Selenium Status of Soil, Herbage and Beef Cattle in Southern Thailand

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ABSTRACT : The selenium status of beef cattle in the southern part of Thailand and the selenium concentration of soil and herbage consumed by those animals were investigated. Samples were collected from three areas with different soil types, namely, sandy soil, peat soil and laterite soil. The selenium concentration of soil, herbage and blood plasma showed a similar tendency; the values of laterite soil were higher than those of the other two areas. However, the selenium concentration of herbage of each pasture was lower than the NRC requirement, and that of blood plasma was not in the sufficient level. These data suggested that beef cattle raised in these areas were in the chronic selenium deficiency. We concluded that selenium supplementation is needed for the increase of animal productivity in the southern part of Thailand. (*Asian-Aus. J. Anim. Sci. 2000. Vol. 13, No. 6 : 757-760*)

Key Words : Selenium, Beef Cattle, Tropical Area

INTRODUCTION

The demand for animal protein is continuously increasing in Thailand, but its self-sufficiency remains low. Although the Thai government promotes domestic production of milk and meat, the shortage of energy and protein as animal feed is becoming a serious problem in Thailand as well as in other equatorial countries. On the other hand, there are many reports showing mineral imbalances in the foodstuff and shortage of mineral intake by animals in this area, for example, deficiencies of phosphorus, copper, sodium and zinc (Vijchulata, 1995; Ngampongsai et al., 1996; Kumagai et al., 1996). Such conditions are considered to be one of the nutritional constraints limiting animal productivity. Therefore, improvement of mineral status of cattle grazed on tropical pastures could contribute to the development of livestock farming.

Although it has recently become clear that selenium plays various new roles in cattle, for example, increase of colostral IgG production (Swecker et al., 1995) and activation of corpus luteum function (Kamada and Ikumo, 1997; Kamada and Hodate, 1998), selenium is also one of most important minerals in beef production. It is known that its deficiency causes nutritional muscular dystrophy in calves, reproductive disorders in adult cattle and others (Ammerman and Millar, 1975; Hoshino et al., 1989). However, the selenium status of ruminants raised in this area is still largely unknown. In Thailand, cattle production is mainly handled by small holders. In such cases, they feed little concentrate for economic reason and their animals are usually fed native grasses, agricultural by-product or some improved grasses. The content of selenium is generally high in the concentrates, but low in the herbage (Van Saun, 1990), so it is expected that the selenium intake of animals in this area is not sufficient.

This study was conducted to get basic informations on the selenium status of beef cattle grazed on tropical pastures in the southern part of Thailand.

MATERIALS AND METHODS

Samples

The fields in Narathiwat province, located in the southern part of Thailand (figure 1), are characterized by three types of soil, namely, sandy soil, peat soil and laterite soil. We suspected that the mineral status of three soils is different from each other, so samples (soil, herbage and blood plasma of beef cattle) were collected from three types of pastures. Sampling areas included Tak Bai (Animal Nutrition Center and Thohem village) for sandy soil, Kolock riverside (Khok nai village) for peat soil, and Waeng and Sungai Padi for laterite soil. Soil samples were dug from the ground surface to 50 cm depth at 5 points from each pasture. The samples in each pasture were air dried, sieved and mixed. Herbage samples were collected at 3 different points in each pasture. Samples were air dried, ground and mixed (Dominant species of each pasture was Ruzi grass. It consisted more than

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Received February 27, 1999; Accepted July 19, 1999

90% of total field (Nishimura et al., 1993). Blood samples were collected from the jugular vein of cattle (12 heads) grazed on three types of soil using a heparinized vacuum tube and cooled immediately. Plasma was collected by centrifugation and stored at -20℃ until analysis.

Figure 1. Location of Narathiwat province in Thailand

Selenium measurement

A fluorometric method (Hoffman et al., 1968) was used to measure the selenium concentration of samples. The sample was digested with nitric acid and perchloric acid using the digestion apparatus, and boiled with hydrochloric acid in a water bath. After the solution containing hydroxylamine and EDTA was added to the digesta, the pH of the mixed solution was adjusted to 1.0-1.5. Then, 2,3-diaminonaphtalene solution which is a fluorescent reagent for selenium was added in a semidark room. This mixed solution was warmed at 50℃ for 25 min and extracted with n-hexane using a separative funnel. The fluorescence intensity of the organic phase was measured at 378 nm of an excitation wavelength and at 525 nm of an emission. Acid digestion of soil samples did not succeed because of bumping. Therefore, it was extracted with 1N hydrochloric acid for 30 min, and the content of selenium in the extract was measured.

