RELATIONSHIP BETWEEN VITAMIN A AND β-CAROTENE LEVELS DURING THE POSTPARTUM PERIOD AND FERTILITY PARAMETERS IN COWS WITH AND WITHOUT RETAINED PLACENTA

YASAR AKAR1 AND ABDULLAH GAZIOGLU2

1 Department of Obstetrics and Gynaecology, 2Department of Internal Medicine, Faculty of Veterinary Medicine, Firat University, 23119 Elazig, Turkey
e-mail: yasakar@yahoo.com

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Abstract

Serum vitamin A and β-carotene levels were ascertained in cows with and without retained placenta during 2-6 weeks postpartum and their relationship to fertility parameters were studied. Twenty cows with retained placenta and 20 controls were examined. In cows with retained placenta, serum vitamin A values were significantly lower in the 2nd week after parturition when compared with the other weeks. In the control group, the values were significantly higher the 6th week than those in the 2nd and 4th weeks. Serum vitamin A level in the retained placenta group was significantly lower than that in the control group in the 3rd, 5th and 6th weeks. Serum β-carotene levels increased gradually in both groups after parturition. Values for the retained placenta cows were significantly lower than in the controls throughout the postpartum period. The calving to the first oestrus and calving to conception intervals were considerably longer in the retained placenta group, but statistically no significant differences were found between the groups in terms of calving to conception interval, services per conception, the first service conception rate, and total pregnancy rate. It was concluded that poor fertility parameters in cows with retained placenta, as compared to the control group, could relate to the low content of vitamin A and especially β-carotene.

Key words: cow, retained placenta, vitamin A, β-carotene, fertility.

Retained placenta (RP) is an important postpartum disease in dairy cows with a frequency range between 2% and 69% (1, 5, 22). Various causes of RP have been identified i.e. uterus atony, abortions, late or premature birth, dystocia, twinning, deficiency in vitamins A and E, β-carotene and selenium, etc. (1, 22). RP causes a decrease in milk yield; creates additional expenses for animal owners and also reduces fertility by increasing the likelihood of metritis (1).

In cows, normal vitamin A level is 25-80 µg/100 ml, subnormal level - 7-12 µg/100 ml, and values below 7 µg/100 ml represent deficiency. β-carotene normal level is 300-1 200 µg/100 ml, subnormal level - 100-200 µg/100 ml and level of 9-100 µg/100 ml is regarded as deficiency (6, 24). Cows fed green fodder have serum β-carotene and vitamin A levels during the summer months (June-July) considerably higher than in other months. Also, a relationship between the levels of serum vitamin A and β-carotene, and feeding sources and seasons was established (3, 7, 22).

Vitamin A is an essential vitamin for sight, bone-muscle growth, protection of the integrity of epithelial cells, immune cell functions, gene arrangement, and normal reproductive activity in cows (9, 11, 13, 14). The clinical signs of vitamin A deficiency towards the end of pregnancy are abortion, RP, night blindness, diarrhoea and an increase in the number of dead, blind, weak and sick calves (11, 14, 27). Persistence of vitamin A deficiency after parturition may decrease the conception rate (14). An adult cow needs 76 IU of vitamin A/kg/d in the diet in order to maintain its normal reproductive function (27).

β-carotene, the precursor of vitamin A, shows antioxidant effect and influences reproductive and thyroid functions (24, 27). One mg of β-carotene is equivalent to 400 IU of vitamin A (3, 12, 13, 24, 27). β-carotene deficiency in cows prolongs the oestrus period, delays ovulation, increases abortions and early embryonic death rates, weakens the oestrus signs, increases ovarian cysts, RP and metritis risk, increases delivery rates of dead, weak, and blind calves and reduces fertility (4, 8, 11, 13, 14, 24). An adult cow needs 0.18 mg of β-carotene/kg/d in order to maintain its normal reproductive functions (13, 27).

