effects on reproductive performance. The other major problem is that there were prepartum treatments that were unrelated to protein source or level. Even though there was no interaction between supplementation treatments in the studies of Wiley et al. (1991), questions remain as to whether or not the prepartum treatments had any bearing, especially when the studies of Marston et al.(1995) are taken into consideration. Marston et al. (1995) found that prepartum energy level had the largest effect on postpartum reproduction. There seems to be a consensus that degradeable and undegradable protein has no effect on cow weight gain and BCS. This appears to be true for calf weights and weaning weights. To the ultimate question of whether different protein sources have any affect on reproduction, it has been proven that there are differences in hormone levels (progesterone and certain IGF binding proteins) related to protein source. However, most studies reported no differences in hormone levels. Therefore, the question of whether hormone levels are affected by protein source is still not answered. However, Triplett et al. (1995) found that postpartum progesterone was higher for the group fed medium UIP supplement, and they reported higher first service conception rates for the high and medium UIP treatments. This was shown again by Wiley et al. (1991). However, there was only one study that reported an increase in pregnancy rate (Patterson et al., 2003) resulting from protein supplementation. He reported that the group supplemented to meet MP instead of CP had a higher pregnancy rate.

Fat and Oilseed Supplementation

The use of fat and oilseeds as a source of energy and lipid for ruminants has been investigated by numerous researchers. There has been little research reported in peer reviewed articles in the area of reproductive parameters and hormones involving cattle supplemented with either product. The research reported has used numerous sources of fat, and utilized different experimental designs.

Rice bran was used as the source of fat in diets fed to multiparous Brahman cows in two studies reported by Lammoglia et al. (1996). In the first study, cows were fed three dietary levels of fat in the diet: 3.74%, 5.20%, and 6.55%, conducted during the spring in Texas. The second study only used the 3.74% and 5.20 fat treatments, and was conducted in Texas during autumn. All treatments were formulated to be isocaloric and isonitrogenous. Diets were fed starting 2 wk before the expected parturition date, and feeding stopped 21 d after parturition. In both studies they found no difference in BW and BCS between treatments. They found that gestation length during the spring study was influenced by treatment, cows on the high fat (6.55%) treatment had a longer gestation length than cows on the other two treatments. Reproductive performance was not affected by fat supplementation in the autumn study, and progesterone levels were elevated on the 5.20% fat diet. The diets with higher fat levels tended to decrease levels of estrodial 17β. Triglycerides were not affected by treatment, however, cholesterol was increased with time and treatment. There were no differences in the number of follicles counted on the ovaries of the cows between groups. Postpartum intervals and the percent of cows cycling were similar between groups. Higher fat treatments increased cholesterol and progesterone levels, decreased estrodial 17β levels, but ultimately did not improve reproductive efficiency.

In another study Lammoglia et al. (1997) used the same supplements of 3.74 and 5.20 % fat from rice bran fed to 19 multiparous Brahman cows. He observed no difference in progesterone levels during the first estrus cycle, but they reported it increased progesterone concentrations during the second cycle for the cows fed higher fat treatments. Plasma cholesterol effects were the exact opposite of progesterone, it was higher during the first cycle and showed no difference during the second cycle in these cows. Triglycerides and growth hormone concentrations were unaffected by treatment. Insulin levels followed a similar pattern to progesterone, and treatments did not affect levels of growth hormone. The follicular growth pattern and size of follicles in this study was determined using rectal ultrasound. They reported no difference in size and numbers of follicles during the first two follicular waves of the first estrous cycle. The ovulatory follicular wave of the first estrous cycle and the first follicular wave of the second estrous cycle tended to show more medium size follicles in the high fat cows. The CL weight and other ovarian characteristics were unaffected by treatment. Follicular fluid was similar between treatments for progesterone, estrogen, testosterone, triglycerides and cholesterol.

De fries et al. (1998) used the 3.74 and 5.20% fat diet formulations that were used in the two experiments conducted by Lammoglia et al. (1996). In this study 40 multiparous Brahman cows on pasture were fed the two diets with rice bran fat. There were no changes in weight gain differences for treatment, but there was an increase in BCS for the high fat cows. The calves of the cows on the high-fat group tended to be heavier during the supplementation period, but showed no difference between groups at weaning. De Fries et al. (1998) used rectal ultrasound to determine follicular development. On d 15 after calving, they observed more small follicles, but no change in medium follicles for cows fed the higher fat diets. At d 29 there were more medium size follicles for the higher fat supplemented cows. They reported an increase in the total number of follicles for the group on the high-fat diet. However, there was no difference in the postpartum interval and progesterone levels, but cows on the high-fat diet tended to have a higher pregnancy rate.

Oilseeds have been used as a fat source in studies investigating fat supplementation effects on reproductive performance. Lammoglia et al. (2000) fed safflower seeds as the fat source in a study with 246 crossbred heifers. Dietary treatments included a 1.9 % dietary fat or a 4.4% dietary fat treatment, with a 40-d adaption period to the low-fat diet. Heifers were fed from 254 days of age until either puberty or the beginning of breeding season, resulting in 162 days on treatment. They found no difference in BW or BCS related to treatment, however, ultrasound back fat taken between the 12th and 13th rib tended to be greater for heifers fed the high-fat diet. They observed no effect of fat supplementation on age at puberty, but more heifers had reached puberty on the high fat diet at the start of breeding season. They determined that dietary effects tended to be minimal in these Hereford-sired heifers. Number of artificial insemination services per conception or percent pregnancy were unaffected by dietary treatment. The higher fat diet resulted in increased concentrations of cholesterol and progesterone.

Additional research was conducted by Bottger et al. (2002) using safflower seeds as the fat source in supplements fed to primiparous Angus x Gelbvieh crossbred heifers. Heifers were fed a dry molasses-based diet with either added corn and soybean meal, high linoleate safflower seed, or high oleate safflower seed. The supplement was fed at a rate to supply 5% of DMI as lipid beginning 3 d postpartum for 90 days, and they found no difference in BW. The heifers fed high oleate safflower had lower BCS than heifers fed the other two fat treatments. Milk production was similar between groups, however milk fat was influenced by diet. Calf weight gains were similar for all fat supplemented treatments. They reported that the postpartum interval and days to conception were similar, and not influenced by dietary treatment. Insulin, IGF-1 and growth hormone levels were similar for dietary treatments.

The type of fat and its affect on reproduction was the focus of research reported by Thomas et al. (1997). They used 27 mature F1 (Brahman x Hereford) multiparous cows for the experiment. They were assigned to one of four treatments: CT- no fat; SAT - animal tallow; PU- soybean oil; or HPU- fish oil. All fat sources were fed at 4% of DMI. The diets were formulated to be isocaloric, isonitrogenous, and isofibrous, and cows were fed in confinement for 50.5 days. They found no treatment differences for BW and BCS. Feeding the fat supplements caused a significant increase in cholesterol, HDL-CHO, and triglyceride levels, and HDL-CHO was significantly increased in follicular fluid for all three fat supplemented treatments. In their study, the PU treatment caused a significant increase in follicular growth and high insulin levels, while SAT and HPU tended to increase follicular growth. Growth hormone and IGF-1 were increased in heifers assigned to the three fat supplement groups compared with the control treatment. This study did not look at reproductive efficiency or actual reproductive levels.

Soybean oil was the fat source fed to Angus x Gelbvieh crossbred heifers in two studies Whitney et al., 2000). In one study, cows were individually-fed three dietary treatments for 104 d: including soybean oil fed at 0 %, 3% or 6% in isonitrogenous diets. In another study they fed the same three fat levels, however fat was fed as top-dressing on hay for 90 days. They found no difference in days pregnant in the first experiment. In the second study they observed that cows fed the 3 % added fat had 11 days older pregnancy than the other two groups. They also found increased cholesterol level with fat supplementation.

Howlett et al. (2003) studied the effect of feeding whole soybeans on reproductive performance of heifers. They used 96 crossbred 9 mo old heifers that were fed isonitrogenous corn silage-based diets supplemented with either a corn-based control, whole-linted cotton seed, whole raw soybean or pelleted soybean hulls. Heifer weight and ADG were different because of an error in estimating soybean hull nutritive content. The percent of heifers that had reached puberty at synchronization, and AI conception rate, were not affected by dietary treatment.

Son et al.(1996) used 68 lactating Holstein dairy cows with supplementation beginning 2 wk postpartum and continuing through 12 wk postpartum. Cows were assigned to four dietary treatments: high fat + high escape protein, high fat + low escape protein, low fat + high escape protein, and low fat + low escape protein. Tallow fed at 3% of DMI was the high fat source, and the protein was either 0 or 5 % feather meal and blood meal in diets that were isocaloric and isonitrogenous. Results indicated that BW loss was greatest for the HF+HE and LF+LE diets, and BCS were lowest for the LF+LE diet. However, no treatment effects were statistically significant. Cholesterol was increased in the high-fat diets, and progesterone tended to be higher in the high fat diets. Postpartum interval to first ovulation, second ovulation and first AI service were all similar for these dietary treatments. Conception rate from first AI was higher for the HF+HE treatment group. Pregnancy rate at 98 d in milk tended to be greater for cows fed the high-fat diets. The use of oilseed and fats as a source of energy has been shown to alter the serum lipid levels, However, there is little evidence that it alters the hormone levels and ultimately reproductive efficiency.

Calcium Soaps of Fatty Acids

The use of calcium soaps of fatty acids (CSFA) in ruminant diets has only been researched since 1990. The most popular product is Megalac®, made from palm oil, produced by Church and Dwight (Princeton, NJ). This product supplies supplemental energy in the form of fat that is not broken down or modified by the ruminal bacteria. The fact that this fat is inert in the rumen means that it can be included in a ration at a greater level than unprotected fat without the decline of intake and decline in fiber digestion generally associated with feeding of unprotected fat (Jenkins, 1993).

Sklan et al. (1991) reported effects of CSFA feeding on reproductive performance using 126 multiparous dairy cows. Cows were fed either a control total mixed ration (TMR) that had no added fat, or a TMR that contained CSFA at 2.6% of DMI from calving to 120 d postpartum. They reported that BW loss was more rapid in cows fed the CSFA treatment. They found no difference in glucose level between groups, a tendency for elevated cholesterol levels, and higher levels of progesterone in cows fed the TMR containing CSFA. During the first 20-d postpartum, more cows assigned to the control treatment formed a CL. Conception rate for first AI service was similar between groups, but the conception rate for second AI service was lower in the control cows. They found that the percent pregnant at 150 days postpartum was higher in the CSFA-fed cows. Therefore, the CSFA cows had significantly fewer days open. In another paper (Sklan et al., 1994) the same dietary formulations were fed but they used multiparous and primiparous dairy cows. Results indicated that cows fed CSFA produced more milk than control cows. In this study BW change was not significant, and there were no differences in cholesterol and phospholipid levels between groups. However, triglycerides were significantly higher in cows on CSFA treatments. Conception rates were lower for the primiparous cows on CSFA treatments than control cows at first AI, but conception rates were similar for treatments at second AI and for pregnancy rates for the multiparous cows. Progesterone levels were similar before estrus for cows on the control or CSFA treatments, and there were no difference in progesterone levels after second ovulation. No treatment differences were detected for luteinizing hormone levels, number of pulses, or pulse amplitude indicating that there was no difference in LH production or pattern of release.

