Prediction of Liver Vitamin A Content from Plasma Vitamin A Concentration in Rats and Cattle

Jarernsak SALAKIJ[1], Fumiko YANO[1], Masayuki KITAGAWA[2],
Takezo NISHINO[2], Hideo YANO[1] and Ryoji KAWASHIMA[1]
[1]*Faculty of Agriculture, Kyoto University* *,
[2]*Faculty of Agriculture, Yamaguchi University* **

SUMMARY

This study was conducted to examine the relationship between liver and plasma vitamin A concentrations in cattle and rats. Liver and plasma samples were collected 100 heads of cattle at a slaughter house and from 150 heads of Wister strain rats. Vitamin A contents were analysed by reverse phase HPLC. Plasma vitamin A concentrations increased and reached the maximum values of about 40 μg/100ml as liver vitamin A contents increased to 20 μg/g in cattle and rats. When plasma vitamin A concentrations were less than 40 μg/100ml, the ralationship between plasma vitamin A concentrations and log of liver vitamin A contents was a significant highly correlation coefficient in both animal species. These result indicated that it was possible to use a simple linear regression equation for predicting liver vitamin A contents from plasma vitamin A concentrations, when plasma vitamin A was less than 40.0 μg/100ml.

It is well known that liver vitamin A content is a good indicator for vitamin A status and a major endogenous source of vitaman A. However, since the assessement of vitamin A status of animal based on liver stores can only be done at necropsy, it is not practical to do liver biopsies at living state[1].

Although plasma vitamin A concentration is not a sensitive indicator of body stores[2], it remains as a common method to measure vitamin A status, especially in a population study where other measures are too expensive or impractical. Plasma vitamin A concentration has to be thought only a limited value for the evaluation of vitamin A status. This study was conducted to study the relationship between plasma vitamin A concentrations and liver vitamin A contents in beef cattle of finishing state and to establish a simple regression equation comparing with the data obtained from rats.

＊所在地：京都市左京区北白川追分町（〒606-01）
＊＊所在地：山口市大字吉田1677-1（〒753）

MATERIALS AND METHODS

Blood and liver samples were collected from 40 heads of Japanese black cattle and 60 heads of Holstein steers at a slaughter house. The average body weight of Japanese black cattle and Holstein steers was 668 and 721 Kg, respectively. The main feed for these cattle were flacked corn, milo meal, soybean meal and hays.

One hundred and fifty heads of weaning male and female Wistar strain rats were housed individually in stainless steel wire bottom cages. The animal room was maintained at 25°C and 65% relative humidity with a 12 hr light dark cycle. These animals were fed a normal diet for 1 week for an adjustment period. Then, they were divided randomly to vitamin A deficient and control groups. Rats in vitamin A deficient group were fed a semipurifed AIN-76 diet without vitamin A supplement, and those in control group were given a semipurified AIN-76 diet with vitamin A supplement. Deionized water was given ad libitum throghout the experiment. Rats were randomly selected at age 5, 10, 20, 30, 40, and 42 weeks old and was sacrificed to collect blood plasma and liver samples. All of the samples were kept frozen at −80°C until the analysis.

Table 1. Composition of semipurified AIN-76 diet

Ingredients	Percentage
Casein, vitamin-free	20.0
DL-methionine	0.3
Corn starch	15.0
Sucrose	50.0
Cellulose	5.0
Corn oil	5.0
AIN-mineral mixture	3.5
AIN-vitamin (Vt.A-free) mixture[a]	1.0
Antioxidant	0.2

[a] : As specified by American Institute of Nutrition.
Control diet (per kg.) contained 8 mg of retinyl palmitate.

Plasma and liver vitamin A concentrations were determined by reverse phase HPLC[3]. The concentration of liver vitamin A was presented as a retinyl palmitate, and plasma vitamin A concentration was shown as a retinol level. The data were analysed by a statistical computing package, SAS (Statistical Analysis System, Cary, NC, USA) program.

RESULT AND DISCUSSION

The vitamin A levels of plasma and liver in rats were shown in Table 2. Plasma and liver vitamin A

concentrations were significantly lower in vitamin A deficient group than those in control group. The effect of vitamin A deficient diet on the vitamin A status was clearly shown in the experiment.

Table 3 showed plasma and liver vitamin A concentrations in beef cattle. Plasma and liver vitamin A levels were significantly lower in Japanese black cattle than those in Holstein steers. The difference between 2 cattle breeds was thought to be due to dietary A content. Beef quality is very important for Japanese black cattle. Recently, farmers are likely to feed Japanese black cattle low vitamin A diets, because they believe that vitamin A deficient status improve beef quality.

