Influence of propylene glycol on conception rate in cows

ZEKI ERISIR¹ and ATILLA YILDIZ²

University of Firat, Elazig 23119 Turkey

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ABSTRACT

The aim of the study was to evaluate effect of propylene glycol (PG) drenched during the first 7 days after fixed-time artificial insemination (FTAI) on plasma progesterone (P₄) and insulin levels, and on pregnancy rate in Holstein cows in summer. Ovsynch program was performed in 40 healthy Holstein cows. Cows were distributed randomly into two groups as propylene glycol (group PG) (20) and control group (group C) (20). Group PG and group C were daily administered with 500 ml of PG and water, respectively for 7 days from day 0 to 7 post insemination. Pregnancy diagnosis was carried out 60 days after insemination via rectal examination. Cows exposed to moderate heat stress due to temperature-humidity index (74.4 ± 1.9 mean THI). Conception rate for cows in group PG increased 2.9 fold when was compared with group C. On day 7, the insulin levels were higher in group PG than group C. It was concluded that PG administered once daily from day 0 to 7 after FTAI increased insulin and P₄ concentrations and the conception rate in Holstein cows. The rise in insulin and P₄ levels depending on the drenched PC are likely related with the increases of conception rate.

Key words: Fertility, Heat stress, Insulin, Progesterone, Propylene glycol

Fertility in lactating cows is decreased during the hot seasons of the year. Summer-calved cows had greater number of services per conception and lower conception rates than cows calved in other seasons (Ghavi Hossein-Zadeh et al. 2013). The lactating cow at an air temperature of 30°C is at risk of infertility because of heat stress (Peter 2007). Heat stress has two major effects on reproduction. First, heat stressed cows demonstrate estrus less highly than other cows. Secondly, conception rate is decreased during heat stress (Hansen 2007). Thatcher (1974) showed that conception rates are depressed at environmental temperatures above the critical temperature of 21°C. Heat stress affects the development and the function of the corpus luteum and causes a decrease in P₄ levels (Ullah et al. 1996). Therefore, the FTAI and various hormonal protocols to improve the use of artificial insemination are widely used in the dairy farms to prevent the negative effects on reproductive performance of high temperature environment. However, the ability of these strategies to improve the fertility is limited. Use of FTAI protocols can eliminate problems of estrus detection that heat stress caused. But this was not adequate to reinstate herd pregnancy rates to a level seen in cool weather due to the serious outcomes of heat stress for embryogenesis (Hansen and Are’chiga 1999). Hence, alternative techniques to FTAI protocols that improve pregnancy rates for a systematic breeding system should be developed. Leroy et al. (2006) showed that cleavage rate and blastocyst development were severely reduced in vitro in a low glucose environment vs. a physiologically normal glucose environment. The use of glycogenic supplements during the estrous cycle increased the synthesis of P₄. Oral drenching of PG raises insulin levels which affect the developing corpus luteum directly. (Miyoshi et al. 2001). Insulin is required for maintenance of P₄ synthesis, which eases lipoprotein using in bovine luteal cells (Poff et al. 1998). Luteal function and conception rate improves in cows treated with insulin subcutaneously (Selvaraju et al. 2002). Propylene glycol is a substance used in prevention and treatment of ketosis in dairy cows (Rakkwamsuk et al. 2010). There are studies where oral drenching of PG has an increased conception rate in cows (McArt et al. 2012, Slobodanka et al. 2012). However, other groups have reported no differences in the success of pregnancy at first artificial insemination for cows drenched with PG (Chagas et al. 2007, Miyoshi et al. 2001). Hidalgo et al. (2004), using PG for embryo transfer, found that the group of cows treated had higher 60–day pregnancy rates than the control group. Propylene glycol improved in vitro embryonic development rate (Ponsart et al. 2014). However, the results of using PG are controversial for the success of conceiving and need more investigation. Thus, it can be speculated that PG drenched in the first seven days post insemination are useful for the establishment of pregnancy by increasing plasma P₄ and insulin concentrations in dairy cows during the hot season. Therefore, the present investigation was undertaken to evaluate the effect of PG
drenched during the first seven days after FTAI on plasma P₄ and insulin levels, and on conception rate in Holstein cows during summer.

