small metal tube, may be made without trouble. Drops as small as 0.01 cc. or as large as 0.05 cc. have been used with entire success. The degree of viscosity (for example, 15% gum acacia solution) or the character of the fluid (electrolyte content) are also unessential for the satisfactory operation of this form of drop recorder, so long as discrete drops may be obtained.

In physiological or pharmacological experiments, the drop inlet tube is attached at its upper end by small rubber tubing directly to the cannula, the flow from which is to be recorded. The recorder should be kept in an approximately vertical position so that the drops fall directly into the capillary tube without spreading over the walls of the surmounting bulb. To obtain a sufficiently rapid response of the tambour, the rubber dam should be taut. Certain response and recording may be easily obtained with this apparatus with as many as 360 drops per minute, in other words, with drops that nearly merge into a stream.

(This drop recorder may be had from E. Machlett and Son, 220 East 23rd Street, New York City.)

7073 C

Influence of Mineral Oil on Assimilation of Vitamin A from Spinach.

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The inhibitory effect of mineral oil on the absorption and utilization of vitamin A has been discussed by several workers.[1, 2, 3] Rowntree[1] considers the phenomenon of little significance so long as abundance of vitamin is provided. Jackson[2] finds but slight effect upon vitamin absorption if the mineral oil is fed separately from the butter fat. In none of the investigations has special attention been given to the effect of mineral oil upon vitamin A from a vegetable source, nor to the quantity of vitamin actually diverted by the parallel use of mineral oil.

Would mineral oil effect the carotin of plant cells in the same manner that it did the true vitamin A from an animal source? This

[1] Rowntree, J. I., *J. Nut.*, 1931, **3**, 345.

[2] Jackson, R. W., *J. Nut.*, 1931, **4**, 171.

[3] Dutcher, R. A., Ely, J. O., and Honeywell, H. E., PROC. SOC. EXP. BIOL. AND MED., 1927, **24**, 953.

question arose at the time some vitamin A assay work on a dry spinach product was being completed in the laboratory. At the end of the 8 weeks' test period these rats were given ½ cc. of mineral oil daily in addition to their spinach supplement. The results were striking and left no doubt that mineral oil does seriously interfere with the assimilation of the provitamin in plant cells.

The subject seemed to warrant further consideration from a quantitative standpoint. Fresh green spinach was used in all subsequent experiments and the standard vitamin A technique discussed by Sherman[4] was employed. Repeated control experiments had demonstrated that 10 mg. of spinach contained slightly more than one unit of vitamin A. When quantities of mineral oil ranging from ¼ to 1 cc. were fed with 10 mg. of spinach, the rats failed to gain and died in from 3 to 11 weeks. This was to be expected as all workers have emphasized that the effect of mineral oil is most pronounced when minimum or marginal doses of the vitamin supplement are employed.

The present question may then be stated: How much more spinach would it be necessary to feed in the presence of ½ cc. of mineral oil in order to obtain the same limited growth as that obtained with 10 mg. of spinach alone?

Graded amounts of spinach were fed, keeping the mineral oil dosage constant (½ cc. daily). This amount has been used by several investigators and is comparable to a moderate human dose. The grade of oil used was that known as Standard Oil "Stanolind" heavy (Viscosity 310 sec. at 100° F. and pour test 0°F.).

All rats fed 10, 20 and 40 mg. of spinach daily as the sole source of vitamin A plus ½ cc. of oil died in a few weeks with definite symptoms of vitamin A deficiency. Those fed 80 mg. of spinach plus the oil showed temporary gains in some cases with subsequent loss of weight and death in 8 out of 11 cases. The 3 rats which gained were in an experimental group fed during the spring on home-grown spinach which proved to have a slightly higher A content than that shipped in during the winter. A limited number of tests using larger quantities of spinach (as a source of A) indicated on the average that 100-120 mg. of spinach daily would be necessary to promote a unit gain of 3 gm. per week if fed with ½ cc. of mineral oil.

When the same spinach and mineral oil supplements were fed separately and at least 6 hours apart the 80 mg. of spinach per-

[4] Sherman, H. C., Chemistry of Food and Nutrition. Macmillan, 1932, 361.

mitted slightly more than unit growth, or approximately the same as that obtained with 10 mg. of spinach when no mineral oil was fed.

Thus 10-12 times as much spinach was required to furnish a unit of vitamin A when accompanied by ½ cc. of mineral oil; and about 8 times as much when fed separately at least 6 hours apart. It would seem that the effect of mineral oil on vitamin A assimilation is of sufficient magnitude to be significant.

TABLE I.

Average gain or loss of weight in rats receiving graded quantities of fresh spinach as the sole source of vitamin A with and without mineral oil.

Spinach** mg.	Mineral Oil cc.	No. Rats	Total Change in wt. gm. aver. Gain	Loss	Survival* Week's Average
10		9	+31		8+
20		4	+64		8+
80		7	+79		8+
20	1	3		—15	5
40	1	3		—25	3
40	1/2	4		—26	3.5
80	1/2	11	+27(3)	—23(8)	8 6,6
80	1/2 P.M.	4	+45		8+
80 P.M.	1/2	9	+27		8+
120	1/2	2	+ 3		5+
120 P.M.	1/2	4	+26		5+

*The total experimental period was 8 weeks except in the last 2 groups where it was limited to 5 weeks.

**Fed in A.M. unless otherwise indicated.

Higher melting point paraffins have not been investigated as to their effect on the assimilation of vitamin A. They have, however, been recommended by some physicians as more efficient laxative agents than the fluid oils. Paramels* are a product of this type containing an oil of viscosity 200 sec. at 100°F. The final product has a variable melting point between 84 and 104°F. Paramels were fed to rats in doses of 0.65 gm. daily, equivalent to ½ cc. of mineral oil and under identically the same conditions as reported above.

Rats fed 80 mg. of spinach plus 0.65 gm. of paramels grew on the average of 4½ gm. a week or 1½ units, as compared with loss of weight and death in 8 out of 11 rats fed the equivalent doses of ½ cc. of fluid mineral oil.

Thus it would appear that the higher melting point paraffin oil and wax mixture has a less detrimental effect upon vitamin A assimilation than does the fluid mineral oil.

* Produced by Battle Creek Food Co., Battle Creek, Mich.