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Influences of supplemental fat, differing in fatty-acid composition, on performance, lactation, and reproduction of beef cows

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ABSTRACT

Angus × Simmental, fall-calving cows (n = 480) were allotted to 1 of 4 supplements containing whole raw soybeans (SY), OmegaFlax (FLX), Energy Booster 100 (EB), or corn–soybean meal (CON). The SY, FLX, and EB supplements were formulated to have the same concentration of crude fat. The FLX, EB, and CON supplements were formulated to be isonitrogenous. Cows were blocked by age (2 groups) and randomly assigned to treatments before calving (36 ± 0.6 d prepartum). The cows were fed 1.81 kg of DM/d of respective supplement for 108 d. There were no differences in BW or BCS change in any contrasts. There were no differences in percentage of cows cycling before the breeding season or first-service AI conception for any of the contrasts. The SY-supplemented cows had lower (P = 0.01) overall pregnancy rate compared with FLX-supplemented cows and tended (P = 0.06) to have lower overall pregnancy rates compared with EB-supplemented cows. There was no difference in overall pregnancy for SY, FLX, and EB versus CON (P = 0.81). The SY-supplemented cows tended (P = 0.06) to have greater AI embryonic loss than did EB-supplemented cows. Fat supplementation during the pre- and postpartum period did not affect cow BW or reproductive performance compared with cows fed control supplement. Cows fed supplement containing soybeans as the fat source had poorer reproductive performance than did cows fed supplements containing OmegaFlax (flaxseed) or Energy Booster 100 (hydrolyzed animal fat) as the fat source.

Key words: beef cow, fat supplementation, polyunsaturated fat, reproduction, soybean

INTRODUCTION

The economic success of a beef cow–calf operation is dependent upon the cow having a short postpartum interval to first estrus and high first-service conception rates. Inadequacies in either of these areas will result in lower pregnancy rates, higher culling rates, and lower weaned calf/cow numbers. Nutrition plays a key role in reproductive success in cattle, and one of the most studied nutrition relationships is the effect of dietary energy and body energy reserves on postpartum breeding performance (Kinder et al., 1987; Randel, 1990). In a review, Hess et al. (2005) concluded that prepartum nutrition is critical in determining the length of postpartum anestrus; a BCS ≥5 will ensure body energy reserves sufficient for postpartum reproduction, and beef cows in a negative energy balance will have lower reproductive performance. Fat supplementation is one method of addressing these concerns. Fat sources vary widely and differ in their fatty-acid content. In general, most of the seed-derived oils contain higher levels of linoleic acid, forages and flaxseed contain higher levels of α-linolenic acid, and rendered fats such as tallow contain a large proportion of saturated fats and the monounsaturated oleic acid (Coppock and Wilks, 1991; Staples et al., 1998). However, once the fats enter the rumen, they are hydrolyzed, and the FFA undergo biohydrogenation (Mattos et al., 2000). Staples et al. (1998) estimated

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that polyunsaturated fatty acids such as linoleic acid are biohydrogenated at a range of 60 to 90% efficiency. Polyunsaturated fatty acids, such as linoleic and linolenic acid, may inhibit prostaglandin $F_{2\alpha}$ (**$PGF_{2\alpha}$**; Mattos et al., 2000). Conversely, Grant et al. (2003) reported that high-linoleate safflower seeds increased $PGF_{2\alpha}$ metabolite. Uterine production of $PGF_{2\alpha}$ is critical during the early postpartum period for proper uterine involution (Madej et al., 1984; Filley et al., 2000). However, elevated levels of $PGF_{2\alpha}$ later in the postpartum interval could result in early embryonic mortality (Troxel and Kesler, 1984; Funston, 2004). Funston (2004), in a summary of work on fat supplementation, concluded that the duration and time of supplemental fat necessary to elicit a response is not precisely known. Much of the benefit of supplemental fat has been proposed to be attributed to polyunsaturated fatty acids (Funston, 2004). Graham et al. (2001) showed soybeans (high in linoleic acid) improved conception rates; Petit et al. (2001) reported improved conception rates for flaxseed (high in linolenic acid). Although saturated fat sources seem to have less effect, Son et al. (1996) found improved reproductive function for tallow. There is no published data available comparing the effects of soybeans, flaxseed, and animal fat on beef-cow reproduction. These 3 fat sources represent differing fatty-acid profiles. The objectives of this experiment were to evaluate the effects of supplemental fat, differing in fatty-acid profile, on cow performance, milk production, and reproduction.

