Effect of propylene glycol on fertility of postpartum dairy cows experiencing seasonal heat stress

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ABSTRACT

The objective of this study was to evaluate effects of a daily oral drench of Propylene Glycol (PG) on fertility in dairy cows experiencing seasonal heat stress. In treatment group, cows (n=9) were treated with drenching 250 ml propylene glycol once daily from 3 to 15 days post-partum following the morning milking. Another group of cows (n=9) was selected as untreated control. The serum beta-hydroxybutyrate (BHBA) concentrations were used as indicators of energy status of the cows. Days to onset of luteal activity, calving to first service interval and pregnancy rate to first service were used to evaluate the reproductive performance. There was no difference in onset of luteal activity postpartum between the treatment and control groups. But the cows in the treatment group tended to have shorter intervals from calving to first insemination compared with cows in control group. The pregnancy rate to first service for cows treated with PG was 2.50 times greater compared with cows in control group. The energy balance was less negative for treatment group compared with control cows. In conclusion, although, drenching with 250 mL of PG per day from 3 to 15 days after calving did not improve the onset of luteal activity postpartum, treated cows tended to have shorter intervals from calving until first service. Propylene glycol administration would improve the negative energy balance status as observed by serum BHBA concentration, which might be an advantage to increase pregnancy rate at first AI in dairy cows experiencing seasonal heat stress.

Key words: Cow, Fertility, Postpartum period, Pregnancy, Propylene glycol.

INTRODUCTION

Milk production per cow has been significantly improved over the past decade, but an increased milk production has brought a higher fertility problems. Reproductive failure in high-yielding dairy cow is a multifaceted problem. Preventive strategies may be focused on animals with certain characteristics that have been identified as a risk factor for decreased fertility (Lomander et al., 2012). Summer heat stress (HS) is a major contributing factor in low fertility among lactating dairy cows (Schüller et al., 2014). It is likely that heat stress affects reproductive performance both by direct actions on reproduction because of the deleterious effect on fertilization and embryo survival (Schüller et al., 2014) and by indirect actions mediated through alterations in energy balance (Rensis and Scaramuzzi, 2003), as there is a strong association between a negative energy balance (NEB) and decreased fertility (Lomander et al., 2012). Insufficient energy supply results in poor reproductive performance which includes a delay in the onset of estrous cycles postpartum (Reist et al., 2000) and a reduction in oocyte quality (Walters et al., 2002), and resulting in low conception rates and a high rate of early embryonic death (Leroy et al., 2008). NEB accordingly could be more deleterious in the early lactation period due to an influence of summer heat stress on fertility.

Although glycogenic diets have been shown to have beneficial effects on fertility (Van Knegsel et al., 2005), experiments focused on reproductive consequences of PG supplementation have divergent results. Some studies have shown that PG treatment has no effect on onset of luteal activity in cows (Chagas et al., 2008; Lomander et al., 2012), whereas, others (Bors et al., 2014; Rukkwamsuk and Seubsai, 2010) observed that cows treated with PG had shorter days from calving to first estrus. Similarly, other researchers (Chagas et al., 2007; Miyoshi et al. 2001) found no differences in the success of pregnancy at first AI for cows drenched with PG. However, there are others studies where oral drenching of PG was found to increase conception in cows (Mcart et al., 2012; Slobodanka et al., 2012).

Therefore, present study was conducted to evaluate effects of a daily oral drench of PG on fertility in dairy cows experiencing seasonal heat stress.

MATERIALS AND METHODS

Study area, animals and treatments: The study was conducted between June and October (2014) in a commercial...
herd in Elazig, located in eastern Turkey, and experimental procedures for animal use were conducted in accordance with the guidelines on animal welfare under the protocol approved by Ethical Committee of Firat University. The mean temperature was 27.4°C (ranging from 18.2°C to 35.5°C) during the experiment period. Eighteen lactating cows were selected for this study. Cows with detectable puerperal complications following calving were not included in the experiment. The body condition scores (BCS; point scale from 1 to 5, Edmonson et al., 1989) of the cows were 2.5-3.0. The ages of the cows ranged between 3 and 5 years. During the experiment, the cows were housed in free-stall barns with slotted concrete floors and cubicles. Drinking water was available ad libitum. They were fed a total mixed ration of corn silage and grains, that was balanced according to nutritional requirements based on milk production. Average daily milk production for the farm was between 21 to 25 kg per cow during the study period. Lactating cows were milked twice daily. The cows were assigned randomly to treatment and control groups. During 3-15 DIM, each cow in the treatment group (n = 9) was given an oral dose of 250 ml propylene glycol (PG) once daily after the morning milking. Control group (n = 9) did not receive energy supplement.

