# Selenium Status of Grazing Beef Cattle in Japan

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## SUMMARY

The selenium(Se) status of cows grazed either in summer season or year round and effects of Se supplementation on grazing cows were investigarted.

The Se concentration in blood from cows grazed in the summer season decreased by pasturing from 0.079 μg/ml to 0.041 μg/ml. The reduced values of autumn samples, however, were above indicative levels of deficiency. It seemed likely that cows pastured through the summer and receiving a concentrate containing a high level of Se through winter may be free of Se deficiency.

Se levels in blood and tissues from cows grazed year round were similar to those previously reported for cows with Se deficiency, but no clinical signs were observed in this study.

Se supplements restored Se status and GSH-Px activity of cows grazing year round, but had no influence on α-tocopherol levels in either plasma or tissues. None of the newborn calves regardless of whether their dams received Se supplementation or not, showed any clinical signs of Se deficiency. An improvement in the growth rate of body weight, wither height and chest girth was, however, observed in calves from Se treated cows at the weaning period.

It was concluded that the occurrence of clinical symptoms of Se deficiency such as muscle dystrophy might be caused not only by the low Se intake, but also because of the vitamin E status and/or other factors.

## INTRODUCTION

Cows are raised on grasslands more often than in drylot feeding. Se poisoning in cows has been reported in localized areas in many countries, when cows were under grazing conditions On the other hand, it was after the Second World War that Se deficiency in grazing cows became a problem and a recently well known disease occurring in grazing cows throughout the world.

As to Se deficiency, the symptom known as whitle muscle disease (WMD) occurs widely in deficient animals and mostly in calves. This disease is a kind of nutritionally induced muscle lesion which causes a white cardiac muscle accompanied by cardiac insufficiency, motor ataxia and retained placenta. Morevoer it sometimes causes depression in body weight gain. Anorexia, loss of tail hair and sloughing hoofs are symptoms of Se poisoning.

In Table 1 the minimal requirements and toxic levels of Se in the cattle diet are shown. As shown in the Table, there are not only considerable differences in Se requirements between countries but a

Table 1. Requirement and toxic level of Se in beef cattle (mg/kg DM of feed)

| | Requirement | Tolerance limit |
|---|---|---|
| France (INRA 1978) | 0.1 | |
| UK (ARC 1980) | 0.05 | 3 |
| USA (NRC 1984) | 0.20 (0.05–0.30) | 2 |

large range of values such as the case from the NRC standard. Japanese standard is applied with NRC values. Thus it may be said that the dietary requirements of Se are not yet well established and fairly uncertain. For example, Jenkins *et al*[1] has reported that a 0.02–0.04 ppm Se concentration in pasture brings on WMD but not in concentrations over 0.1 ppm. Nevertheless, cases have been reported of WMD with 0.05 ppm Se in the ration[2] and, on the contrary, no outbreaks of WMD with a concentration lower than 0.02 ppm in pasture[3]. Liekwise, the relationship between the outbreak of Se deficient symptoms and Se content in pasture is not obvious in grazing cattle.

Meanwhile, it has been known that the values of Se content in Japanese pastures are usually much lower than that of dietary requirements for cows[4]. The outbreak of deficient symptoms such as WMD has, however, not yet been reported in Japan.

This report is the first to show the Se status of grazing cows in Japan and then to clarify the relationship between Se content of pasture and Se deficiency.

## I. Se status of grazing cattle in summer season

In the so called "summer mountain, winter village system", cows are pastured from spring to autumn and housed in winter. This grazing system is used extensively in Japan, especially in the northern areas. For experimental purposes, 35 cows, Japanese black, which were maintained in this system in two ranches located in Aomori and Fukushima prefectures, were used as experimental animals. Samples of blood and grass were collected at the beginning (Spring) and the end (Autumn) of the grazing period and assayed for Se concentration. The results of Se assays are shown in Fig. 1. Se content in blood sampled both in Aomori and Fukushima was significantly ($P<0.01$) higher in Spring than in Autumn. In other words, the Se content in blood significantly decreased by pasturing from Spring to Autumn. The Se content in pastures from both sites was considerably low, judging from the feed requirements for beef cattle. No apparent differences in Se concentration of pasture were observed between Spring and Autumn. In spite of the low values in blood Se which were observed in Spring, none of the symptoms for Se deficiency, such as WMD, was diagnosed among dam cows and their calves. The fact that the blood Se is high in Spring and low in Autumn means that the Se content in the cows blood increased during the winter season when cows were fed some cereal and meal in addition to grass hay, since the grazing system was repeated yearly for many years.

