Animal Reproduction Science 127 (2011) 140–147

Contents lists available at ScienceDirect

Animal Reproduction Science

journal homepage: www.elsevier.com/locate/anireprosci

Associations among milk production and rectal temperature on pregnancy maintenance in lactating recipient dairy cows

J.L.M. Vasconcelos[a,*], R.F. Cooke[b], D.T.G. Jardina[a], F.L. Aragon[c], M.B. Veras[c], S. Soriano[d], N. Sobreira[d], A.B. Scarpa[a]

[a] São Paulo State University, Department of Animal Production, Botucatu 18168-000, Brazil
[b] Oregon State University, Eastern Oregon Agricultural Research Center, Burns, OR 97720, United States
[c] Pioneiros Veterinary Clinic, Carambei 84145-000, Brazil
[d] Colorado Dairies, Araras 13600-000, Brazil

ARTICLE INFO

Article history:
Received 1 March 2011
Received in revised form 10 July 2011
Accepted 25 July 2011
Available online 30 July 2011

Keywords:
Dairy cows
Embryo transfer
Heat stress
Milk production
Pregnancy maintenance
Rectal temperature

ABSTRACT

The objective of this study was to evaluate the associations among milk production, rectal temperature, and pregnancy maintenance in lactating recipient dairy cows. Data were collected during an 11-mo period from 463 Holstein cows (203 primiparous and 260 multiparous) assigned to a fixed-time embryo transfer (ET) protocol. Only cows detected with a visible corpus luteum immediately prior to ET were used. Rectal temperatures were collected from all cows on the same day of ET. Milk production at ET was calculated by averaging individual daily milk production during the 7 d preceding ET. Pregnancy diagnosis was performed by transrectal ultrasonography 21 d after ET. Cows were ranked and assigned to groups according to median milk production (median = 35 kg/d; HPROD = above median; LPROD = below median) and rectal temperature ($\leq$39.0 °C = LTEMP; >39.0 °C = HTEMP). A milk production × temperature group interaction was detected (P = 0.04) for pregnancy analysis because HTEMP cows ranked as LPROD were 3.1 time more likely to maintain pregnancy compared with HTEMP cows ranked as HPROD (P = 0.03). Milk production did not affect (P = 0.55) odds of pregnancy maintenance within LTEMP cows, however, and no differences in odds of pregnancy maintenance were detected between HTEMP and LTEMP within milk production groups (P > 0.11). Within HTEMP cows, increased milk production decreased the probability of pregnancy maintenance linearly, whereas within LTEMP cows, increased milk production increased the probability of pregnancy maintenance linearly. Within HPROD, increased rectal temperature decreased the probability of pregnancy maintenance linearly, whereas within LPROD cows, no associations between rectal temperatures and probability of cows to maintain pregnancy were detected. In summary, high-producing dairy cows with rectal temperatures below 39.0 °C did not experience reduced pregnancy maintenance to ET compared to cohorts with reduced milk production.

1. Introduction

In the U.S. dairy industry, milk production per cow increased whereas reproductive efficiency decreased over the last few decades (Lucy, 2001). Most of these reproductive losses can be attributed to increased embryonic mortality (Zavy, 1994). More than 50% of dairy cows that conceive lose their pregnancy during the initial 6 weeks of gestation (Santos et al., 2004). Several physiological consequences of increased milk production can be associated with early pregnancy losses, such as increased incidence of metabolic and reproductive postpartum

* Corresponding author. Tel.: +55 14 3811 7185; fax: +55 14 3811 7180.
E-mail address: vasconcelos@fca.unesp.br (J.L.M. Vasconcelos).

0378-4320/$ – see front matter © 2011 Elsevier B.V. All rights reserved.
doi:10.1016/j.anireprosci.2011.07.012

diseases, intensified postpartum negative energy balance, and reduced circulating concentrations of steroids (Opsomer et al., 2000; Lucy, 2001; Vasconcelos et al., 2003). More specifically, high producing cows have lesser plasma progesterone (P4) concentrations (Vasconcelos et al., 1999) compared to less-productive cohorts, mainly due to their greater DMI (Harrison et al., 1990), increased hepatic blood flow, and consequent hepatic catabolism of progesterone (P4) (Sangsritavong et al., 2002; Vasconcelos et al., 2003). P4 affects the uterine environment (Thatcher et al., 2001; Green et al., 2005) and early embryonic development (Mann and Lamming, 2001), whereas reduced P4 concentrations after artificial insemination (AI) is detrimental to subsequent pregnancy rates (Stronge et al., 2005; Mann et al., 2006; Demetrio et al., 2007).

