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### A Method of Enhancing the Vitamin A Value of Cod Liver Oil.

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Some unpublished data kindly supplied to the authors by Dr. Walter H. Eddy have indicated that cod liver oil in an emulsified form is a more efficient source of the fat soluble vitamins than plain cod liver oil.

Recent comparisons in this laboratory of the vitamin values of emulsified vs. plain cod liver oil yield results in accord with those obtained by Eddy, and show quite conclusively that the emulsified cod liver oil which we have examined is a decidedly more efficient source of vitamin A than the same oil in the unemulsified state.

The particular type of emulsion which has interested us is the same as that employed by Eddy in his earlier investigations, and consists of 22.37% by weight of high grade cod liver oil with 77.63% of concentrated malt extract.\* Emulsification of these constituents is effected by thoroughly agitating the cod liver oil and the malt extract in an especially constructed apparatus operated under reduced pressure. A fine emulsion results, with the oil uniformly distributed in the aqueous phase as minute droplets microscopic in size.

While other tests have shown that the malt extract itself contains relatively little vitamin A, it was thought that some factor or factors present in the extract, such as vitamin B or G, might exert a synergistic action of some kind upon the vitamins of cod liver oil and thus increase their effectiveness. We have, therefore, included not only a study of the vitamin A value of the plain as well as the emulsified cod liver oil, but also that of a mixture of the malt extract and cod liver oil.

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\* The commercial product Maltine with Cod Liver Oil.

Sherman's<sup>1</sup> method for determining vitamin A was employed. When young rats fed the vitamin A-free diet had ceased to grow and showed by other symptoms that their surplus bodily stores of this vitamin were depleted, they were divided into 3 groups. To one group was fed as daily supplements 4.0 mg. of the cod liver oil emulsion (22.37% cod liver oil by weight); to the second group 0.8948 mg. (22.37% of 4.0 mg.) of the same oil used in the emulsion; and to the third group 0.8948 mg. of the cod liver oil + 3.1052 gm. of the concentrated malt extract. In the case

TABLE I.

Daily Supplement	Rat No.	Survival	Total gain in body wt. end of 35-day test period.
			gm.
4.0 mg.	8258	entire period	21
Cod Liver Oil	8298	" "	40
Extract Emulsion	8312	" "	47
	8348	" "	43
	8352	" "	36
(Contains 22.37%	8353	" "	58
C. L. O. by weight)	8517	" "	50
	8521	" "	18
	8522	" "	44
			Average 39.7
	8257	entire period	-29
	8259	" "	- 8
0.8948 mg.	8261	" "	20
	8295	23 days	dead
Plain	8296	entire period	-15
	8299	" "	7
Cod Liver Oil	8313	" "	-21
	8314	31 days	dead
	8349	25 days	"
	8355	28 days	"
	8515	entire period	13
	8516	" "	- 9
	8256	34 days	dead
0.8948 mg.	8260	entire period	- 1
Plain	8262	" "	-21
Cod Liver Oil	8292	" "	-19
+	8293	30 days	dead
3.1052 mg.	8297	entire period	3
Malt Extract	8315	" "	-41
fed	8316	34 days	dead
separately	8350	entire period	12
	8354	" "	10
	8518	30 days	dead
	8519	30 days	"
	8520	entire period	10

<sup>1</sup>Sherman, H. C., Chemistry of Food and Nutrition, 4th Edition, 1932, Macmillan.

of the cod liver oil + malt extract supplement, each of these materials was measured as a separate portion but both were consumed almost immediately after they were offered to the test animal.

To facilitate measurement of the small dosages required for the daily feedings, the emulsion was diluted with water, the cod liver oil with peanut oil and the malt extract with water, the aqueous solutions being made to a definite volume before each feeding and dilution of the cod liver oil made at least once each week. All dosages necessary to furnish the required amount of each test material were then carefully measured with a pipette.