The corpus luteum contains a high level of β-carotene (12-14). However, it does not contain vitamin A and low fertility is related to a low level of β-carotene.
Hurley and Doane (14) reported that a high β-carotene level influenced the release of ovarian steroids. On the other hand, other researchers (11) reported that β-carotene stimulated LH secretion from the hypophysis and thus increased progesterone production. Dunn and Moss (8) showed high vitamin A and 17-β oestradiol concentrations in normal follicles compared to tiny and atretic follicles, and suggested that this was a sign of the survival of the follicle.

In this study, serum vitamin A and β-carotene levels in cows with or without RP were examined during the postpartum period and their relationship to fertility parameters was studied.

**Material and Methods**

The study was performed on 40 Brown Swiss breed cows, aged 2-6 years, at the research and practice farm of Firat University. The animals that were unable to discharge foetal membranes totally or partially within 24 h postpartum were considered to have RP (20 cows), while those that could discharge all the membranes were considered the control group (20 cows). All the cows were in the same barn and fed the same diet.

Jugular vein blood samples were collected into sterile containers between January to May, 2002. Ten milliliter of the blood was collected from all cows on days 14, 21, 28, 35 and 42 postpartum. The blood was centrifuged at 3000 r.p.m. for 20 min and sera were placed into sterile tubes and then frozen at –20 °C. Serum vitamin A and β-carotene levels were measured using spectrophotometric method (Schimadzu UV-1208, UV-VIS spectrophotometer).

The cows were examined rectally three times per week from week 2 postpartum until the first service, and their ovarian activity was recorded. Cows were inseminated at each oestrus detected on day 45 or later and pregnancy was determined by ultrasound examinations 35 d after the service. The animals were observed until day 120 postpartum and those that were not pregnant were considered infertile.

Vitamin A and β-carotene levels were compared by paired t-test within each group, whereas these values between groups were compared by independent Student t-test. Calving to the first oestrus, calving to the first service and calving to conception intervals were compared by independent Student t-test; the services per conception, the first service, and total pregnancy rates was compared by Chi-square test (26). These analyses were made with SPSS (25).

**Results**

The serum vitamin A values are given in Table 1. In the RP group, vitamin A level on day 14 was significantly lower (P<0.05) compared to the other days. In control group, vitamin A level was significantly higher at day 42 postpartum compared to days 14 and 28 (P<0.05). In both groups, the serum β-carotene levels increased considerably (P<0.05) on the succeeding days after the parturition (Table 2).

The comparison of serum A vitamin levels between the both groups (Table 1) indicates that while there were no differences in vitamin A levels on days 14 and 28 postpartum between cows with and without RP, the levels on days 21, 35 and 42 were significantly higher in the control group (P<0.05, P<0.01, P<0.01, respectively). On all days postpartum, the β-carotene levels of the control group were statistically higher than those in the group with RP (P<0.05 or P<0.01) (Table 2).

Table 3 shows the fertility parameters of control and RP cows. The calving to the first oestrus and calving to the first service intervals were considerably longer in the group with RP (P<0.05). Regarding other fertility characteristics, no differences were found between control and RP group (P>0.05).

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Vitamin A levels (µg/dl) in cows with and without RP</th>
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<tbody>
<tr>
<td></td>
<td>Postpartum days</td>
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<tr>
<td></td>
<td>14</td>
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<tr>
<td>RP (n:20)</td>
<td>38.49±2.07&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>C (n:20)</td>
<td>51.92±2.60&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>P</td>
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</tbody>
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<sup>a,b,c,d</sup>: the group average difference represented by different letters in the same line is significant (P<0.05).
- P>0.05; * P<0.05; ** P<0.01.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>β-carotene levels (µg/dl) in cows with and without RP</th>
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<tr>
<td></td>
<td>Postpartum days</td>
</tr>
<tr>
<td></td>
<td>14</td>
</tr>
<tr>
<td>RP (n:20)</td>
<td>11.24±0.88&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>C (n:20)</td>
<td>14.11±0.97&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>P</td>
<td>*</td>
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</table>

