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Effect of irradiated winter milk and cod liver oil on growth of young of milk-fed rats.

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During an investigation pertaining to the mineral deficiencies of milk, it was observed that the young, born of milk fed rats in February and March, 1926, were smaller, and their rate of growth was far less rapid, than that of any which we had heretofore noted in a long series of milk fed animals. These young were furthermore much smaller than young born of these same mothers during October and September, 1925. The appearance of the young in all groups (6) were so strikingly similar, even though the milk modifications were somewhat unlike, that it seemed as if the difficulty must be inherent in the milk, and not in the added inorganic substances. This was further emphasized by the fact that in two cases in which the mother rats were being used as controls, the animals were receiving only milk with the customary iron and iodine additions.

To determine what constituent of this particular "winter" milk was lacking, we reduced the number of young in each litter to four, and added to the milk rations of the mothers the following substances respectively: $Ca_3(PO_4)_2$, Vitamin B preparation, Yeast, and cod liver oil. In no case did we get satisfactory growth. Slight gains were observed with three of the cod liver oil groups. One group receiving the cod liver oil addition died, as did also the group receiving the $Ca_3(PO_4)_2$.

Besides the small and spindling appearance of these young, it was observed that the skin had a peculiar pink, yellow color, and

the fur was very thin and peculiarly wiry. In spots it was quite gone, giving the animals a moth-eaten appearance. A somewhat similar condition in the fur of animals receiving a purified ration, containing cotton seed oil for its chief fat component, seemed to have been corrected by irradiating the food mixture with ultra violet light from a quartz mercury vapor lamp. Therefore, it occurred to us that a similar procedure with our milk was worth trying. We were a bit skeptical as to the effect of such procedures, since the cod liver oil addition (1 cc. per day*) had been of little benefit, and since in animals receiving all milk, it did not seem possible that the anti-rachitic properties of the diet would be so low as to produce the stunted appearance. Furthermore, neither mother nor offspring had any of the gross symptoms of rickets. However, the very rapid improvement of the young in all of the groups receiving the irradiated milk[1] left no room for doubt regarding the effectiveness of the treatment. Growth was at once resumed. The appetite of the animals increased. The fur became thick, soft, and silky, and in a very short time the animals gave every appearance of being normal.

A study of the growth curves of the young of milk fed rats during other seasons, for example, July and August, and October and November, gave no such picture, nor did the growth curves of young reared on our milk rations in March, 1922, show such very great variations. It seemed, therefore, that the low growth promoting qualities of the February, March and April (1926) milk tested may be explained in part by the unusually long cloudy winter.[2] Numerous investigators have reported an increase in the anti-rachitic potency of milk by direct radiation,[3] and Hart,

* An approximate measure only. During the first days of the experiment the cod liver oil was added to the milk, all of which was not taken. The oil was then incorporated in a starch paste and fed as such.

[1] The milk was irradiated for one-half hour at a distance of two feet with a quartz mercury vapor lamp.

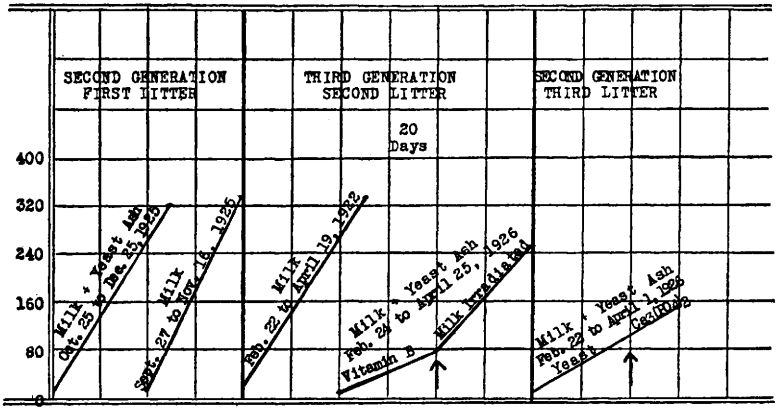
[2] Average percentage of sunshine in the reports of the United States Weather Bureau for Iowa City was:

	January	February	March	April
1922	66.4	62.8	44.8	47.7
1925	59.0	40.4	67.4	59.3
1926	48.2	44.9	44.6	64.3

[3] Steenboch, H., Hart, E. B., Holport, C. A., and Black, Archie, *J. Biol. Chem.*, 1925, lxiv, 441; Hess, A. F., *J. Am. Med. Assn.*, 1925, lxxxiv, 1910; Co well, S. J., *Brit. Med. J.*, 1925, i, 594.

