J. Dairy Sci. 100:1–14
https://doi.org/10.3168/jds.2016-11334

Effect of concentrate supplementation during the dry period on colostrum quality and effect of colostrum feeding regimen on passive transfer of immunity, calf health, and performance

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ABSTRACT

The objectives were to evaluate the effect of (1) supplementing concentrates to multiparous Holstein cows during the dry period on colostral and milk immunoglobulin G (IgG) concentration; and (2) feeding calves colostrum at either 5 or 10% of their body weight (BW) on passive transfer of immunity, health, and performance. Holstein multiparous cows (n = 37) were assigned to 1 of 2 nutritional treatments during an 8-wk dry period: (1) offered ad libitum grass silage only (GS) or (2) offered ad libitum access to the same grass silage plus concentrate [total mixed ration in a 75:25 dry matter (DM) ratio], providing a mean concentrate DM intake of 3.0 kg/cow per day (GSC). Both treatment groups were offered identical levels of mineral and vitamin supplementation. Calves from these cows were weighed immediately after birth and fed either 5% (5BW) or 10% (10BW) of their BW in colostrum from their own dams within 2.5 h of birth. Calves in the 10BW group received their second feed of colostrum from first-milking colostrum. Concentrate supplementation during the dry period had no effect on colostral IgG concentration, first-milking IgG yield, or fat, protein, and lactose contents. However, cows in GSC produced a greater mean milk yield over the first 8 milkings compared with cows in the GS group. Concentrate supplementation had no effect on calf BW or BW gain, serum IgG, or apparent efficiency of absorption (AEA) at 24 h after birth. However, offspring from the GSC group had fewer cases of enteritis during the first 56 d of life compared with offspring from the GS group. Calves in the 10BW group had greater mean serum IgG concentration for the first 3 d following birth; however, at 24 h after birth, we observed no treatment effect on AEA. The rate of enteritis was greater for calves in the 5BW treatment compared with 10BW. The colostrum-feeding regimen had no effect on BW gain or on the incidence of pneumonia among calf treatment groups. In conclusion, concentrate supplementation regimens offered during the dry period had a positive effect on colostrum yield, and offspring from the GSC group had a reduced rate of enteritis. Feeding 10% of BW of colostrum versus 5% of BW resulted in a greater serum IgG concentration for the first 3 d postpartum, and 10BW calves had a reduced rate of enteritis. Overall, to achieve successful passive transfer, decrease the rate of enteritis, and increase efficiency in the dairy calf, we recommend that dairy calves be fed 10% of their BW in colostrum as soon as possible after birth.
Key words: calf, colostrum, concentrate, dry period, immunoglobulin G

INTRODUCTION

Bovine colostrum is the primary source of nutrients and immunity for the newborn calf (Quigley and Drewry, 1998). The process of colostrogenesis takes place several weeks before parturition; during this time, immunoglobulins are transferred from the dam's circulation into mammary secretions and subsequently the transfer of Ig ceases immediately before parturition (Brandon et al., 1971; Barrington and Parish, 2001). Previous research has focused primarily on dietary and management strategies for beef cows during their dry period on colostrum quality (Blecha et al., 1981; Hough et al., 1990; McGee et al., 2006). However, limited data are available for the dairy cow and the effect these strategies have upon their offspring (Funston et al., 2010; Nowak et al., 2012). Studies have been conducted on beef cows to investigate the effects of protein and energy restrictions (Blecha et al., 1981; Hough et al., 1990) on colostrum quality. However, further research is required because dairy cows face different metabolic challenges during the peripartum period compared with beef cows (Mann et al., 2016).

