Color Image Based Measurement of Blood Vitamin A Level for Beef Cattle

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Summary

Marbling score is an important index of beef quality. Most Japanese breeders usually decrease cattle's blood VA level to improve beef marbling score maintaining the critical VA value. It is desirable to monitor the blood VA level without collecting blood sample. The objective of this study is to investigate the relationship between blood VA level and colors of cattle eye, for developing a monitoring system of VA level in cattle blood with non-invasive method using image processing technique.

The images of cattle eye were captured using a color CCD camera and analyzed. The relation between blood VA level and the chromaticity values "*r*, *g*, and *b*", as well as HSI values of pupil color were investigated. Although the data had variability, a linear relation between blood VA level and "*r*" value was found and the coefficient of determination was around 0.7 after elimination of higher intensity image data.

Key word: *cattle, pupil, image processing, blood Vitamin A,*

Introduction

Marbling score is an important index of quality in beef. Vitamin A (VA) in blood inhibits differentiation of preadipose cells into adipose cells. Generally speaking, higherVA level makes lower beef marbling score, but too low VA level (less than 30 IU/dl) often brings VA dificiency. Most Japanese breeders usually decrease cattle's blood VA level to improve beef marbling score maintaining the critical VA value (30IU/dl). When blood VA level is under the value, cattle may get a disease of VA deficiency such as anorexia, nerve disorder, visual deficit, and so on . It is important to monitor blood VA levels of the cattle for avoiding the diseases when controlling the VA level. To measure the blood VA, collection of blood sample by use of injectors is common, but the method is expensive, invasive, time-consuming, and stressful to cattle. Another invasive and quick method is desirable.

A research of relation between blood VA and pupil shrinking speed at pupillary reflexwas reported (Matsuda et al., 1999). In previous study of our research group, a linear relation between blood VA level of cattle and the light reflection at around 470nm from cattle eye was obtained. The objective of this study was to investigate the relation between blood VA level and color of beef cattle pupil. The final goal of this project is to develop a fast and non-invasive monitoring system of VA level in blood for marbling score quality management of Japanese black beef cattle.

Material and methods

25 Japanese Black Cattle (16 bullocks and 9 cows) with the ages from 12 to 25 months and Blood VA level varied from 18.2 IU/dl to 90.2 IU/dl were used for this experiment. The measurements were conducted in Hokubu Agricultual Technology Institute Hyogo prefecture Technology Center, Japan.

The images of cattle’ left eyes were captured using a color CCD camera. Its shutter speed was 0.03sec, and F number was 4. Ring-shaped white LEDs were used as a lighting device. PL filters were equipped in front of camera lens and lighting device to reduce the images from halation. In front of the camera lens, 150-millimeters-long, 75mm across plastic tube was installed to prevent ambient light. Figure 1 and Figure 3 shows appearance of this device.

The way of image acquisition was as below.

(1) Put the device on cattle’s left eye.

(2) Turn on the light (Light intensity was 1700lx at the end of tube.)

(3) At the same time, start to acquire the image.

It was conducted twice per cattle. Figure 2 shows a scene of capturing images. The VA levels in blood were determined using HPLC as blood sample was immediately collected just after image capturing processes.

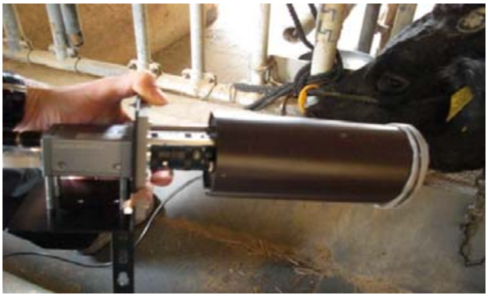


Figure 1: Measurement device (1)

Figure 2: Scene of image acquisition

The color images were analyzed with software. The images were split into three colors *R*, *G*, and *B* components mean *RGB* gray scale values of pupils were acquired. From those values, chromaticity values “*r, g,* and *b*”, and *HSI* (Hue, Saturation, and Intensity) values were calculated.

$r = R/(R+G+B)$

$g = G/(R+G+B)$

$b = B/(R+G+B)$

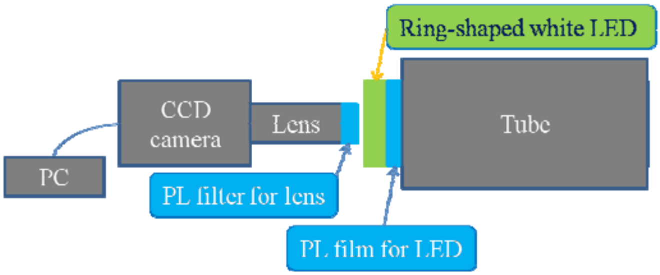
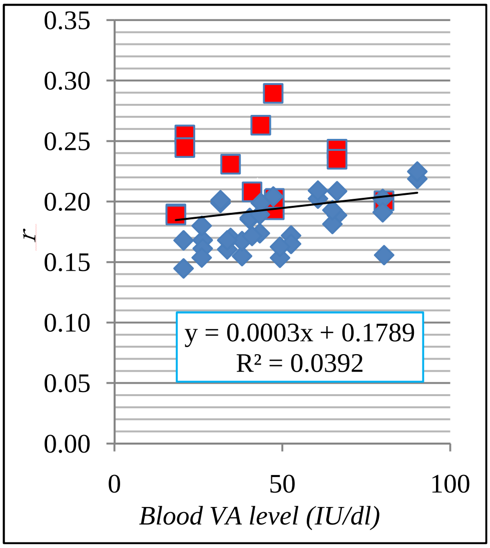