Ferguson et al. (1990) reported results from five high-producing dairy herds that included primiparous and multiparous cows. The cows were fed 0.45 kg prilled fat per cow daily from d 1 after calving through 150 d postpartum. They reported an increased first service conception rate and overall increased conception rate in cows fed the prilled fat, but they observed no difference in days to first AI service. Scott et al. (1995) conducted a similar study compared with the study of Ferguson et al. (1990), using five dairy herds with both primiparous and multiparous cows. Cows were fed prilled fat at the rate of 4.2% of DMI for 180 d to 200 d postpartum, or a basal diet with no added fat. They observed no treatment effects on BW or BCS, but there was a significant increase in milk production for cows fed prilled fat. Reproductive performance was similar for treatments, including similar conception rates at 150 d and 200 d postpartum between groups.

Hormone concentrations and ovulation in cows fed CSFA were focal points of research with dairy cows reported by Spicer et al. (1993). They used 14 multiparous Holstein cows that were fed either a control TMR, or the control TMR with CSFA added at 1.8 % dietary DM, from parturition to 84 d postpartum. They observed no difference in milk production between treatments, but BW loss was greater for controls from wk 1 to wk 4 until the end of the supplementation period, and BCS was unaffected by treatments. Cows on the two treatments had similar IGF-1 concentrations, but they reported greater progesterone levels during wk 5 to wk 12 for the cows on the diet with added CSFA. Cholesterol concentrations were higher in the cows fed CSFA, but treatment did not affect the interval to first ovulation. Cows fed the CSFA TMR showed a higher percentage of third postpartum ovulations associated with estrus..

Moallem et al. (1997) conducted studies involving CSFA and bovine somatropin injections in 48 multiparous dairy cows. They fed either a control basal diet or basal diet plus 0 .5 kg CSFA/cow daily, and then either administered 500 mg of Zn-sometribove (Monsanto Co. St. Louis, MO) every 14 d, or no injections composing four treatments. Diets were fed from calving until 150 d in milk. They reported increased milk production for cows fed CSFA, BW was similar between treatments, and BCS was affected by CSFA feeding and somatropin administration. Cow BCS was increased by CSFA feeding, and BCS was decreased by somatropin treatment. Level of free fatty acids and cholesterol were increased by both treatments, but triglycerides were only increased by CSFA feeding. They reported no significant difference in mean number of days in milk before first postpartum ovulation. Pregnancy rate at 120 days in milk was highest for control cows followed by CSFA supplemented cows, and then bovine somatropin treated cows.

In one of two published papers using CSFA fed to beef heifers, Hawkins et al. (1995) fed a control diet and a control plus 0.57 kg of Megalac® daily. Dietary treatments were fed beginning 100 days before expected parturition, and stopped after the third postpartum estrus cycle using 11 heifers. Treatment did not affect BW or BCS, They observed a doubling in cholesterol and HDL levels in heifers fed CSFA treatment, and LDL levels tended to be higher for the CSFA treatment. Their research indicated an increase in the percent area occupied by lipid in the steriodic lediac cells, luteal ledaic cells, and steroidgenic cells of the ovaries in the CSFA treated heifers. They reported an increase in progesterone levels on d 12 to d 13 of the estrus cycle for heifers on the CSFA treatment, but these heifers had a decrease in progesterone clearance rate.

In another publication that looked at CSFA fed to beef heifers (Filley et al., 2000), 39 Angus x Hereford crossbred primiparous heifers were fed a control diet and a diet with Megalac® added at 3% of expected DMI. They used ground barley supplementation to make the two treatments isocaloric. The free fatty acid profile of the serum was affected by treatment with an increased lipid level in the heifers fed Megalac. They reported no difference in BW or BCS due to treatment, and no difference in reproductive performance, defined as a total look at percent estrus exhibited, days to first estrus, pregnancy rate, and calving interval.

Results reported in these articles are variable, but the one thing that seems to hold true is an increase in blood lipid levels when fat is included in diets of cows and heifers. There is some disagreement about exactly what type of blood lipid increases. Some reports show an increase in cholesterol, others increases in HDL and LDL. One reason for this inconsistency in the literature is associated with the remainder of the diet being fed. All of these researchers fed different diets with CSFA fed at different levels. Most of the dairy papers tend to show an increase in some reproductive parameters, but they may disagree in what the parameters are. Some of the papers did not report follicular development and growth, and that is an area that seems to be influenced by CSFA supplementation. In the two beef papers, some design problems were noted. Hawkins et al. (1995) used only 11 heifers, and this low number of test animals increased variability, making it difficult to find statistical significance between treatments. Another problem is apparent decreased clearance rate of progesterone, reported by Hawkins et al. (1995) which is not well supported. Their experiment was not designed to determine progesterone clearance, and the inference made on data points that are not spaced correctly to show concrete evidence of this event is questioned. In the other report (Filley et al., 2000) CSFA was only fed for 30 d, which is generally considered a minimal or to insufficient of a feeding time to influence reproductive performance.

Leptin

Leptin is a 16 kilodalton protein hormone that is made up of 146 amino acids, and it is the product of the Ob gene in mice (Zhang et al. 1994). Leptin is produced mainly in the adipose tissue, and is then secreted into the bloodstream following a cleavage of a signal protein. The leptin then travels in the blood in both a free state and bound to carrier proteins. The leptin mainly affects the brain, and certain regions in the brain are sensitive to changes in leptin levels. Leptin is thought to be a key hormone in appetite, energy balance, metabolism and also reproduction in pigs (Barb et al. 2001). Frederick et al. (1995) found that leptin secretion and expression reflects body fat stores in animals where energy intake is at least at maintenance level in mice.

Leptin in ruminants is a fairly new area of research. Devavuad et al. (2002) reported dietary restriction significantly reduced the concentration of circulating leptin in cattle and sheep, and breed tended to have an effect on plasma leptin concentrations. Ciccioli (et al., 2003) reported that leptin levels were different 3 wk before the end of feeding cattle a supplement; however, at 3 wks after the end of supplement feeding there was no difference in leptin levels between control and supplemented groups. Devavuad et al. (2002) observed that body fatness has a major effect on plasma leptin concentration, and this conclusion was supported by other research (Ehrhardt et al. 2000). Season of the year may also play a role in the level of leptin circulating in the blood. Garcia et al. (2002) found a 34% increase in leptin during early winter to summer in cows with no change in BW. Leptin has been shown to have an effect on puberty. A review article (Williams et al., 2002) relates the events of puberty and how leptin affects puberty. He explained the rise in leptin observed as the onset of puberty approaches as being mostly due to the increase in body weight. Spicer et al. (2001) stated that systemic leptin levels increase in both males and females as sexual maturity (puberty) approaches, however the high leptin level is only maintained in the female. They also stated that males have a decline in leptin level after puberty because of testosterone inhibition of leptin secretion. Leptin administration in the lateral ventricle increased plasma LH concentrations, but not frequency of LH pulses in mature cows (Williams et al. 2002)

Calf Removal and Suckling Influences on Reproduction

Another way of influencing postpartum reproduction is early weaning or calf nursing restriction. Williams et al. (1990) reviewed suckling and its physiological effects on the cow. He stated that both suckling and presence of mammary tissue without suckling delayed postpartum estrus. This relates to one of the key parts of this puzzle, which is the energy used for lactation and by mammary tissue that results in inadequate energy for the ovary to start the processes involved with and leading up to ovulation. Suckling also appears to distort or prevent the pulsatile LH release that is a necessary part of normal ovulation and follicular development. This maybe caused by stimulating a neural system originating in the nerves from the mammary system causing an effect on the LH pulse generator. Another part of this neural puzzle is the lack of progesterone from normally short-lived corpus luteum. The progesterone is thought to organize the hypothalomo-hypophyseclovarian axis during the transition from anestrus to normal cyclicity.

These effects are usually observed when suckling is either terminated by early weaning or in the case of limited and / or once-daily suckling. If cows are suckled more than once daily, the desired effect of reducing interval from calving to first estrus tends to be prevented. Another effect of calf removal / suckling restriction is to improve conception rates associated with the use of estrus synchronization protocols.

When selected papers are considered instead of a review article, some similarities are apparent for suckling effects on reproduction in cows The practice of 48-h calf removal does not appear to influence reproduction (Wettemann et al., 1986; Salfen et al., 2001). Wettemann et al. (1986) observed no difference in pregnancy rates or interval from calving to first estrus resulting from 48-h calf removal imposed on two separate dates. Salfen et al. (2001) determined follicular size and development associated with calf removal at different times in the follicular waves of the cows. They reported no difference in the number of follicles recruited or the maximum size of the dominant follicular between different days or control. They observed no difference in progesterone levels. In accordance with research reviewed by Williams (1990), once a day suckling had a dramatic effect on reproduction (Hill and Godke, 1987; Browning et al., 1994). Hill and Godke (1987) reported an increase in percent of cows observed in estrus associated with limited nursing. They found no difference in postpartum interval or pregnancy rate. Browning et al. (1990) observed that diet and suckling restriction changed endocrine levels and profiles, and the interval to first estrus was 3 wks shorter in the restricted cows compared with the unrestricted cows. This resulted in a calving interval that was 34 d shorter for the restricted group. Hill and Godke (1987) reported a significant decrease in weight gain of calves on the restricted treatments that was reflected in lower weaning weights compared with control calves. Browning et al. (1990) did not observe calf gain effects related to suckling restriction, but calves on their study were on the restricted suckling treatment for a shorter time interval than calves in the study Hill and Godke, (1987).

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CHAPTER 2

REPRODUCTIVE PERFORMANCE OF YEARLING HEIFERS FED MEGALAC® BEFORE BREEDING

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Abstract

Effects of energy supplementation before breeding on beef heifer (age 14 to 15 mo; initial BW 376.9 +/- 29.9 kg) reproductive performance was determined. Angus (A; n=24) and Polled Hereford (PH; n=17) heifers grazed sod-seeded ryegrass pastures, and were randomly assigned to Control (C; n= 20; no supplementation;) or Megalac® (M; n=21; mixture of 8% Megalac, 92% corn gluten feed fed 5 d/wk at 3.45 kg/d) during the pre-breeding interval from February 11 (Feb 11) to April 11(Apr 11). During the 71-d breeding period beginning Apr 11, estrual activity was monitored visually and using the Heatwatch® system. Heifers were bred using AI during the first 44 d, and with fertile bulls during the remaining 27 d. Using initial BW at Feb 11 as a covariate, least squares means for heifer BW (kg), and ultrasound subcutaneous fat (US; cm), for C and M, respectively, were: Feb 11= 376, 373, 2.23, 2.15, SE 6.4, .11; Apr 11= 431, 434, 2.20, 2.36, SE 6.4, .11; June18= 444, 446, 2.09, 2.22, SE 3.1, .11. Treatments (T) did not affect ($P > 0.10$) heifer BW or US on Apr11 or June 18. Cholesterol started out at 121.25 ng/dl for control and 123.82 ng/dl for Megalac heifers on Fed 11, and was at 139.60 ng/dl for control and 162.90 ng/dl ($p<.0001$) for Megalac heifers on Apr 11. Heifers on control treatment had high-density lipids(HDL) levels at 94.76 ng/dl while HDL for Megalac heifers was at 97.17 ng/dlon Feb 11, and the HDL for therespective treatments were 100.92 and 122.20 ng/dl ($p <.0001$) on April 11. Serum low-density lipids (LDL) and triglyceride (TRI) were affected ($p < 0.5$) by T or sampling date. Initial leptin levels were almost identical on Fed 11 (C= 8.27, M=8.23), and Megalac raised leptin levels (C= 8.38 and M= 10.70 P=0.15) by Apr. 11. Heifers expressing ovarian luteal activity (OLA; %), indicated by srum progesterone concentrations of 1.0 ng/ml, or greater, on

Apr 11 were increased by Megalac supplementation (C= 29.17%, M= 62.50 %, p =. 0.009). Pre-breeding Megalac tended to increase pregnancy rates when cows were examined after weaning (C= 56.19% and M= 78.48%, $p = 0.118$). Breed affected pregnancy rate ($p < 0.05$), with higher values for A than PH heifers. Feeding M pre-breeding to beef heifers increased serum CHO, HDL, and ovarian luteal activity, and tended to increase pregnancy rate ($P < 0.12$). Breed (B)affected pregnancy rate ($P <0.05$), with higher values for A than PH heifers.

