# The Relationship between Serum Vitamin A Level of Japanese Black Cattle and Light Reflection on the Pupil

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*Abstract*— **In order to make better beef with high marbling score, breeders need to control serum vitamin A level from 30 IU/dl to 50 IU/dl during the middle fatting phase. Today, serum vitamin A level of beef cattle is usually measured by blood assay. However, blood assay has some disadvantages such as it is cost and time-consuming. For establishment of new method for prediction of serum vitamin A level, this study examined the relationship between serum vitamin A level of Japanese black cattle and the light reflection on pupil. Light reflection measurement was carried out by image processing. This study showed that B in RGB components around halation area on cattle's pupil of color images has possibility of correlation with serum vitamin A level.**

## I. Introduction

Recently, breeders of beef cattle have tended to add more value to Japanese black cattle for high quality beef. Wheeler stated that marbling score was an important index in beef quality [1]. To make better beef with high marbling score, breeders need to control serum vitamin A level from 30 IU/dl to 50 IU/dl in the middle fatting phase (about from 15 to 25 months old). However, too lower vitamin A level (less than 30 IU/dl) causes cattle vitamin A deficiency such as night blindness, anorexia, nerve disorder and visual deficit [2][3][4]. Therefore, it is essential to measure and monitor blood vitamin A level. Figure 1 shows desirable time-series serum vitamin A level of beef cattle. Today, blood assay of blood taken from cattle is common to measure serum vitamin A level. But this method has some disadvantages such as expensive, time-consuming and invasive. Furthermore, it is stressful to cattle. So, a new, rapid and non-invasive measurement at low cost is desirable.

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Fig. 1. Desirable transit of serum vitamin A level in Japanese Black Cattle to make better beef.

The goal of our group was to establish an easy method of serum vitamin A level measurement by use of the light reflection changes of cattle's pupil for the production of high quality beef. Our group utilized the image processing method to measure the changes on the pupil light reflection.

Because of the deficient mucin, the mucus membrane, the cornea and conjunctiva become dry and rough when serum vitamin A level becomes low [5]. Then, this research focuses on light reflection on the surface of the cattle's pupil according to that previous study. This study was based on the hypothesis that some kinds of changes of the light reflection on cattle's pupil occur by the dryness and roughness on the surface of eyes when their serum vitamin A level goes down. The objective of this study is to examine the relationship between serum vitamin A level and the light reflection on the surface of cattle's pupil to analyze data of RGB components around halation area on their pupils. Color images and near infrared (NIR) images were taken. The B component among RGB components of the color image around the halation area was analyzed.

## II. Materials and Devices

### A. Experiment in 2010

*1) Materials:* 42 live Japanese black cattle with serum vitamin A level varied from 7.3 IU/dl to 89.7 IU/dl were used for this research. The experiment was conducted in Hyogo Prefectural Hokubu Agricultural Technology Institute, Japan. Cattle's ages were from 15 months old to 22 months old during the experiment period (from July 2010 to November 2010).

*2) Devices:* Images of cattle's eyes were taken by 2CCD camera (AD-080CL, JAI, Japan) [6] equipped with a lens (C mount lens, Edmond Optics Japan) with PL filter (ML-PL270LB, MORITEX, Japan). 2CCD camera can get color images and NIR images at the same time. The lighting devices were NIR LEDs (MDRL-CIR31, MORITEX, Japan) and White LEDs (MDRL-CW50, MORITEX, Japan) with PL film. A plastic tube was mounted in front of the lighting device to prevent ambient light and to keep distance constantly. Imaging condition is stated as below, Table 1. Figure 2 shows appearance of this device.

TABLE 1.
IMAGING CONDITION
(FROM JULY 2010 TO NOVEMBER 2010)

| | |
|---|---|
| Shutter speed[s] | 1/30 |
| F number | 2.2 |
| Light intensity[lx] | 1300 |
| Length of tube[mm] | 100 |