Statistical analysis

All analyses were conducted using the General Linear Models procedure of SAS (1988). The results were considered significant at $p<0.05$ or $p<0.01$.

RESULTS AND DISCUSSION

Table 1 shows the results of selenium analysis of herbages. Only Ruzi grass (*Brachiaria ruziziensis*) was commonly grown in all pastures (sandy soil: n=2, peat soil: n=1, laterite soil: n=2). The selenium concentration was low in sandy soil and higher in laterite soil. Other herbages showed a similar tendency; the selenium concentration of herbages grown in laterite soil was higher than in the other two areas. These concentrations, except for a few samples, were not lower than the values in Japan or the United States. The herbages grown on laterite pasture had a relatively high selenium content. However, the selenium requirement recommended by the National Research Council (NRC, 1988) and Food and Drug Administration (FDA) of USA (American Veterinary Medical Association, 1997) is 300 ppb, so the selenium requirement in this area would not be satisfied if the animals were fed herbage alone.

Table 1. Selenium content in herbage collected from sandy soil, peat soil and laterite soil areas

plant	Sandy soil (ppb)	Peat soil (ppb)	Laterite soil (ppb)
Ruzi grass (*Brachiaria ruziziensis*)	33±26	125	200±123
Creeping signal grass (*Brachiaria humidicola*)	96		
Torpedo grass (*Panicum repens*)	107	51	
Cori grass (*Brachiaria milliformis*)	44±8		
Hamata (*Stylosanthes hamata*)	134		
Orientalis (*Chrysopogon orientalis*)	171		
Carpet grass (*Axonopus compressus*)		23	300
Native grass			271

Figure 2 shows the acid soluble Se content of the soils. It is known that the selenium concentration of herbage generally reflects the value of the soil (Ammerman and Millar, 1975). The amount of soluble selenium in the soils showed a similar tendency to the herbages. The laterite soil contained slightly more soluble selenium than the other types soil.

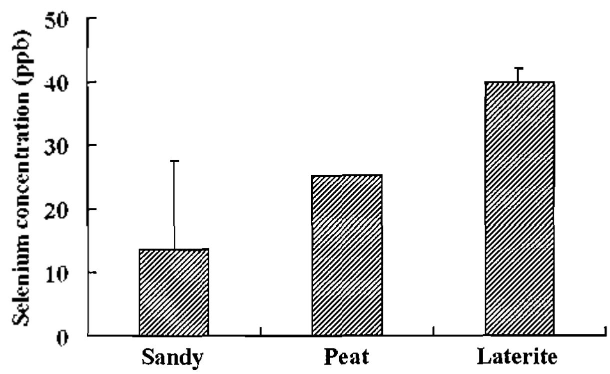

Figure 2. Acid soluble selenium content of soil in the three pastures

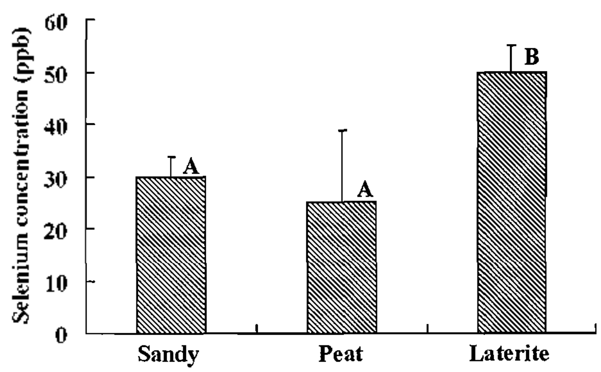

Figure 3. Selenium concentration of blood plasma in the three pastures

The plasma selenium concentration of animals is basically influenced by the amount of selenium in the feed. This relationship was also observed in this experiment. The plasma selenium showed a clear difference among the animals raised on three types of pastures (figure 3), and the value of the cattle raised on the laterite pasture was significantly higher than the others ($p<0.01$). However, its level was lower than the sufficient level (70 ppb) (Smith et al., 1988). In particular, values of sandy soil and peat soil were considered to be deficient (<40 ppb). In the area that we investigated, farmers generally did not use commercial concentrate that contains a large amount of selenium compared to herbages. As the animals are forced to ingest the herbage mainly which has a lower selenium content than the selenium requirement of the NRC all year round, they would inevitably develop chronic selenium deficiency. The sampling in this cxperiment was conducted at the end of rainy season (Oct-Jan). This season is relatively abundant in the foodstuff for animals. However, feed shortages become a serious problem in the dry season. The plasma selenium level is also strongly affected by the amount of feed intake, so it is expected that the selenium status of animals in the dry season would be worse than that in the rainy season. Furthermore, it is known that the digestibility of tropical herbages is low (Wilson, 1991), so animals may not be able to effectively utilize the selenium of herbage. This may also cause low plasma selenium in the cattle. In respect of the interactions between minerals, the excess of minerals inhibiting the absorption of Se, for example, Ca, As, Co and S (NRC, 1988), is not reported in Thailand.

The shortage of selenium intake, together with other nutritional and climatic factors, must decrease the productivity of animals as reflected by the growth rate and reproduction. Interestingly, however, the typical symptom of selenium deficiency, white muscle disease, was not observed in this area. Two hypotheses are proposed to explain this finding: Low productivity itself may decrease the requirement of minerals (Our data about animal performance in table 2 showed the low productivity of cattle grazed on three pastures. Nishimura et al. (1993) also reported that the daily gain of raising steer in this area was only 0.2 kg in a year, though NaPuket (1980) showed that the average daily gain of native cattle and cross (N×AB) in Thailand are 0.27-0.34 and 0.45-0.46, respectively.), and vitamin E (VE) from herbages, which partly compensate for the selenium function *in vivo*, may prevent white muscle disease. As stated above, the animals in this area live on a fresh herbage, so it seems likely that they can get enough amount of VE, which would prevent the appearance of selenium deficiency. Actually, Ogura (1996) observed the high vitamin E concentration of blood plasma of cattle in the southern Thailand.

Although energy-protein malnutrition is the most serious problem in this area, many studies have also indicated other mineral deficiencies in the foodstuff (Ngampongsai, 1996). Our findings showed that increased supply of TDN and CP for high productivity of milk and meat must be carried out together with selenium and other mineral supplementation.

ACKNOWLEDGMENT

We wish to express our sincere gratitude to the National Research Council of Thailand (NRCT) and Department of Livestock Development (DLD), Ministry of Agriculture and Cooperative, Thailand for giving us a chance to study in Narathiwat.

We would also like to thank the National Institute of Animal Health (NIAH) for allowing us to carry out selenium analysis at NIAH.

Furthermore, we wish to thank the other staff at Narathiwat Animal Nutrition Research Center for their assistance.

Table 2. Average weight, age and body condition score of cattle in each area

		Body weight (kg)	Age (month)	Body condition score*	head
Sandy soil					
Cross (AB×N)	♂	153.1±19.6	0.8±0.0	2.6±0.8	10
	♀	255.0±60.3	3.7±0.6	3.5±0.9	3
Native (N)	♂	109.0±18.4	1.3±0.4	3.3±0.4	2
	♀	149.6±32.6	4.9±3.3	2.7±1.0	9
Peat soil					
Native (N)	♂	155.5±38.4	2.9±1.8	2.9±0.2	12
	♀	163.0±56.4	4.7±2.4	2.9±0.3	11
Laterite soil					
Cross (AB×N)	♂	192.7±73.2	1.6±0.6	2.0±0.5	3
	♀	202.0± 9.9	2.3±0.4	2.0±0.0	2
Native (N)	♂	155.7±51.8	2.1±0.8	2.9±0.7	7
	♀	182.2±56.2	4.5±2.4	2.5±0.4	31
Average values					
Cross (AB×N)		182.1±52.6	1.6±1.1	2.6±0.9	18
Native (N)		166.2±51.2	4.0±2.5	2.7±0.5	72
♂		155.4±40.9	1.9±1.4	2.8±0.6	34
♀		177.8±55.9	4.5±2.4	2.6±0.6	56

AB: American Brahman; * NRC (1996).

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