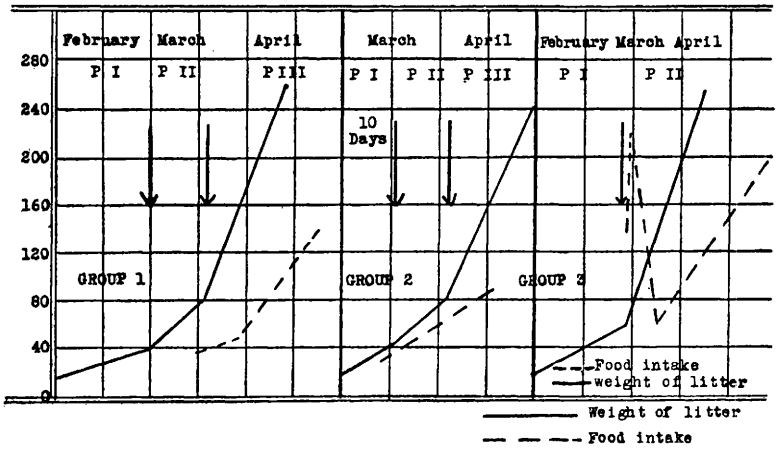
Steenboch and co-workers have observed differences in calcium balances in milking cows in different seasons.[4] It is possible that

CHART I.



Growth curves of the suckling young of milk-fed rats during different seasons, and during the same season, in different years. Neither the addition of a Vitamin B extract, yeast, nor calcium phosphate to the milk ration was as effective in promoting growth in the young, as the irradiation of winter milk with the ultra violet light from a quartz mercury vapor lamp.

CHART II.



Growth curves of the suckling young of milk-fed rats. During Period I (P I) the mother rats received milk plus the usual addition of iron and iodine. During Period II (P II), groups 1 and 2 received the cod liver oil additions. Groups 1 and 2 received irradiated milk in Period III (P III), while Group 3 received irradiated milk in Period II. The growth stimulation in Groups 1 and 2, therefore, was not the result of the cod liver oil, which in the two groups preceded the irradiated milk period.

[4] Hart, E. B., Steenboch, H., Elvehjem, C. A., and Scott, H., *J. Biol. Chem.*, 1926, xiii, 371.

our rats receiving the "winter" milk were suffering from rickets, and the irradiated milk brought about increased calcium and phosphorus balances. Macroscopic examination of the animals which died gave none of the characteristic symptoms of rickets, but since histologic examinations were not made, exact evidence is lacking. It would seem, however, that the very rapid growth of the animals on the irradiated milk, was more deep seated than just an increase in the anti-rachitic potency of the milk.

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Vitamin A content of fecal excretion of a breast fed and artificially fed infant. Preliminary report.

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Rats fed on diets adequate in all other respects but low in the Vitamin A factor, develop, in the course of time, infection of the upper respiratory tract. The first symptoms of the dietary deficiency are snuffles, loss of appetite, and failure to gain. These animals invariably die unless appropriate dietary treatment is introduced fairly early in the course of the infection. Macroscopic examination of the various organs of these animals, with the exception of the aural and nasal passages, which have been found filled with pus, shows nothing consistently abnormal. Occasionally the lungs are infected, often the intestines are filled with gas and greatly distended. Death in these animals seems to be the result of an infection superimposed on tissues which have been altered by the dietary deficiency.

The excessive reaction to infection of the upper respiratory tract (nasal and aural passages) of the artificially fed baby and the low incidents of such infection amongst breast fed babies, suggests that in the former case as in the rats, we are dealing with an infection superimposed on tissues which have been altered by a dietary deficiency.

The possibility of the occlusion of Vitamin A in the calcium soap excreted by the artificially fed baby, and the consequent failure to absorb enough to meet the physiological needs, was