Key Words: Heifer Reproduction, Megalac, Cholesterol, Leptin

Introduction

Much research has been focused on management practices to improve reproductive efficiency in yearling heifers. Genetics and nutrition have the most influence on age at puberty in heifers (Whitbank et al., 1966), and a high plane of nutrition decreased the age at onset of puberty in their study. Additionally, heifers that are bred earlier during the first breeding season have improved reproductive performance as cows for the rest of their lifetime (Lesmeister et al., 1973). This is extremely important to cattle producers in the Southeastern United States. In this region heifers are usually bred between February and June. This corresponds to the availability of high quality, winter annuals mainly rye and oats, and early spring production of summer perennials. The typical heifer can be maintained on winter annuals forages without supplementation. The belief that fat supplementation of heifers grazing winter annual would negatively impact digestion of structural carbohydrates (Jenkins, 1993), is likely responsible for few experiments reported using fat as a supplement. Rumen protected fat has recently been utilized to meet and exceed energy needs of cattle, while minimizing reductions in DMI and decreased OM digestion typically associated with other sources of supplemental fat (Spicer et al., 1993; Moallem et al., 1997; Filley et al., 2000). Our objectives were to determine effects of rumen protected fat supplementation on reproductive performance of yearling heifers grazing winter annual pastures.

Material and Methods

Forty one Angus (A; n = 24) and Polled Hereford (PH; n = 17) heifers averaging 14 mo of age were used in an experiment to test the effects of supplemental rumen protected fat. Heifers had an average initial BW of 376.9 kg. On February 11, 2003 the heifers were ranked by weight, breed, and sire and randomly assigned to either control (C) or to a rumen protected fat (Megalac®;M) supplemented group. The C heifers (n = 20) were maintained on pasture and not supplemented. The M group (n = 21) were maintained on pasture and fed a supplement that contained 8% Megalac® and 92% corn gluten feed. Supplement was fed at 3.45 kg/heifer daily, five times each week. Both groups grazed dormant Coastal bermudagrass pastures that were sod-seeded with Passerell annual ryegrass (26.73 kg/ha) . Pasture rotation was performed twice to eliminate pasture effects on the experiment. Bermudagrass hay was provided in hay feeders to each group free-choice. The supplementation period was initiated 60-d before the start of the breeding season. All heifers and bulls were managed under procedures approved by the University of Georgia Animal Care and Use Committee Guidelines.

Samples of all major components of heifer diets were sampled and chemically analyzed for DM and CP using AOAC (1990) procedures. The ADF and NDF were determined using the methods outlined by Van Soest (1991). Standard prediction equations were used to calculate TDN and NEm. Three randomly selected round bales of hay were sampled in three different locations on each bale using a core sampling tube, and then core samples were composited by bale. Each composite was ground through a 1mm screen. The composite hay samples were analyzed and found to have little variability, so the three analyses were averaged and reported (Table 1). Corn gluten feed was representatively sampled from several sites in the load of the byproduct, then composited into two final samples that were analyzed in duplicate (Table 1). Ryegrass forage was sampled on d 18 and d 48 of the supplementation period. Pastures were sampled at three different locations within each pasture using a 0.0929 meter square, and forage was cut at ground-level, using electric shears. The samples were dried in a forced-air oven at 60° C for 48 h, ground through a 1mm screen, composited by pasture, and chemically analyzed (Table 1) .

On d1, (February 11), heifers were weighed, subcutaneous fat depth was measured at the 12th rib using ultrasound (US), and heifers were body condition scored (BCS; scale 1-9, 1=emaciated, 9=obese). In addition, hip height was recorded, and a blood sample taken by tail veinipuncture. On d 28 (March 11) midway through the supplementation period, the heifers were weighed, condition scored, and a blood sample was taken via tail veinapuncture. Heifers were weighed, BCS and US were recorded on d 60 (April 11), the final day of supplementation and on d 128 (June 16), with a final blood sample taken on d 60. Weights were recorded at 28-d intervals from d 128 (June 16) to d 218 (September 19) when the last BW was recorded.

The breeding interval began on April 14, and heifers in both the C and M groups were combined. The breeding season consisted of a 44-d artificial insemination (AI) interval followed by a 27 d period using natural service as a clean-up period. Heifers were monitored for estrual activity by visual observation twice daily for thirty minutes at 07:00 and 19:00 hours. In addition to visual observation a Heatwatch System (DDX Inc, Denver Colorado) was used to monitor estrus activity. The heifers were bred as close to twelve hours as possible from the onset of estrus based on the Heatwatch System data. The onset of estrus was defined as two mounts in four hours detected by the Heatwatch system. If the heifer was visually observed in standing heat, and if there was no Heatwatch data for the heifer, she was bred twelve hours after the standing heat observed. At the end of the AI breeding interval the heifers were regrouped by breed and put into two adjoining pastures. Polled Hereford heifers were exposed to an Angus bull, and Angus heifers were exposed to a Polled Hereford bull. The bulls used in the natural breeding season passed a breeding soundness exam one week before the start of the breeding season. Natural breeding of heifers began on May 28, and ended on June 24. On September 17, pregnancy examinations via rectal palpation were completed for each heifer. Fetal age was estimated at time of palpation in pregnant heifers, and this age was used to determine approximate breeding date.

All blood samples were refrigerated as soon as possible after collection, and stored overnight at 4°C before being centrifuged at 3200 rpm for 20 min to separate serum. Serum was collected, frozen, and stored for later analysis. A Boehringer Mannhiem / Hitachi 912 analyzer was used to analyze the serum for cholesterol (Cholesterol / HP; Roache Diagnostics), high density lipoprotein (HDL) (HDL- C plus 2nd generation; Roache Diagnostics), and Triglycerides(Triglycerides/ GB; Roache Diagnostics). The low density lipoprotein (LDL) was calculated using the formula: Total Cholesterol - (HDL [triglycerides/5]). Serum progesterone was determined using a commercial RIA kit (Progesterone CT kit; MP Biomedicals INC., Irvin, CA) as outlined by Imwalle et al. (1998). Duplicate samples were analyzed and compared with a standard curve, and all RIA samples were analyzed at one time eliminating the need for estimating the intra assay CV%. The results reported are the average of the two tubes. The samples were reanalyzed if they had a 5% error between duplicate tubes. Circulating levels of leptin were determined using an ovine leptin RIA that had been validated for Bovine serum (Delavaud et al., 2000). Each sample was analyzed in triplicate and leptin was reported as the average of the triplicate. Ovarian luteal activity (OLA) is defined as progesterone concentrations equal to, or in excess of, 1ng/dl.

The experiment was statistically analyzed as a two by two factorial design with breed and treatment as the two factors. The data were analyzed using the mixed procedure of SAS (2001; SAS Inst., Inc., Cary, NC). The BW and reproductive data were in one analysis, with the initial BW (February 11) used as a covariate for all subsequent weight measurements and ADG calculations. This covariate removed a breed interaction that was present beginning with the first day of the study and was present throughout the experiment. Serum components from the 2 x 2 x3 factorial design (Breed, treatment, and date as factors) were statistically analyzed using the mixed procedure of SAS (2001) . The Corr Procedure (SAS, 2001) was used to determine any correlations between leptin, US subcutaneous fat, pregnancy rate, and OLA, all measured and calculated for d 60 (April11), the last day of the prebreeding supplementation period.

Results

All heifer BW, US, and BCS data are shown in Table 2. Breed affected BW ($p = 0.0143$), hip height($p = 0.0006$) and US rib fat ($p = 0.0267$) on d1 (February 11). On day 28 (March 11) half way through the supplemental period, treatment affected both BW ($p= .0347$) and BCS (p=.0434) and breed affected BCS (p=.0186). On d 60 (April 11) the date that corresponds to the end of the supplementation period, BW, BCS, and US were similar for treatments and breed.. Treatments did not affect BW, BCS, or US on subsequent dates when these varibles were measured, except breed tended to affect BW. Heifer ADG are shown in Table 3, with prebreeding ADG defined as ADG during the supplementation feeding period, d 1through d 60. The breeding season ADG is the ADG of the heifers during the entire 74 day breeding season, from d 60 through d 134. The total ADG is the total ADG of the heifers from d1 through d 218 (Table 1). Fat supplementation did not affect ($P > 0.10$) ADG of heifers for any time period.

Results of analyses conducted on blood serum appears in Table 4. Cholesterol showed a 60.8 % difference on d 28 and a 16.7% difference on d 60 with Megalac heifers having the higher values. Cholesterol had treatment x date ($p < 0.0001$) and treatment x breed ($p = 0.042$) interactions, and cholesterol was affected by treatment ($p <.0001$) and date ($p= < 0.0001$). Feeding Megalac to heifers resulted in 30.9% increase in triglyceride levels on d 28 and a 9.2% difference on d 60 of the study. Triglycerides were affected by treatment ($p = 0.01330$) and breed ($p < 0.0001$), with a treatment x date interaction ($p = 0.0034$). Megalac supplemetation increased HDL by 65.3% on d 28, and by 21% on d 60 of the experiment. Two different interactions occurred for HDL: treatment x date ($p < 0.0001$) and treatment x breed ($p = 0.0382$). Serum LDL was increased by Megalac supplementation by 56.7% on d 28, and by 4% on d 60. A treatment x date interaction ($p < 0.0001$) occured for LDL, with treatment and date being independently significant ($p = 0.0002$ and $p < 0.0001$, respectively). Progesterone was only affected by the treatment x breed interaction ($p = 0.0047$). Ovarian luteal activity was affected by treatment ($p = 0.0090$) , but was unaffected by breed. Serum leptin concentrations are shown in

Figure 1, and leptin tended to be influenced by treatment (p = 0.1553). Serum leptin increased 20% on d 28 and 27.6% on d 60 of the experiment due to supplemental feeding of heifers with Megalac (p = 0.0030), and there was a treatment x date interaction (p = 0.0201) for serum leptin.

The pregnancy data for heifers on control or Megalac prebreeding treatments is shown in Figure 2. The C heifers had a conception rate of 64.04% for Angus and 35.01% for Polled Hereford. Angus and Polled Hereford heifers fed Megalac had conception rates of 92.92% and 77.37% respectively. Pregnancy rates tended to be higher (p = 0.1063) for heifers supplemented with Megalac. Angus Heifers had higher (p = 0.0300) pregnancy rates than Polled Hereford heifers, and there were no treatment x breed interactions for pregnancy rate. When days pregnant (C=104.54 d and M=113.14 d) were statistically analyzed, there were no treatment effects (P > 0.10). The number of days pregnant determined at time of palpation was greater (p = 0.0262) for Angus heifers than Polled Hereford heifers.