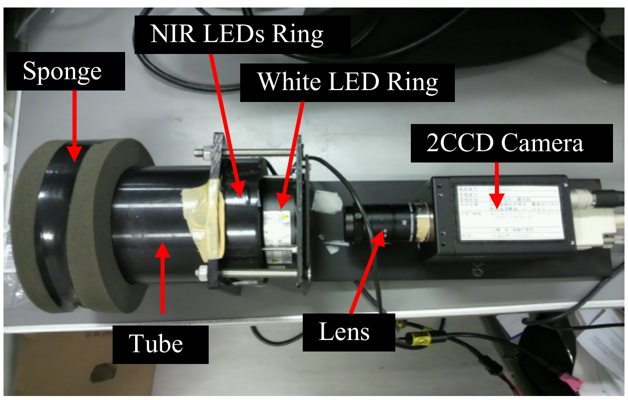


Fig. 2. Appearance of the device

## B. *Experiment in 2011*

*1) Materials:* In the experiment in 2011, 42 different beef cattle from the research in 2010 were used. Serum vitamin A level was from 24.3 IU/dl to 126.7 IU/dl. The experiment was also conducted in the same institute as the experiment in 2010. Cattle's ages were from 7 months old to 19 months old during the experiment period (from December 2010 to August 2011). Images of 22 cattle were taken from December 2010, 8 cattle were taken from February 2011 and the other 12 cattle were taken from March 2011.

*2) Devices:* The experiment in 2011 was also carried out by use of the same devices. However, camera conditions were different from the previous experiment in 2010. Except for December 2010 and January 2011, the camera condition was as in Table 2. F number was 2.2 in December and January. F number was 1.8 in March, April and May. The other conditions (shutter speed, light intensity, length of tube) were same as in Table 2.

TABLE 2.
IMAGING CONDITION
(FROM FEBRUARY 2011 TO AUGUST 2011)

| | |
|---|---|
| Shutter speed[s] | 1/30 |
| F number | 1.8 |
| Light intensity[lx] | 1300 |
| Length of tube[mm] | 100 |

# III. METHODS

## A. *Methods of Experiments*

Methods of the experiment in 2010 and those in 2011 were same. The research procedure is separated into two steps, experiments and analysis. The experiments were conducted to take images of cattle's eyes monthly. The experiment was conducted as below. At first, by a black cloth, the head of cow was covered to dilate pupil for 120 s. Secondly, the NIR LEDs were switched on, to detect the pupil position and to fix camera at an adequate place. Even if NIR LEDs are put on and illuminate cattle's pupil, the pupil doesn't shrink because NIR is invisible for the cattle. So, pupil image of living cattle can be taken under the dark conditions easily by use of the NIR LEDs. Finally, we put white LEDs on and started to input the images. Figure 3 shows an example of the color image and the NIR image which were taken in the experiment.

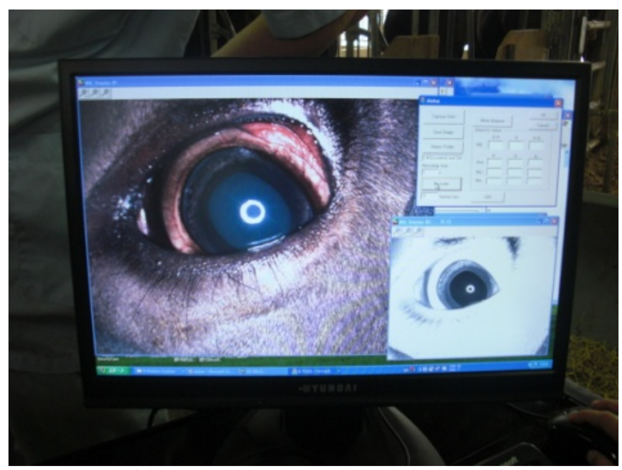

Fig. 3. Display of the computer connected to the device. It shows the color image and the NIR image which were used in the research..

## B. *Methods of Image Processing*

Image processing was carried out as below (Fig. 4). Fig. 5 shows sample of the color image. The resolution of image is XGA (the width is 1024 pixels and the height is 768 pixels). Firstly, the color images were separated to grayscales of RGB components. Then, HSI grayscales were calculated from RGB components. These HSI grayscales were used for only image processing. Grayscale of H was binarized (Fig. 6). Noise was removed by salt-and-pepper noise reduction process to detect pupils of cattle (Fig. 7). The images were reversed to remove the halation part where RGB components were saturated and cumbersome for the analysis (Fig. 8). To decide ROI (Region of Interest), the center of the LED ring shown in Figure 9 was detected. A 45 pixels radius circle from the center of LED ring except for the halation area was selected as ROI.