MATERIALS AND METHODS

Study area, animals and treatments: The study was conducted on 40 healthy Holstein cows at a private dairy farm located in Elazig province of Turkey in summer season. Elazig region is between the latitude of 38° 40’N and longitude of 39° 13’E, at an altitude of 1,093 m. Ambient temperature (AT) (°C) and relative humidity (RH) were obtained from reports prepared at Turkish State Meteorological Service. The mean temperature was 29.4 ± 0.5°C with in the period of the experiment. The relative humidity was 29.7 ± 2.3%. The temperature and humidity index (THI) was obtained using the formula: THI=(0.8×AT+(RH%/100)×(AT°14.4)+46.4) (Thom 1959). Cows with detectable puerperal complications following calving were not included in the experiment. The body condition score (point scale from 1 to 5) were 2.5–3.0 units. The mean body weight was 517.0 ± 34.57 kg. The parity of cows ranged between 2 and 3. During the experiment, all the animals were kept under the similar feeding and managerial conditions. Average daily milk production for the farm was between 20 to 23 kg/cow during the study period. Lactating cows were milked twice daily. All cows were examined by rectal palpation and vaginoscopic examination at week 6 post-partum. There were no clinically detectable disorders in their reproductive tracts. On 45th day of lactation, Ovsynch protocol was done with the administration of GnRH (Busereline acetate). The administration of PGF₂α analogue D- Cloprostenol (25 mg, Dinoprost tromethamine) was done on day 8 after first administration and second GnRH administration was on day 10 after first administration. Cows were artificially inseminated after 18h following second GnRH administration. At insemination (day 0), cows were distributed randomly into two groups as group PG and control group (group C). The randomization was stratified by parity, body weight and BCS. Propylene glycol (group PG) and water (group C) were supplied via drench in a volume of 500 ml once daily from day 0 to 7 post insemination. The diagnosis of pregnancy was done on 60th day after insemination via rectal examination.

Sample collection and biochemical assays: In all animals, blood samples to be assayed for P₄ and insulin were obtained from the jugular vein using heparinized vacutainer tubes just before the application on day 0 (oestrus) and one hours after the administration of PG or water on day 7. Samples were later centrifuged at 1,500 × g for 15 min for plasma separation, which was then stored at −20°C until being analyzed. Insulin concentrations were measured by RIA in solid phase, using the insulin kit, having a 0.05 ng/ml sensibility and a 9.5% intra assay variation coefficient. Plasma P₄ concentration was determined using a commercial solid-phase RIA kit. The sensitivity of the assay was 0.1 ng/ml and the intra assay CV was 5.6%.

**Statistical analysis:** The conception rates of groups were compared with the Odds ratio (OR). The reference category had an OR = 1. An adjusted OR > 1.0 indicates that the probability of the increased conception rate because of the treatment was, compared with cows in the reference category. Insulin and P₄ concentrations were compared using a t-test to determine the effects of treatment. Results were considered statistically and declared significant at P < 0.05.

RESULTS AND DISCUSSION

Mean values of THI were equal to 74.4 ± 1.9. Cows in the study exposed to moderate heat stress according to the temperature-humidity index (74.4 ± 1.9 mean THI).

Plasma concentrations of insulin and P₄ on Day 0 and Day 7 are presented in Table 1. On day 7, the insulin levels were higher in group PG (P < 0.05) than group C. The insulin levels on Day 7 for cows in group PG were statistically higher compared to ones on day 0 (before treatment) (P < 0.05). In the current study, we obtained that drenching of PG increased insulin plasma concentrations, which is in accordance with other previous studies that reported an increase in the concentrations of insulin following administration of PG (Christensen et al. 1997, Miyoshi et al. 2001). Propylene glycol may stimulate insulin secretion directly (Studer et al. 1993). Likewise, it is possible that the PG stimulates pancreatic insulin secretion indirectly by PG metabolizes to propionate (Webb et al. 1999).

The average P₄ concentration was higher (P<0.05) in group PG when compared with group C on Day 7 after insemination. Plasma P₄ concentrations increased significantly on day 7 after PG drenching. This was similar to the findings of Miyoshi et al. (2001) who found a significant rise in milk P₄. Elevation of insulin by PG drenching affects the developing corpus luteum directly (Miyoshi et al. 2001). Insulin is a requisite to maintain P₄ synthesis and ease lipoprotein using in bovine luteal cells (Poff et al. 1998). Cows treated with insulin subcutaneously display rises in P₄ concentrations (Selvaraju et al. 2002). Likewise, insulin-like growth factor-1 (IGF-I) stimulates P₄ production by cultured bovine luteal cells (Chakravorty et al. 1993). Also, drenching of PG is known to rise IGF-I

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Days</th>
<th>Group C n=20</th>
<th>Group PG n=20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Progesterone (ng/mL)</td>
<td>0</td>
<td>0.67 ± 0.19A</td>
<td>0.69 ± 0.17A</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>2.89 ± 0.37Bb</td>
<td>3.38 ± 0.41Bb</td>
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<tr>
<td>Insulin (ng/mL)</td>
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<td>15.69 ± 0.43</td>
<td>15.63 ± 0.51A</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>14.78 ± 0.37A</td>
<td>19.87 ± 0.59Bb</td>
</tr>
</tbody>
</table>

Values with different superscript letters within a row differ significantly at P < 0.05. Values with different superscript letters within a column differ significantly at P < 0.05.
In conclusion, the results of the present study indicate that drenching of PG at a dose rate of 500 ml/day from days 0 to 7 after insemination increases insulin and P₄ concentrations and the conception rate in Holstein cows. The rise in insulin and P₄ concentrations after drenching PG leads to an increase in the conception rate. This application can provide a contribution to improve low conception rates due to moderate heat stress occurred especially in the summer.

**REFERENCES**