Leptin level on d 60 (April 11; the end of supplementation) was correlated (R^2=.49491) with the US subcutaneous fat measurements taken on D 60 (p=.0012). The estimate of variation was high for US at d 60 (R^2 =1.00) and it was directly opposite of luteal activity on d 60 (P = 1.00). Leptin was not correlated with luteal activity at the beginning of the breeding season (d 60; April 11) or with pregnancy rate.

Discussion

Feeding rumen protected fat (Megalac®) during the pre-breeding period had minimal effects on BW or BCS of heifers, except for a difference observed at the d 28 weighing date for both measurements (Table 2). This difference might be explained by the control heifers being in holding pens slightly longer than Megalac heifers before being weighed and body condition scored. This additional holding time may have resulted in less gut fill that could account for the minimal differences observed in BW. Pastures grazed by the heifers were similar in nutrient content with, the same TDN and NEm values for each pasture (Table 1). Pasture nutritional differences were minimized by the pasture rotation for heifer treatments. Heifer breed affected heifer BW throughout the pre-breeding, breeding, and postbreeding intervals, even when initial BW was used as a covariate. The US data indicated that breed was significant at the start of the study with PH having more fat than A heifers; however, on subsequent dates there were no US differences caused by breed or treatment (Table 2).

The differences observed in our study between control and Megalac-fed heifers for cholesterol, LDL, HDL and triglycerides had been confirmed by others feeding rumen protected fat in the form of Megalac (Hawkins et al., 1995; Moallem et al., 1997; Spicer et al., 1993). Our study is the first to report that feeding Megalac increased circulating levels of all four blood lipids. However, Sklan et al. (1994) reported no difference in cholesterol concentrations between control and experimental treatments fed 2.5% protected fat in a TMR. The reason for the increased cholesterol in this study is not clear. Hawkins et al. (1995) suggested that increased cholesterol resulted from slowed clearance of progesterone, a major product of cholesterol. However, the diet seems to be the most likely source of the increased cholesterol, either directly, or through increased acetyl CoA production, which is the substrate of cholesterol genesis. Another dietary reason for increased cholesterol is the increased level of palmitic and mysteric acids found in the fat supplement because of the concentrations of these fatty acids in Megalac. Palmitic and mysteric acids have been shown in other animals to increase cholesterol levels (Keys et al., 1965;

Hogsted et al., 1965). In the present study, an increase in triglycerides was observed, which is supported by Sklan et al. (1994), who fed both primiparous and multiparous dairy cows 2.5% CSFA as part of a TMR, and Moallem et al. (1997), who fed 2.2% of CSFA to multiparous dairy cows. However, Sklan and Tinsley (1993) fed 4.0% of a bypass fat to multiparous dairy cows, and they reported no differences in triglycerides. The increase in HDL observed in our study agrees with research by Hawkins et al. (1995) who fed Megalac (0.57 Kg / heifer daily) as part of a corn silage-alfalfa hay based complete ration. No other paper reported a significant increase in LDL associated with the feeding of CSFA. However, Hawkins et al. (1995) reported a trend for increased LDL (P=.08) . In our study increased LDL probably resulted from feeding Megalac as a part of a supplement to heifers on pasture, while Hawkins et al. (1995) fed the product as part of a silage-and alfalfa hay-based complete feed, before and after parturition. The major difference between results of the studies could be the difference in levels of CSFA fed along with differences in dietary composition.

In our study, heifer progesterone concentrations were unaffected by treatment (Table 4). The sampling dates were a month apart, to provide an indication of luteal activity. Serum was not collected on schedules with enough sampling frequency to accurately make an assumption about the effect of rumen bypass fat on progesterone levels. Our observations were supported by research of Moallem et al. (1997), who observed no difference in progesterone levels when Megalac was fed. However, Hawkins et al. (1995) and Spicer et al. (1993) reported increased levels of progesterone. Spicer et al.(1993) accounted for the increase by indicating that it was the result of increased luteal function. Hawkins et al. (1995) attributed it to increased lipid droplets in the steriodogenic cells of the ovary resulting in greater levels of cholesterol for progesterone synthesis, and also to a decreased clearance rate for progesterone. The increase in ovarian luteal activity observed in our study (Table 4) agrees with research of Spicer et al.(1993) and Garcia-Bojalil et al. (1998). While Spicer et al. (1993) indicated the increased ovarian activity was related to luteal function, Garcia-Bojalil et al. (1998) reported increased ovarian volume, increased number of corpora lutea, and an increase in size of the large corpus lutea when Megalac was fed. However, OLA in the present study is a product of the progesterone levels which were taken infrequently during the prebreeding supplemental phase of the study, and may not fully reflect actual luteal activity over the entire supplementation period.

The pregnancy percentages for heifers in our study (Figure 2), indicated that feeding Megalac increased overall conception rates for the whole breeding season. When the age of fetus was analyzed, we found that fetal age was approximately nine days older for heifers fed Megalac than controls (C=104.54 d and M=113.14 d). This difference was not significant, but was worthy of note. Our results showing higher pregnancy rates for Megalac supplemented heifers are supported by Sklan and Moallum (1991) and Ferguson et al. (1990). However, there have been other reports of no differences in pregnancy rates (Sklan et al., 1994, Sklan and Tinsley, 1993; Scott et al., 1995; and Filley et al., 2000). With this controversy being stated, consideration of first service and later service conception rates indicate that there are differences between these studies. Ferguson et al.(1990) and Sklan et al. (1993) reported higher conception rate at the first service than the second. The opposite was reported by Sklan and Moallum (1991) and Sklan et al.(1994). Observation of our data indicates that higher conception rates occurred after the first AI service. This is apparent because of the younger fetus at palpation.

Leptin is a protein hormone that is synthesized in the adipose tissue, which travels to the brain and other tissues through the blood. Leptin has a negative effect on feed intake, and tends to increase metabolism. The present study was the first to evaluate effects of feeding high-fat concentrates as supplements to heifers on pasture, while measuring leptin concentrations in the blood. This experiment showed increased leptin concentrations when the Megalac supplement was fed ($p = 0.1553$), and it showed a significant treatment by date interaction (Table 4). There is little research indicating effects of energy and / or fat supplementation of heifers on leptin concentrations, and almost none looking at the role of leptin in heifer reproduction. It has been shown that an increase in BW results in an increase in leptin levels in heifers, especially for prepubital heifers (Garcia et al., 2002). However, this does not explain the difference between the two treatment groups in our study, since there was little difference in BW of heifers especially at the end of supplementation, the time when the largest difference in leptin concentrations were observed. Another possibility for increased leptin could be an increase in nutrient intake, which has been shown to increase leptin levels in cattle (Ehrhardt et al. 2000; Delavand et al., 2002). However this would not fully explain increased leptin levels in our experiment because the pastures were identical in nutrient content (Table 1), and because the supplement did not appear to affect the NE intake of the heifers. The heifers did not have differences in BCS or BW at the end of supplementation period, which would be expected if the energy status was different for the two groups. The US on d 60 did not show any difference between the treatments (Table 2), however, leptin was correlated with the US measurements on d 60. A question then arises as to why leptin tended to be different when US was not different. Ciccioli et al.(2003) reported an increase in leptin resulting from feeding a high nutrient level during the postpartum period in primiparous cows. One possible explanation for increased leptin is that the supplement was supplying essential amino acids, other nutrients, and there was more energy because of less synthesis of biologically needed materials in the heifers that were supplemented. There are no clear reasons for the increase in leptin in the heifers fed Megalac. However, leptin concentrations were not correlated with percentage of pregnant heifers or luteal activity at the beginning of the breeding season. The lack of correlation between reproductive parameters and leptin concentration leads to the conclusion that leptin is only one of many factors affecting reproduction in postpubital heifers.

Implications

Feeding rumen protected fat in the form of calcium salts of fatty acids, also known as Megalac®, as part of a supplement altered the lipid profile of beef heifers. It resulted in an increase in cholesterol, triglycerides, and both low and high-density lipoprotein. In addition to elevating serum lipids, Megalac supplementation tended to increase serum leptin concentrations. The feeding of the supplement tended to increase reproductive performance. However, we did not observe an improvement in the ability to get the heifers bred earlier in the breeding season, one of the primary goals of this project. Differences in blood metabolites that were measured were not reflected in weight, body condition score or ultrasound 12th rib subcutaneous fat. Serum leptin was correlated with ultrasound fat thickness at the end of the Megalac supplementation period. Feeding a supplement that contained Megalac to heifers on pasture improved reproduction and also increased blood metabolites even in heifers that were on an exceptionally high plane of nutrition. It would be expected that supplementation with Megalac would have resulted in even more difference between supplementation groups if the heifers were on a lower plane of nutrition, or if they had lower BCS during the pre-breeding interval.

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Table 1. Chemical analyses of hay, supplemental corn gluten feed, and sod-seeded ryegrass pastures grazed by heifers.

Item	Dry matter	C P	ADF	NDF	TDN	NE_m
	% DM					
Bermudagrass hay	88.6	14.2	39.5	70.86	56	0.48
Corn gluten feed	87.9	23.4	11.65	32.3	74	0.77
Pasture 1, d 18[ab]	92.3	31.1	24.6	50.1	65	0.64
Pasture 2, d 18[ab]	92.6	32.4	24.7	49.1	65	0.65
Pasture 1, d 47[a]	92.1	16.3	26.3	45.6	69	0.72
Pasture 2, d 47[a]	92.3	18.3	27.1	45.5	69	0.72

[a] Pastures consisted of Coastal bermudagrass sod-seeded with ryegrass. Bermudagrass was dormant during experimental period. Ground-level samples of forage (n = 3) in each pasture were chemically analyzed.

[b] High CP in ryegrass resulted from N fertilizer application relatively soon before sampling.

Table 2. Rumen bypass fat effects on least square means for weight, body condition score, and ultrasound of hiefers.[a]

	Control		Megalac			Probability		
Item[b]	A	P H	A	P H	SE	T	B	T * B
Heifer BW	---------------------------- kg ----------------------------							
d 1	389.26	363.49	383.36	362.81	9.89	0.7173	0.0143	0.7739
d 28	406.51	402.66	409.96	411.54	3.14	0.0347	0.7105	0.3397
d 60	433.17	428.03	437.81	430.78	4.50	0.3636	0.1710	0.8156
d 106	445.49	438.66	448.00	440.75	4.76	0.5923	0.1357	0.9616
d 128	442.61	445.69	445.62	445.41	4.94	0.7597	0.7670	0.7111
d 218	487.90	478.08	489.05	478.41	6.73	0.9022	0.1247	0.9458
Visual condition score (BCS)[c]								
d 1 BCS	5.14	5.25	5.13	5.33	0.06	0.7866	0.2303	0.7218
d 28 BCS	5.37	5.75	5.70	5.89	0.05	0.0434	0.0186	0.3996
d 60 BCS	4.96	4.88	5.00	5.06	0.06	0.4202	0.9194	0.6134
d 106 BCS	4.71	4.88	4.79	4.89	0.05	0.6858	0.2755	0.7725
d 128 BCS	4.63	4.81	4.71	4.94	0.06	0.4229	0.1193	0.8558
Ultrasound rib fat (US)								
	--------------------------- cm ----------------------------							
d 1	2.13	2.31	1.86	2.37	0.02	0.4605	0.0267	0.2781
d 60	2.22	2.25	2.21	2.48	0.02	0.4030	0.2658	0.3794
d 128	2.16	2.16	1.85	1.96	0.03	0.8259	0.7340	0.7340
Hip height (Hip ht)								
	--------------------------- cm ----------------------------							
d 1 hip ht	123.08	119.30	122.91	119.53	0.18	0.9746	0.0006	0.8452

[a] Data analyzed using the mixed procedures of SAS (2001) 2 × 2 as a factorial arrangement of treatments.