The Se concentration in most of these additional feeds was considerably higher than that of grass.[4] Thus it is conceivable that cows in this grazing system are supplied Se in feed rations containing sufficient Se during the winter.

## II. Se status of cattle grazing all year round on pasture

In the warm (temperate) district of southwest Japan it is not unusual to find cows grazing all year round on pasture. We found a ranch in Kagawa prefecture in Shikoku Island where cows grazed year round on pasture without any other additional ration and a survey was conducted for Se

condition in these cows. Se concentration was determined in the grass samples and blood samples which were collected from 42 cows in Spring and Autumn. The results are shown in Fig. 2. Blood Se content in Spring and Autumn were very low and similar to each other, and differed from that of Aomori or Fukushima. The marginal value of blood Se concentration for outbreak of Se deficiency has not been clearly established.

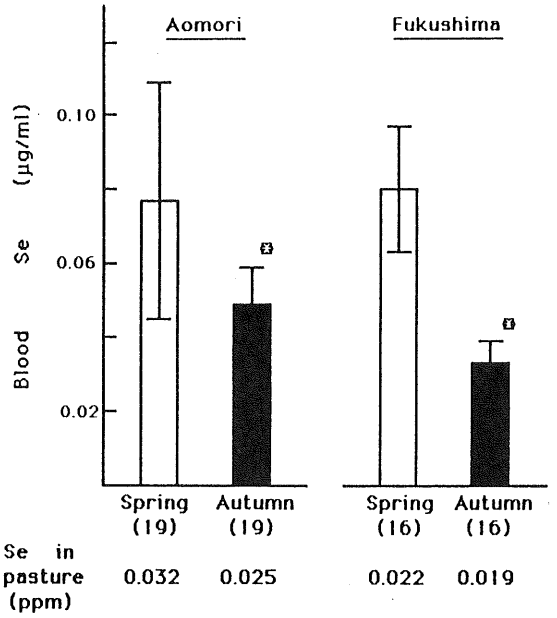


Fig. 1. Se concentration in pasture and Se levels in cows grazing in summer season. The numbers in parentheses express the number of experimental cows.

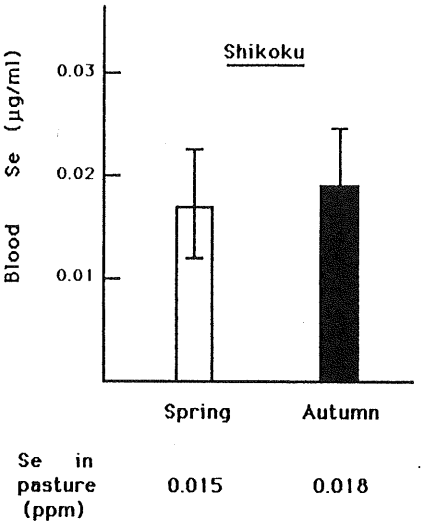


Fig. 2. Se concentration in pasture and average blood Se level in 42 cows grazing all year round.

| Blood Se (μg/ml) | Diagnosis |
|---|---|
| < 0.01 | deficient |
| 0.01 – 0.02 | doubtful |
| > 0.02 | normal |

The following criteria has been reported for the diagnosis of Se deficiency in young sheep[5]:

Since there is a species difference between cows and sheep it is questionable whether to directly apply the data of sheep to cows. It was considered, however, that the values of 0.017 and 0.019 μg/ml observed in the experiment might induce Se deficiency. In practice, as a matter of fact, no evidence for Se deficiency in dams and their calves has been observed thus far. On the other hand, the 42 cows examined in this experiment varied in age from 1 to 8 years. Blood Se concentration arranged according to age is shown in Fig. 3.