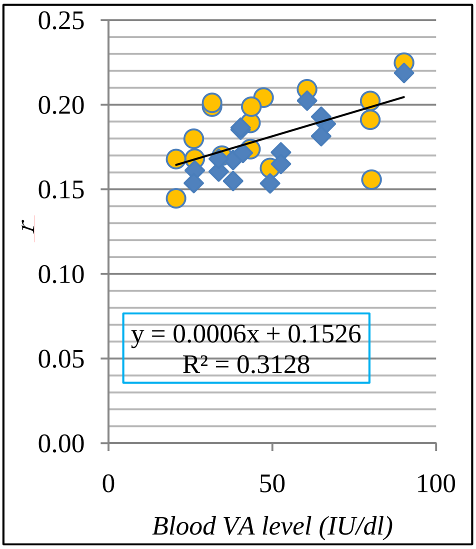
Figure 3: appearance of the device (2)

Results

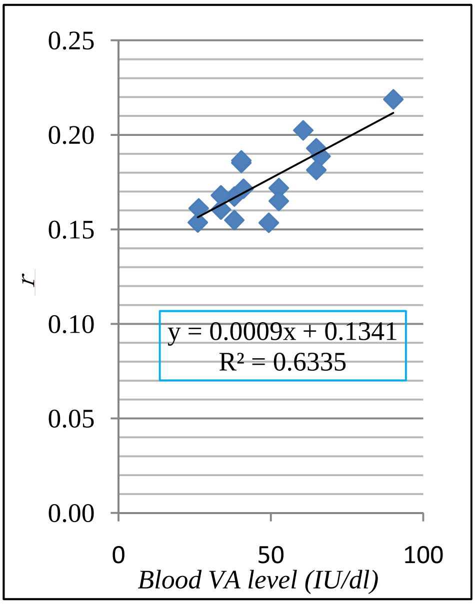
Figure 4 (a) shows a result on relation between blood VA level and "*r*" value. The regression line and coefficient of determination were described in the figure. The coefficient of determination was quite low and data had much variability. However, it was found that pupil color was emerald in some images. "*I*" (Intensity) values of these images ("emerald-pupil images") were more than 21. The color of emerald seemed to come from tapetum located behind retina, and it is said that the tapetum has the function to enhance a sensitivity of eye in dark condition. It was considered that the emerald-pupil images are one of reasons of the variability. After elimination of the emerald image data, coefficient of determination became 0.31as shown in *Figure 4 (b)*. In the *Figure 4 (b)*, it was observed that yellow dots are data whose "*I*" value were more than 18.6. The coefficient of determination became 0.63 (*Figure 4 (c)*), after elimination of the data of "high-brightness-pupil image." In the *Figure 4 (c)*, some data are from same cattle. The coefficient of determination became 0.70, when the same cattle data were averaged.

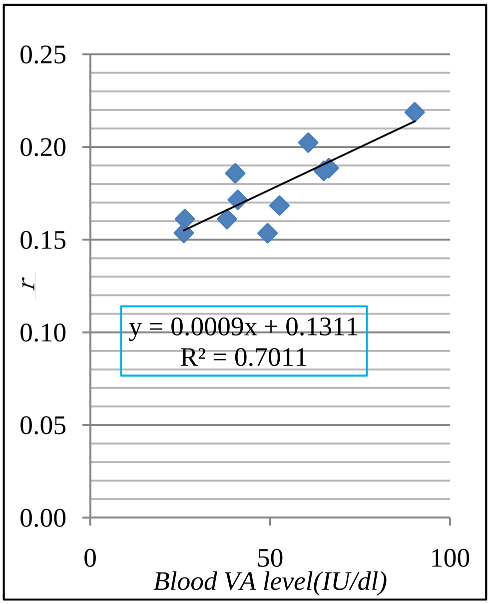
The other values (*g*, *b*, *H*, *S*, and *I*) were investigated as "*r*", but the highest correlation was obtained from "*r*" as shown in Table 1.





(a) *(b)*





(c) *(d)*

Figure 4: Relation between blood VA level and "r" value.

Table 1: Coefficient of determination between each value and blood VA level

	The coefficient of determination
r	0.70
g	0
b	0.45
H	0.01
S	0.18
I	0.08

Discussion

The best correlation (that coefficient of determination was 0.70) was between blood VA level and "*r*" value. It was considered that the cause of data variability was "emerald-pupil image" or "high- brightness -pupil image". The reasons why the emerald color happened on pupil and "*r*" value had the highest correlation should be investigated as near future subjects. It was efficient to eliminate "the emerald-pupil images" or "high-brightness-pupil images" for reduce the data variability.

From this experiment, there is feasibility to predict blood VA level of cattle by use of the pupil images. It is necessary to determine the specification of imaging devices such as illumination, color temperature of lighting device, camera setting, and the most suitable wavelength band, and to confirm repeatablity for commercial model. It was expected to investigate biological mechanisms on pupil color.

Acknowledgement

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References

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