Blood sampling and biochemical analysis: Blood from the jugular vein was collected into 10-ml vacuum tube from each cow at 4, 7, 14 and 21 days post partum. Blood tubes for serum collection were kept skill for approximately 0.5 hour and centrifuged at 1500 g for 10 min at room temperature to separate serum. Serum samples were recovered, frozen and stored at -20°C until analysis.

Serum beta-hydroxybutyrate (BHBA) (Randox Laboratories Ltd, UK, Cat # RB 1008) concentrations were determined spectrophotometrically.

Milk samples for progesterone analysis were taken in the second week after parturition. Milk was sampled twice weekly until ovarian cyclical activity was detected, defined as the first sample indicating luteal activity. Progesterone concentration was measured in whole milk samples using RIA kit (Coat-A-Count Diagnostic Products Corporation, Los Angeles, CA, USA) (Petersson et al., 2006).

Gynaecological examination: Weekly regular gynecological examinations were performed by manual rectal palpation during postpartum. Cows with serum P4 concentrations ≥ 1.5 ng/mL on at least two consecutive blood samplings were considered to have luteal activity. Pregnancy diagnosis was carried out 45 d post insemination through rectal examination.

Reproductive parameters: Reproductive performance of the cows in the present study was evaluated using the following parameters; days to onset of luteal activity, calving to first service interval, pregnancy rate to first service.

Statistical analysis: The reproductive performance was studied comparing control with treatment cows using the Odds ratio (OR) for qualitative variables, and one-way analysis of variance (ANOVA) and a T test for quantitative ones. Differences with p ≤ 0.05 were considered significant and 0.05 < p ≤ 0.10 were considered as a tendency towards statistical difference.

RESULTS AND DISCUSSION

The oral drench of 250 ml of PG from 3 to 15 days after calving in the present study had no effect on the onset of luteal activity postpartum (P>0.05), even though animals from the treatment group (median = 29 d; range = 15 to 84 d) had numerically an earlier postpartum luteal activity (29.0 versus 37.8 days, respectively) when compared to the control group (median = 37.8 d; range = 21 to 98 d) (Table I). The median interval from calving until first service were 63.0 (range = 49 to 103 d) and 88.4 (range = 51 to 117 d) days for cows in the treatment and control groups, respectively. Cows in the treatment group tended to have shorter intervals from calving until first service, compared with cows in the control group (P = 0.08). At their first service, 55.6% of cows in treatment group conceived compared with 33.3% of cows in control group. The pregnancy rate to first service for cows treated with PG was 2.5 times greater compared with cows in control group (OR = 2.5; 95% CI = 0.8 to 16.9) (Table I).

A significant effect of treatment was observed in serum BHBA concentrations, with PG treated animals presenting a lower serum BHBA concentration in the examined days of lactation when compared to the control animals (Table 2). The differences in the serum BHBA concentrations between 7 and 21 days of lactation for cow

### TABLE I. Reproductive performances of dairy cows in the treatment and control groups

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Control</th>
<th>Treatment</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day to onset of luteal activity (d ± SEM)</td>
<td>37.8 ± 7.9</td>
<td>29.0 ± 4.9</td>
<td>0.49</td>
</tr>
<tr>
<td>Calving to first service interval (d ± SEM)</td>
<td>88.4 ± 9.6</td>
<td>63.0 ± 8.7</td>
<td>0.08</td>
</tr>
<tr>
<td>Pregnancy rate at first service (%)</td>
<td>33.3</td>
<td>55.6</td>
<td>0.35</td>
</tr>
<tr>
<td>Odds ratio</td>
<td>Reference</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>95% Confidence Interval</td>
<td>0.4 to 16.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE 2. Serum Beta-hydroxybutyrate (BHBA) concentrations (mean ± S.E.M.) in Holstein cows fed 3% propylene glycol in concentrate at day 4, 7, 14 and 21 of lactation.

