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High Carbohydrate and High Fat Diets.

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During the course of a study of glucose tolerance in relatives of diabetics[1] we became interested in determining the effect of various diets on glucose tolerance, and on some of the constituents of the blood.

One of us served as subject. Arrangements were made with the University Hospital for weighed diets of known caloric value. The diet for the first 7 days, Period 1 (March 6 to 12 inclusive), was a balanced one; that for the second 7 days, Period 2 (March 13 to 19 inclusive), was high in carbohydrate; during this period, carbohydrate constituted more than 90% of the total caloric intake. The balanced diet was used for the third 7 day period, Period 3 (March 20 to 26 inclusive). The diet for Period 4 (March 27 to April 2 inclusive), was high in fat. The ketogenic-antiketogenic ratio was 2:1 for the first 3 days, 2.5:1 for the fourth day, and 3.0 to 1 for the fifth, sixth and seventh days. Acetonuria was present from the fourth day on. The diet for Period 5 (April 3 to 6 inclusive) was balanced. The total caloric intake varied somewhat during the experimental period, according to the subject's wishes.

TABLE I.

Date		Carbohydrate	Protein	Fat	Total
			Calories		
Period I	Min.	852.0	183.6	489.6	1527.1
3/6–3/12	Max.	1016.0	216.4	516.6	1749.0
	Aver.	922.3	197.4	510.8	1630.4
Period II	Min.	1120.0	71.2	14.4	1205.6
3/13–3/19	Max.	1143.9	79.1	14.9	1237.9
	Aver.	1130.3	77.2	14.6	1222.0
Period III	Min.	665.0	158.8	387.3	1242.8
3/20–3/26	Max.	823.7	218.7	514.6	1554.0
	Aver.	739.7	189.2	434.2	1364.7
Period IV	Min.	62.7	97.6	1164.8	1552.0
3/27–4/2	Max.	253.0	164.1	1401.5	1630.0
	Aver.	117.5	148.8	1326.6	1601.3
Period V	Min.	820.4	211.5	497.5	1536.0
4/2–4/6	Max.	954.4	241.9	563.6	1778.0
	Aver.	888.2	229.2	539.5	1664.2

[1] Greisheimer, E. M., and Goldsworthy, E., *Am. J. Physiol.*, in press.

Table I presents the total caloric intake, and the distribution among the various foodstuffs for each period.

Glucose tolerance was tested at intervals during the experimental period; the results are presented in Table II. One gram of glucose for each kilo of body weight was ingested. It will be noted that a diabetic response was secured after the ketogenic diet. The subject's usual type of response appeared shortly after cessation of the ketogenic diet.

TABLE II.

Date		Fasting	½ hr.	1 hr.	2 hr.	3 hr.
3/13/33	After 7 days on balanced	81.3	106.5	120.9	94.8	63.4
3/20	After 7 days on high carbohydrate	86.2	115.3	115.6	94.4	70.1
3/27	After balanced diet	82.0	117.9	120.5	103.7	81.8
4/3*	After ketogenic diet	66.9	115.8	154.9	201.5	134.7
4/4	One day after cessation of ketogenic diet	82.2	127.7	154.2	132.3	102.3
4/7	4 days after cessation of ketogenic diet	81.8	110.0	109.5	108.6	89.5

*The urine showed acetone and sugar.

Twelve determinations of inorganic phosphate, calcium, total non-protein nitrogen, urea nitrogen, blood sugar, hemoglobin (Newcomer method), red count, and white count were made between March 8 and April 7, 1933. Marked variations occurred in total non-protein nitrogen (29.5 to 47.7 mg.), urea nitrogen (6.41 to 18.67 mg.), and sugar (64.1 to 86.4 mg.). It should be kept in mind that these constituents are influenced by diet.

The inorganic phosphate varied slightly during the study, averaging 3.1, 3.3, 3.4, 2.8 and 3.9 for the 5 periods. None of these values are beyond the limits of normal, and are not of clinical importance.

The serum calcium averages were 10.39, 10.12, 10.23, 10.61 and 10.42 for the 5 periods; the differences are not important clinically.

The urea nitrogen averages vary greatly; the values were 8.34, 9.49, 17.69, 15.90 and 18.09 for the 5 periods. With the exception of the first period, the urea nitrogen roughly parallels the protein intake.

The total non-protein nitrogen averages were 39.9, 34.4, 41.1, 31.8, and 38.1 for the 5 periods. The lowest value was found on the high fat diet even though the protein intake was not lowest at this time. The other constituents of the diet influence the total non-protein nitrogen.

The fasting blood sugar is remarkably constant on a balanced diet.

It is altered but little by an increase in the intake of carbohydrate. The values found in the different periods were 82.2, 83.3, 81.3, 65.5, and 81.8. It will be noted that the fasting sugar drops to a fairly low level on the high fat diet. It seems that a decrease in carbohydrate intake has more effect than an increase.

The average weight, temperature on arising, temperature on retiring, fluid intake, and fluid output for each period are given in Table III.

TABLE III.

Period	Wt. lb.	Temperature on arising	Temperature on retiring	Fluid intake	Fluid output
I	117	98.3	98.2	1086	797
II	115	97.9	97.3	614	619
III	113	98.6	98.1	843	614
IV	111	98.6	98.6	1046	726
V	111	98.5	98.6	1018	625

There was some weight loss during the period of study. The morning and evening temperatures showed no remarkable variations from normal. Since the only fluid output measured was the urine, no conclusions of value can be drawn from the relation between intake and output on the various diets.

Summary. The glucose tolerance was not significantly altered by a very high carbohydrate intake, over a period of 7 days. After 7 days on a high fat diet, the response to the glucose tolerance test was typical of diabetes mellitus; the tolerance rapidly returned to the usual type, after return to the balanced diet. Since the diet can so markedly influence the tolerance, this should be kept in mind in glucose tolerance studies. The urea nitrogen and total non-protein nitrogen vary markedly with different dietary conditions. This fact is of clinical importance. The fasting blood sugar is markedly influenced by a diet low in carbohydrate. A high intake of carbohydrate seemed without effect on the fasting blood sugar. It was planned to make more extensive studies, but the subject developed undulant fever, and the experimental work was necessarily postponed.