[b] Abbreviations: A = Angus, PH = Polled Hereford, B = Breed, and T = Treatment; BCS = Body condition score; US = Ultrasound fat depth at 12th rib.

[c] Heifer BCS (scale 1-9; 1 = emaciated; 5 = normal flesh; 9 = obese).

Table 3. Least squares means for gain performance of heifers fed rumen bypass fat during pre-breeding supplemental feeding period.

	Control		Megalac		SE
Item[ab]	A	PH	A	PH	
No. heifers	11	9	12	9	
Pre-breeding ADG (d 1-d 60), kg[c]	0.957	0.869	1.035	0.916	0.10
Breeding season ADG (d 60-d 128), kg	0.328	0.301	0.336	0.314	0.09
Total ADG (d 1-d 128), kg	0.357	0.326	0.310	0.286	0.08

[a] Abbreviations: A = Angus, PH = Polled Hereford.

[b] Data analyzed as a 2 × 2 factorial arrangement of treatments using the mixed procedure of SAS (2001).

[c] Rumen bypass fat supplemented only during pre-breeding interval, d 1 to d 60.

Table 4. The effect of rumen bypass fat supplementation on least square means of serum lipids, progesterone, and leptin.

	Control		Megalac		Selected	
No. heifers[ab]	A	PH	A	PH	effects	Probability
Cholestrol						
d 1	124.75	117.75	112.42	135.22	T	*P* = 0.0420
					T × B	*P* = < 0.0001
d 28	115.42	102.00	173.92	175.89	D	*P* = <.0001
d 60	141.83	137.37	153.58	172.22	T × D	*P* = <.0001
SE		5.15				
Triglycerides						
d 1	40.08	27.63	38.33	30.56	T	*P* = 0.013
					Breed	*P* = <0.0001
d 28	35.00	26.63	45.92	34.78	D	NS
d 60	38.92	29.38	39.58	35.00	T × D	*P* = 0.0034
SE		1.58				
HDL						
d 1	96.36	93.18	85.92	108.42	T	*P* = <0.0001
					T × B	*P* = 0.0382
d 28	82.48	74.81	127.68	132.33	D	*P* = 0.0002
d 60	101.24	100.60	113.93	130.47	T × D	*P* = < 0.0001
SE		4.19				
LDL						
d 1	20.37	18.47	18.90	20.69	T	*P* = 0.0002
d 28	25.94	21.31	37.06	36.99	D	*P* = < 0.0001
d 60	32.81	30.90	31.74	34.76	T × D	*P* = < 0.0001
SE		1.12				
Progesterone	-----------------	ng/ml	----------------			
d 1	4.66	3.13	3.07	2.67	T	NS
					T × B	*P* = 0.0047
d 28	4.64	0.46	1.37	4.28	D	NS
d 60	4.81	1.61	3.43	4.44	T × D	NS
SE		0.81				

OLA	---------------------- % -----------------					
d 1	0.4167	0.2500	0.5000	0.3333	T	*P* = 0.0090
d 28	0.3333	0.0000	0.3333	0.7778	D	NS
d 60	0.3333	0.2500	0.5833	0.6667	T × D	NS
SE		0.10				
Leptin ng/ml	----------------- ng/ml -----------------					
d 1	8.20	8.34	8.67	7.79	T	*P* = 0.1553
d 28	7.54	7.46	10.54	7.52	D	*P* = 0.0030
d 60	8.66	8.11	12.05	9.36	T × D	*P* = 0.0201
SE		0.70				

[a] Abbreviations: A = Angus; PH = Polled Hereford; T = treatment; D = blood samplingdate; B = breed; HDL = high density lipoproteins; LDL = low density lipoproteins; OLA = ovarian luteal activity; NS = not statistically significant.

[b] Data analyzed as a 2 x 2 x 3 factorial (breed, treatment, and date as factors) using the mixed procedure of SAS (2001). Common SE for al means for each variable.

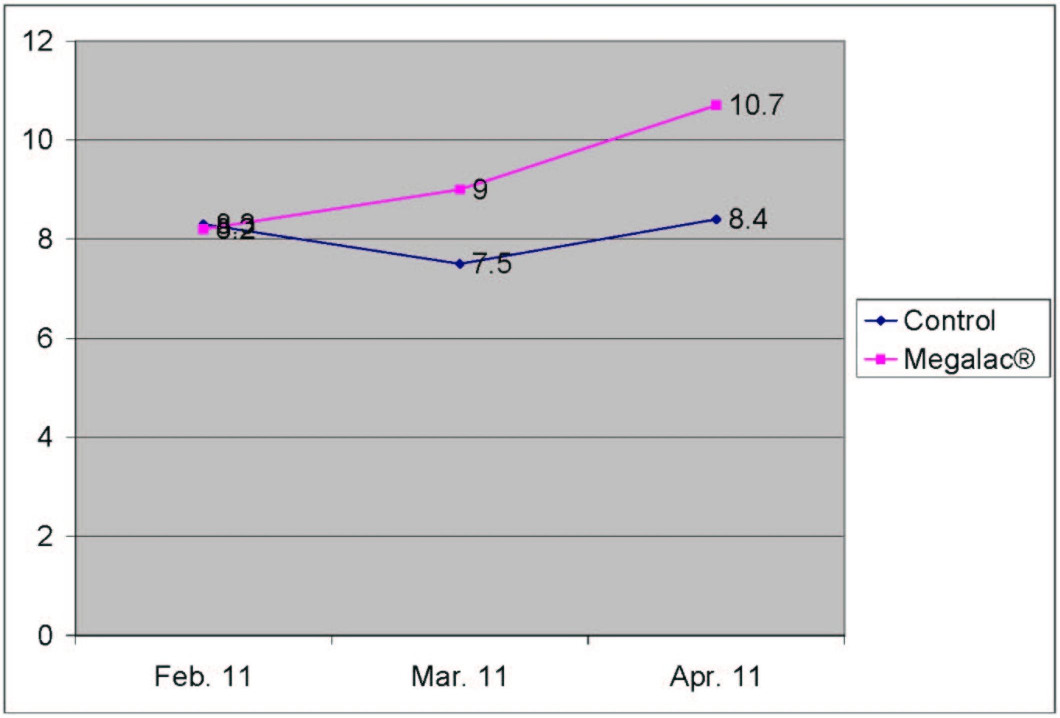

Figure 1. Influence of supplemental rumen bypass fat on leptin concentrations in heifers.

Pooled SE =0.7

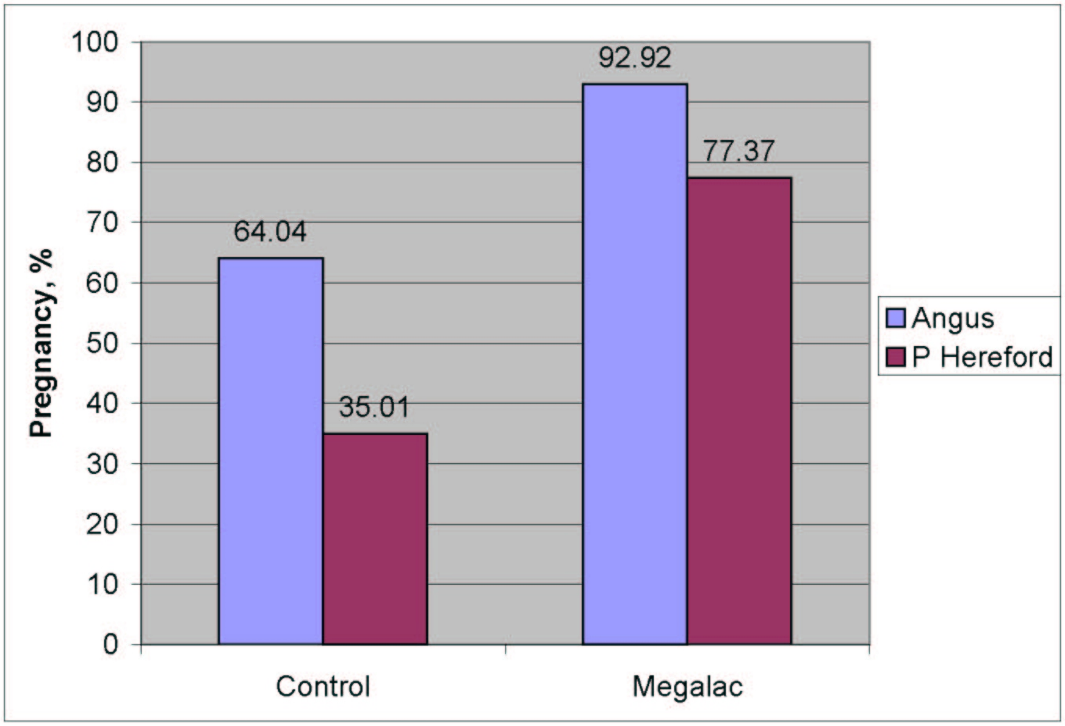

Figure 2. Least square means for pregnancy rates in Angus and Polled Hereford supplemented with rumen bypass fat (Megalac®). Pooled SE =0.1

CHAPTER 3

REPRODUCTIVE PERFORMANCE OF PRIMIPAROUS AND MULTIPAROUS COWS FED WHOLE SOYBEANS BEFORE BREEDING

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Abstract

Effects of supplemental energy before breeding on primiparous (PC; 508.84 +/- 35.8 kg BW) and multiparous (MC 581.4 +/- 66.57 kg BW) reproductive performance were determined using Angus (A; PC=17; MC=36) and Polled Hereford (PH; PC=12, MC=11) beef cows. Parity (P), breed, cow and calf initial BW, and calf age were used to rank cows before random assignment to control (C; no supplementation, PC = 15, MC= 25) or soybean (S; cracked whole soybeans, 2.26 kg/cow daily, PC=14; MC=24) treatments (T) during a pre-breeding period (Feb 11 to Apr 11). The breeding interval began April 14, estrual activity was monitored visually and by Heatwatch® system, and cows were bred A.I. (d 1 to d 44), or natural service (fertile bulls, d 45 to d 71). Cow blood serum (Feb 11 and Apr 11) was analyzed for triglyceride, cholesterol, low and high density lipids, and leptin (TRIG, CHO, LDL, HDL, LEP, mg/dl). Calf ADG (kg) from Feb 11 to end of breeding season, with birthweight as a covariate was affected ($P < 0.10$) by P (PC and MC within C and S, respectively, were : 0.91, 0.95, 0.93, 0.98, SE = 0.023). Pregnancy rate (%) on Sep 17, for PC and MC within C and S, respectively, were: 66.7, 85.0, 62.5, 58.3, SE = 8.2, and it was unaffected by T and P. Initial values for CHO, LDL, HDL and TRIG were unaffected ($P > 0.10$) by T or P, but all increased by Apr 11, resulting in differences for PC and MC within C and S treatments (TRI: 28.1,25.9, 32.6, 29.7, SE = 1.55; CHO: 133.7, 180.7, 190.9, 202.8', SE = 8.1; HDL: 104.6, 143.1, 145.5, 160.1, SE = 6.2; LDL: 23.4, 32.3, 39.2, 36.6, SE = 2.06; respectively). Leptin values increased from Feb 11 to Apr 11 for all treatments except PC-C (LEP Fed 11, PC and MC within C and S treatments: 6.8, 5.5, 6.7, 4.1 respectively; April 11 LEP concentrations:

5.7, 9.0, 8.4, 8.6 respectively). Feeding S to PC cows resulted in increased LEP ($P > 0.05$), and elevated TRIG, CHO, LDL, and HDL of PC-S to levels comparable with MC.

