Comparison of crossbred and purebred Holstein cows during the transition period

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Introduction

Since the early 1900s, scientists have been comparing phenotypic characteristics of purebred and crossbred dairy cows in an attempt to determine the advantages of heterosis. However, the benefit of heterosis on the immune system has not been investigated during the transition period in lactating dairy cows. Innate immunity during the transition period (three weeks pre- to three weeks postpartum) plays a critical role on the postparturient health of dairy cows. The objectives of this study were to compare dry matter intake (DMI), metabolite concentration, innate immunity, and postpartum health of purebred Holstein (HO) and Montbéliarde-sired crossbred (MS) cows.

Materials and Methods

Cows (HO = 52 and MS = 52) were enrolled in the study 45 days (d -45) before expected calving date and monitored until 90 days (d 90) after calving. Each cow was assigned a body condition score (BCS) and weighed on days -45, -15, 1, 28, and 56. Milk yield and composition during the first three months postpartum were recorded and yield of energy corrected milk (ECM) was calculated. Daily DMI was measured for a subgroup of multiparous cows (HO = 26 and MS = 38) from study day -45 to 45. For purposes of statistical analyses, daily DMI and mean weekly DMI were used. From each cow, blood samples were obtained weekly from study day -14 to 56 for determination of non-esterified fatty acid (NEFA), β-hydroxybutyrate (BHBA), and glucose concentrations. On study day -7, 1, 7, 14, 21, and 42, polymorphonuclear leukocytes (PMNL) were isolated from blood samples obtained from a subgroup of cows (HO = 29 and MS = 33) for determination of percentage of PMNL positive for phagocytosis (PA) and oxidative burst (OB), intensity of PA and OB, percentage of PMNL expressing CD18 and L-selectin, and intensity of CD18 and L-selectin expression. Daily rectal temperature was recorded for each cow from study days 0 to 15. All cows were examined on study days 1, 4, 7, 10, and 14 for detection of postparturient diseases, on study day 24 for detection of clinical endometritis, and on study day 42 for detection of subclinical endometritis. For each cow, the uterus was examined by ultrasonography every three days from study day 14 to 41 to determine postpartum uterine involution.

All statistical analyses were performed with SAS. Continuous outcomes were analyzed by ANOVA (PROC GLM) or ANOVA for repeated measures (PROC MIXED). Dichotomous outcomes were analyzed by logistic regression (PROC LOGISTIC).

Results

No association was found between breed and body weight from study days -45 to 56 ($P = 0.41$), but the interaction between breed and study day was associated with body weight ($P = 0.04$). Holstein cows had a significantly ($P < 0.01$) lower BCS than did MS cows, but BCS was not associated ($P = 0.26$) with the interaction between breed and study day. Breed was not associated ($P = 0.72$) with mean ECM yield during the first three months postpartum. Mean ± SD DMI (36.3 ± 1.54 lb (16.5 ± 0.7 kg)/d) for Holstein cows tended ($P = 0.08$) to be greater than the DMI (32.8 ± 1.32 lb (14.9 ± 0.6 kg)/d) for MS cows from six weeks before to six weeks after calving, but the interaction between breed and study day was not associated ($P = 0.29$) with DMI during that time period. Plasma NEFA concentration was not associated with breed ($P = 0.56$) or the interaction between breed and study day ($P = 0.93$) from study days -14 to 56. Plasma BHBA concentration was not associated ($P = 0.95$) with breed, but was associated ($P < 0.01$) with the interaction between breed and study day. Plasma glucose concentration was not associated ($P = 0.54$) with breed, but was associated ($P < 0.01$) with the interaction between breed and study day. Intensity of CD18 expression was greater ($P = 0.04$) for MS cows, compared with that for HO cows. Although intensity of PA was not associated ($P = 0.54$) with breed, it did tend to be associated ($P = 0.09$) with the interaction between breed and study day. Incidences of retained fetal membranes (HO = 7.7 and MS = 7.7%; $P = 0.82$), metritis (HO = 13.5 and MS = 4.0%; $P = 0.11$), and subclinical endometritis (HO = 32.0 and MS = 18.4%; $P = 0.12$) did not differ between breeds, but HO cows tended ($P = 0.07$) to have more clinical endometritis than did MS cows. Finally, a significantly ($P < 0.01$) higher percentage of HO cows (63.5%) had at least one uterine disorder than did MS cows (36.7%).

Significance

Results of the present study indicated that HO cows had greater incidence of uterine disorders postpartum and an impaired innate immune response during the periparturient period, compared with those of MS cows. Because the metabolic parameters between the HO and MS cows were similar, heterosis is the most likely reason for the observed differences in immune response and health performance. The comparison of HO and crossbred lactating dairy cows during the transition period is relevant to the dairy industry because the transition period of dairy cows greatly influences reproductive and productive performance during the subsequent lactation.