Plasma Concentrations of β-Carotene and Vitamin A in Cows with Ovarian Cyst

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\textbf{Abstract.} Plasma levels of β-carotene and vitamin A in Holstein cows with ovarian cysts, raised on a feed with low β-carotene contents were determined. Feeding green forages significantly increased plasma β-carotene but had small effect on vitamin A in cows. The levels of β-carotene were significantly lower in cows with ovarian cysts than those in cows without ovarian cysts, when they were fed only straw and concentrates. The levels of vitamin A were also slightly lower in cows with ovarian cysts.—key words: β-carotene, dairy cattle, ovarian cysts.


The role of vitamin A in livestock has been reported from many different aspects [1, 12]. The role of β-carotene, a provitamin A in plant materials, however, is less clear. Recently, German researchers [8,10] reported that dairy cows fed with low β-carotene contents showed impaired reproductive functions such as an increase in the number of ovarian cysts, changes in the pattern of sexual behaviour and a decrease in conception rates. In many parts of Japan, as in southern Osaka where green forages and hay are scarce and expensive, many cows are raised on a feed with low β-carotene contents. In the present study we determined the β-carotene and vitamin A levels in the daily cows with ovarian cysts, together with seasonal and estrous-cyclic changes.

A total of 61 Holstein cows from two different feedings were used in this study. They were multiparous and lactating. Eleven cows in group 1 were mainly fed silage, some hay, straw, and concentrates in winter, while they were fed ample amounts of green forage in early summer. Fifty cows in group 2 were fed no green forages and were given only straw and concentrates ad libitum over a period of 6 months. Reported β-carotene concentrations of rations were 150–300 mg/kg in green forages, 2–30 mg/kg in silage and hay, and little in straw and concentrates [8]. In group 1, blood samples were collected at 2-day intervals during an estrous cycle between September and November from 5 cows and at monthly intervals throughout a year from the remaining 6 cows. Animals in group 1 had no ovarian cysts. The presence of the ovarian cysts was examined through rectal palpation and the cyst was defined as smooth, rounded follicular structures having diameter of 2.5 cm or more on one or both ovaries [9]. Cows diagnosed as having ovarian cysts were examined again 2 weeks later. Blood samples were collected once between January and June from cows in group 2 that were classified into 2 subgroups based on the presence of ovarian cyst. Blood samples were collected into a heparinized syringe by puncture of the tail vein or artery, and placed immediately on ice in a dark contain-
er for transport to the laboratory for processing. Blood was centrifuged at 800×g for 20 min. Plasma was stored in a dark container and frozen at −80°C until assay. Plasma vitamin A (total vitamin A) and β-carotene were extracted by the method of Johnston and Chew [5] and determined by the high performance liquid chromatography with ODS C18 column (46×150 mm, 5 μm) [3]. Plasma concentration of progesterone was measured by radioimmunoassay [4]. Results of the assays were analyzed for significance by Student's t test.

The changes of plasma levels of β-carotene, vitamin A and progesterone at different stages of an estrous cycle in cows of group 1 given green forages are shown in Fig. 1. There was no difference in plasma levels of β-carotene and vitamin A throughout an estrous cycle, though progesterone increased from the day of ovulation to 14 days after ovulation and then decreased. The changes in vitamin A levels during an estrous cycle obtained in the present study agreed with those reported previously [8]. In contrast to the previous report where the β-carotene levels were reported to be highest during the luteal phase [8], the present data indicate no significant changes in the β-carotene levels in cows given green forages throughout an estrous cycle. The discrepancy may be due to the low levels of plasma β-carotene in our research.

Monthly changes in plasma β-carotene and vitamin A levels are shown in Fig. 2. Plasma concentration of β-carotene rose to much higher levels during early summer when green forages provided ample amounts of β-carotene. Immediately after the cows were put on a winter ration which usually supplied much smaller amounts of β-carotene, the plasma concentration rapidly dropped. These results suggest that the body pool of β-carotene is relatively small. On the contrary plasma concentration of vitamin A was slightly higher during summer.

![Fig. 1](image1.png)

**Fig. 1.** The changes of plasma levels of β-carotene, vitamin A and progesterone at different stages of the cycle in cows given green forages. The points and vertical lines represent means±SEM of 5 cows.

![Fig. 2](image2.png)

**Fig. 2.** Seasonal variations of plasma levels of β-carotene and vitamin A in cows given green forages. The points and vertical lines represent means±SEM of 6 cows.
Table 1. Plasma concentrations of β-carotene and Vitamin A in cows with and without ovarian cyst which were given straw and concentrates

<table>
<thead>
<tr>
<th>Subjects</th>
<th>n</th>
<th>β-Carotene (µg/dl)</th>
<th>Vitamin A (µg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cows without ovarian cyst</td>
<td>29</td>
<td>33±4*</td>
<td>28±2</td>
</tr>
<tr>
<td>Cows with ovarian cyst</td>
<td>21</td>
<td>11±2**</td>
<td>21±2*</td>
</tr>
</tbody>
</table>

a) Mean±SEM.  
* P<0.01, ** P<0.001.

The seasonal differences in plasma β-carotene and vitamin A levels disappeared in cows which were not fed green forages over a period of 6 months. Table 1 shows the plasma levels of β-carotene and vitamin A in cows given only straw and concentrates. As a whole these cows had low β-carotene levels, and the levels were significantly lower (P<0.001) in cows with ovarian cysts than in cows without ovarian cysts. Plasma levels of vitamin A were slightly but significantly lower in cows with ovarian cysts. It has been reported that bovine fertility might be affected when the blood plasma contained less than 200 µg of β-carotene per dl [8], and 22 µg of vitamin A per dl [2]. The levels of plasma β-carotene of cows with ovarian cysts obtained in the present study seem to be the severely deficient levels and the levels of plasma vitamin A of these cows seem to be the deficient levels.

It has been reported that the ovarian cyst was detected in 48% of dairy cows during winter when β-carotene supply was usually low [7]. A lack of dietary β-carotene seems to be one of the factors for the high incidence of ovarian cysts in this season. It has been suggested that β-carotene itself plays a specific role on the reproduction in the cattle apart from that of vitamin A [8, 10]. Sklan [11] reported β-carotene cleavage enzyme activity in bovine ovaries in vitro and suggested a possible conversion of β-carotene to vitamin A prior to its action in the ovary. Alternatively, vitamin A may act on the biosynthesis of ovarian steroid hormones. In this respect, Juneja et al [6] reported that vitamin A deficiency markedly affected the synthesis of steroid hormones in rat ovaries.

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REFERENCES

要約
卵巣腫瘍の血漿中β-カロチンおよびビタミンA量：稲葉俊夫・免山枝時1)・清水亮佑1)・中野長男2)・森純一（大阪府立大学農学部家畜臨床繁殖学教室, 1)家畜外科学教室, 2)栄養学教室）——ホルスタイン種乳牛に低β-カロチン飼料を与えて、卵巣腫瘍を誘起させたときの血漿中β-カロチンおよびビタミンA量について検討した。青草飼料を給与すると血漿中β-カロチン量は有意な上昇を示し、ビタミンA量はわずかな上昇を示した。稲わらと燕麦飼料のみを給与した場合には、血漿中β-カロチン量は卵巣腫瘍罹患牛では非罹患牛に比べて有意に低値を示した。血液中ビタミンA量も卵巣腫瘍罹患牛では非罹患牛に比べてわずかに低値を示した。