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Effect of Grazing and Fat Supplementation on Production and Reproduction of Holstein Cows*

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ABSTRACT

The objective of this trial was to investigate the effects of feeding a soybean oil refining by-product (SORB), made up mainly of sodium salts of long-chain fatty acids, on reproductive performance and productivity of 36 early lactation Holstein cows managed in a free-stall barn or on annual rye-ryegrass pasture. In this 2 × 2 factorial arrangement of treatments, cows consumed 0 or 0.5 kg/d of SORB as part of a total mixed ration for barn cows or as part of a grain supplement fed to cows on intensively, rotationally stocked pasture. Blood was sampled 3 times weekly and plasma was measured for progesterone to assess ovarian activity. Estrus activity was recorded using the HeatWatch estrus detection system. Although average 14-wk milk production (37.2 kg/d) was not different among treatments, barn cows had more persistent lactations than did grazing cows. Cows housed in the barn lost less body weight and returned to initial body weight sooner and had lower mean concentrations of plasma nonesterified fatty acids (464 vs. 261 mEq/L) than those managed on pasture. The milk fat of cows on pasture contained greater proportions of conjugated linoleic acid and linolenic acid but a corresponding 0.22 percentage unit decrease in milk fat concentration (3.39 vs. 3.16%). Cows managed on pasture had greater peak concentrations of plasma progesterone during the first estrous cycle. Cows managed on pasture and fed SORB had the greatest accumulation of plasma progesterone over the 14 wk of the study (SORB × housing interaction). These cows experienced the most mounts during their first estrus (9.3) and pregnancy rate was also greatest for this treatment (62.5%). Feeding SORB did not affect production of milk, fat, or protein. Loss of body condition was less in cows fed SORB. Ruminal fluid concentration of propionate increased and ruminal pH decreased in cows fed SORB. A lower proportion of fatty acids less than 18 carbons in length was found in the milk fat of cows fed SORB, thus indicating lower de novo synthesis of fatty acids. Higher proportions of C18:2n-6 and conjugated C18:2 were found in the milk fat of cows fed SORB. Based on concentrations of plasma progesterone, cows fed SORB experienced their first ovulation earlier (26.7 vs. 42.4 d postpartum) than did cows not supplemented with SORB. Neither housing system nor SORB supplementation influenced detection of first estrus (50.5 d) or the mean length of each estrus period (447 min).

(**Key words:** grazing, soybean oil, fat, reproduction)

Abbreviation key: CLA = conjugated linoleic acid, **FA** = fatty acid, **HW** = HeatWatch, **SORB** = soybean oil refining byproduct.

INTRODUCTION

Adding supplemental dietary fat as whole cottonseeds (Harrison et al., 1995), tallow (Maiga et al., 1995), calcium salts of long-chain fatty acids (Sklan et al., 1989), and yellow grease (Cant et al., 1991) to the diets of dairy cows in early lactation has often increased milk production. In addition, fat added as calcium salts of long-chain fatty acids (Garcia-Bojalil et al., 1998) and tallow (Son et al., 1996) at 2 to 3% of dietary DM for dairy cows in early lactation has resulted in increased conception rates.

An oil by-product produced from the refining of soybeans for oil has received little research attention. Milk production was increased by 4.5 kg/d when this product (including lecithin) was fed to dairy cows at 0.9% of dietary DM (Shain et al., 1993). However milk production was not improved when various mixtures of the refining by-product (soybean oil soapstock and soy lecithin) were fed to dairy cows at 2.25% of dietary DM (Abel-Caines et al., 1998b). The concentration of linoleic acid in milk fat was increased by feeding a 1:1 mixture of soybean oil soapstock and soy lecithin compared with

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soybean oil (Abel-Caines et al., 1998b). This increased delivery of linoleic acid postruminally by the refining by-product might influence reproductive performance.

Pasture grazing is the most common practice for managing dairy cows worldwide. Although the practice diminished in the United States during the last 5 decades, new equipment and potential labor and economic benefits of intensive rotational stocking practices have generated renewed interest by US producers. In a study comparing the performance of pasture-based dairy cows offered supplemental grain to cows fed a TMR kept in free-stall housing, Fontaneli et al. (2005) reported that milk production was 19% lower in pasture-based cows. Kolver and Muller (1998) also reported decreases in milk production, DMI, and BW by unsupplemented grazing dairy cows vs. cows fed a TMR.