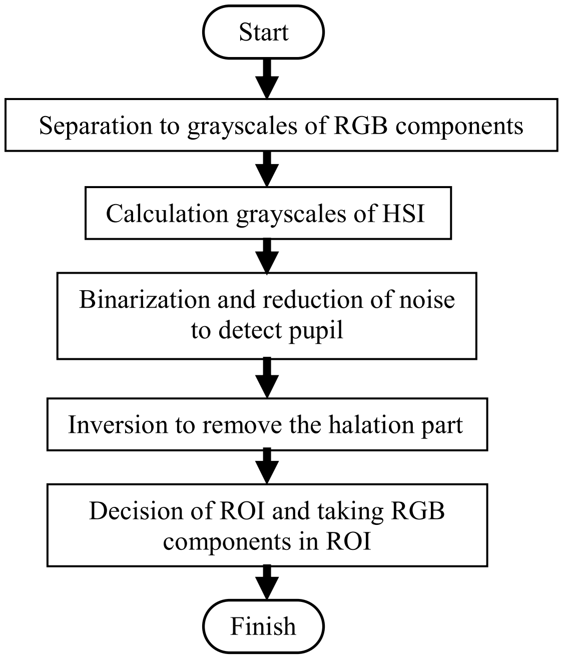


Fig. 4. Flow chart of image processing

Fig. 5. Color image of cow's eye. The center part with dark blue color is the pupil of cattle, and the center ring is the specular reflection of white LED ring.

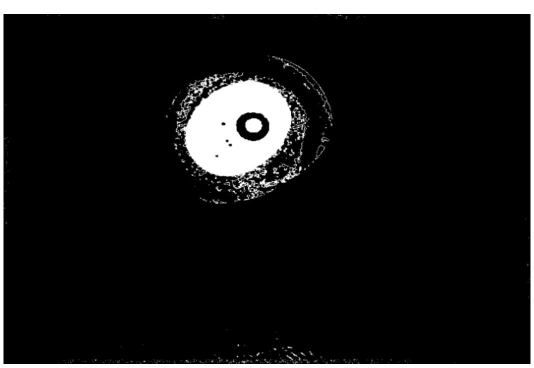

Fig. 6. Binarized image with H value

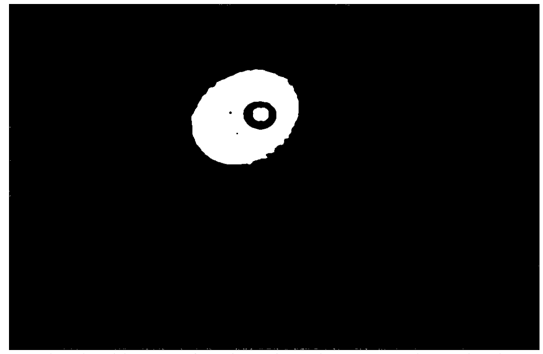

Fig. 7. Binarized image after the salt-and-pepper noise reduction (pupil detection)

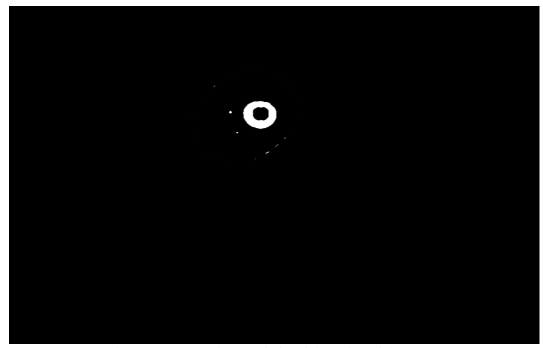

Fig. 8. Inversion of the binarized image.

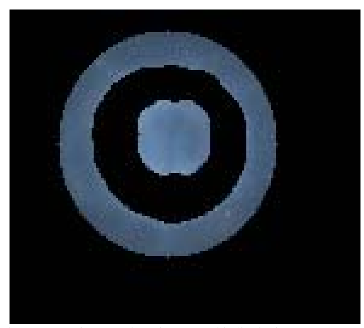

Fig. 9. Enlarged image of ROI in the pupil (bright part). It is removed the halation of the white LED ring (black ring part).

## IV. RESULTS AND DISCUSSION

### *A. Experiment in 2010*

Experimental result in 2010 showed possibility that the light reflection on the pupil of the beef cow was correlated with serum vitamin A level. Figure 10 shows time-series results of the relationship between serum vitamin A level and the mean value of B at the same cow. When serum vitamin A level went down, the mean value of B became low. This means that the relationship between serum vitamin A level and mean value of B was positive correlation. Figure 11 shows scatter chart related in serum vitamin A level and mean value of B of the same beef cow as in Figure10. This showed positive linear correlation between serum vitamin A level and mean value of B. More than half cattle (22 cattle) indicated the correlation such as in Figure 10 and Figure in 11.