Since all cows had been raised on the ranch and kept grazing on pasture throughout the year, older cows were kept under low Se feeding conditions for a longer period than the younger cows. Blood Se concentration of grazing cows lower than a certain level was observed in young cows aged 0–1 year rather than in older cows. This might be related to a higher incidence of WMD in young cows than in mature cows.

Table 2 shows Se content in tissues collected from 5 Japanese black steers born on the ranch and raised on pasture all year round for three years. In order to compare results, data reported by Kume *et al.*[6] and by Hoffman *et al.*[7] are also listed in Table 2. Se content in tissue observed in the

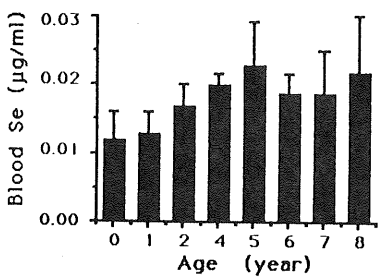


Fig. 3. Mean concentration of blood Se in grazing cows arranged according to their age.

Table 2. Se concentrations in tissue of steer (mg/kg in DM)

| | KAWASHIMA *et al.* | KUME *et al.* (1981) | HOFFMAN *et al.* (1973) | |
|---|---|---|---|---|
| Diagnosis | ? | Normal | Deficiency | Normal |
| No. of steers | 5 | 15 | 33 | 18 |
| Liver | 0.25 | 1.12 | | |
| Kidney | 3.83 | 4.25 | 2.40 | 5.45 |
| Spleen | 0.34 | | | |
| Heart muscle | 0.18 | 0.31 | 0.18 | 1.10 |

experiment was considerably lower than values for normal animals reported by Kume *et al.* and Hoffman *et al.* and close to Hoffman's values for deficiency. Although Se concentration in tissues was lower than the values of 5 ppm and 0.5 ppm proposed by Hoffman *et al.* as the indicative levels of deficiency in kidney and heart muscle respectively, no histological abnormality was observed in internal organs or muscle tissues.

**III Effect of Se supplementation on grazing cattle**

Eighteen cows of 37 mature Japanese Black cows grazing continuously on fairly low Se pasture were each administered 2 Se containing iron pellets in the rumen and the remaining 19 cows served as controls. All cows were kept under grazing conditions for about 2 years. The changes in blood Se concentration after Se pellet administration are shown in Fig. 4.

Se pellet administration significantly increased blood Se concentration and kept its efficacy more than 2 years. Glutathion peroxidase activity (GSH-Px) showed changes similar to those of blood Se concentration. Creatine phosphokinase activity (CPK) appears intensively in the plasma of cows with muscular disease. Since no especially high value even in pellet untreated cow was determined, none of the cows were diagnosed as having muscle disease. No difference in fertility between the group treated with Se pellet and the control group was observed.

Fig. 5 shows the effect of Se pellet administration on plasma α-tocopherol ( α-Toc). No obvious influence of Se treatment on plasma α-Toc level was determined. Few reports concerning plasma α-Toc concentration in Se-deficient cows have been published at this point. Plasma α-Toc observed in the experiment was slightly higher than that reported in other papers[8,9]. It is well known that α-Toc content of forage in young pasture grass is usually high, and decreases with the advance of growth. Fresh pasture is also known to be higher in α-Toc content than both hay and silage. It appeared likely that the elevated level of Vitamin E (V.E.) in grazing cows observed in this experiment might result from grazing in green forage all year round. The concentration of Se and α-Toc, and GSH-Px activity in the tissues of the three cows each for Se pellet treated group and control group which were slaughtered eight months from the commencement of the experiment are shown in Table 3. Se concentration and GSH-Px activity in most tissues was significantly higher in the Se treated group than in the untreated control group. No difference in α-Toc concentration between groups was observed. The values for α-Toc were comparatively higher than those reported by other researcher[10].

