

1954

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Recommended Citation

Allen, R. S. and Jacobson, N. L. (1954) "Effect of Massive Dosage of Vitamin A on the Blood Plasma Fat and Vitamin A Levels in Dairy Calves," *Proceedings of the Iowa Academy of Science*, 61(1), 205-209.
Available at: <https://scholarworks.uni.edu/pias/vol61/iss1/23>

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Effect of Massive Dosage of Vitamin A on the Blood Plasma Fat and Vitamin A Levels in Dairy Calves¹

By R. S. ALLEN AND N. L. JACOBSON

Although the significance of vitamin A in the nutrition of the young dairy calf is well recognized, the effects of ingestion of large amounts of this vitamin, particularly as related to other blood constituents, have received comparatively little attention. Investigations with other species suggest that there may be a relationship between vitamin A intake and the level of the serum lipids. Josephs (1942) reported that the administration of large amounts of vitamin A increased total serum lipids in both normal and vitamin A-deficient rats, the effect being much greater and persisting longer in the latter. Similar results were observed in vitamin A-deficient infants (Josephs, 1945). Children with the nephrotic syndrome also displayed a marked rise in total plasma lipids following administration of vitamin A alcohol in aqueous dispersion (Kagan, Thomas, Jordan and Abt, 1950).

The objective of the present study was to ascertain the effect of massive doses of vitamin A in oily and in aqueous dispersion on the blood plasma vitamin A and fat levels in dairy calves which were near the state of vitamin A deficiency.

EXPERIMENTAL

Six Holstein calves (four males, two females) from the Iowa State College dairy herd were fed a vitamin A-free, low-carotene diet for a period sufficient to reduce the blood plasma vitamin A to near-depletion levels (approximately 6 γ per 100 ml.) The dietary consisted of a limited amount of reconstituted skim milk, a concentrate mixture² fed up to a daily maximum of 4 lb. per calf, and oat straw (18 months old) ad libitum. The experimental plan and data pertinent to the calves are summarized in Table 1.

Venous blood samples (potassium oxalate anticoagulant) were drawn from calves in Group I just prior to the administration of vitamin A, 12 and 24 hours later and daily thereafter for 8 days.

¹Journal Paper No. J-2513 of the Iowa Agricultural Experiment Station, Ames, Iowa. Project No. 814.

²Composed of 50% crushed oats, 38% wheat bran, 10% linseed oil meal, 1% steamed bone meal and 1% iodized salt.

Table 1

SUMMARY OF EXPERIMENTAL PLAN AND PERTINENT CALF DATA

| Group | Treatment | Calf No. | Sex | Data at start of experiment | | | |
|-------|---|----------|-----|-----------------------------|-----------|-------------------------------------|--------------------------|
| | | | | Age (days) | Wt. (lb.) | Plasma vit. As. (γ /100ml.) | Plasma fats (mg./100ml.) |
| | (Vit. A ^a per 100 lb. body wt.) | | | | | | |
| I | 100,000 I.U. (Fed, in capsules, daily for 6 days) | 3400 | F | 140 | 196 | 7.8 | 65 |
| | | 3409 | M | 118 | 219 | 4.7 | 41 |
| | | 3410 | M | 105 | 175 | 5.7 | 50 |
| | | 3420 | M | 87 | 150 | 5.1 | 54 |
| | | Mean | | 112 | 185 | 5.8 | 53 |
| II | 150,000 I.U. (Emulsified with Tween 80 ^b and fed as single dose in milk) | 3372 | F | 185 | 300 | 6.3 | 135 |
| | | 3390 | M | 132 | 300 | 5.3 | 94 |
| | | Mean | | 158 | 300 | 5.8 | 115 |

^aNatural ester form produced by distillation from fish liver oils.

^bPolyoxyethylene sorbitan monooleate.

Blood samples from calves in Group II were drawn before feeding the vitamin A and at 4, 8, 12, 24 and 52 hours thereafter. Following centrifugation of the blood, plasma samples were analyzed for

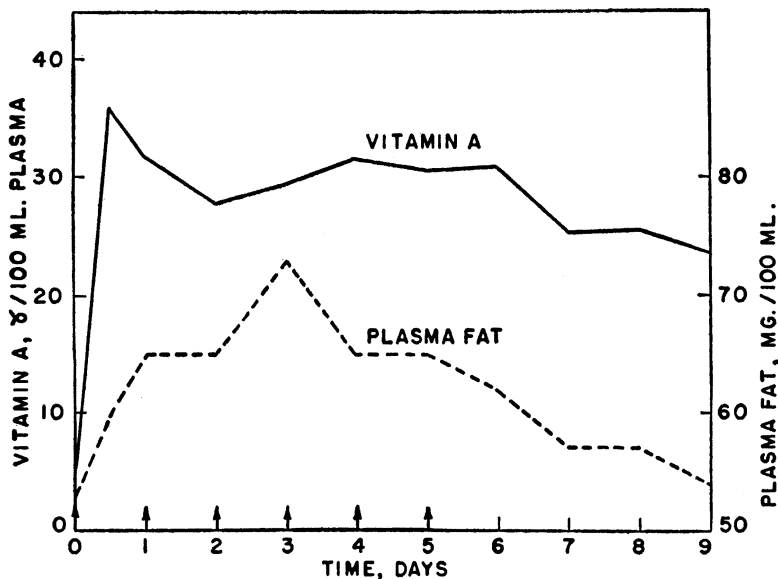


Figure 1. Effect of massive oral doses of vitamin A in oil to dairy calves (group I) on blood plasma vitamin A and fat values. Each arrow indicates administration of 100,000 I.U. per 100 lb. body weight.

vitamin A by the saponification method of Allen, Wise and Jacobson (1949) and for fat by the method of Allen (1934).