Key words: cow, soybean, leptin, cholesterol

Introduction

Postpartum reproduction is one of the most economically important factors affecting cow-calf profitability. This is especially true for primiparous and young multiparous cows that may have difficulty in rebreeding on a timely basis during a defined breeding season. Lipids and oilseeds have been used to influence postpartum reproduction. The use of safflower seed fed during the postpartum period improved subsequent conception rates in primiparous cows (Lammoglia et al., 1997). Soybean oil improved ovarian follicular growth compared with either tallow or fish oil (Thomas et al., 1997). Little published research exists describing the use of whole soybeans and their effect on postpartum reproduction and cow performance. Howlett et al. (2003) fed whole raw soybeans to beef heifers, and reported no difference in AI conception rates. Our research was designed to investigate the effects of feeding whole raw soybeans to young cows on pasture and the subsequent gain and reproductive performance of the cows.

Material and Methods

The effects of supplemental feeding of raw soybeans was determined using primiparous (PC; 508.84 +/- 35.8 kg BW) and multiparous (MC; 581.4 +/- 66.57 kg BW) beef cows. The cows were purebred Angus (A; PC=17; and MC= 36) and Polled Hereford (PH; PC=12; and MC=11).

The cows calved from December 30 to February 24. On d 1 (February 11) all cows that had calved to this date were ranked by parity (P), breed, cow and calf initial BW, and calf age before random assignment to either control (C) or soybean supplement treatments (S). An additional 12 MC and 7 PC were added to the study that calved between d1 and d10. These cows and calves were ranked in the same manner as the original cows and randomly assigned to the treatments. The C cows (PC =14 , MC =25) were maintain on separate pastures from S cows and C cows were given no supplementation. The S cows (PC=14, MC=24) were fed cracked whole soybeans as a supplement. The soybeans, containing 23.1 % ether extract (Table 1) were fed at 2.26 kg/cow daily for 70 d, immediately before and at the start of breeding season. Both treatment herds were grazed dormant Coastal bermudagrass pastures that were sod-seeded with Passerell annual ryegrass (planting rate = 26.73 kg/ha) . Cows and calves were rotated among treatment pastures twice to eliminate pasture effects on reproductive and cow-calf performance. Bermudagrass hay was provided free-choice in hay feeders to each herd. A mineral mixture providing salt, trace minerals, Ca and P was provided free-choice to cows in each pasture. All cows, calves and bulls were managed under procedures approved by the University of Georgia animal care and use guidelines.

Major dietary components were sampled and chemically analyzed for DM and CP (AOAC, 1990). The ADF and NDF were determined using the methods outlined in Van Soest et al. (1991). Standard prediction equations were used to calculate TDN and NEm. When the TDN or NEm values of the diets of the cows on this study is compared to the recommended requirements (NRC, 1996), cows on both C and S were fed diets that were well above the requirements of cows of similar breeding and production state. Three randomly selected round bales of hay were sampled three different times using a core sampling tube and forage samples were then composited by bale. Each composite was ground through a 1mm screen. Each three-bale composite was analyzed in duplicate. There was little variability between samples for CP, ADF, and NDF; therefore, the three analyses were averaged (Table 1). Soybeans were sampled from several sites in the load of the grain, and samples were composited into two final samples that were analyzed in duplicate (Table 1). Ryegrass forage was sampled on d 18 and d 48 of the supplementation period. Pastures were sampled at three different locations in different areas of the pasture using a square (0.929 m^2) and forage was cut at ground-level. Forage samples were dried in a forced-air oven at 60° C for 48 h, ground through a 1mm screen, composited by pasture, and analyzed for CP and fiber contents (Table 1). .

On d1, (February 11), cows were weighed, subcutaneous fat depth was measured at the 12th rib using ultrasound (US), and cows were assigned a visual body condition scored (BCS; scale 1-9, 1=emaciated, 9=obese). In addition, hip height was recorded, along with a blood sample taken by tail veinipuncture. Calf BW was also recorded at this time. The same procedures were followed for the 19 cow-calf pairs that were added to the study on d 10 (February 24). These cows calved later than the original group, and they were added after the last calf was born. On d 28 (March 11) midway through the supplementation period, the cow-calf pairs were weighed separately, condition scored, and a blood sample was taken via tail veinapuncture. On d 60 (April 11) cows and calves were again weighed separately, US and BCS were recorded on the cows, along with blood samples taken using the same methods as described for d 1,On June 16, cows and calved were weighed, BCS were assigned, and US measurements were recorded. Additional cow BW were recorded from June 16 to September 19, and calves were weaned on d 213 of the experiment. Weaning weights were adjusted to 205 d weight using standard Beef Improvement Federation adjustments (BIF, 2002).

The breeding season began on d 63 (April 14),which consisted of a 44-d artificial insemination (AI) season followed by a 27-d natural service clean-up period. Cows were maintained in original supplementation groups for 14 days into the breeding season to allowall S cows to have at least 60 d of supplemental feeding. At d 77, all cows were combined and maintained in a group throughout the AI breeding season. Cows were monitored for estrual activity by visual observation twice daily for thirty minutes at 12 h intervals. In addition to the visual observations a Heatwatch ® System (DDX Inc, Denver, Colorado) was used. The cows were bred as close to 12 h as possible from the onset of estrus according to the Heatwatch system. The onset of estrus was defined as two mounts in four hours detected by the Heatwatch system. If a cow was visually observed in standing heat, and if there was no Heatwatch data for that cow, she was bred twelve hours after the standing heat was observed. At the end of the AI breeding season, the cows were regrouped by breed and put into two pastures. A mature Angus bull was put into the pasture with Polled Hereford cows, and a mature Polled Hereford bull was put into the pasture with Angus cows. The bulls used for the natural breeding season passed a breeding soundness exam one week before the start of the breeding season. Natural breeding of cows began on May 28, and ended on June 24. On September 17 pregnancy examinations via rectal palpation were completed for each cow, and the fetus of the pregnant cows was aged to determine the approximate date of conception.

All blood samples were refrigerated as they were collected, and stored overnight at 4°C before being centrifuged at 3200 rpm for 20 min to separate the serum. The serum was collected, frozen, and stored for later analyses. A Boehringer Mannhiem / Hitachi 912 analyzer was used to analyze the serum for cholesterol (Cholesterol / HP; Roache Diagnostics), high density lipoprotein (HDL; HDL- C plus 2nd generation; Roache Diagnostics), and triglycerides(Triglycerides/ GB; Roache Diagnostics). The low density lipoprotein (LDL) was calculated using the formula: Total Cholesterol - (HDL [triglycerides/5]). Serum progesterone was determined using a commercial RIA kit (Progesterone CT kit; MP Biomedicals INC., Irvin, CA) as outlined by Imwalle et al. (1998). Duplicate samples were analyzed and compared with a standard curve, and all samples were analyzed in the same batch. The progesterone results reported are the average of the two duplicate analysis. The samples were reanalyzed if analyses differed by more than 5% between duplicates. Circulating levels of leptin were determined using an ovine leptin RIA that had been validated for bovine serum (Delavaud et al., 2000). Each sample was analyzed in triplicate, and results reported as the average of the three tubes. Ovarian luteal activity (OLA) is defined as progesterone concentrations equal to or in excess of 1ng/dl.

The experiment was statistically analyzed using the mixed procedure of SAS (2001). The BW, BCS, and US measurements and reproductive data for the cows were analyzed as a 2 x 2 x 2 factorial with treatment breed and parity as the factor The ADG for each period was calculated and analyzed in the same manner. Additional analyses were conducted for cow serum components using the mixed procedure of SAS, analyzed as a 2 x 2 x 2 factorial with treatment, breed, and parity as factors. Calf BW and ADG were analyzed as a 2 x 2 x2 factorial with treatment, breed, and parity as factors using the mixed procedure. Calf BW and calf age at weaning were used as covariates and age of dam was used in this analysis instead of parity. The Correlation Procedure was used to determine possible correlations between leptin, US subcutaneous fat, percent pregnant, and OLA, all measured and calculated on d 60 (April 11, 2003).

Results

The main effects for initial BW and three ADG of the cows are given in Table 2. Treatment ($p = 0.0379$), breed ($p = 0.0395$) and parity ($p < 0.0001$) were different on d 1 of the experiment. The three way interaction was also different ($p = 0.02919$). Cow ADG during supplementation resulted in no differences for treatment, breed, or parity. The ADG during the whole breeding season (AI and natural service periods) was affected by breed (A= -0.37 kg and PH= 0.14 kg/d; $p < 0.0001$), with S cows losing less BW than C cows ($p = 0.0061$). Total ADG from d 1 to weaning was not affected by treatment or parity. The main effects for BCS are also shown in Table 2. Parity ($p = 0.0014$) was different for BCS on d 1 along with a breed x parity interaction ($p = 0.0144$). A treatment x parity interaction was the only difference for BCS on d 28. A parity ($p = 0.0026$) and a breed x parity interaction ($p = 0.0483$) appeared again for BCS on d 60. The BCS on d 106 resulted in a difference between breed ($p = 0.0351$) and parity ($p = 0.0370$). At the end of breeding season (d 128), BCS was still affected by breed ($p < 0.0001$) and parity ($p = 0.0322$). The main effects for US are shown in Table 2, and a breed x parity interaction ($p = 0.0129$) occurred at the start of the experiment (d 1) for US subcutaneous fat measurements, with no treatment or parity differences for US on d 60 or d 128.

The main effects for calf initial BW, actual weaning weight and 205-d adjusted weaning weight are shown in Table 3; along with three ADG periods, including prebreeding supplementation period, breeding season, and total ADG from d 1 to d 218. Treatment was not significant for any of the calf BW or ADG, and initial BW was not different. Breed was different for actual weaning BW (p = 0.0005), and for the 205-d adjusted weaning weight (p = 0.0055), with heavier Angus calves than Polled Hereford calves. Calf breed was different for the ADG during the supplemental feeding period (p < 0.0001) and for the total ADG (p = 0.0084) with higher ADG recorded for Angus calves. Calves had similar ADG for treatments, and breed did not affect calf ADG during the breeding season.