Housing management may play a role in the reproductive performance of dairy cows. In New Zealand, rotational stocking is the standard management system for dairy production. Compared with the United States, conception rate to first service is 2 times higher. In a comparison between the 2 locations, cows in New Zealand grazed perennial ryegrass and clover, whereas cows in the United States were fed a TMR (Bilby et al., 1998). Plasma progesterone clearance after ovariectomy and removal of a controlled intravaginal drug release device was less in grazing cows from New Zealand. Progesterone is a key hormone produced by the corpus luteum that helps maintain pregnancy.

The objectives of this trial were 1) to compare the effect of managing cows in an intensive rotational stocking system to free stall confinement and 2) to determine whether supplementation of a by-product of soybean oil refining would influence the productivity or reproductive performance of lactating Holstein cows.

MATERIALS AND METHODS

Cows, Design, and Treatments

The trial was conducted at the University of Florida, Dairy Research Unit (Hague, FL) between January and May. Immediately after calving, 36 Holstein multiparous cows were assigned randomly to 1 of 4 treatments arranged in a 2×2 factorial design. One main treatment factor was housing management system (free-stall housing vs. intensive rotational stocking of winter pastures). The second main treatment factor was type of supplement (without and with fat). The fat source used was a soybean oil refining by-product (**SORB**; Archer Daniels Midland Co., Chattanooga, TN) composed of approximately 65 to 70% sodium salts of long-chain fatty acids and 30% water having a pH of 8 to 9. Only a trace of lecithin was present. The oil was mixed with liquid molasses (Westway Trading Corp., Tomball, TX) such that the SORB made up 30% of liquid volume (DM basis). Liquid molasses alone or molasses with SORB were mixed with the concentrate portion of the diet. The fatty acid (**FA**) profile of SORB was 15.4% palmitic acid, 4.6% stearic acid, 16.1% *cis*-9 oleic acid, 1.5% *cis*-10 oleic acid, 53.5% linoleic acid, 6.2% linolenic acid, and 2.7% other FA (Ralston Analytical Laboratories, Ralston Purina Co., St. Louis, MO). Cows remained on experimental treatments through 14 wk postpartum.

Pastures were seeded with a mixture of 'Grazemaster' rye (*Secale cereale* L.) and 'Big Daddy' annual ryegrass (*Lolium multiflorum* Lam.) between October 20 and 22. Pastures were irrigated to ensure establishment in the fall and during periods of drought in the spring. The initial fertilization on November 18 included N at a rate of 45 kg/ha and K at a rate of 37 kg/ha. Thereafter, 45 kg of N/ha was applied on December 28, February 3, March 3, April 3, and April 25. The seasonal total of N applied was 270 kg/ha. Soil tests indicated that no P fertilizer was needed. Pastures were 0.8 ha each.

Three cows were assigned randomly to each pasture (n = 18) resulting in a stocking rate of 3.75 cows per ha. Three pasture replicates of each supplement treatment were established. Each pasture was subdivided into 29 paddocks and cows were moved to a new paddock daily, allowing for a 28-d rest period between grazing. Energized polywire fencing prevented cows from grazing the next day's allotment and from grazing previously grazed areas. Cows were provided water tubs that were moved each morning along with the cows. When air temperature exceeded 27°C, portable shade structures were placed in each paddock to provide 4.6 m^2 of shade per cow and were moved daily. Supplements were fed to each group of cows housed in individual pastures after each milking at a rate of 1 kg (as-fed) per 2.5 kg of milk produced per day. Averages of 3- or 4-d milk weights were reviewed twice weekly and the amount of supplement provided was adjusted accordingly. Fifty percent of this daily amount was fed after each milking according to treatment assignment. The ingredient (Table 1) and chemical composition (Table 2) of the diets are provided. Certain feedstuffs were selected as ingredients for the supplement (Table 1) that are known to have a slower rate of fermentation or that are fermented toward greater proportions of acetate rather than propionate such as citrus pulp, soyhulls, and dried distillers grains with solubles compared with ground corn to minimize the acid load within the rumen.

Cows assigned to the barn treatment (n = 18) were managed in an open-sided, free-stall barn bedded with sand and fed in 2 groups of 9. Diets were fed daily as TMR. The SORB made up 0 or 2.0% of dietary DM. The DM content of corn silage was measured weekly