

tubes. After 18 to 24 hours the former cultures were examined for capsules and the pour plates were studied for colony formation. In 28 strains (70%) capsules could be demonstrated. Of the 8 strains in which capsules could not be identified before mouse inoculation, 7 showed them after this process. Mouse passage also increased the size of the capsules already present in a majority of cases.

Twenty-nine strains of the pour plates developed colonies of the mucoid type. Four plates were unreadable, 3 showed colonies of an intermediary type and 4 produced colonies unchanged from the original. In 3 of these 4 strains it was likewise impossible to demonstrate capsules in broth cultures.

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A Study of the Relation of Dietary Fats to Action of Thyroid Extract in Rats.

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A relation between dietary fats and thyroid activity has been reported by several investigators.¹⁻⁴ Jaffe⁵ has reported interesting variations in the lipid content of the thyroid in various diseases of the gland. Several reports have suggested the possibility that cod liver oil¹ or vitamins A and D in combination with iodine or iodized fat exert a favorable influence in Grave's disease.^{6, 7, 8} These reports stimulated the author to test the effect of various oils including cod liver oil on rats rendered toxic by the administration of thyroid extract. The results are briefly reported here.

Methods. Both growing (3 months old and weighing from 100-110 gm.) and adult (150-195 gm.) rats were used in different groups of experiments. They were fed the standard Steenbock diet and kept in individual cages. One hundred mg. of thyroid extract

¹ Mellanby, *J. Physiol.*, 1921, **55**, 7.

² McCarrison, *Ind. J. Med. Res.*, 1923, **11**, 1.

³ Abelin and Kurosteiner, *Biochem. Z.*, 1928, **198**, 19.

⁴ Abelin, *Biochem. Z.*, 1930, **228**, 88.

⁵ Jaffe, *Arch. Path. and Lab. Med.*, 1928, **5**, 13; 1927, **3**, 955.

⁶ Adamson and Cameron, *Canad. Med. Assn. J.*, 1928, **19**, 420.

⁷ Fraser and Cameron, *Canad. Med. Assn. J.*, 1929, **21**, 153.

⁸ Rabinowitch, *Canad. Med. Assn. J.*, 1929, **21**, 156.

(U.S.P.) was added to the diet. The control rats received the diet plus thyroid extract, water being used to make a paste. The treated rats received the diet plus thyroid extract plus the fat to be tested, the caloric intake being kept constant in the various series of experiments. Litter mates were distributed between the control and treated groups. The fats used were olive oil, cocoanut oil and cod liver oil. They were mixed with the diet to form a paste.

Thyroid extract plus olive oil. Group 1A—Adult rats. Twenty-four rats were used in this experiment. The 12 rats which received the olive oil (3 cc.) plus the thyroid extract lost weight less rapidly during the first 2 or 3 weeks than the controls, but after this preliminary period their rate of loss of weight was greater than that of the controls. In other words, the olive oil first inhibited and then facilitated the action of the thyroid extract. This 2-stage effect is shown in Fig. 1.

Growing rats. The preceding experiment was repeated in 24 growing rats, which are considered as being more resistant to thyroid extract (Falta.⁹) The control rats continued to grow for about 2 weeks and then began to lose weight.⁹ The rats receiving olive oil at first grew more rapidly than the controls, then ceased growing and remained stationary for about one week, after which they lost weight more rapidly than the controls. Thus, the same 2-stage effect observed in the adult rats was also observed in the growing rats, the effect being more evident, however. (Fig. 2.)

We did not assay the olive oil for iodine and vitamin content.

Thyroid extract plus cocoanut oil. Group 1B. The experiment was repeated in 24 adult rats, using cocoanut oil (3 cc.). The addition of cocoanut oil to the diet very definitely augmented the action of thyroid extract from the start. The preliminary protective effect of olive oil was not observed. (Fig. 3.)

Thyroid extract plus cod liver oil. Group 1C. The experiment was repeated in 24 adult rats, using plain cod liver oil. The cod liver oil (3 cc.) in the dosage used contained approximately 0.03 mg. of iodine, 3,750 U.S.P. units of vitamin A, and 2,250 A.D.M.A. units of vitamin D. The cod liver oil had a more marked protective effect than olive oil. (Fig. 4.)

This experiment was repeated in 24 growing rats. In the experiment, the protective effect of cod liver oil was also more evident than that of olive oil.

⁹ Cameron and Carmichael, *J. Biochem.*, 1920, **45**, 69; Cameron and Sednak, *Am. J. Physiol.*, 1922, **58**, 7.