MATERIALS AND METHODS

Experimental Animals

Angus × Simmental, fall-calving cows (n = 480) from the University of Illinois beef herd at the Dixon Springs Agriculture Center were used in this experiment. Animals used in this experiment were managed according to the guidelines recommended in the *Guide for the Care and Use of Agricultural Animals in Agriculture Research and Teaching* (FASS, 1988). Experimental protocols were submitted and approved by the Institutional Animal Care and Use Committee.

Management and Diets

Cows were blocked by age (2 age groups) and randomly assigned to treatments before calving (36 ± 0.6 d prepartum). There were 8 groups with 2 replications per treatment. The cows were fed 1 of 4 supplements: whole raw soybeans (**SY**); corn, soybean meal, and OmegaFlax (ground flaxseed; ADM Alliance Nutrition Inc., Quincy, IL; **FLX**); corn, soybean meal, and Energy Booster 100 (hydrolyzed animal fat; Milk Specialties Company, Dundee, IL; **EB**); or corn–soybean meal (**CON**). The fat sources were selected based on their fatty-acid composition (Table 1). The FLX and EB supplements were formulated to have the same level of crude fat as the SY supplement. The FLX and EB supplements were formulated to be isonitrogenous with the CON (80% corn/20% soybean meal). Corn and soybean meal made up the balance of the FLX and EB supplements. Ingredient and nutrient compositions of supplements are presented in Table 2. Cows grazed endophyte-infected tall fescue (*Festuca arundinacea*), red clover (*Trifolium pratense*), and white clover (*Trifolium repens*) pastures. The cows were fed 1.81 kg of DM/d of respective supplement for 108 ± 0.6 d from trial initiation (36 ± 0.6 d prepartum) until trial completion (72 ± 0.6 d postpartum).

Performance, Lactation, and Reproduction Data Collection

Initial shrunk cow BW and BCS were measured at the start of the experiment (36 ± 0.6 d prepartum). Calf birth weights were measured within 24 h of being born and used as initial calf BW. Final shrunk BW and BCS, as well as calf BW, were measured at experiment completion (72 ± 0.6 d postpartum). Cow BW change and BCS change, as well as calf ADG, were calculated for the 108-d period.

Milk production estimates (n = 150) were attained using the weigh-suckle-weigh technique at d 55 ± 0.6 of lactation. Twenty-four-hour milk production estimates were determined using a 12-h weigh-suckle-weigh technique (Beal et al., 1990). Six hours following the weigh-suckle-weigh, a subsample of 6 cows per treatment were milked using a commercial portable milk machine (Porta Milker, The Coburn Company Inc., Whitewater, WI). Cows were administered 20 USP units of oxytocin (Phoenix Scientific, St. Joseph, MO) intravenously within 2 min of milking to initiate milk letdown. Milk was sampled and sent to Dairy Lab Services (Dubuque, IA) for compositional analysis.

The cows were estrus synchronized using either the CoSynch+CIDR or 7–11 estrus synchronization protocols (Bremer et al., 2004) and artificially inseminated on d 76 ± 0.6. Synchronization protocols were applied evenly across treatments. After AI, cows were exposed to bulls for a 45-d breeding season. First-service conception rates were determined via transrectal ultrasonography at 32 d after AI. Overall pregnancy rate was determined via rectal palpation 64 d after bulls were removed. Cows that were not pregnant at the time of ultrasound and pregnant at the time of palpation were considered pregnant to the clean-up bulls. Cows that were pregnant at the time of ultrasound and not pregnant at the time of palpation were considered to have embryonic loss.

Blood and Feed Data Collection

Two blood samples (10 mL) were taken via jugular venipuncture 10 d apart before the breeding season to determine the percentage of cows cyclic. After collection, blood was stored on ice to prevent progesterone metabolism (Wiseman et al., 1982) before centrifugation at 1,000 × *g* for 20 min at 5°C within 6 h of collection. Serum was stored at −20°C until assaysis for progesterone concentration. Serum