The results in Table I and Fig. 1 show the superiority of the emulsion over the plain cod liver or plain cod liver oil + extract fed separately. The animals fed 0.8948 mg. of cod liver oil daily in the form of the cod liver oil-malt extract emulsion made an average gain in weight of 39.7 gm. during the 5 weeks' experimental period. Further, when xerophthalmia existed in the animals of this group at the beginning of the test period, the eye condition became decidedly improved or was entirely cured.

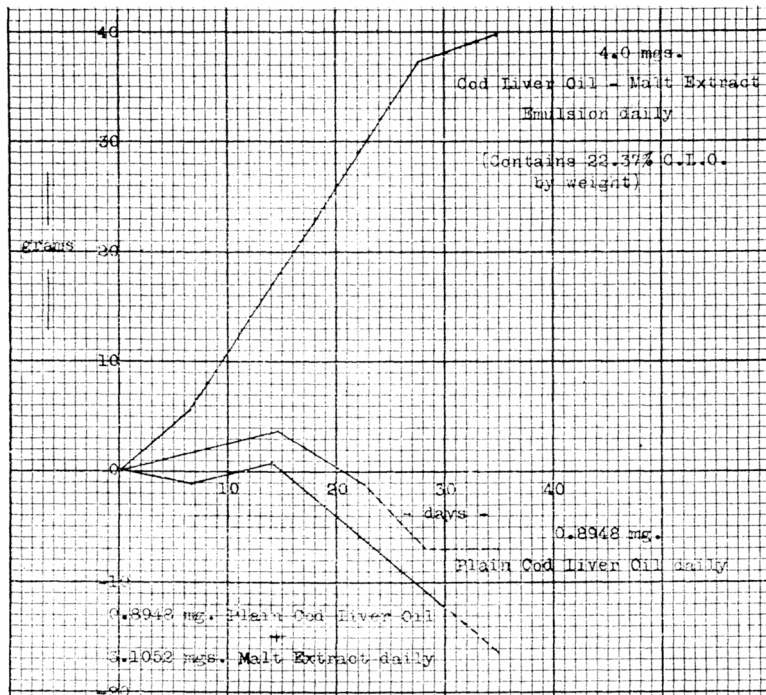


FIG. 1.  
Average growth curves of rats fed supplements indicated as their sole source of vitamin A.

In striking contrast to the emulsion-fed animals were those receiving the same amount of cod liver oil supplied as plain oil alone or as plain oil + the concentrated malt extract fed separately. Several of the animals in each of these groups died before the end of the 35-day test period, while those that did live made poor growth or lost weight and were in poor physical condition, with more or less severe xerophthalmia at the end of the period.

From the results there can be little doubt but that the vitamin A present in the oil-malt extract emulsion is much better utilized than that of the plain cod liver oil.

Although the plain cod liver oil + the malt extract fed separately showed no better results than the plain oil alone, thus tending to discount the idea of the synergistic action postulated above, there is still the possibility that such an action may function only when the extract and oil are intimately mixed, *i. e.*, in the emulsified form. Unless it can be shown, however, that the malt extract *per se* plays some part in increasing the value of the emulsified oil, it would appear that the logical explanation for the better results with the emulsified product is that the very fine subdivision of the oil favors a more complete absorption and utilization within the animal body.

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## Blood Cholesterol in Dogs on an A Deficient Diet.

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Drummond<sup>1</sup> showed that vitamin A was linked to cholesterol and could be separated from it without losing its vitaminic activity. No mention was made that vitamin A might affect the metabolism of cholesterol. Liang and Wacker<sup>2</sup> found that the total cholesterol in rats fed a diet low in vitamin A, fat and cholesterol was greater than in a group of animals fed a diet containing butter and fat. They felt that these results showed that the metabolism of cholesterol was

\* The expenses of this investigation were defrayed by a grant from the Josiah Macy Jr. Foundation.

<sup>1</sup> Drummond, J. C., *J. Soc. Chem. Ind.*, 1924, **43**, 928. Drummond, J. C., and Coward, K. H., *J. Soc. Chem. Ind.*, 1922, **41**, 561.

<sup>2</sup> Liang, B., and Wacker, L., *Biochem. Z.*, 1925, **164**, 371.