<table>
<thead>
<tr>
<th>Days</th>
<th>Control (n=9)</th>
<th>Treatment (n=9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>865.7 ± 12.6*</td>
<td>782.9 ± 12.0*</td>
</tr>
<tr>
<td>7</td>
<td>864.7 ± 12.4*</td>
<td>810.6 ± 10.8*</td>
</tr>
<tr>
<td>14</td>
<td>837.9 ± 14.9*</td>
<td>778.9 ± 18.3**</td>
</tr>
<tr>
<td>21</td>
<td>776.4 ± 15.6*</td>
<td>728.0 ± 17.4*</td>
</tr>
</tbody>
</table>

P: P < 0.01, **: P < 0.001

* Different superscript letters (a,b) within the same column indicate significant differences within the groups. Different superscript letters (x,y) within same row indicate significant differences among groups.

In the treatment group were statistically significant (p < 0.001). The average serum BHBA concentration on days 7 and 14 of lactation for cow in the control group were significantly higher (p<0.05) in comparison with the values obtained on day 21 of lactation. The energy balance was less negative (P < 0.05) for the treatment group compared with the control cows.

PG treatment had no significant effect on the onset of luteal activity postpartum in the present study, but the animals in the treatment group had numerically an earlier postpartum luteal activity (29 vs. 37.8 days, respectively) compared with the control group. Similarly, several researchers (Chagas et al., 2008; Lomander et al., 2012) observed no effect on commencement of luteal activity in cows fed with PG when compared with controls. Conversely, some researchers (Miyoshi et al., 2001; Bors et al., 2014; Rukkwamsuk and Seubsai, 2010) found that cows treated with PG had shorter days from calving to first estrus than that of cows without PG treatment. Prolactin is temperature sensitive and its levels in summer are increased. Prolactin can inhibit follicular development and suckling-induced prolactin secretion is a cause of increased postpartum anestrus in suckled cattle (Rensis and Scaramuzzi, 2003). The fact that these animals do not return rapidly to estrus may be due to the inhibitory effects of prolactin on return to estrus cycling. In this study, the median interval from calving until first service for the treatment group was shorter than those of the control group. This result was similar to those obtained by Miyoshi et al. (2001). The pregnancy rates at first service were 55.6% of cows in the treatment group versus 33.3% of cows in the control group. The current study showed that PG-treated cows were 2.5 times more likely to conceive at first insemination than cows in control group. This finding is in agreement with a previous study (Slobodanka et al., 2012) in which an increased conception in cows following PG treatment was observed. Similarly, McArt et al. (2012) found that PG treated cows were 1.3 times more likely to conceive at first service than the control cows. Other studies (Chagas et al., 2007; Miyoshi et al. 2001) have reported no differences in the success of pregnancy at first AI for cows drenched with PG. In postpartum period, NEB negatively affects intrauterine environment, necessary for embryo implantation (Villa-Godoy et al., 1988). In serum and milk, BHBA levels are commonly used as biomarkers of energy balance in dairy cattle (Geishauser et al., 2000), the duration of elevated BHBA concentrations were associated negatively with the probability of pregnancy following the first postpartum AI (Ospina et al., 2010; Walsh et al., 2007). In this study, BHBA concentrations decreased after propylene glycol application. Likewise, a lot of studies show decreased concentrations of BHBA in plasma in response to propylene glycol administered as an oral drench (Chung et al., 2009; Gamarra et al., 2014). However, it has been reported that BHBA was not affected by propylene glycol administration (Castañeda-Gutiérrez et al., 2009). The gain in pregnancy rates due to PG observed in the present work may be attributed to improved energy status, as indicated by lower BHBA concentrations during this period. Similarly, Walsh et al. (2007) and Ospina et al. (2010) demonstrated that the increase in concentration of blood BHBA was associated negatively with pregnancy at first service, but Kessel et al. (2008) found no difference in first-service conception rate between cows diagnosed with and without elevated blood BHBA.

In conclusion, although, drenching with 250 mL of PG per day from 3 to 15 days after calving did not improve the onset of luteal activity postpartum, but these cows tended to have shorter intervals from calving until first service. Propylene glycol administration improved the negative energy balance status as observed by serum BHBA concentration. Reducing of the negative energy balance might be an advantage to increase pregnancy rate at first AI in dairy cows experiencing seasonal heat stress.

REFERENCES