**IV. Effect of Se supplementation to cows on Se status of their calves**

The outbreak of WMD more common in young calves than in cows. In connection with this phenomena, the relationship between Se status in cows and that in their calves was examined. Four cows each from Se treated group and control group were calved 20 to 22 months after the administration of Se pellet and the blood Se levels of calves were compared with those of their dams. As shown in Fig. 6, the blood Se concentration of calves which were born from Se treated

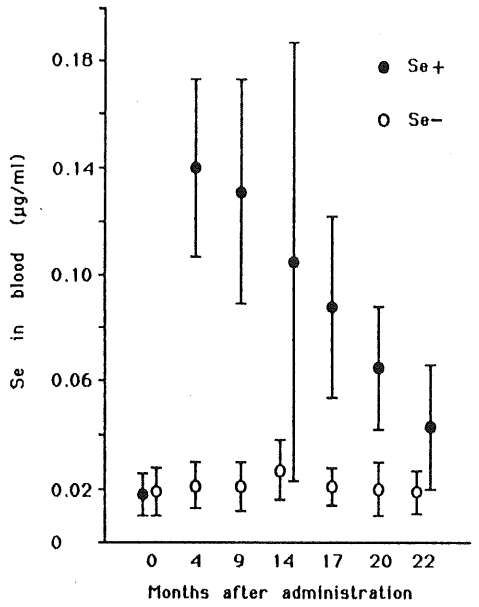


Fig. 4. Change in blood Se levels in grazing cows;
Se −: control group, Se +: Se treated group.

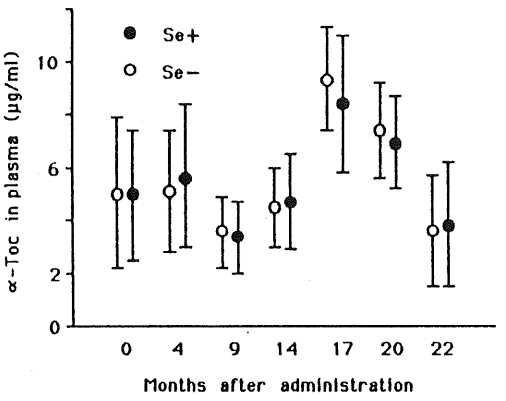


Fig. 5. Change in plasma α-tocopherol levels in grazing cows;
Se −: control group, Se +: Se treated group.

Table 3. Effect of Se supplement on Se concentrations in tissue of cows; Means with asterisk(*) are significantly different from control ($P < 0.05$)

| | Liver | Kidney | Hart muscle | Skeltal muscle | Spleen |
|---|---|---|---|---|---|
| Control | | | | | |
| Se (mg/kg) | 0.24 | 2.52 | 0.16 | 0.08 | 0.28 |
| GSH-Px (E.U./g protein) | 40 | 331 | 556 | 730 | 477 |
| α-Tox (mg/kg) | 24.3 | 9.4 | 20.8 | 7.2 | 10.2 |
| Se treated | | | | | |
| Se (mg/kg) | 0.72* | 4.28* | 0.72* | 0.28* | 0.88 |
| GSH-Px (E.U./g protein) | 202* | 495* | 1008* | 956* | 704* |
| α-Toc (mg/kg) | 22.1 | 9.1 | 21.5 | 7.2 | 10.1 |

cows was distinctly higher than that in calves from the untreated control cows. Meanhile, dams of Se treated group received Se pellets 20 to 25 days after parturition. In the two weeks follwoing administration, the Se concentration in blood increased in dam cows, but was unchanged in their calves which received dams' milk. It is conceivable that Se administered to cows might be transported through the plancentae and affect the Se status of their fetuses, but not so much through milk during the suckling period. Blood GSH-Px activity showed changes similar to the changes in blood Se concentration.

The changes of plasma α-Toc in dams and their calves are shown in Fig. 7. Plasma α-Toc concentration in calves in both groups tended to be lower than their dams throughout the experiment. According to the report by Hidirogrou *et al*[12], α-Toc levels in calf were lowest at the day of birth and then gradually increased until the age of 6 months. Further examination will be required to better understand the reason for the low α-Toc level usually observed in calves. Plasma α-Toc concentration of both cows and calves tended to be higher in the Se pellet treated group than in the control group, although the difference was not statistically significant. Compared with the value from 0.2 to 0.4 mg/dl which was reported[8] as the plasma level of α-Toc in normal healthy calves, the values obtained in this experiment were within this normal range.