The relationship between plasma vitamin A concentrations and liver vitamin A contents in beef cattle was calculated by non linear regression model (data not shown). The relationship was a curvilinear line. When liver vitamin A contens increased to around 20 μg/g, plasma vitamin A concentrations elevated obviously until about 40 μg/100ml. Beyond the liver vitamin A level, however, plasma vitamin A concentrations did not increase.

As same as the case of cattle, plasma vitamin A concentrations elevated and reached the maximum value of about 40 μg/100ml as liver vitamin A contents increased to 20 μg/g. Beyond 20 μg/g of liver vitamin A, plasma vitamin A concentrations did not increase and kept to be constant.

The relationship between plasma vitamin A and liver vitamin A appeared to be linear when plasma

Table 2. Vitamin A status in rats

Items	Vit A deficient	Control
Liver vitamin A content (μg/g)	$1.9^{a} \pm 0.6$	$219.5^{b} \pm 22.5$
Range	0.02 − 16.8	15.9 − 969.1
Plasma vitamin A concentration (μg/100ml)	$12.4^{a} \pm 1.2$	$40.5^{b} \pm 1.2$
Range	0.6 − 38.2	20.9 − 75.3

Mean ± SEM ; ^{a,b} ; difference at $p < 0.01$

Table 3. Vitamin A status in beef cattle

Items	Jpn. Black	Holstein
Liver vitamin A content (μg/g)	$8.4^{a} \pm 2.9$	$66.9^{b} \pm 7.2$
Range	0.01 − 103.9	1.5 − 283.6
Plasma vitamin A concentration (μg/100ml)	$19.7^{a} \pm 2.0$	$41.4^{b} \pm 1.4$
Range	1.1 − 44.0	25.0 − 96.4

Mean ± SEM ; ^{a,b} ; difference at $p < 0.01$

vitamin A concentrations were less than 40.0μg/100 ml. Therefore, the relationship was recalculated by using a simple regression model and the transformation of liver vitamin A value to logarithm (base10) value.

Figure 1 and 2 showed the simple regression equation and the relationship between log of liver vitamin A contents and plasma vitamin A concentrations in beef cattle and rats, respectively. These results indicated that when plasma vitamin A concentrations were less than 40μg/100ml, there was a significanyly high correlation between plasma vitamin A concentrations and log of liver vitamin A contents. Therefore, under the limitation of regression coefficient equal 0.70, it appears to be possible to use a simple linear regression equation for the prediction of liver vitamin A contents from plasma vitamin A concentrations when plasma vitamin A concentrations were less than 40.0μg/100ml in cattle and rats.

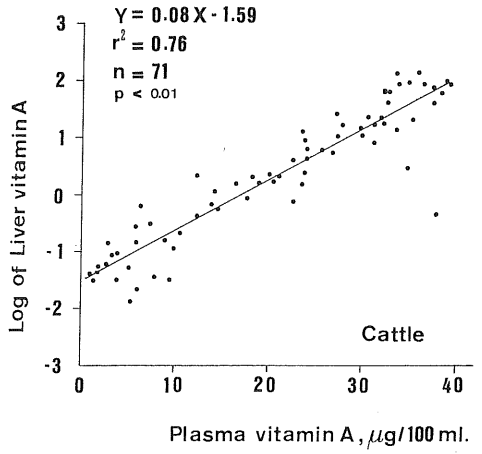

Fig. 2 The relationship between liver vitamin A contents and plasma vitamin A concentrations in rats.

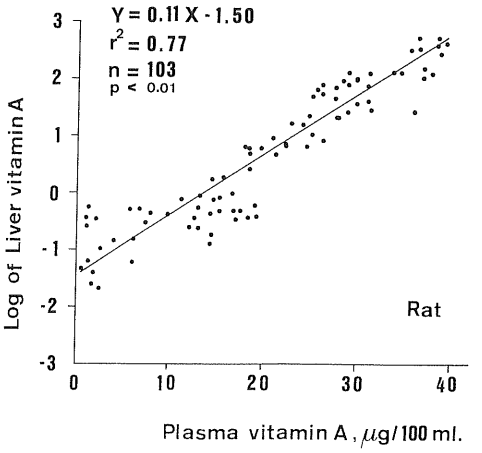

Fig. 1. The relationship between liver vitamin A contents and plasma vitamin A concentrations in cattle.

REFERENCE

1) UNDERWOOD, B.A (1990) J. Nutr. 120 : 1459-1463

2) RIETZ, P., O. WISS and F. WEBER (1974) Vitam. Horm 32 : 237

3) ABE, K., K. ISHIBASHI, M. OHMAE, K. KAWABE and G. KATSU (1977) Vitamins (Japan), 51(7), 275-280