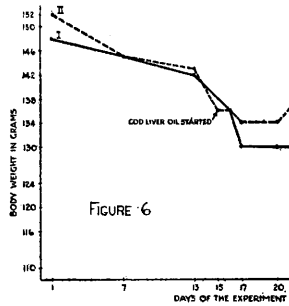
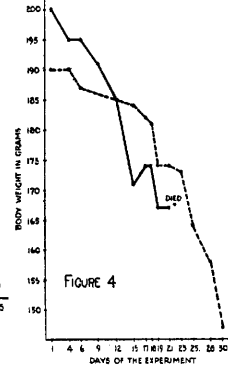
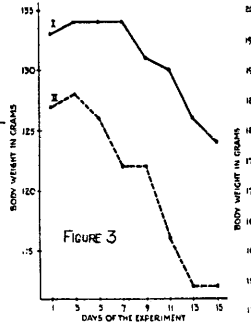
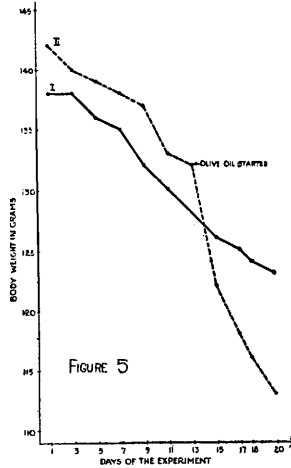
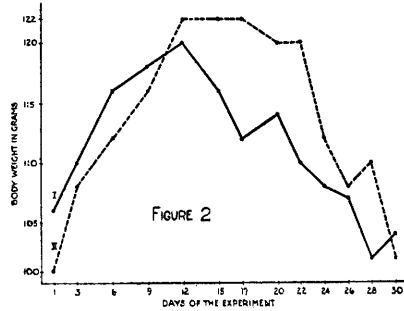
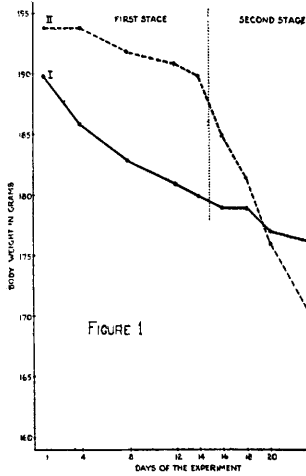


FIG. 1. Simultaneous feedings of thyroid extract and olive oil to adult rats, showing the 2 stages of olive oil action. Curve I is the weight curve of control rat receiving thyroid extract. Curve II is the curve (litter mates) of the rat receiving thyroid extract plus olive oil.

FIG. 2. Simultaneous feeding of thyroid extract and olive oil to growing rats (3 months old). Curve I is the weight curve of the thyroid fed control; II is the weight curve of the litter mate receiving thyroid plus olive oil.

FIG. 3. Simultaneous feeding of thyroid and cocoanut oil to adult rats. Curve I is the weight curve of the thyroid fed control; II of the litter mate receiving thyroid plus cocoanut oil.

FIG. 4. Simultaneous feeding of thyroid and cod liver oil to adult rats. Curve I is the weight curve of the thyroid fed control; II of the litter mate receiving thyroid plus cod liver oil.

FIG. 5. Effect of addition of olive oil to diet after the induction of hyperthyroidism. Curve I is the weight curve of the control; II of the litter mate receiving olive oil after the 13th day.

FIG. 6. Effect of addition of cod liver oil to diet after the induction of hyperthyroidism. Curve I is the weight curve of the control; II of the litter mate receiving cod liver oil after the 14th day.

Effect of addition of fats to the diet after the development of experimental hyperthyroidism. Mellanby¹ observed an aggravation of hyperthyroidism in man when butter was added to the diet and an inhibitory action when cod liver oil was added. Abelin^{3, 4} observed that fats added to the diet after the induction of experimental hyperthyroidism in animals aggravated the condition. With this in mind, the various experiments performed above were repeated, except that the fats were not added to the diet until the thyroid extract administration had resulted in a marked decrease in weight, usually about 2 weeks after the thyroid extract had been started. Twelve rats were used in each group of experiments.

The results may be summarized as follows: The addition of olive oil and cocoanut oil to the diet caused a rather sudden increase in the rate of weight loss. (Fig. 5.) The addition of the plain cod liver oil to the diet arrested the loss of weight for about 10 days, after which it was resumed. (Fig. 6.)

The effect of a Vitamin A and D concentrate. This quite definite protective effect of cod liver oil suggested that some attempt be made to analyze the factors concerned. These factors may be the presence of iodized fat, or Vitamin A or D. In this regard only preliminary findings may be reported.

Hyperthyroidism was induced in 12 rats, then a cod liver oil concentrate was added, the quantity of fat being so small that no caloric adjustment of the diet was made. The rats received a daily dosage of the concentrate which contained only a trace of iodine (Kendall's method) 10,000 U.S.P. units of A and 3,300 A.D.M.A. units of D. The results were analogous to those obtained with the plain cod liver oil. The protection was neither greater nor less.

It would appear from these preliminary results as if the vitamin content of the cod liver oil played an important rôle in the protective action. It is well known that iodine alone does not protect against the action of thyroid extract. These results would support the clinical observations of Cameron and others^{6, 7, 8} which indicate that in Grave's disease Vitamins A and D increase the therapeutic effectiveness of iodine. However, these studies should be pursued further to ascertain the effect of the various fats *per se*, of iodized fat, of Vitamin A, and of Vitamin D. Vitamins A and D should be studied particularly because of the presence of excessive calcium elimination and of liver damage in Grave's disease. The effect of lecithin or phospholipins should also be studied.