HEALTH, IMMUNE FUNCTION AND SURVIVAL OF HOLSTEIN AND CROSSBRED JERSEY X HOLSTEIN DAIRY CALVES

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INTRODUCTION

For many years, the superiority of the Holstein breed for milk production and the strong role of breed associations in developing selection policies have limited the use of crossbreeding in dairy cattle. However, trends in milk pricing favoring high fat and protein content, coupled with increasing concerns about health, fertility, and calving performance have led to greater interest in crossbreeding among commercial dairy producers. In a recent crossbreeding survey (Weigel and Barlass, 2003), dairy producers with crossbred cattle indicated improved survival rates among F_1 Holstein x Jersey calves and backcross (Holstein x Jersey) x Holstein calves, relative to their pure Holstein contemporaries. Furthermore, a preliminary study (Maltecca and Weigel, 2004) on a commercial farm reported significantly ($P < 0.05$) higher serum protein and IgG levels in F_1 Jersey x Holstein calves at 0 to 72 hr of age, relative to their Holstein contemporaries. In the same study, Holstein calves tended ($P < 0.10$) to have higher fecal consistency scores than F_1 Jersey x Holstein calves, reflecting a greater incidence of scours. The objective of this study was to assess differences in serum protein and IgG levels, scours, respiratory disease and perinatal and pre-weaning mortality between Holstein and backcross (Holstein x Jersey) x Holstein calves.

MATERIALS AND METHODS

Data collection. Crossbred calves were produced via backcross mating of randomly chosen lactating Holstein cows to randomly allocated young F_1 Holstein x Jersey sires (N = 7). The remaining lactating Holstein cows were randomly mated to young Holstein sires (N = 74) to produce experimental controls. Data were collected from November 2003 to December 2005. Calves were isolated from their dams immediately after birth and were not allowed to suckle maternal colostrum. Calves were weighed within 15 min of birth and were fed a single colostrum meal by nipple bottle with pooled, frozen colostrum from multiparous Holstein cows within 1 hr, at a rate of 7% of body weight. An esophageal feeder was used when calves refused to suckle. Fecal consistency scores and respiratory disease scores were measured on Monday, Wednesday, and Friday of each week. The former were measured on a 4-point ordinal scale (1 = normal, 2 = soft, 3 = runny, 4 = watery), while the latter were measured on a 5-point ordinal scale (1 = normal, 2 = runny nose, 3 = heavy breathing, 4 = moist cough, 5 = dry cough). Data for female calves were collected from birth through weaning, while data for male calves were collected from birth through 7 d of age, when these calves were sold from the farm. Therefore, mean and maximum fecal and respiratory scores were evaluated from birth to 7 d of age for male and female calves and from birth to weaning for female calves only. Perinatal and pre-weaning mortality data were recorded at 24 hr of age and 6 wk of age, respectively. Serum protein level and serum IgG level were evaluated as follows. Blood samples (5 ml) were collected at 24 to 72 hr of age by jugular venipuncture using evacuated tubes containing no anticoagulant. Serum was harvested from the blood via centrifugation and was frozen at –20°C until analysis. Serum protein was measured using a refractometer, while serum IgG was determined using a radial immunodiffusion assay. The IgG specific antiserum was incorporated into agarose gel; the sample antigen diffused into gel containing the antibody, and a ring of precipitation was formed, proportional in size to the concentration of the antigen.

Statistical analyses. A general linear model was used to analyze traits measured on a continuous scale, including: mean fecal consistency score and respiratory disease score from birth to 7 d of age and from birth to weaning, serum protein level, and natural logarithm of serum IgG level. Least-squares means and contrasts by breed (Holstein vs. crossbred) were computed. Traits measured on a binary scale were analyzed using logistic regression, as were traits measured on an ordinal scale (the latter were grouped into two categories due to low frequencies of some scores); these included: perinatal survival (0 = dead; 1 = alive at 24 hr of age), pre-weaning survival (0 = dead; 1 = alive at 6 wk of age), maximum fecal consistency score from birth to 7 d of age or from birth to weaning (1 = normal; 2, 3, 4, or 5 = scours), and maximum respiratory disease score from birth to 7 d of age or from birth to weaning (1 = normal; 2, 3, 4, or 5 = ill). Odds ratios were calculated by breed (Holstein vs. crossbred). Both models contained fixed effects of year-month of birth, breed of calf, parity of dam, sex of calf, and birth weight of calf, as well as a random residual. Calves from twin births were excluded.

RESULTS AND DISCUSSION

Results for perinatal mortality (stillborn calves and calves dead by 24 hr) and pre-weaning mortality (calves alive at 24 hr but dead by weaning) are shown in Table 1. Holstein calves were more susceptible to perinatal mortality and pre-weaning mortality ($P < 0.05$) than crossbred calves, as indicated by odds ratios of 1.42 and 1.23, respectively. Perinatal mortality was also signficantly higher ($P < 0.01$) among male calves than among female calves, as noted previously by Johanson and Berger (2003).