RESULTS AND DISCUSSION

The effect of administration to calves of group I of 100,000 I.U. vitamin A ester in oil per 100 lb. body weight for 6 consecutive days on the blood plasma vitamin A and fat values is shown in Figure 1. Initially the mean plasma vitamin A levels increased markedly and subsequently remained at approximately 30 γ per 100 ml. during the supplementation period. Thereafter the values declined gradually. The mean plasma fat levels increased slightly when the vitamin was administered and were maintained at approximately 65 mg. per 100 ml. during the supplementation period. Thereafter the values declined slowly until at 9 days the fat levels were essentially the same as at the beginning of the experiment.

In group II the rate of vitamin supplementation was increased (above that used in group I) and the supplement was dispersed by an emulsifying agent in an attempt to effect rapid absorption and high blood plasma vitamin A levels. The results indicate that these were accomplished. Figure 2 shows the effect of a single feeding of 150,000 I.U. of vitamin A ester in aqueous dispersion per 100 lb. body weight on the blood plasma vitamin A and fat levels. The plasma vitamin A values were characterized by marked increases 4 hours after intake of the vitamin and by subsequent decreases. The mean vitamin A tolerance curve obtained in this study was similar to that observed earlier by Wise, Jacobson, Allen and Yang (1949). The mean plasma fat levels increased slightly at 4 hours, decreased to a minimum at 12 hours, then increased somewhat until the end of the experiment.

The results of this investigation indicate that in contrast to observations with other species (Josephs, 1942; Josephs, 1945) no marked increase in plasma fat levels of calves occurs following supplementation with high levels of vitamin A (either as a single massive dose or as repeated massive doses). Moreover, there were no indications that the responses were affected either by sex or by age of animal. Between-calf variations in responses both in group I and in group II were exceedingly small.

The blood plasma fat values reported herein do not represent the total plasma lipids. It has been shown (Chung, Saarinen and Shaw, 1950) that the Allen method measures primarily the neutral fats, cholesterol and cholesterol esters. This was confirmed by Zaletel, Allen and Jacobson (1952) who found a high correlation

between "Allen" fat values and total plasma lipids minus phospholipids and free fatty acids. In a recent study it was found that plasma "Allen" fat constituted from 74 to 87% of the total plasma

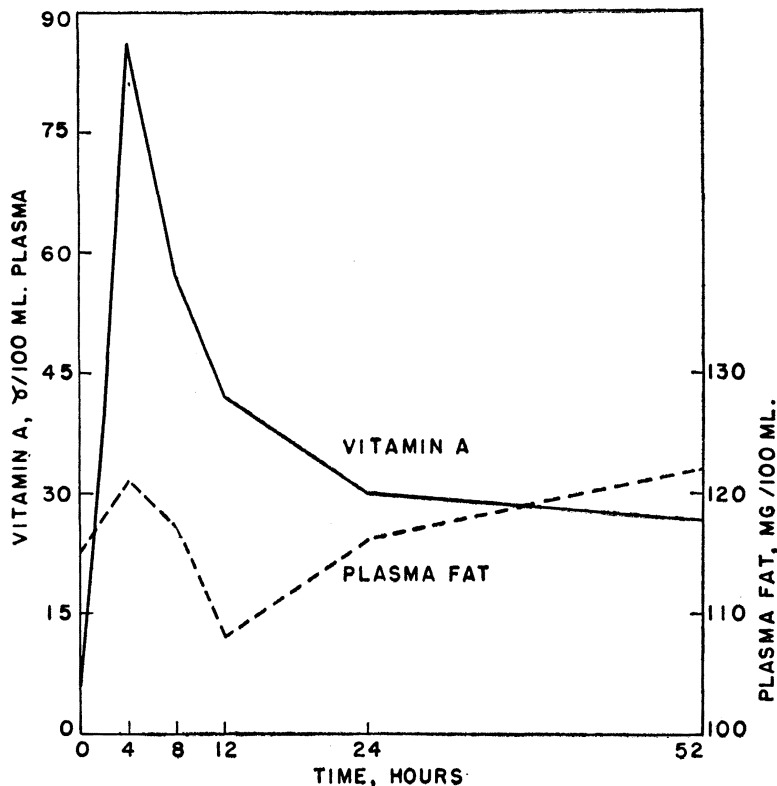


Figure 2. Effect of a single massive dose (150,000 I.U./100 lb. body wt.) of vitamin A in aqueous dispersion on blood plasma vitamin A and fat values of dairy calves (group II).

lipids of calves and further that these percentage figures were not altered to any great extent by change in type of dietary lipid (Jacobson, Zaletel and Allen, 1953). Thus, it would seem that the plasma fat values reported herein probably represent a major portion of, and are indicative of changes in, the total plasma lipids.

Van Bruggen and Straumfjord (1948) reported that daily supplementation of hospital patients with 100,000 I.U. vitamin A for an extended period of time (36 months) caused significant increases in both free and total plasma cholesterol levels. Moreover, a tendency toward higher phospholipid values also was noted. Slight increases in plasma fat values noted in the present study

suggest a tendency toward a similar response in calves even though the supplementation periods were considerably shorter.

SUMMARY

Six Holstein calves with low blood plasma vitamin A values were employed to ascertain the effect on the blood plasma vitamin A and fat levels of feeding massive doses of vitamin A. Vitamin A supplementation resulted in marked increases in the level of the vitamin in the blood plasma but effected only slight increases in plasma fat values.

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