The results of body weight gain in calves at 4, 6, and 8 months old are shown in Fig. 8. Calves of Se treated dams showed statistically significant ($P<0.05$) improvement in body weight gain at 8 month of age as compared with controls. No clinical signs of WMD in calves from either group were observed in this experiment. The available data reported thus far[3,11] were not always sufficient to prove the effectiveness of Se supplements in calves to increase body weight gain. According to a recent paper[12], improvement in weight gain observed in Se treated calf is principally due to the intensification in vital resistance to disease through the immune system. Therefore, the mechanism for improvement of body weight gain by Se supplement might be different from that for occurrence of WMD in calf.

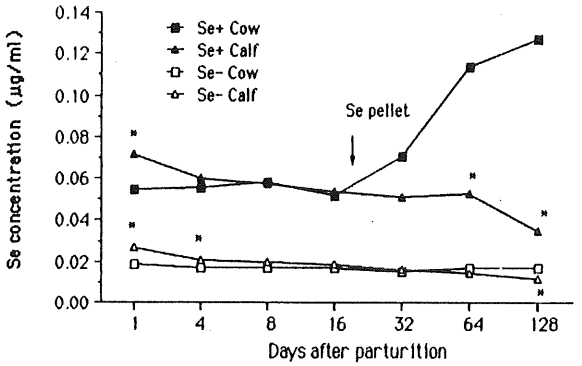


Fig. 6. Change of blood selenium concentration in cows and calves after parturition; *Significantly different from their cow's value ($P<0.05$).

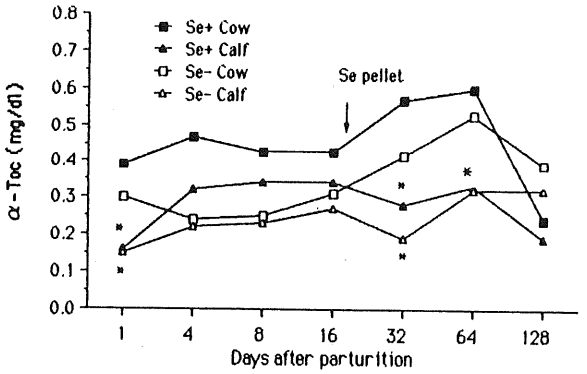


Fig. 7. Change of plasma $\alpha$-tocopherol in dam cows and calves after parturition; *significantly different from their cow's value ($P<0.05$).

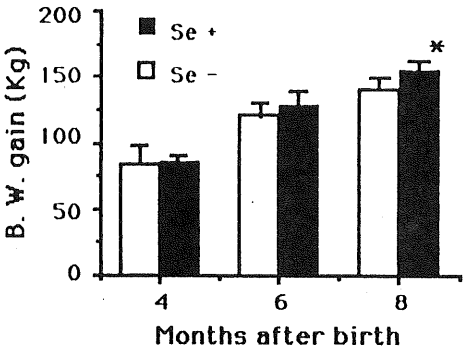


Fig. 8. Body weight gain in calves from Se treated dams (Se+) and control dams (Se−) *Significantly different from control($P<0.05$).

## CONCLUSION

In view of the experimental evidence in this study, we have come to the conclusion that the incidence of Se deficiency symptoms in cattle such as WMD in calves might be influenced by V.E. status and/or other factors in addition to the lowered Se intake. As shown in Table 4, grazing cows in the warm district of the southern part of Japan received fresh grass with low Se but high V.E. almost all the year round. In the cold district of northern Japan, they received concentrates with high Se content besides hay which is low both in Se and V.E. during winter season. These feeding systems might protect grazing calves from Se deficient disease.

Table 4. Schema of Se and vitamin E levels in feed consumed by grazing cattle in Japan

| | | | | | |
|---|---|---|---|---|---|
| Southern districts of Japan (Most of the year round) | | | | | |
| Fresh grass | : | Low | Se, | High | V. E. |
| Northern district of Japan | | | | | |
| (Summer) | | | | | |
| Fresh grass | : | Low | Se, | High | V. E. |
| (Winter) | | | | | |
| Hay | : | Low | Se, | Low | V. E. |
| Concentrates | : | High | Se, | Low | V. E. |

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