Received April 19, 2016.
Accepted September 30, 2016.
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The bovine dam has a syndesmochorial placenta, which prevents transmission of antibodies to the unborn calf while it is in the uterus (Weaver et al., 2000). Therefore, the calf is born agammaglobulinemic and is solely dependent on colostrum for the passive transfer of immunoglobulins, immune cells (Barrington and Parish, 2001), and for nutrients that only minimally cross the placenta such as fat-soluble vitamins (Spielman et al., 1946). Immunoglobulins are proteins that are produced in reaction to stimulation by antigens and that later destroy those antigens (Murphy et al., 2005). The transfer of passive immunity from cow to calf via colostrum is considered adequate when the IgG concentration in the serum of the calf exceeds 10 mg/mL in the first few days after birth (Godden, 2008; Logue and Mayne, 2014). Successful passive transfer has been related to lower veterinary costs during the preweaning stage, enhanced weight gain, improved performance, and prolonged existence in the milking herd (Weaver et al., 2000; Faber et al., 2005; Lorenz et al., 2011). However, recent findings from the All-Island Animal Disease Surveillance Report (AFBI-DAFM, 2013) showed 56% of calves to have undergone failure of passive transfer (FPT) based on blood samples submitted by private veterinary practitioners and on samples from dead calves submitted for postmortem. Several studies have examined the effect of colostrum volume on passive transfer of immunoglobulins, and recommendations on the volume of colostrum to feed to the newborn calf vary between breeds (Jaster, 2005; Conneely et al., 2014). Chigerwe et al. (2008) recommended that Holstein-Friesian calves of normal size should be fed 3 L of high-quality (IgG >50 mg/mL; McGuirk and Collins, 2004) colostrum via esophageal tube within 2 h of life. Jaster (2005) found that Jersey calves fed 2 L of good quality colostrum at 0 and 12 h had higher serum IgG_1 levels at 24 h than calves fed 4 L of colostrum at birth. Recent research has focused on feeding colostrum in a volume based on a percentage of BW (Conneely et al., 2014). In most dairy systems, the calf is removed from the dam immediately after birth, fed colostrum, and offered milk replacer or whole milk thereafter until weaning. Recently it has become popular to house calves in groups during the preweaning period; consequently, it is more difficult to detect disease (Chua et al., 2002), and the spread of disease is more frequent compared with that among individually penned calves. However, calves in group pens are generally fed via automated feeders, and feeding behavior can be recorded. This may be a useful tool for identifying sick calves in the early stages and can allow for early treatment (Borderas et al., 2009).

The objectives of this study were to investigate the effect of concentrate supplementation of dams during the nonlactating period of approximately 8 wk on colostrum quality and yield and subsequent calf health and performance when fed different levels of colostrum according to BW.

MATERIALS AND METHODS

All procedures and treatments within this study were conducted under the United Kingdom Animals (Scientific Procedures) Act (1986; http://www.legislation.gov.uk/ukpga/1986/14/contents). The study was conducted at the Agri-Food and Bioscience Institute (AFBI) research dairy farm in Hillsborough, located in County Down, Northern Ireland (54°27′ N, 6°4′ W). The average (±SD) daily air temperature during the experiment was 6.9°C, with a range of −0.5 to 13.4°C. The study population consisted of 37 multiparous Holstein cows that calved between February 9 and April 17, 2014. The mean (±SD) birth weight of calves was 40.4 ± 6.2 kg; 19 of these calves were female and 18 were male.

Experimental Design

The experiment had a 2 × 2 factorial design, which included 2 dry-cow feeding treatments: (1) grass silage only (**GS**) or (2) grass silage plus concentrate (**GSC**), offered in the form of a mixed diet providing a nominal concentrate intake of approximately 3 kg/cow per day; and 2 first-feed colostrum treatments fed according to calf BW at birth: (1) 5% of BW of colostrum at birth (**5BW**) or (2) 10% of BW of colostrum at birth (**10BW**). Colostrum was defined as the first and second milkings after parturition, and transition milk referred to any subsequent milkings.

Dry-Cow Management

Cows were balanced according to BCS, previous 305-d milk yield, and parity (Little et al., 2016). Dry cows in the GS group received access to ad libitum medium-quality grass silage only, whereas cows in the GSC group were offered ad libitum access to a mixed diet containing the same medium-quality grass silage plus concentrates (mixed in a 75:25 DM ratio), which was intended to provide an average concentrate intake of approximately 3.0 kg/cow per day (Little et al., 2016). These diets were anticipated to be representative of typical UK on-farm management strategies and to offer approximately 100 and 130% of the cow's ME requirement during the dry period (ME intake of 106 and 138 MJ/d with the GS and GSC treatments, respectively), based on the equations contained in *Feed into Milk* (Agnew et al., 2004), the current UK ration-