THE EFFECT OF CAROTENE INTAKE ON THE VITAMIN-A CONTENTS OF THE LIVER AND BLOOD OF LAMBS

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INTRODUCTION

The importance of vitamin A in the nutrition of farm animals is well recognized. Every effort is made to incorporate sufficient "green" feed in the rations of all animals to supply an adequate intake of vitamin A in the form of carotene. During dry seasons and winter feeding periods the problem of supplying sufficient carotene in the ration from this source becomes acute. Fortunately, animals are able to store reserves of vitamin A in the liver during periods of abundant carotene intake. This reserve

vitamin A is available to the animal during a period of low intake and the amount of storage determines how soon deficiency symptoms will develop after the animal is placed on a vitamin-A-deficient ration.

In the course of an experiment, the purpose of which was to study some of the factors which may influence the concentrations of vitamin A and vitamin C in the blood plasma of fattening lambs, it was possible to collect data on the storage of vitamin A in the livers of lambs which had received varying amounts of carotene.

EXPERIMENTAL

The fine-wool feeder lambs used in this study were fed a low-carotene ration composed of prairie hay, oats, soybean oil meal, and mineral. The prairie hay fed was three-years old and so badly weathered that it contained no measurable carotene. Two different carotene supplements were used; alfalfa meal and a carotene concentrate, supplied as Research Carrot Oil.

The crude- and the true-carotene contents of these supplements were determined colorimetrically at frequent intervals by a combination of the Peterson, Hughes, and Freeman (1937) procedure as modified by Peterson (1941) and the Wall and Kelley (1943) method.

Colorimetric methods were also employed for the determination of vitamin A. Blood-plasma vitamin-A determinations were made according to a modification of Kimble's (1939) procedure. In making vitamin-A determinations on liver tissue Benham's (1943) method and a modification of Kaser and Stekol's (1943) method were employed. Both methods proved to be satisfactory when conditions were carefully controlled. Color intensities were measured with an Evelyn photoelectric colorimeter in the usual manner.

RESULTS

The data collected in this experiment on the storage of vitamin A in the liver as related to carotene intake may be classified into four groups as follows:

Group I. Experimental treatments were started shortly after the feeder lambs were received. Two lots of lambs were involved, one receiving no carotene for 165 days and the other receiving 5.82 mg of carotene daily per lamb for 158 days.

Group II. Experimental treatments were started after the lambs had been fed a low-carotene ration for 194 days. One lot of lambs received 1.94 mg of carotene daily per lamb and the other received 3.88 mg.

Group III. The lambs in this group received the low-carotene ration for 286 days, at the end of which time their average blood-plasma vitamin A was 8.6 micrograms per 100 ml. During the next 87 days they were fed prairie hay which contained approximately 10 parts per million of carotene. These lambs were then turned out on green pasture for 7 days before being slaughtered.

Group IV. The lambs in this group were handled very much like those of Group III except that they received the low-carotene ration for 194 days and approximately 2.9 mg of carotene daily for 92 days before being placed on pasture.

Data on the liver and blood-plasma vitamin A of lambs which received the different levels of carotene are summarized in Table I.

TABLE I

Liver and blood-plasma vitamin A of lambs in relation to carotene intake

Group	Lot no.	No. of lambs	Daily carotene intake	Days	Blood-plasma vitamin A		Liver vitamin A
					Initial	Final	
			Mg		γ%[a]	γ%[a]	γ per 100 gm
I	1	4	0	155	22.0	13.2	974.8
I	2	6	5.82	158	21.0	25.2	3922.6
II	3	4	1.94	92	12.0	17.2	166.8
II	4	4	3.88	92	13.1	24.2	499.5
III	5	3	pasture	7	14.9	29.6	1094.8
IV	6	4	pasture	7	17.4	39.2	1897.7

[a] γ% —micrograms per 100 ml.

At the beginning of the experimental period the vitamin-A content of the blood plasma of the lambs in Lots 1 and 2 was 22.0 and 21.0 micrograms percent respectively. Blood-plasma vitamin-A values, which for these two lots of lambs were 13.2 and 25.2 micrograms percent respectively at the conclusion of the experiment, indicate that the dietary treatments had a significant influence on the vitamin-A content of the blood plasma. It is apparent that the lambs in Lot 1 were not receiving enough carotene to maintain the original level of vitamin A in the blood, whereas the lambs which received 5.82 mg of carotene daily showed a slight increase in blood-plasma vitamin A during the experimental period.

Vitamin-A determinations on liver samples showed that the lambs in Lot 1 had liver reserves of 974.8 micrograms of vitamin A per 100 gm whereas in Lot 2 liver reserves of vitamin A amounted to 3922.6 micrograms per 100 gm. These figures show a positive relationship between carotene intake and vitamin-A storage, and are in good agreement with the trends suggested by the changes in concentration of vitamin A in the blood plasma during the feeding period.

The two lots of lambs in Group II received a low-carotene ration for a period of 194 days before any carotene supplements were fed. During this time, their body reserves of vitamin A were being depleted as indicated by the low concentration of vitamin A in the blood. During the next 92 days the lambs in Lot 3 were given 1.94 mg of carotene per day while the lambs in Lot 4 were given twice this amount. Both lots of lambs showed increases in plasma vitamin A although, in Lot 3 the increase was only from 12.0 to 17.2 micrograms percent. Vitamin A in the liver of the lambs in Lots 3 and 4 was found to be 156.8 and 499.5 micrograms per 100 gm respectively. Although the carotene intakes of 1.94 and 3.88 mg daily were sufficient to bring about increases in blood-plasma vitamin A it is evident that not much storage of vitamin A occurred at these low levels. It may be noted, however, that doubling the carotene intake resulted in a 3-fold increase in liver vitamin A.

The data in Table I for the lambs in Groups III and IV emphasize the importance of green pasture as a source of carotene for farm animals. Undoubtedly the lambs in these groups, especially those in Group III, were extremely low in vitamin-A reserves at the time they were turned out on pasture. The few days they spent on pasture had a tremendous effect upon the concentration of vitamin A in both the blood plasma and liver. The increase in blood-plasma vitamin A was extremely marked and was accompanied by a storage of vitamin A in the liver.

In general the figures reported in this study show that blood-plasma vitamin A is quite sensitive to changes in intake of the provitamin A.

carotene. Changes in carotene intake are reflected by changes first in the blood and then in the liver. Liver values and blood values seem to show a close association only when blood values are below normal.

SUMMARY

The vitamin-A contents of the blood plasma and the liver of fattening lambs receiving carotene at varying levels of intake were determined. The levels at which the carotene supplements were fed represented intakes of 0, 1.94, 3.88, and 5.82 mg of carotene per lamb per day. The results obtained in this study indicate that a positive relationship exists between carotene intake and the concentrations of vitamin A in the blood plasma and the liver of fattening lambs. There was very little storage of vitamin A in the liver of lambs that received only 1.94 mg of carotene per day.

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