The main effects for cholesterol, triglycerides, HDL, and LDL are shown in Table 4. There were no differences observed for cholesterol on d 1, but treatment was different for cholesterol on d 28 (p = 0.0002) resulting in a 27.2% difference and on d 60 (p < 0.0001) with a 27.8 % difference with higher concentrations in cows supplemented with soybeans. On d 60, there was a parity effect (p = 0.0110) with higher cholesterol in multiparous cows. Triglycerides (Table 4) were affected by parity (p = 0.0046) on d 1, and breed tended to be different (p = 0.0707). Parity (p = 0.0173) and breed (p = 0.0410) affected triglyceride concentrations on d 28, resulting in a 0.1% difference and on d 60 triglycerides were different for treatment (S was 14.6 % higher than C; p=0.0133), parity (p=0.0200) and breed (p=0.0023). There were no treatment or parity differences in HDL on d 1 of the experiment, but on d 28, S cows had 27.7% higher HDL (p=0.0001) than controls. On d 60, The S cows had 25.4% higher HDL (p=<0.0001), MC cows had higher HDL than PC cows (p=0.0026), and there was a treatment x breed interaction (p=0.0473). The LDL in cows was 30.1% higher for S cows (p=0.0017) on d 28. On d 60, LDL was 40.9% higher in soybean supplemented cows, but there was a treatment x parity interaction (P=0.0079), in which MC cows on the S treatment had only slightly increased LDL compared with control MC cows, but PC cows fed soybeans had much higher LDL than controls. Leptin in serum of cows on dietary treatments is shown in Table 5. Within a treatment x parity combination, serum leptin was higher ($p < 0.05$) for PC than MC control cows on d 1. On d 28 of the soybean supplementation period, leptin was similar for control PC and MC cows, and concentrations were lower than on d 1 for each parity. Leptin increased for both PC and MC cows that were on the S treatment on d 28, with higher ($p < 0.05$) leptin in MC than PC cows. On d 60, leptin was similar for treatment x parity combinations; however, within controls, leptin was higher ($p < 0.05$) for MC than PC cows, but within soybean supplemented cows, PC cows had similar ($p > 0.10$) leptin concentrations compared with MC cows. Additionally, PC cows fed soybeans had higher ($p<0.05$) leptin than control PC cows on d 60. Therefore, feeding soybeans to cows prebreeding increased leptin values during the 60-d supplementation period, and PC cows had increased leptin, bringing concentrations in serum of these cows to the levels observed in MC cows. Leptin on d 60 (Table 5) was highly correlated ($R^2 = .49491$) to US fat measurement on d 60 (Table 2). However, leptin was not correlated with pregnancy percent (Table 6) or OLA on d 60 (Table 4).

Progesterone levels and OLA for the cows are shown in Table 4. There were no differences in progesterone concentrations on d 1, d 28 or d 60 of the experiment. There were no treatment or parity differences in OLA for d 1 and d 28. There was a treatment x parity interaction on d 60 of the experiment. Since some cows were not cycling by d 1, missing data caused statistically non-estimateable results in some treatment x parity combinations. There were no differences in OLA at d 1 or d 28. On d 60 differences were observed for parity ($p = 0.0009$), and a treatment x parity interaction ($p = 0.0124$), with much higher OLA in control MC cows than supplemented MC cows. Pregnancy rates are shown in Table 6, and pregnancy rates were unaffected by treatment. The age of fetus at palpation on d 218 (September 17) was found to be almost identical for treatment (C = 115.96 d and S = 115.29 d). However, parity resulted in the largest difference between factors, the fetal age was 11.31 d greater for MC than PC cows. Additionally, OLA was directly opposite to US on d 60 (R^2 =0.000)

Discussion

When BW and ADG of cows (Table 2) are considered we see significant differences at the beginning of the experiment, differences in both treatments and parity at the beginning of the experiment. During the prebreeding supplementation period there were no differences in the ADG of cows on the treatments. This indicated that there was little difference in energy intake during this period, which is supported by the fact that calves (Table 3) did not show a difference in ADG due to treatment during the same time. Initial treatment differences were not observed for cows (Table 2) until the end of the breeding season, at which point C cows lost slightly more BW than S cows. This cannot be explained based on dietary composition differences. The cows were on the same pastures during the last 61 d of the breeding season and the 10 d of additional soybean supplementation should not have affected overall ADG for this period. Considering the cow ADG for the entire experiment, we observed no effect related to treatment or breed. This might be expected because of the relatively short time of supplementation, and the small differences in diets during the treatment period. In addition, the cows were managed as a single herd for the period after the prebreeding period involving soybean feeding of S cows, meaning that all cows had equal availability to forages that were essentially the same quality (Table 1).

The BCS and US data for the cows on control and soybean supplementation treatments are shown in Table 2. The BCS results indicate no differences related to Supplementation treatment.

However, there were differences in BCS related to parity on d 1 of the study, at the end of supplemental feeding, and through the breeding season, with multiparous cows having higher BCS. This was expected since primiparous cows have more difficulty maintaining condition than multiparous cows, because of energy demand from the calf and continued growth of the young cow. For the first half of the prebreeding period the soybean supplement appeared to remove the differences related to parity. The US measurements were unaffected by treatment or parity at any of the three dates (Table 2).

Performance data for calves of cows on prebreeding treatments, including calf initial BW, weaning weights (both actual and 205-d adjusted weight), and ADG are shown in Table 3. Prebreeding dietary treatments did not affect calf weight or ADG. These results agree with a study by Bottger et al. (2002), who saw no difference in calf weight when safflower seed was fed at 1.55 and 1.25 kg/d to cows during the prebreeding period. In our study cow age did not affect initial calf BW or actual weaning BW**.** Based on literature, one would expect calves from primiparous dams to weigh less at weaning, and this is a major reason that calf weaning BW are adjusted to a 205-d weight along with age of dam adjustments. No refereed literature documents effects of feeding soybeans or soybean oil to lactating beef cows. The only factor that affected calf BW at weaning, and the ADG during the three designated periods, was the breed of calves, with Angus calves having higher performance than Polled Hereford calves. Historically, milk production has been lower in Polled Hereford cows in this herd from which the cows were selected.

The serum lipids in cows were most affected by feeding of soybeans. In our study cholesterol, triglycerides, LDL, and HDL were all elevated on the soybean treatment (Table 4). These results are supported by Whitney et al. (2000) who reported an increase in cholesterol concentrations in cows when feeding soybean oil at 3% and 6 % of a supplement that was fed at 2.87% of BW. Thomas et al. (1997) reported an increase in total cholesterol, HDL, and triglycerides when soybean oil was fed at 4% of DMI as part of a complete diet. An observation from our study that has not been previously reported was the differences we documented in the way cows of different parities responded differently in serum lipid concentrations. The MC cows had higher cholesterol and HDL concentrations compared with PC on the same treatments. The opposite was true for triglycerides, with PC cows having higher concentrations than MC cows. Parity had no affect on LDL concentrations. There was little difference in the response of the cows of different parity levels fed soybeans. This may indicate that the parity effects originated in, and were influenced by, the control treatment cows.

Progesterone and associated OLA results for cows fed soybeans during the prebreeding period are shown in Table 4. The progesterone in serum samples on d 1, d 28, and d 60 was determined to indicate some level of estrual activity in cows during the prebreeding period, and to determine if supplementation had a major effect on progesterone in the cows. It was not meant to define estrual activity in terms of onset of estrus, because much more frequent sampling would be required. Consequently, non-detectable concentrations of progesterone were reported for many cows on d 1, resulting in non-estimable statistics. Some cows were in the first, second or third wk postpartum when the experiment began, therefore these cows had not ovulated and had not formed a functional CL. There was no difference in progesterone levels resulting from soybean treatment or parity of the cows (Table 4). Because of very low or non-detectable progesterone concentrations, the OLA also had non-estimable values (Table 4) at d 1 and d 28, parity affected

OLA at d 60 with multiparous cows having greater percent with luteal activity. Luteal activity has not been reported for mature cows fed soybean or soybean oil in any previous refereed article.

Pregnancy rate data are shown in Table 6, based on palpation of cows after weaning in September. Pregnancy rates were unaffected ($P > 0.1000$) by prebreeding supplemental treatment or parity of the cow. Pregnancy rate was affected ($P < 0.05$) by cow breed, with higher pregnancy rates for Angus cows than Polled Hereford cows on both treatments and for both parity groups. The polled Hereford cows assigned to the soybean supplementation prebreeding treatment had a low (50%) pregnancy rate for both PC and MC cows, which resulted in slightly lower pregnancy rates for the soybean supplemented cows. Pregnancy rate variation associated with breed of cows increased difficulty in drawing conclusions for treatments effects. The lack of treatment difference observed in our study is supported by Whitney et al. (2000) and Howlett et al. (2003) who both found no difference in pregnancy rates when cows were on prebreeding fat supplementation treatments. Pregnancy rates for all herds at the same research farm where the present study was conducted were lower than normal (approximately 70% for 180 cows), and cows on this experiment fit the overall pattern observed for the entire herd during the year when the experiment was conducted.

The serum leptin data is shown in Table 5, and in our study feeding soybeans during the prebreeding period caused an increase in leptin levels. Leptin concentrations generally declined in control cows except for the control MC on d 60, when they had the highest levels reported in this study. The high levels for the MC control cows is unexpected and cannot be explained, since there were no differences in US fat measurements, or in cow BW on control and soybean treatments on d 60. In our study, a correlation was recorded between US fat measurement on d 60 with the leptin levels on the same day. The correlation was expected since leptin is a product of adipose tissue. This is the first study to report effects of prebreeding fat supplementation of Pc and MC cows on serum leptin concentrations.

Implications

The feeding of soybeans as a postpartum supplement is a relatively new idea and there are few published results supporting or dismissing the practice as a feasible option for improving postpartum reproduction. In our study feeding soybeans increased the concentrations of cholesterol, triglycerides, HDL and LDL, precursors for important hormones, and sources of energy for the cow. These increases occurred with no changes in BW, BCS, or US fat measurements. However, we did not observe an improvement in pregnancy rates of cows on the soybean treatment after weaning, with pregnancy rate being one of the most important economic factors to cow-calf producers. A slight decrease in pregnancy rates in the cows fed soybeans for 60 d postpartum up until the start of breeding season was recorded. Feeding of raw soybeans as a short-term postpartum supplement effectively delivered high levels of fat and CP to the cows, but additional research is needed to determine if the practice can reliably enhance reproductive performance in beef cows.

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Table 1. Nutritive quality of hay, pastures, and soybeans fed to cows during the prebreeding soybean supplementation period.

Item	DM	C P	ADF	NDF	TDN	NEm
	---------------------------- % DM -------------------------------					
Bermadagrass hay	88.6	14.2	39.5	70.86	56	0.48
Soybeans	93.6	41.9	8.95	17.9	103	1.32
Pasture 1 d 18	92.1	32.3	27.4	55.0	64	0.62
Pasture 2 d 18	91.7	33.0	27.2	52.2	65	0.64
Pasture 3 d 18	92.9	35.2	22.2	47.5	66	0.66
Pasture 4 d 18	91.9	36.4	23.4	49.4	66	0.65
Pasture 1 d 48	92.1	16.3	26.3	45.6	69	0.72
Pasture 2 d 48	90.2	18.2	25.4	44.8	70	0.72
Pasture 3 d 48	94.5	12.2	30.5	50.6	68	0.70
Pasture 4 d 48	92.0	15.9	27.4	48.8	69	0.71

[a] Pastures consisted of Coastal bermudagrass sod-seed with ryegrass. Bermudagrass was dormant during experimental period. Ground level samples of forage (n = 3) in pasture were chemically analyzed.

