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Estimation of Genetic Parameters for Perinatal Sucking Behavior of Italian Brown Swiss Calves

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ABSTRACT

Brown Swiss breeders sometimes experience difficulties in feeding calves because of the weak sucking ability of the calves in the early days of life. For the welfare of the calves, they should be suckled by their dams or should aggressively ingest colostrum immediately after birth. The composition of colostrum changes rapidly during the first few days of lactation, and the ability of calves to absorb the Ig decreases quickly as well. The aim of this study was to increase our knowledge of environmental and genetic components affecting the sucking response, to evaluate the possibility of selecting for this trait. Sucking ability was recorded in 3 categories (drank from the milk bucket nipple or bottle without help, drank with help, did not drink) at 5 postnatal meals (6, 12, 24, 48, and 72 h from birth). Records were analyzed with 2 different models: a single-trait threshold sire model, in which all observations were analyzed as a single trait with 5 levels, and a multiple-trait threshold liability sire model, in which meal-by-meal observations were analyzed as 5 different binary traits. Management procedures, the interval between birth and meals, parity, and season of birth were environmental factors affecting the variability in sucking ability. The heritability estimate for the single-trait analysis was 0.14, whereas heritabilities for the multiple-trait analysis were 0.26, 0.22, 0.21 0.12, and 0.13 for the first, second, third, fourth, and fifth meal, respectively. Estimated genetic correlations among traits were high (0.82 to 0.99). This study suggests the possibility of selection based on sucking ability. Future collection of larger data sets on the sucking response of calves in the first 2 meals after birth would increase the accuracy of genetic parameter estimates.
Key words: sucking ability, functional trait, Brown Swiss, dairy cattle

INTRODUCTION

Calves with suboptimal feed intake during the first days of life exhibit greater postnatal mortality, and this can adversely affect the profitability of dairy farms. In Danish Holstein cattle, Hansen et al. (2003) found that 2.7% of calves did not survive to 2 wk of age. In American Brown Swiss cattle, Erf et al. (1990) found even more disconcerting results, showing that 6.4% of calves died by 2 d after birth. In European Brown Swiss, newborn calves sometimes do not show sufficient sucking instinct, which can often be lethal. This lack of sucking aptitude can limit the diffusion of the breed in an intensive farming system (Bulot 2004; Santus, 2004; Zemp, 2004).

In ungulates, as in other mammals, contact with the mother represents a multisensorial stimulation with which the young animal comes into contact at birth (Nowak et al., 1997). In the modern dairy industry, calves are separated from their mothers immediately after calving. This practice could be causal in affecting calves' motivation and aptitude to suck aggressively, because calves reared separately from their mothers are often fed by buckets. Additionally, they can only suck on objects in the pen, or on pen mates, to satisfy their sucking motivation (de Passilè, 2001). The exact stimuli that influence the first sucking by calves are not known. Along with environmental factors, Schaal et al. (2003) identified in rabbits a pheromone, 2-methylbut-2-enal, that elicits a complex behavioral sequence that culminates in the attachment of a pup to the mother's nipple. The pheromone 2-methylbut-2-enal is also present in cow's milk, but with no additional knowledge of its effect on sucking behavior in cattle, assumptions about the effect of this pheromone in calves that are separated from their mothers immediately after birth are difficult to infer (Blass, 2003).

Passive immunity in newborn calves occurs through the absorption of Ig 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; Faber et al., 2005). The colos-

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trum composition begins to change soon after calving, particularly the Ig concentrations, which decrease and ultimately disappear after 3 d postpartum. The energy and protein content of colostrum (i.e., its nutritional components) also decrease significantly (Blum and Hammon, 2000). For the aforementioned reasons, along with the decreased ability of calves to absorb colostral Ig after birth (Stott et al., 1979; Staley and Bush, 1985), the presence of sucking aptitude is very important for the health and welfare of calves immediately after birth. The aim of this study was to investigate the effects of environmental and genetic factors and estimate variance components for different measures of sucking behavior in the Brown Swiss breed to evaluate the possibility of genetic improvement of this trait.

MATERIALS AND METHODS

Data Collection

Observations regarding the capacity of the newborn calf to drink from a nipple bucket or bottle were collected from January 1998 to March 2003 in the Italian Brown Swiss population. Calves were not allowed to nurse from their dams. A nipple bucket or calf bottle with colostrum was offered to each calf. The feeding system and the person recording the phenotype were consistent within herd and during the measurement. Behavior of the calf with respect to the action of sucking from an artificial teat (nipple bucket or bottle) was measured (hereafter referred to as sucking ability). Sucking ability was recorded by the farmer as a categorical trait during the first 5 postnatal meals, at 6, 12, 24, 48 and 72 h after birth (**SA6**, **SA12**, **SA24**, **SA48**, and **SA72**, respectively). Sucking ability for each calf at each meal was recorded on a scale ranging from 0 to 2, with 0 representing a calf that consumed colostrum or milk without help (no farmer intervention after the beginning of sucking to the end of the meal), 1 representing a calf that consumed colostrum or milk with some farmer intervention (calf sucked only if the farmer placed the teat in the mouth of the newborn), and 2 representing a calf that did not consume milk or colostrum (the calf did not suck, or even completely refused the teat). A total of 5,913 observations were recorded on 1,274 calves on 263 farms. An aggregate measure (**SA**) was also considered, which combined the aforementioned measures (SA6 to SA72) into a unique trait (SA) with repeated measures. The scale of this last trait was the same as noted previously (0, 1, 2). Participation in the project was voluntary, ensuring that the farmers involved were motivated to record the sucking ability at different meals on the form provided according to the category definition. To guarantee reliable data collection, each farmer was specifically trained by personnel of the Italian Brown Swiss Association, and breed inspectors regularly visited farms and monitored data collection. Farmers were trained in using an explanatory form and in simulating the recording of measurements.

Table 1. Summary statistics of the edited data set

Statistic	Number	
Calves	855	
Observations	4,275	
Sires with data	187	
Herd classes	110	
Season classes	2	(399 Jan. to Jun.; 456 Jul. to Dec.)
Parity of dam classes	2	(229 primiparous; 626 multiparous)
Twin classes	2	(817 single; 38 twin)

Data Editing

Herds with <3 observations, along with individuals with missing date of birth or identification of dam, were excluded from the analysis. Furthermore, only individuals with complete information on all 6 postnatal meals were considered in the study. After editing, 4,275 phenotypes on 855 calves, sired by 187 bulls, in 110 herds in 23 Italian provinces were available for the analysis. Pedigree information was provided by the Italian Brown Swiss Association database. A summary of the data set is provided in Table 1.

Statistical Analysis of Environmental Effects

Given the scarce literature regarding postnatal sucking behavior, an exploratory analysis to assess the significance of various environmental components was carried out. Analysis of variance was performed on Snell scores (Snell, 1964) of sucking ability as a single trait and as multiple traits. Briefly, Snell scores are used to transform categorical variables to conform to intervals of the normal distribution.

Explanatory variables included in the analysis were: herd, parity, year × season of calving interaction, meal number, and twin status. The analysis was carried out by using PROC GLM of SAS (SAS Institute, Cary, NC). Least squares means for the meal number were obtained for SA only.

Multiple-Trait Threshold-Liability Sire Model. To estimate genetic and environmental variance components, correlations, and heritabilities, 2 different approaches were taken. A 5-variate threshold-liability model was used in the first analysis, similar to the model proposed by Gianola (1982) and used by Heringstad et al. (2006) to analyze clinical mastitis and nonreturn rate in different time periods. The model is as follows: