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Serum Retinol and β-carotene Values in Japanese Black Calves in Kagoshima Prefecure, Japan

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Abstract: To obtain basic data of serum retinol and β-carotene in Japanese black calves in Kagoshima Prefecture, Japan, blood samples were obtained from 633 clinically healthy calves on 29 farms and 13 cases with symptoms of respiratory disease calves. Calves were divided into 6 stages: the early suckling stage (between 10 and 45 days of age, n = 103), late suckling stage (between 46 and 90 days of age, n = 115), the first growing stage (between 91 and 135 days of age, n = 105), the second growing stage (between 136 and 180 days of age, n = 113), the third growing stage (between 181 and 225 days of age, n = 96) and the fourth growing stage (between 226 and 270 days of age, n = 101). The mean serum concentrations of retinol were above 15 μg/dL in the late suckling stage and in all growing stages. On the other hand, the mean concentrations of retinol in early suckling stage and concentrations of retinol in all cases with respiratory disease were below 15 μg/dL. The mean serum concentrations of β-carotene in all stages were between 50 and 85 μg/dL and concentrations of β-carotene in all cases were between 15 and 144 μg/dL (average 54.4). These results suggest that the blood parameters obtained in this study are considered useful as one of data to clarify reference values of Japanese black calves.

Key words: Growing stage, Japanese black calf, serum β-carotene, serum retinol, values, growing stage

INTRODUCTION

Fat-soluble vitamins such as retinol and β-carotene are important nutrients for maintaining health in cattle (Herdt and Stowe, 1991). Dietary supplementation with retinol and β-carotene enhanced host defense mechanisms in cattle (Eicher *et al*., 1994; Franklin *et al*., 1998; Michal *et al*., 1994). The Japanese black is a breed of beef cattle that is originated and is mainly distributed in Japan (Gotoh *et al*., 2009). An animal's health can be defined as absence of diseases determined by clinical examinations combined with various diagnostic tests. Although, many blood reference values of retinol and β-carotene have been reported for the dairy calves (Eaton *et al*., 1972; Hoppe *et al*., 1996; Iwanska *et al*., 1986), there have been few published references for beef calves (Greenberg *et al*., 1986). To the best of the researcher's knowledge, reference values of serum vitamin parameters have not been established for particular stages of Japanese black calves. Almost all Japanese black calves are sold by auction at a market at around 8-9 months of age. Therefore, the current study was conducted to determine the serum retinol and β-carotene concentrations from the birth to 9 months of age in Japanese black calves kept on ordinary farms in Kagoshima Prefecture, Japan.

MATERIALS AND METHODS

Privately owned 29 Japanese black farms in Kagoshima Prefecture, Japan were enrolled in this study. The number of calves in each farm ranged from 40 to <300. The 633 Japanese black bulls or steer calves (10-270 days of age) on these farms were used and blood samples were collected once per head by the authors between April, 2014 and May, 2015. All calves were stayed with their dams generally for 5 days after birth and mainly milk replacer was fed from 5 days of age and weaned at around 90 days of age. Supplemental concentrate and dry grass were fed from 91-270 days of age. Supplemental concentrate was purchased from several feed companies. Day grass such as rice straws, Italian ryegrass or oats were produced at each farm. All calves were housed indoor (not being grazed) and were fed hays not fresh grass.

About 21 calves on each farm were sampled at random during the early suckling stage (between 10 and 45 days of age, n = 103), late suckling stage (between 46 and 90 days of age, n = 115), the first growing stage (between 9 and 135 days of age, n = 105), the second growing stage (between 136 and 180 days of age, n = 113), the third growing stage (between 181 and 225 days of age, n = 96) and the fourth growing stage (between 226 and

270 days of age, n = 101). The 13 calves with rectal temperatures of ≥40°C symptoms of respiratory disease as previously reported from 10 farms were sampled (Galyean *et al*., 1995).

Blood samples were collected from the jugular vein into plain vacuum tubes between 10 a.m. and noon. Serum was separated within 30 min after blood collection and stored at -30°C until analysis (a centrifuge and a freezer were brought to farms). The concentration of serum retinol was measured using a high performance liquid chromatograph (Prominence, Shimazu, Kyoto, Japan) as previously reported (Adachi *et al*., 1996). The serum β-carotene concentration was analyzed by Labospect 7020 autoanalyzer (Hitachi High-Technologies Corporation, Tokyo, Japan). Data are expressed as mean±standard deviation in several stage calves.

RESULTS AND DISCUSSION

The results of serum retinol and β-carotene analysis for the 6 stages are shown in Table 1. The mean concentration of retinol was below 15 μg/dL in early suckling stage and was above 20 μg/dL in the other stages. The mean serum concentration of β-carotene was between 50 and 85 μg/dL in all stages. The results of calves with respiratory disease cases are shown in Table 2. The serum retinol concentration was under 15 μg/dL in all cases. The serum concentration of β-carotene was between 15.4 and 144.3 μg/dL (average 54.4) in all cases.

Retinol plays important roles as antioxidant and is necessary for cell replication and appears to be consumed during this process (Herdt and Stowe, 1991). Growth of animals requires cell proliferation and growth rate is very sensitive to retinol level in most species including cattle (Herdt and Stowe, 1991). Normal disease resistance is clearly dependent on retinol level, regarding integrity of epithelial tissues as well as optimum function of immune system (Herdt and Stowe, 1991). The impact of retinol on immune function appears to span from cellular immunity such as phagocytosis to humoral immunity (Herdt and Stowe, 1991). The mechanism of retinol deficiency induced immune compromise is not well understood but it appears that retinol deficiency cattle are more susceptible to infection diseases such as respiratory or diarrhea disease (Herdt and Stowe, 1991). Additionally, retinol utilization is increased by inflammation or infection disease (Herdt and Stowe, 1991). These observations suggest that the increased cellular proliferation rates associated with infection disease may increase retinol requirements. In dairy calves, the serum retinol concentration between 25.0 and 32.5 μg/dL was considered adequate range at 30-300 days of age and below 15 μg/dL was considered deficient range after birth to 300 days of age (Iwanska *et al*., 1986). In the present study, the mean serum retinol concentration in first to forth growing stage calves (46-270 days of age) were within 25.0 and 32.5 μg/dL. Therefore, many first to forth growing stage calves might be adequate of serum retinol concentration. On the other hand, the mean serum retinol concentration in the early suckling stage and all cases with respiratory disease calves were below 15 μg/dL. Therefore, many early suckling stage calves and all cases with respiratory disease calves might be deficient of serum retinol concentration. The observation of this study that calves suffering from respiratory disease displayed a reduction in serum concentration of retinol was in accordance with previous study (Ragbetli *et al*., 2009).

β-carotene is provitamin A which is converted to vitamin A in the intestinal mucosa. β-carotene also plays important roles as antioxidant against inflammation (Herdt and Stowe, 1991). β-carotene is associated with the follicular function and ovulation in breeding cattle (Herdt and Stowe, 1991). It has been reported that serum β-carotene concentration in dairy cattle during pregnancy were around 200 μg/dL (Yildiz *et al*., 2005) and desirable serum β-carotene concentration in dairy cattle is considered >300 μg/dL (Herdt and Stowe, 1991). However, deficient range of the serum β-carotene concentration have not been clarified in daily and beef cattle and also daily and beef calves. Therefore, further studies are need to clarify reference serum β-carotene concentration in beef cattle and calves. Although, the data in the present study were obtained only from ordinary farms in one prefecture of Japan, the blood parameters obtained in this study were considered useful as one of data to clarify reference values of Japanese black calves.

Table 1: Serum concentration of retinol and β-carotene in Japanese black calves in differnt stages

Factors (μg/dL)	Early sucking (n = 103)	Late suckling (n = 115)	First growing (n = 105)	Secong growing (n = 113)	Third growing (n = 96)	Fourth growing (n = 101)
Retompl	13.9±4.20	20.2±6.90	27.7±7.50	28.5±7.30	29.6±7.50	30.4±6.40
β-carotene	50.9±29.1	63.4±32.7	55.6±35.6	56.7±24.5	72.8±4.08	84.5±42.3

Data are expressed as mean±SD; The early suckling stage was between 14 and 45 days of age, late suckling stage was between 46 and 90 days of age, the first growing stage was between 91 and 135 days of age, the second growing stage was between 136 and 180 days of age, the third growing stage was between 181 and 225 days of age and the fourth growing stage was between 226 and 270 days of age

Table 2: Serum concentration of retinol and β-carotene in calves with respiratory disease

Cases	Age (days)	Retinol (μg/dL)	β-carotene ((μg/dL)
1	31	13.4	29.8
2	39	11.2	109.5
3	39	14.4	144.3
4	95	9.2	75.1
5	116	14.4	18.7
6	125	13.1	40.2
7	146	14.0	15.4
8	152	7.1	55.0
9	196	12.4	53.6
10	196	12.4	53.6
11	201	13.6	42.8
12	215	14.8	32.8
13	218	14.0	36.4

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