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Effect of linseed feeding on blood metabolites, incidence of cystic follicles, and productive and reproductive performance in fresh Holstein dairy cows

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ABSTRACT

This study was done to investigate the effect of feeding linseed on blood metabolites, incidence of cystic follicles, resumption of postpartum ovarian cyclicity, pregnancy rate, milk production, and composition in fresh Holstein dairy cows. A total of 399 dairy cows were assigned randomly to 2 diets. Diets contained either protected palm oil (CON) or extruded linseed (LIN) and were fed from calving to d 40 postpartum. Ovaries of each cow were examined on d 10, 20, 30, and 40 after parturition (parturition = d 0) by transrectal ultrasonography to determine follicular development, ovarian disorders, and cyclicity. Blood samples were collected at 14-d intervals for 6 wk starting on the day of parturition to determine plasma concentrations of glucose, β-hydroxybutyrate (BHBA), nonesterified fatty acids (NEFA), and blood urea N (BUN). Results showed plasma glucose concentration was affected by the diets and was greater in the LIN treatment, but BHBA, NEFA, and BUN concentrations were similar among treatments. Dietary treatments had no significant effect on milk production and composition except milk fat percentage that significantly decreased in cows fed LIN (3.55%) compared with those fed with CON (4.17%). Plasma progesterone concentrations were greater in LIN treatment than CON treatment (1.31 ± 0.09 vs. 0.87 ± 0.09) at early postpartum. The resumption of cyclicity and onset of estrus were influenced by treatments and reduced by 7 d in LIN treatment compared with CON treatment. Cows fed diets enriched in LIN fatty acids had a lesser incidence of cystic follicles. Treatments did not differ significantly in terms of the number of days open, number of services per pregnancy, and pregnancy rate. In conclusion, feeding linseed immediately after parturition decreased milk fat and incidence of cystic follicles, increased progesterone concentrations early postpartum, and caused earlier resumption of cyclicity but did not affect pregnancy rate.
Key words: fertility, Holstein dairy cow, linseed, postpartum, reproduction

INTRODUCTION

Negative energy balance in dairy cows after calving is characterized by low blood concentrations of glucose, insulin, and IGF-1 and high blood concentrations of NEFA and BHBA (Ingvartsen and Andersen, 2000). These shifts in blood metabolites and hormones might compromise ovarian function and fertility. Feeding diets that promote increases in plasma glucose and insulin may improve the metabolic and endocrine status of cows in early lactation (Santos et al., 2004).

In recent years, dietary fats rich in n-3 PUFA have been widely used to enhance reproductive performance in dairy cows (Silvestre et al., 2011; Caldari-Torres et al., 2011; Dirandeh et al., 2013a; Badiei et al., 2014) by improving dietary energy density (Ferguson et al., 1990); influencing follicular growth and ovulation (Silvestre et al., 2011; Dirandeh et al., 2013b); increasing the number, diameter, and the life span of the corpus luteum (**CL**; Garcia-Bojalil et al., 1998); increasing concentrations of progesterone (Santos et al., 2008; Dirandeh et al., 2013b); early postpartum ovarian cyclicity (de Veth et al., 2009); prevention of luteolytic signals around maternal recognition of pregnancy (Mattos et al., 2000; Dirandeh et al., 2013a); and improved embryo quality (Cerri et al., 2004).

Linseed and its oil have been used widely as a conventional source of n-3 PUFA that contain >500 g of α linolenic acid (**ALA**) per kilogram of total fatty acid (Moallem, 2009). Linseed is incorporated into dairy feeds to improve reproduction and milk quality in dairy cows (Dirandeh et al., 2013b). Feeding protected linseed or its protected oil may enhance reproductive performance and increase the n-3 PUFA content of milk fat (Gonthier et al. 2005). Recent studies have shown a 16% increase in pregnancy rate in cows fed linseed compared with those fed palm oil (Dirandeh et al., 2013a).

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Because ovarian activity usually returns within the first 4 wk of calving, initiating fat feeding prepartum would allow the absorbed fatty acids to influence early ovarian activity (Santos et al., 2010). The incidence of cystic follicles is higher in high-producing dairy cows and is associated with lower percentages of pregnancy per AI and increases interval to pregnancy, culling, and economic losses. Cows with cystic follicles take 6 to 11 d longer to first service and 20 to 30 more days to conception (Fourichon et al., 2000).