<sup>a,b,c,d</sup>: the group average difference represented by different letters in the same line is significant (P<0.05).
* P<0.05; ** P<0.01.
Discussion

It is well known that vitamin A and β-carotene deficiency causes negative impacts on fertility and increases RP incidence in cows. In addition, abortion, night blindness, increase in the birth of weak and sick calves, weakening the oestrus symptoms, and delay in ovulation are other negative outcomes related to deficiency of vitamin A and β-carotene. Several authors have suggested that vitamin A and β-carotene supplementation have some beneficial effects, including stronger oestrus symptoms, decreased incidence of luteal cysts, decreased services per conception, shortening of calving to the first oestrus and calving to conception intervals and increase in total pregnancy rate. However, our results disagree with the results of the two previous works, which found no difference for the mentioned parameters one day postpartum. The low levels of vitamin A and β-carotene in both groups in our trial were thought to be due to the collection of blood samples in the winter months.

Several authors have suggested that vitamin A and β-carotene supplementation have some beneficial effects, including stronger oestrus symptoms, decreased incidence of luteal cysts, decreased services per conception, shortening of calving to the first oestrus and calving to conception intervals and increase in total pregnancy rate. It was reported that the pregnancy rate following the first insemination was 48.6% and there was no significant association between this rate and serum vitamin A or β-carotene levels in dairy cows. The other authors reported that vitamin A supplementation had no effect on the incidence of RP and did not improve the reproductive parameters. They also noted that services per conception were 3.08 for controls and 2.2 for supplemented cows; the intervals from calving to conception were 122 and 129 d for controls and supplemented cows, respectively. In the present study, calving to conception intervals were significantly increased in cows with RP. The findings that poor fertility and lower vitamin A and β-carotene levels in infertile cows whether housed or at pasture, but β-carotene levels were significantly lower in housed cows. These findings agree with the previous studies which generally report a decrease in vitamin A and β-carotene levels at calving and thereafter an increase in their levels in the postpartum weeks. However, our results disagree with the results of the two previous works, which found no difference for the mentioned parameters one day postpartum. The low levels of vitamin A and β-carotene in both groups in our trial were thought to be due to the collection of blood samples in the winter months.

Table 3

<table>
<thead>
<tr>
<th>Fertility parameters</th>
<th>RP (n:20)</th>
<th>C (n:20)</th>
<th>P</th>
</tr>
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<tbody>
<tr>
<td>Calving to oestrus interval (d)</td>
<td>50.06±6.36</td>
<td>31.50±2.33</td>
<td>*</td>
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<tr>
<td>Calving to first service interval (d)</td>
<td>81.00±4.93</td>
<td>62.38±4.88</td>
<td>*</td>
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<tr>
<td>Calving to conception interval (d)</td>
<td>95.60±7.51</td>
<td>73.86±10.34</td>
<td>-</td>
</tr>
<tr>
<td>Services per conception</td>
<td>1.4</td>
<td>1.3</td>
<td>-</td>
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<tr>
<td>First service pregnancy rate (%)</td>
<td>53.33</td>
<td>62.50</td>
<td>-</td>
</tr>
<tr>
<td>Total pregnancy rate (%)</td>
<td>65.55</td>
<td>70.00</td>
<td>-</td>
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- P>0.05; * P<0.05.
β-carotene levels occurred in cows with RP were controversial to the above mentioned literature.

In conclusion, serum vitamin A and β-carotene levels increased gradually postpartum in cows both with and without RP, but their levels were significantly lower in cows with RP compared to the control group. It was thought that the low fertility observed in cows with RP was associated with the deficiency of vitamin A and β-carotene. Additionally, it seems that the observed low levels of β-carotene and vitamin A in all the cows were due to lack of green fodder in animal diet.

References


25. SPSS 2000: 10.0 software for Windows.
