# THE SPECIFIC EFFECT OF VITAMIN A ON GROWTH

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A study of vitamin A supplements in their relation to growth developed from observations made during an investigation of the nutritive value of cottonseed by-products in dairy rations. Calves which were being raised on rations composed of cottonseed meal and beet pulp developed symptoms characteristic of vitamin A deficiency. Ophthalmia was of frequent occurrence and in some instances the animals became partially if not totally blind. The calves showed such other symptoms of a less characteristic nature as roughness of coat, loss of appetite, bloating, swollen joints, stiffness and peculiar spasms. Prompt recovery from these conditions followed the daily administration of 60-100 cc, of cod-liver oil. It was later found that 30 cc. of cod liver oil was close to the minimum amount required by the calves for complete recovery. This result suggested that the calves were suffering from typical A-avitaminosis. Blood analyses showed normal values for inorganic Ca and P and since the calves received an abundance of sunshine it did not appear likely that vitamin D was a limiting factor in their basal ration. Furthermore, there was no beneficial responses when irradiated yeast formed a part of their ration.

Further investigation of vitamin A supplements revealed that canned tomatoes when supplied daily in amounts equivalent to the vitamin A content of the cod-liver oil failed to promote complete recovery. The eye condition of the animals was usually improved by the tomato supplement, but their appetites and general condition gave evidence of a poor nutritive condition. A combination of tomatoes and vitamin D, the latter supplied as irradiated yeast or aerated (vitamin A-free) cod-liver oil, was likewise only partially effective in promoting recovery. In some instances, the aerated oil by itself proved to be slightly efficacious, but as a whole the results obtained with this supplement were inconsistent.

One of our problems was to determine by more refined feeding methods the vitamin A and D content of the above supplements and to determine whether or not vitamin A had greater growth promoting properties when supplied in the form of cod-liver oil than when supplied as tomatoes. The possibility that cod-liver oil contained some growth promoting substance other than vitamins A and D, which was only partially destroyed during the aeration and which was present in relatively small amounts in tomatoes, also presented itself. The results presented here relate to the specific effect of vitamin A on the growth of albino rats when this vitamin is supplied in cod liver oil and in canned tomatoes.

To determine whether or not vitamin A was completely destroyed in the aerated cod-liver oil, eight drops were fed daily to young rats while on a vitamin A-free diet. Their growth and condition were compared with other rats on the same diet supplemented with refined cottonseed oil. The A-free diet was composed of casein (alcohol-extracted) 18, salts 4, agar 2, Crisco 5, yeast (ether-extracted) 15 and starch 56. Vitamin D was supplied by irradiating the diet. The results presented in Table I leave no doubt as to the complete destruction of vitamin A in the aerated cod-liver oil. Rats which received this supplement grew at about the same rate as did rats which received cottonseed oil or no supplement, and developed severe xerophthalmia. Similar results not presented here have shown that the aerated oil is also ineffective in promoting recovery of rats suffering from a depletion of vitamin A. In view of the possible

beneficial effect of the aerated oil in the calf rations, this result was not anticipated.

To determine the specific effect of vitamin A on growth, a large number of rats were depleted in their stores of vitamin A and then divided into pairs according to litter origin, sex and weight. Only those animals which lost a similar amount of weight during depletion and which were comparable in other respects were used in these experiments. One rat of each pair was given a daily supplement of either canned tomatoes or cod-liver oil and its daily food allowance restricted to that of its litter mate on the deficient diet. Since the plane of nutrition as determined by the amount of food eaten was maintained the same for both rats, any increased growth made by the rat which received the vitamin supplement must be attributed to the effect of the supplement alone. The results are presented in Charts 1 and 2.

From a comparison of the growth curves given in Figures 1 and 2, it is evident that vitamin A when supplied either as cod-liver oil or canned tomatoes has a specific effect on growth. In every case the rat which received the vitamin A supplement made a slightly greater gain in weight than did its litter mate on the deficient diet. This effect is as apparent when the canned tomatoes were used as when the cod liver oil was used to furnish vitamin A. Again the results obtained with the rats were not those anticipated from the behavior of calves on low vitamin A rations.

To observe further the growth of rats receiving tomatoes and cod-liver oil as sources of vitamin A, litter mates which had been depleted in vitamin A were arranged in pairs according to the practice in paired feeding experiments. One member of each pair was given daily five or ten times the previously established unit dose of vitamin A as canned tomatoes and the other an equivalent amount of vitamin A as cod-liver oil. They were allowed to eat the basal diet ad libitum and a record was made of their food intake and growth. The results which are presented in Table 2 establish strong evidence for the opinion that rats, perhaps unlike dairy cattle, utilize vitamin A from these two sources to an equal advantage.

TABLE I.

Growth of Rats on a Basal Vitamin A-Free Diet With and Without Daily Supplements of Cottonseed and Aerated Cod Liver Oil.

| Litter No. | Supplement Received | Experimental Period | Initial Weight | Maximum Weight | Final Weight | Food Intake | Eye Condition* |
|---|---|---|---|---|---|---|---|
| | | days | gm. | gm. | gm. | gm. | |
| I | C. S. oil | 38 | 52 | 112 | 109 | 259 | ++ |
| | A. C. L. oil | 38 | 50 | 108 | 102 | 273 | ++++ |
| II | C. S. oil | 38 | 53 | 110 | 100 | 245 | + |
| | A. C. L. oil | 38 | 56 | 132 | 116 | 298 | ++++ |
| III | C. S. oil | 39 | 47 | 114 | 107 | 286 | + |
| | A. C. L. oil | 39 | 48 | 105 | 100 | 273 | ++++ |
| | ..... | 38 | 52 | 114 | 105 | 281 | + |
| III | C. S. oil | 38 | 50 | 106 | 100 | 245 | +++ |
| | A. C. L. oil | 38 | 48 | 115 | 106 | 265 | ++++ |
| | ..... | 40 | 52 | 113 | 106 | 286 | ++++ |
| IV | C. S. oil | 40 | 54 | 125 | 119 | 315 | + |
| | A. C. L. oil | 40 | 55 | 120 | 117 | 301 | + |

*The plus signs signify varying degrees of severity of xerophthalmia.