Table 2. Least square means for cow performance when soybeans were fed during the pre-weaning interval.

	Control		Soybeans			Probability		
Item[a]	PC	MC	PC	MC	SE	T	P	T * P
No. cows	15	25	14	24				
Cow gains	----------------- kg -------------------------							
Initial BW[b]	508.1	566.9	512.1	619.6	20.86	*P* = 0.0376	*P* = <.0001	*P* = 0.0733
Prebreeding ADG[c]	0.31	0.32	0.34	0.03	0.15	*P* = 0.1944	*P* = 0.1506	*P* = 0.1171
Breeding interval ADG[d]	-0.23	-0.16	-0.07	-0.01	0.08	*P* = 0.0061	*P* = 0.3158	*P* = 0.8546
Total ADG[e]	0.01	0.02	0.02	-0.06	0.05	*P* = 0.3570	*P* = 0.3023	*P* = 0.2353
Visual condition score (BCS)	-------------- Scale 1 to 9 ----------------							
d 1[f]	4.93	5.51	4.96	5.4	0.10	*P* = 0.7910	*P* = 0.0014	*P* = 0.6292
d 28[f]	5.23	5.50	5.7	5.34	0.08	*P* = 0.2060	*P* = 0.6988	*P* = 0.0149
d 60[f]	4.86	5.35	4.96	5.29	0.09	*P* = 0.8499	*P* = 0.0026	*P* = 0.5245
d 106[f]	5.02	5.45	5.3	5.38	0.08	*P* = 0.3763	*P* = 0.0037	*P* = 0.1657
d 128[f]	4.63	5.03	4.84	5.00	0.08	*P* = 0.5119	*P* = 0.0322	*P* = 0.3430
Ultrasound rib fat (US)	------------------ cm ----------------------							
d 1[f]	1.67	1.56	1.68	1.58	0.03	*P* = 0.9391	*P* = 0.4235	*P* = 0.9907
d 60[f]	1.84	1.80	1.89	1.74	0.06	*P* = 0.9800	*P* = 0.5403	*P* = 0.7137
d 128[f]	1.39	1.70	1.60	1.83	0.04	*P* = 0.3261	*P* = 0.1118	*P* = 0.8113

[a] Abbreviations: PC = primiparous cows; MC = multiparous cows; T = Treatment; P = Parity of cow; BCS = Visual body condition score (scale 1 to 9); 1 = emaciated; 5 = normal flesh; 9 = obese; US = ultrasound rib fat measured at 12th rib.

[b] Initial BW recorded on d 1 of supplemental feeding period, 60 d before breeding interval began.

[c] Prebreeding ADG computed for cows during supplemental feeding period 60 d before breeding began.

[d] Cow ADG during 71-d breeding interval.

[e] Cow ADG from d 1 of study until calf weab-ning in September.

[f] Cow BCS and US recorded during pre-breeding supplemental feeding interval.

[g] Cow BCS and US recorded near end of breeding interval.

Table 3. Least squares means of Angus and Polled Hereford calf performance for cows supplemented with soybeans during the prebreeding interval.

	Control		Soybeans			Probability		
Item[a]	A	PH	A	PH	SE	T	CB	T × CB
No. calves	29	10	25	11				
Calf performance	------------------------		kg	---------------------				
Initial BW	56.9	57.6	59.8	54.4	2.87	*P* = 0.9438	*P* = 0.2087	*P* = 0.1114
Weaning BW	243.5	231.8	254.0	226.9	11.24	*P* = 0.6719	*P* = 0.0075	*P* = 0.2818
Adjusted 205-d BW	225.6	213.2	235.6	209.2	10.42	*P* = 0.6861	*P* = 0.0050	*P* = 0.3192
Calf ADG								
Prebreeding [b]	1.17	0.99	1.18	1.03	0.06	*P* = 0.4443	*P* = <0.0001	*P* = 0.7957
Breeding season [c]	0.79	0.86	0.84	0.83	0.04	*P* = 0.7967	*P* = 0.2119	*P* = 0.1994
Total [d]	0.91	0.84	0.95	0.83	0.05	*P* = 0.7532	*P* = 0.0084	*P* = 0.4828

[a] Abbreviations: A= Angus; PH = Polled Hereford; T= treatment; CB = calf breed.

[b] Prebreeding season (d 1 to d 60) while cows were on control or soybean supplementation treatments.

[c] Breeding season (d 60 to d 128 when cows were subjected to AI or natural service breeding.

[d] Total ADG from d 1 to weaning on d 218 (February 11 to September 17).

Table 4. Pre-breeding soybean supplementation effects on least squares means for serum lipids and progesterone.

	Control		Soybeans				Probability	
Item[ab]	PC	MC	PC	MC	SE	T	P	T × P
No. cows	15	25	14	24				
Cholesterol	-------------------- ng/dl -----------------------							
d 1	109.31	102.08	114.77	106.28	4.06	$P = 0.4034$	$P = 0.1759$	$P = 0.9129$
d 28	134.50	118.60	160.19	161.89	6.17	$P = 0.0002$	$P = 0.4200$	$P = 0.3180$
d 60	134.58	176.2	195.77	201.47	4.52	$P < 0.0001$	$P = 0.0110$	$P = 0.0513$
Triglycerides								
d 1	21.00	18.42	21.64	17.05	0.86	$P = 0.7684$	$P = 0.0046$	$P = 0.4132$
d 28	24.69	21.50	24.85	21.72	1.83	$P = 0.8834$	$P = 0.0173$	$P = 0.9809$
d 60	28.58	25.55	33.22	28.83	1.10	$P = 0.0133$	$P = 0.0200$	$P = 0.6638$
HDL								
d 1	89.21	83.21	92.14	86.03	3.18	$P = 0.5176$	$P = 0.1795$	$P = 0.9993$
d 28	102.29	92.89	123.13	126.28	4.66	$P = 0.0001$	$P = 0.6377$	$P = 0.3458$
d 60	105.82	139.66	148.98	158.96	4.96	$P = <0.0001$	$P = 0.0026$	$P = 0.0938$
LDL								
d 1	15.89	15.28	18.27	16.83	0.97	$P = 0.1589$	$P = 0.4590$	$P = 0.7635$
d 28	27.26	21.4	32.08	31.26	3.17	$P = 0.0017$	$P = 0.1424$	$P = 0.2658$
d 60	23.04	31.53	40.14	36.75	3.06	$P = <0.0001$	$P = 0.2451$	$P = 0.0079$
Progesterone	-------------------- ng/ml ---------------------							
d 1	ND	0.081	0.036	1.6	0.53	$P = 0.0653$	$P = 0.0738$	ND
d 28	2.77	1.85	0.94	3.28	2.06	$P = 0.6647$	$P = 0.9752$	ND
d 60	3.55	4.58	4.6	6.14	0.86	$P = 0.3070$	$P = 0.3119$	$P = 0.8394$
OLA	--------------------- % -------------------------							
d 1	ND	ND	ND	0.05	0.02	$P = 0.4968$	$P = 0.4368$	$P = 0.4968$
d 28	0.13	0.07	ND	0.19	0.05	$P = 0.9012$	$P = 0.4058$	$P = 0.1024$
d 60	0.14	0.82	0.22	0.33	0.08	$P = 0.0810$	$P = 0.0009$	$P = 0.0124$

[a] Abbreviations: PC = primiparous cows; MC = multiparous cows; T = treatment; P = Parity; HDL = high density lipoproteins; LDL = low density lipoproteins; OLA = ovarian luteal activity.

[b] Data analyzed as a 2 × 2 × 3 factorial with treatment, parity, and sampling date in prebreeding interval as main effects, using the mixed procedure of SAS (2001).

Table 5. Least squares means for serum leptin in cows fed soybeans during the pre-breeding interval.

	Control		Soybean	
	PC	MC	PC	MC
No. cows	15	25	14	24
Serum leptin	---------------------------- ng/ml		------------------------------	
d 1	6.8[a]	5.5[b]	6.7[bm]	4.1[bn]
d 28	5.5[a]	4.3[b]	6.8[b]	8.5[a]
d 60	5.4[any]	9.0[am]	8.4[ax]	8.6[a]

[a,b] Means bearing different subscripts within a treatment × parity combination for dates (*P* < 0.05; SE 0.58 with 140 df).

[m,n,x,y] Means bearing different subscripts differ (*P* < 0.05). The SE = 0.81 with 140 df means within a date comparing appropriate pairs consistent with the factorial.

Table 6. Least squares means for pregnancy rates of cows fed soybeans during the prebreeding interval.

	Control				Soybeans			
	PC		MC		PC		MC	
Item[a]	A	PH	A	PH	A	PH	A	PH
No. cows	9	6	20	5	8	6	19	6
Pregnancy rate	--			%	--			
Cows[bc]	66.67	66.67	90.00	80.00	75.00	50.00	66.67	50.00

[a] Abbreviations: PC = primiparous cows; MC = multiparous cows; A = Angus; PH = Polled Hereford.

[b] Pregnancy rate was unaffected ($P > 0.1000$) by T and P.

[c] Pregnancy rate was affected ($P < 0.05$) be breed of cow.

Chapter 4

EFFECTS OF FEEDING RUMEN PROTECTED FAT TO HEIFERS AND RAW SOYBEANS TO COWS WITH CALVES DURING THE PREBREEDING INTERVAL ON REPRODUCTIVE PERFORMANCE

Feeding rumen protected fat in the form of calcium salts of fatty acids, also known as Megalac®, as part of a supplement altered the lipid profile of beef heifers. It resulted in an increase in cholesterol, triglycerides, and both low and high-density lipoprotein. In addition to elevating serum lipids, Megalac supplementation tended to increase serum leptin concentrations. The feeding of the supplement tended to increase reproductive performance. However, we did not observe an improvement in the ability to get the heifers bred earlier in the breeding season, one of the primary goals of this project. Differences in blood metabolites that were measured were not reflected in weight, body condition score or ultrasound 12th rib subcutaneous fat. Serum leptin was correlated with ultrasound fat thickness at the end of the Megalac supplementation period. Feeding a supplement that contained Megalac to heifers on pasture improved reproduction and also increased blood metabolites even in heifers that were on an exceptionally high plane of nutrition. It would be expected that supplementation with Megalac might result in more difference between supplementation groups if the heifers had been in a lower plane of nutrition with lower body condition.

The feeding of soybeans as a postpartum supplement is a relatively new idea, and there are few published results supporting or dismissing the practice as a feasible option for improving postpartum reproduction. In our study feeding soybeans increased the concentrations of cholesterol, triglycerides, HDL and LDL, precursors for important hormones and sources of energy for the cow. These increases occurred with no changes in BW, BCS, or US fat measurements. However, we did not observe an improvement in pregnancy rates of cows on the soybean treatment after weaning, with pregnancy rate being one of the most important economic factors to cow-calf producers. A slight decrease in pregnancy rates was observed in the cows fed soybeans for 60 d postpartum before the breeding season began. Feeding of raw soybeans as a short-term postpartum supplement effectively delivered high levels of fat and CP to the cows, but additional research is needed to determine if the practice can reliably enhance reproductive performance in beef cows.