Although many experiments have determined the effects of n-3 PUFA supplementation on productive and reproductive performances, little information is available on the effects of feeding linseed immediately postpartum on parameters influencing reproduction such as the incidence of cystic follicles and resumption of postpartum ovarian cyclicity. Therefore, the objectives of the current study were to determine the effect of linseed on blood metabolites, plasma concentrations of progesterone, resumption of postpartum ovarian cyclicity, incidence of cystic follicles, milk production, and composition and pregnancy rate in fresh Holstein dairy cows.

MATERIALS AND METHODS

Cows and Treatments

The experiment was conducted on a commercial dairy farm in Iran from November 2011 to April 2012 using 399 Holstein dairy cows (yielding 30.4 ± 0.3 kg of milk/d, 199 primiparous and 200 multiparous) with no overt clinical illnesses. The experiment was conducted from calving until wk 6 of lactation. Cows were blocked according to calving date, parity, and BCS and randomly assigned to 1 of 2 isonitrogenous and isoenergetic total mixed diets (Table 1). No difference was present among groups (mean ± SEM) in parity (2.5 ± 1.4) or BCS at calving (3.2 ± 0.07). All cows calved within 3 wk. Treatments included (1) protected palm oil (**CON**; Magnapac, Norel S.A., Suez, Egypt) and (2) extruded linseed (**LIN**, OmegaLin; Nutri Advance, Ploufragan, France). Diets were fed twice daily (0700 and 1700 h) for ad libitum intake (10% of refusals on an as-fed basis) during the whole experiment. Cows were milked 3 times daily at 0600, 1400, and 2200 h. All cows had a similar dry period condition and were fed a diet primarily consisted of alfalfa, corn silage, barley grain, and wheat bran in far-off. The composition of close-up diet has been shown in Table 1. Mature cows and heifers were housed together during close-up and postfresh periods. Twenty-three days before the expected calving date, mature cows and heifers were moved to the close-up group in a twice per week schedule.

Analysis of Feed

Total mixed ration were sampled each week and pooled each month and analyzed. Briefly, the DM of the feed sample was determined by placing it in a drying oven at 100°C for 48 h (AOAC, 1990; method 930.15). Crude protein was determined using the Dumas method and a Leco FP-528 (Leco Corporation, St. Joseph, MI). Acid detergent fiber and NDF concentrations were determined (Van Soest et al., 1991).

Milk Sampling and Analysis

Milk production was recorded at every milking. Milk samples were taken weekly (Sunday and Tuesday; 3 times per day, milk samples pooled on a yield basis so only 1 sample was taken per week) during experiment and analyzed for fat, protein, and lactose by infrared spectroscopy (AOAC International, 2000; method 972.16). The Milkoscan 4000 uses infrared technology to analyze the components of milk.

Blood Sampling and Processing

Blood samples (only for 30 cows within each treatment, a total of 60 cows) were collected at 14-d intervals for 6 wk starting 24 h after parturition (d = 0) for determining glucose, BHBA, NEFA, and BUN. Blood samples (only for 20 cows per treatment, a total of 40 cows) were collected daily from d 10 to 25 postpartum for determination of plasma progesterone concentrations. Blood samples (10 mL) were collected, by coccygeal venipuncture into anticoagulated (EDTA) evacuated tubes (Monoject, Sherwood Medical, St. Louis, MO), before the feeding and were kept on ice. All blood samples were centrifuged for 10 min at 2,000 × g at 4°C, and plasma was harvested and transferred into 2-mL microcentrifuge tubes and kept at −20°C until assayed. Plasma concentrations of glucose (Glucotrend, Roche, UK), NEFA (FA 115, Randox Laboratories Ltd., Antrim, UK), and BHBA (Abbott Diabetes Care Ltd., Witney, UK) were determined enzymatically using a spectrophotometer (Shimadzu 2100, Kyoto, Japan). Intra- and interassay coefficients of variation were <5%. Plasma progesterone concentrations were analyzed by ELISA following the manufacturer's instructions (DRG, Frauenbergstr, Marburg, Germany).

Ultrasonographic Examination and Estrus Detection

Cows were synchronized with 2 $PGF_{2\alpha}$ injections 14 d apart started at d 45 postpartum. The voluntary waiting period of the dairy herd was 60 d, and cows were inseminated based on a voluntary waiting period. Preg-