Table 1. Perinatal mortality and pre-weaning mortality, according to breed and sex of calf, as well as corresponding odds ratios and contrasts (Holstein vs. crossbred).

Breed	Sex	No.	Perinatal Mortality	Pre-Weaning Mortality	Serum Protein	Log (Serum IgG)
Holstein	M	47	14.9%	10.0%	4.06	6.56
	F	67	13.4%	11.9%	3.95	6.87
Crossbred	M	130	10.8%	2.6%	4.95	6.94
	F	105	9.5%	8.4%	5.10	7.02
			Odds Ratio	Odds Ratio	Contrast	Contrast
			1.42^{*} (1.13-1.64)	1.23^{*} (1.14-1.55)	$-1.17 \pm 0.25^{**}$	$-0.26 \pm 0.12^{*}$

* $P < 0.05$
** $P < 0.01$

Least square means for serum protein and logarithm of serum IgG are also presented in Table 1, according to breed and sex of calf. Crossbred calves had significantly higher serum protein ($P < 0.01$) and IgG levels ($P<0.05$) than Holstein calves. No differences were observed between sex of calf or parity of dam. Passive immunization in newborn calves occurs through the absorption of immunoglobulins from colostrum shortly after birth (Bush and Staley, 1980), and low serum Ig concentrations are directly related to long-term calf performance (Wittum and Perino, 1995). Blood IgG or protein concentrations have been used as predictors of passive immune transfer in newborn calves (Quigley *et al*., 1995). Jones *et al.* (2004) reported that Jersey calves had higher serum concentrations of IgG at 24 hr of age than Holstein calves (16.47 ± 0.71 and 11.12 ± 0.60 g/L, respectively), despite lower levels of IgG in the colostrum (250 g fed to Holsteins and 182 g to Jerseys, due to differences in volume of colostrum fed). These authors also reported differences in immunoglobulin absorption between the two breeds, with 21.9 ± 0.9% absorption efficiency for Jersey calves and 17.0 ± 0.7% absorption efficiency for Holstein calves. Similar results were reported (Jones *et al*., 2004) for total serum protein, with serum protein content being higher in Jersey calves than in Holstein calves. Thus, it appears from the present study and the previous work of Jones *et al*. (2004) that passive transfer of immunity may be more efficient in Jersey calves or crossbred Jersey x Holstein calves than in Holstein calves.

Table 2. Least-squares means for fecal consistency score and respiratory disease score during the first week of life and from birth to weaning and percent of calves with maximum score > 1, by breed of calf, as well as corresponding odds ratios and contrasts (Holstein vs. crossbred).

	Fecal Consistency Score			
	Birth to 7 d of Age		Birth to Weaning	
Breed	Mean	Calves > 1	Mean	Calves > 1
Holstein	1.31	33.3%	1.31	72.3%
Crossbred	1.21	34.1%	1.27	69.6%
	Contrast	Odds Ratio	Contrast	Odds Ratio
	0.12±0.03[†]	0.96 (0.75-1.53)	0.01±0.07	1.02 (0.62-1.32)
	Respiratory Disease Score			
	Birth to 7 d of Age		Birth to Weaning	
Breed	Mean	Calves > 1	Mean	Calves > 1
Holstein	1.12	34.3%	1.13	91.1%
Crossbred	1.14	33.6%	1.18	86.2%
	Contrast	Odds Ratio	Contrast	Odds Ratio
	0.05±0.07	1.10 (0.44-1.58)	0.01±0.07	1.00 (0.62-1.43)

[†] P < 0.10

Least squares means for fecal consistency scores from birth to 7 d of age, as well as from birth to weaning, are presented in Table 2, according to breed of calf. Fecal scores measured from birth to 7 d of age can be viewed as secondary indicators of passive immune transfer, while fecal scores taken from birth to weaning can be viewed as dual indicators of passive transfer and calf vigor. Holstein calves tended (P < 0.10) to have higher mean fecal consistency scores from birth to 7 d of age and from birth to weaning than crossbred calves, as indicated by the contrast in least-squares means. Least-squares means for respiratory disease scores from birth to 7 d of age and from birth to weaning are also presented in Table 2. No differences in respiratory disease scores were found between crossbred calves and Holstein calves.

CONCLUSIONS

This study evaluated differences in perinatal mortality, pre-weaning mortality, scours, respiratory disease, and serum protein and IgG levels among Holstein and backcross (Holstein x Jersey) x Holstein calves. Crossbred calves exhibited lower perinatal and pre-weaning mortality rates, higher serum protein and IgG concentrations, and reduced incidence of scours, suggesting improved passive transfer of immunity and greater vigor. Many factors must be considered before implementing a dairy crossbreeding program, including potential gains or losses in milk yield, milk composition, feed costs, female fertility, longevity, and salvage value. Furthermore, challenges associated with increased variation in growth, mature size, and performance must be considered. However, results of the present study suggest that crossbreeding with Jerseys may lead to improvements in calf health and survival. Future studies should attempt to quantify heterosis for these traits, as well as other traits that contribute to lifetime profitability, as precise knowledge of such parameters is needed to develop efficient, effective dairy crossbreeding systems.

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