The Absorption of Oleic Acid from the Small Intestine of the Rat

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With one plate (fig. 1)

Summary

By the use of histochemical techniques, the lipids (fatty acid, neutral fat, and phospholipid) were studied in the villi of the small intestine of the rat, 1 h and 2¾ h after feeding with oleic acid. The results of these experiments were identical with those previously described when triolein was administered. Neutral fat, fatty acid, and phospholipid were present in varying quantities within the cells. Between the cells and in their striated border, neutral fat and fatty acid were detectable. Within the cells, fatty acid was most abundant 1 h after feeding, whereas neutral fat and phospholipid predominated 2¾ h later. The direct relationship between the amounts of neutral fat and phospholipid present in the cells, which had been observed in the studies with triolein, prevailed in the experiments described here.

Introduction

DURING the absorption of neutral fat, phospholipid appears in the epithelial cells of the small intestine. It has been suggested that this substance is concerned with the reformation of the fat, which had undergone hydrolysis in the intestinal lumen. In previous experiments (Hewitt, 1956) neutral fat, fatty acid, and phospholipid were detected in varying proportions in the intestinal epithelial cells of rats which had previously been fed with triolein. There appeared to be a direct relationship between the amounts of neutral fat and phospholipid present and it was suggested this might indicate a link between them. It was possible, however, that much of the neutral fat had not been synthesized but was actually unhydrolysed fat which had been absorbed as such. To exclude this the experiments were repeated, but each animal was fed on 0·18 ml of oleic acid instead of triolein. The average weight of the rats used was 200 g. A group of animals was killed, as before, 2¾ h after feeding and an additional group was killed after 1 h. Apart from these differences the materials and histochemical techniques employed for detecting lipid, neutral fat, fatty acid, and phospholipid were the same as those previously described and reference should be made to this description for details.

Results

The results obtained were indistinguishable from those obtained after feeding with triolein. Neutral fat and fatty acid were detected between the epithelial cells, in their striated border, and within them, where phospholipid was also present. As before, the intracellular content of these three substances

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was variable, but there were marked differences in their relative proportions in the two groups of experiments. In the group killed 1 h after feeding, fatty acid predominated in the cells with only small amounts of neutral fat and phospholipid present. In the other group the reverse prevailed: there was a preponderance of neutral fat and phospholipid with the complete absence or only minimal amounts of fatty acid. The same relationship was also observed between the amounts of neutral fat and phospholipid present, as in the previous experiments, and this was even better demonstrated by comparing the two groups of results (fig. 1).

Discussion

It was tempting to conclude from these observations that phospholipid formation was essential for the formation of the neutral fat which appeared within the epithelial cells. However, no support for this was provided by these results. The formation of phospholipid and neutral fat may have been occurring at the same time and merely delayed until the mobilization of their other components, the glycerol fraction of which was common to them both. It was not unreasonable to assume that the neutral fat had been formed from the ingested fatty acid and that this occurred within the epithelial cells. The synthesis could, however, have been in the intestinal lumen before absorption and might have explained the presence of neutral fat both between the cells and in their striated border. The possibility, however unlikely, that some or even all of the neutral fat was not synthetic but had been derived from other sources should not be overlooked. It could have been derived from the intestinal lumen or from the lymphatic or blood vessels of the villi. The presumption is made that the flow of lipid is from the intestinal lumen towards the core of the villus; but in static preparations there is nothing to indicate the direction of movement of the particles, and the possibility of a two-way flow should be borne in mind. It may well be that some of the lipid seen was travelling towards the intestinal lumen into, through, or between the epithelial

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Fig. 1 (plate). Photomicrographs of 10-μ sections of villi from the small intestine of the rat.

A, Sudan black preparation, showing the location of the lipid in two villi 1 h after feeding with oleic acid. The majority of the lipid within the cells consists of fatty acid with only small quantities of neutral fat and phospholipid.

B, Sudan black preparation, showing the location of the lipid in two villi 2¾ h after feeding with oleic acid. Apart from the lipid seen in the core of the villi and in the cells deep to their nuclei, the appearances are similar to A. This lipid, however, consists of neutral fat and phospholipid.

C, Fischler preparation. Section of a villus from the same segment of intestine as A, showing that much of the lipid consists of fatty acid.

D, Fischler preparation. Section of a villus from the same segment of intestine as B, showing the absence of fatty acid.

E, acid haematein preparation. Section of villi from the same segment of intestine as A and C. Only a small amount of phospholipid can be seen in the cells around the site of the Golgi apparatus.

F, acid haematein preparation. Section of villus from the same segment of intestine as B and D. In contrast with E, the phospholipid content of the epithelial cells is much higher, particularly deep to their nuclei.

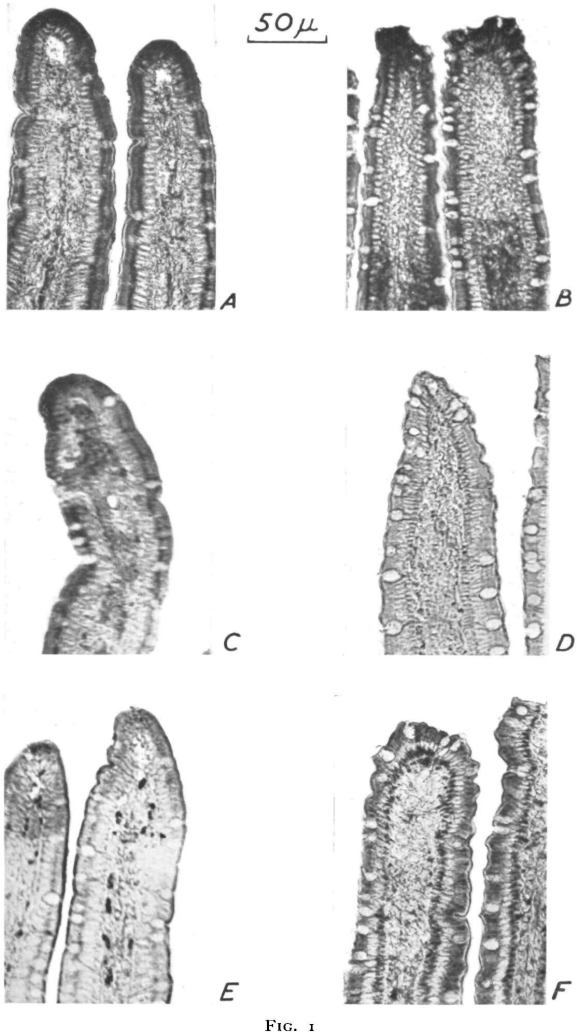

FIG. 1

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cells. It is conceivable, therefore, that some of the neutral fat was mono- or diglyceride from the animal's own resources, which by combining with the incoming oleic acid formed a mixed triglyceride. This would avoid the necessity of providing glycerol for the synthesis of triolein; a problem discussed by Frazer, Schneider, and Sammons (1956), who gave references.

Although these results are of interest, they neither confirm nor disprove the theory that phospholipid formation is an essential part of triglyceride fat absorption. However, they provide a basis for further investigations which are being undertaken.

REFERENCES

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