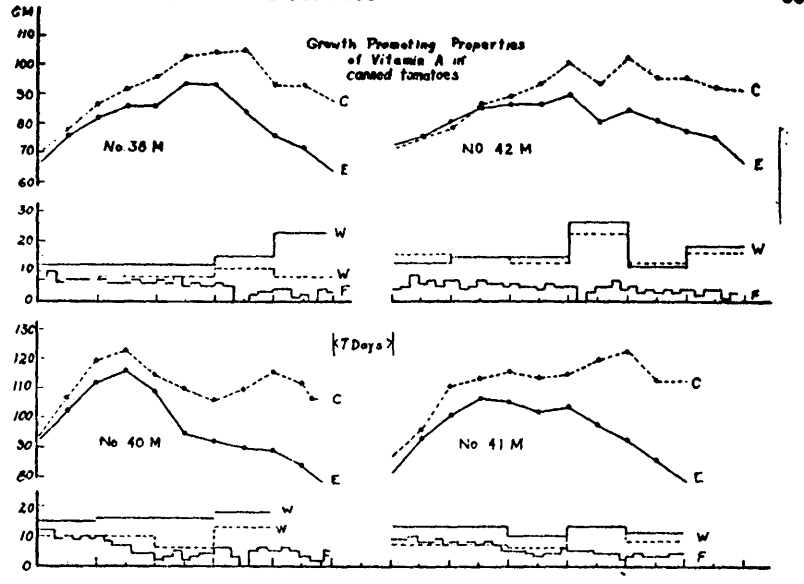


Figure 1. Growth rate and food and water intake of 4 pairs of rats in paired feeding experiments in which one animal of each pair received daily in addition to the basal vitamin A- free diet, 1 cc. of canned tomatoes. The letter F indicates the daily food intake; W, the average daily water intake during each week; E, the growth curve of the animal which received no supplement; and C, the growth curve of the animal which received the tomato supplement.

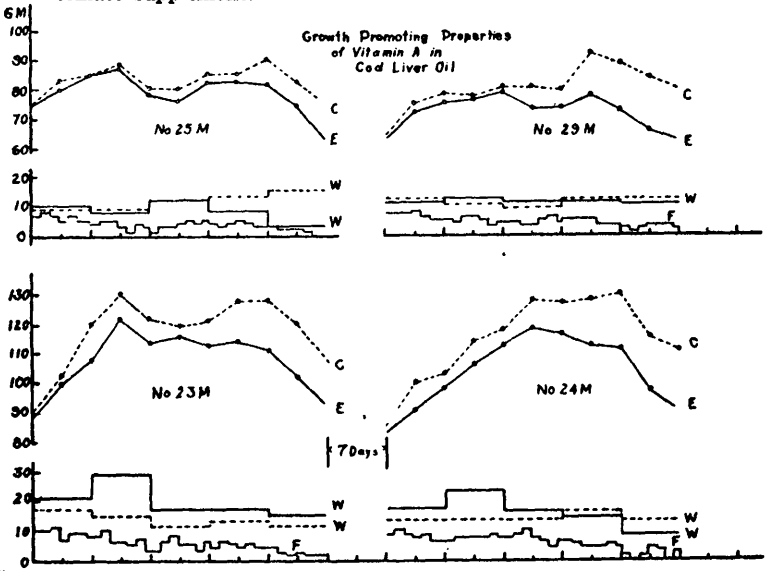


Figure 2. The same as Chart 1 except that 4 drops of cod-liver oil were used in place of tomatoes to furnish vitamin A. An equal amount of aerated cod liver oil was given the rats on the deficient diet.

TABLE II

Growth of Rats Which After Depletion in Vitamin A Received Daily for 28 Days 5 or 10 Times the Established Unit Dose of Vitamin A in the Form of Canned Tomatoes and Cod Liver Oil.

| | Pair 1 | | Pair 2 | | Pair 3 | | Pair 4 | |
|---|---|---|---|---|---|---|---|---|
| | 5xT. | 5xC. | 10xT. | 10xC. | 10xT. | 10xC. | 10xT. | 10xC. |
| Initial weight, gm. | 84 | 75 | 74 | 84 | 103 | 106 | 91 | 80 |
| Gain, gm. | 72 | 66 | 66 | 66 | 69 | 64 | 82 | 84 |
| Food intake, gm. | 285 | 241 | 219 | 250 | 282 | 275 | 275 | 264 |

SUMMARY

Vitamin A has a specific effect on the growth of the rat when this vitamin is supplied either as canned tomatoes or cod-liver oil. Equivalent amounts of vitamin A from these two sources produce similar responses in the food intake, growth and condition of A-avitoaminotic rats. Cod-liver oil which has been aerated at 100° C. for 48 hours does not influence the food intake or growth of rats on a vitamin A-free diet nor does it delay the onset of xerophthalmia in these animals. These results are not in accord with the observations made of calves on vitamin A-low rations and suggest that the nutritive requirements of these two species may differ with respect to vitamin A.

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