

118 (2641)

The utilization of fat in diabetes.*

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It is a well attested fact that in severe diabetes there is a pronounced tendency for the fat of the blood to be abnormally high (using the term fat to include all compounds of the fatty acids). In certain instances the fatty compounds may increase beyond the ability of the blood to carry them in solution and there is produced a visible milkiness, while in extreme cases the fat may reach very high figures—twenty percent and over having been reported. In a discussion of diabetic lipemia some time ago¹ evidence was collected which indicated that the lipemia of diabetes was the result of a diminished outflow of fat from the blood, directly or indirectly connected with the pancreatic insufficiency. Direct proof of diminished ability of the diabetic organism to utilize fat was however lacking, and it was with desire to obtain positive evidence on this point that the following work was undertaken. Experiments to elucidate this point were planned and carried out by Allen² and Wishart some years ago, but owing to loss of the data during the war they were never recorded. The subject is one of great practical importance, for while insulin has provided a means of abolishing the acute symptoms and saving life it does not cure diabetes, and its continued administration especially in large doses is, to say the least, inconvenient. Recourse must still be had to diet, and since fat is one article of food that does not form carbohydrate—or does so least readily—the use of high fat diets in diabetes has had a considerable vogue (Newburgh and Marsh, Petren) notwithstanding the warning of Allen that while good results may be obtained temporarily there is great danger of disaster.

The experiments were planned so as to provide a direct comparison between the effects of fat on the blood lipoids in a normal

* This work was made possible by a gift from Mr. and Mrs. W. H. Robinson of Pittsburgh.

¹ Bloor, W. R., *J. Biol. Chem.*, 1921, xliv, 201.

² Allen, F. M., *J. Metab. Res.*, 1922, ii, 219.

animal and in the same animal rendered diabetic by removal of most of the pancreas. Normal young adult dogs were taken and their blood reaction to fat studied by a series of feedings with analysis of the blood lipoids by the micro methods. About nine-tenths of the pancreas was then removed† leaving the part around and near the main duct, and, after recovery, the fat feedings were repeated. The diet after the operation was high protein and low fat. Sugar appeared in the urine at once after the operation. The two animals were killed to obtain the blood for gross study, one after seven weeks when moribund, and the other after two months while still in good condition although thin. The effect on the utilization of fat appeared only after a month, and showed itself not on the digestion and absorption, which apparently proceeded normally, but in the greatly increased reaction to the fat feeding as exhibited by the much greater and more persistent increase in the free fat of the blood plasma. The other lipoid constituents did not appear to be much affected nor were the corpuscle lipoids. In one animal (24-6) there was persistent lipemia (total fatty acid 3 percent) during the last week of life.

A table illustrating the significant effects is given below :

† I am indebted to Dr. John R. Murlin, director of the Department of Vital Economics, of this University, for these operations.

Fat Feeding Experiments.

Dog 24-6 before operation		Plasma mgm. per 100 cc.			
	Time	Cholesterol	F'ty Acids	Lecithin	Free Fat
Date, 9/11/23	8:45	52	470	406	183
Weight 29 lbs.	10:50	106	505	486	146
70cc. olive oil at 9:15	12:35	141	545	518	152
after one day fasting	2:35	150	692	544	280
	4:20	135	560	504	179
After operation					
Date, 6/24/24	8:45	88	510	296	283
Weight 22 lbs. 8 oz.	10:40	120	683	410	369
100cc. olive oil, 9:15,	12:40	107	1580	506	1260
after one day fasting	2:35	174	1440	478	1074
Total sugar output for day 46.1 gm.	4:30	199	1505	468	1127
Next day before feeding		148	635	408	314
Dog 24-7 before operation		Plasma mgm. per 100 cc.			
	Time	Cholesterol	F'ty Acids	Lecithin	Free Fat
Date, 9/27/23	9:45	129	620	466	267
Weight 26 lbs. 5 oz.	10:35	150	652	248	436
225 cc. olive oil af-	12:35	180	645	256	415
ter one day fasting	2:35	156	654	232	446
	4:20	188	640	224	427
After operation					
Date, 6/26/24	8:40	175	565	588	115
Weight 24 lbs. 6 oz.	10:40	171	1190	430	847
100 cc. olive oil af-	12:40	288	1530	468	1122
ter one day fasting	2:30	260	1430	448	1045
Total output sugar 54.9 gm.	4:25	159	985	480	612
Next day before feeding		156	610	346	328

The results show that in these animals, removal of enough of the pancreas to render them diabetic resulted in a much greater accumulation in, and slower removal of fat from the plasma than when a normal amount of pancreas was present. Further experiments are of course necessary to show whether the effect is general in diabetic animals, but the experiments indicate that these animals may not be able to utilize fat as well as normals.