Many studies also reported that increased body temperature is detrimental to reproductive function in dairy cattle, particularly early embryo development and survival (Hansen and Arechiga, 1999; Wolfenson et al., 2000; Hansen et al., 2001). These outcomes become of greater concern during the summer, when increased environmental temperatures contribute to greater increases in body temperature and substantial decreases in reproductive efficiency of dairy cows (Badinga et al., 1985; Sartori et al., 2002). However, this decrease in reproductive performance appears to be influenced by milk production (Badinga et al., 1985; Al-Katanani et al., 1999; Sartori et al., 2002; López-Gatius, 2003) because high-producing dairy cows have a greater average body temperature compared to less-productive cohorts due to their hastened metabolism and increased heat production (Berman et al., 1985; Kadzere et al., 2002).

However, Ravagnolo and Misztal (2000) reported that the correlation between milk production and heat tolerance is weak in dairy cows, indicating that selection for heat tolerant and high-producing dairy cows is possible. Umphrey et al. (2001) also reported weak partial correlation between milk yield and rectal temperature. Based on these observations, it was hypothesized that higher-producing dairy cows with normal body temperature do not experience reduced pregnancy maintenance compared to lesser producing cohorts. The objectives of this study were to evaluate the relationships among rectal temperature, milk production, and pregnancy maintenance of lactating recipient dairy cows within one year.

1.1. Materials and methods

This experiment was conducted from February to December 2007 at a commercial dairy farm located in Araras, Brazil. The latitude, longitude, and altitude of this location are, respectively, 22°21′ south, 47°23′ west, and 614 m. The animals utilized were cared for in accordance with the practices outlined in the Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching (FASS, 1999).

1.2. Animals and diets

Data were collected during an 11-mo period from 463 lactating recipient Holstein cows (203 primiparous and 260 multiparous). Cows were housed according to parity into 12 free stall barns with access to an adjoining sod-based area. Barns were cooled by intermittent sprinkling and forced ventilation to minimize the effects of heat stress. Cows were fed *ad libitum* with a TMR based on corn silage, bermudagrass (*Cynodon dactylon* cv. coast-cross), ground corn, cottonseed, soybean meal, and a mineral and vitamin mix, which was balanced to meet the nutritional requirements of lactating dairy cows (NRC, 2001). Cows were milked three times daily in a side-by-side milking system. Daily milk yield for each cow was recorded automatically.

1.3. Reproductive management

During the experiment, all non-pregnant recipient cows which were more than 55 d in milk (DIM) were evaluated monthly by transrectal ultrasonography examinations (Aloka SSD-500 with a 7.5 MHz linear-array transrectal transducer; Tokyo, Japan) to determine estrous cyclicity by presence of a corpus luteum (CL). Cows determined as estrous cycling were assigned to a monthly ovulation synchronization + fixed-time embryo transfer (ET) protocol. Prior to ET, all cows received a health evaluation which included clinical and subclinical mastitis exam (Smith et al., 1984; Dohoo and Leslie, 1991; Maunsell et al., 1999), endometritis (LeBlanc et al., 2002; Kasimanickam et al., 2004) and lameness evaluation (Sprecher et al., 1997). Only cows diagnosed as healthy were assigned to ET to prevent confounding effects between health issues and environmental heat on rectal temperatures and pregnancy maintenance. At ET, mean milk production was 35.2 ± 0.40 kg/d, with mean DIM of 204 ± 6.3 d and BCS of 3.0 ± 0.02 (Wildman et al., 1982). For the estrous synchronization protocol, cows received a 100 μg injection of GnRH (Fertagyl®; Schering-Plough Co., São Paulo, Brazil) and received an intravaginal P4 releasing device (CIDR®, containing 1.9 g of P4; Pfizer Animal Health, São Paulo, Brazil) on d 0, a 25 mg injection of prostaglandin $F_{2\alpha}$ (Lutalyse®; Pfizer Animal Health) and CIDR removal on d 7, and a 1 mg injection of estradiol cypionate (ECP®; Pfizer Animal Health) on d 8. Transrectal ultrasonography examinations (Aloka SSD-500 with a 7.5 MHz linear-array transrectal transducer) were performed in all recipient cows immediately before ET (d 17) to verify presence of a CL. Only cows detected with a visible CL were assigned to ET, which was performed with fresh and frozen Holstein embryos (34.5% frozen and 65.5% fresh; Table 1) which originated from *in vivo* procedures and obtained from a private company (Policlinica Pioneiros; Paraná, Brazil). Embryo collection and ET procedures were similar to those described by Vasconcelos et al. (2011), and embryos were originated from a combination of 75 donors (nonlactating heifers and cows) and 7 sires. Embryos were assigned randomly to recipient cows (Table 1). Pregnancy diagnosis was performed by detecting a viable conceptus with transrectal ultrasonography (Aloka SSD-500 with a 7.5 MHz linear-array transrectal transducer) 21 d after ET (d 38 of the study). Cows that did not become pregnant to ET were assigned to different breeding procedures and consequently removed from the study.