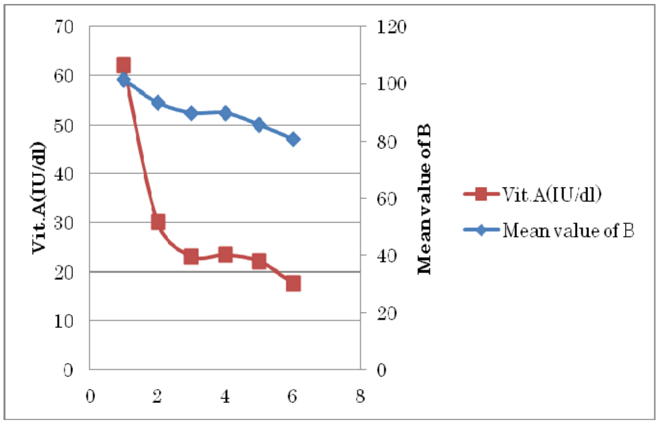


Fig. 10. Time-series data of serum vitamin A level and mean value of B (Dates of the experiment was stated as below; 1: July 23, 2: September 15, 3: October 14, 4: October 29, 5: November 10, 6: November 24).

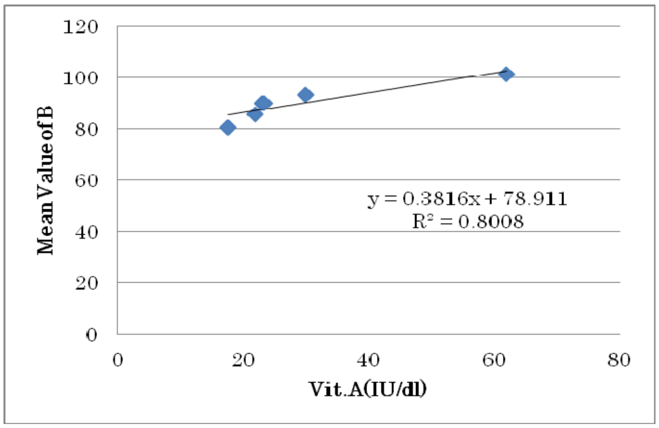


Fig. 11. Relationship between serum vitamin A level and mean value of B.

On the other hand, variance of B showed different relationship with serum vitamin A level. As seen in Figure 12, variance of B became high when serum vitamin A level went down. This figure indicates that variance of B is negatively correlated with serum vitamin A level. Figure 13 is the scatter chart related to serum vitamin A level and variance of B in the same cow as Figure 12. This also shows negative correlation between serum vitamin A level and variance of B. Thirteen of 42 cattle indicated the correlation shown in Figure 12 and Figure 13.

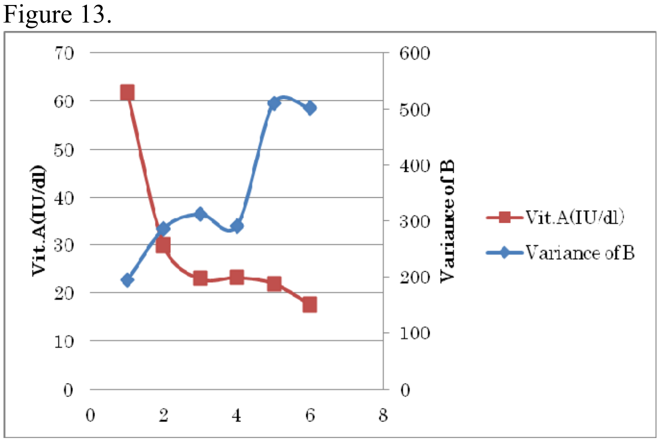


Fig. 12. Time-series data of serum vitamin A level and variance of B (Dates of the experiment was stated as below; 1: July 23, 2: September 15, 3: October 14, 4: October 29, 5: November 10, 6: November 24).

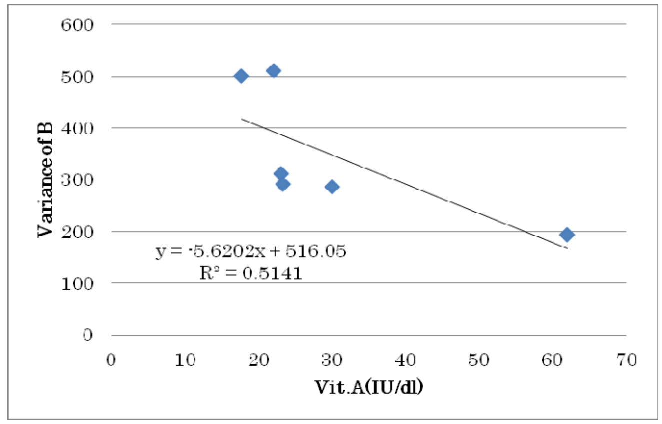


Fig. 13. The relationship between serum vitamin A level and dispersion of B

## B. *Experiment in 2011*

To confirm the reliability of the experimental result in 2010, the experiment in 2011 was carried out. Figure 14 is time-series data of serum vitamin A level and mean value of B. Before May, it was difficult to find any correlation.

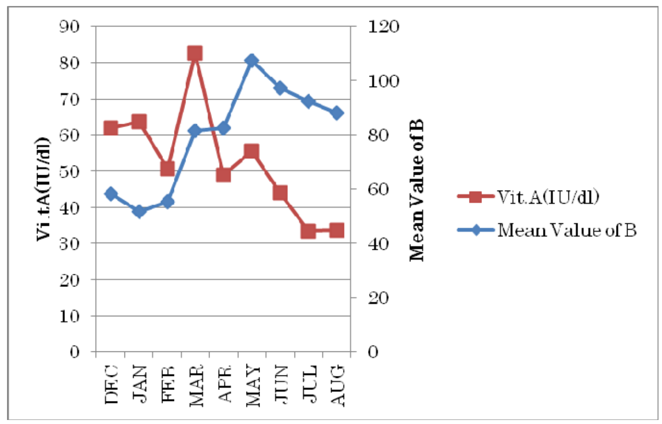


Fig. 14. Time-series data of serum vitamin A level and mean value of B

Some reasons were considered for results. One reason is that the camera condition changed in February and May, and the brightness of images itself changed. In February, F number was changed from 2.2 to 1.8. And in May, gain was changed about 1.5 times bigger than before. Therefore, Mean values of B in Figure 14 are separated into three stages, from December to February, from March to April, and from May to August. So after May, the relationship between serum vitamin A level and mean value of B was positive correlation because condition of camera was fixed. Another reason is that the transit of serum vitamin A wasn't stable (especially in March), therefore, mean values of B were also irregular. This is because breeders gave cattle vitamin A with injections in March to prevent vitamin A deficiency in early fatting phase (less than about 15 months old). The other reason is that serum vitamin A level of beef cattle in 2011 wasn't low enough to cause them dryness of eyes resulted from vitamin A deficiency.

Figure15 shows time-series data of serum vitamin A level and variance of B. This figure indicates that variance of B is negatively correlated with serum vitamin A level. That is the same result as the experiment in 2010.

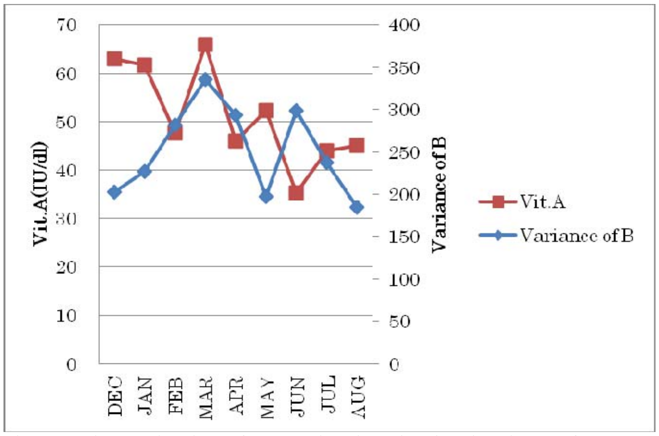


Fig. 15. Time-series data of serum vitamin A level and variance of B

However, there were only 6 of all the 42cattle which show these correlations. This is caused by the problems stated above such as camera condition, injections of vitamin A and serum vitamin A level. The beef cattle with lower vitamin A level (such as the experiment in 2010) may help to get more correlated results.

## V. CONCLUSION

The result the experiment in 2010 indicated the possibility that the serum vitamin A level of beef cattle is correlated with the light reflection on their pupils. Mean value of B is positively correlated with serum vitamin A level. On the other hand, the variance of B is negatively correlated with serum vitamin A level. However, the experimental result in 2011 was not able to confirm reliability of that in 2010. This is because conditions of camera and also serum vitamin A level affected to the result.

Our study group also researches color and shrinking speed of pupils of beef cattle, and examined the relationship with serum vitamin A level. The feasibility of an easy method to measure serum vitamin A level is expected by combining this research with the other researches of our group.

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