13612

Relation of Fasting Ketosis to Nature of Protein and Fat Content of Preceding Diet.

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It has been shown that the rapidity of onset and the degree of ketosis reached during fasting bears an inverse relation to the protein content of the preceding diet,[1, 2] apparently because this determines the amount of "stored" protein available for catabolism and thus for the formation of antiketogenic material (glucose) during fasting.[2] The present study was designed to examine the influence of the nature of the protein and of the fat content of the preceding diet upon a fasting ketosis.

The experimental and analytical methods used were similar to those which have been described before.[2] The degree of ketosis was measured by the height of the blood ketone body concentration as well as by the urine excretion of ketone bodies in one experiment. Details of the experiments are presented in Tables I and II.

Nature of Protein Intake. The onset was more rapid and the degree of ketosis reached definitely higher when the protein of the preceding diet was the incomplete and biologically poor protein, gelatin (Exp. 1, Table I). Blood albumen feeding led to the lowest fasting ketosis of the four proteins studied. Edestin and casein gave similar results, the degree of ketosis being less than that found after gelatin feeding and greater than that following the blood albumen diet. The urine nitrogen figures indicate that the degree of ketosis is influenced by feeding these proteins through the amount of body protein they make available for catabolism during the fasting period. In this the effect is the same as the result of feeding varying amounts of the same protein.[2] The amount of antiketogenic material—glucose from the protein being catabolized—appears to be the all-important factor determining the extent of a fasting ketosis.

Nature of the Fat Intake. We failed to find any significant influence upon a fasting ketosis of the amount of fat in the preceding diet. The influence of the nature of the preceding fat intake has been studied by feeding a number of natural fats. The feeding of

1 MacKay, E. M., Carne, H. O., and Wick, A. N., PROC. SOC. EXP. BIOL. AND MED., 1939, **41**, 40.

2 MacKay, E. M., Carne, H. O., Wick, A. N., and Visscher, F. E., *J. Biol. Chem.*, 1941, **141**, 889.

TABLE I.
*Experiment 1—Influence of Nature of Protein in †Preceding Diet upon Fasting Ketosis.

Diet group	Hrs of fasting	Liver glycogen, %	Blood ketones, mg%	Urine excretion per sq. dm. body surface per day	
				mg acetone	mg N
1 Gelatin	0	1.60	3		
	12	.06	20	tr.	20
	24	.05	41	1	20
	48	.04	54	18	19
	72	.02	53	32	17
2 Edestin	0	.30	3		
	12	.04	15	tr.	26
	24	.03	22	1	24
	48	.05	30	5	22
	72	.02	41	17	21
3 Casein	0	.82	5		
	12	.08	12	tr.	26
	24	.05	24	1	25
	48	.04	34	14	24
	72	.03	44	17	22
4 Albumen	0	.40	4		
	12	.03	17	tr.	23
	24	.04	26	tr.	25
	48	.06	29	tr.	25
	72	.05	33	6	26

*Fifteen female albino rats 120 days old were placed on the special diets for 10 days; 3 were sacrificed for liver glycogen and blood ketone determinations at each point where observations are recorded. The rats averaged 150 g in body weight when placed on the diets and 147 (grp. 1), 160 (grp. 2), 165 (grp. 3) and 155 (grp. 4) g respectively at the end of 10 days. Food was removed from the cages 14 hours before the recorded fasting periods were begun.

†The diets contained sucrose 50, salt mixture 5, brewer's yeast 5, cod-liver oil 5 and hydrogenated vegetable oil 20 (see ref. 3 for details of these ingredients), plus 15 parts of the protein ingredient. The gelatin was a high grade finely powdered food product, the edestin Pfanstiehl's highest purity, the casein "Labco" brand vitamin free casein, and the albumen an Eimer & Amend product termed Albumen from blood, C.p. The food intakes on the 4 diets were 6.7, 7.7, 8.4 and 6.2 g per rat per day respectively.

none of these appeared to influence directly the subsequent fasting ketosis. After feeding 7 of the fats (Table II, diet grps. 1-7), namely cottonseed oil, cocoanut oil, corn oil, cod-liver oil, beef fat, butter fat, and mutton fat, there was a high and rapidly developing fasting ketosis. This was accompanied by fairly low rates of nitrogen excretion, indicating that no large amount of antiketogenic material was being formed from catabolized protein. The degree of fasting ketosis was much less when pork fat, cocoa butter, and olive oil (Table II, grps. 8, 9 and 10) had been fed. This lesser ketosis was accompanied by higher rates of nitrogen excretion. It would seem obvious that here the nature of the fat in the preceding diet

TABLE II.

*Experiment 2—Influence of Nature of Fat in Preceding Diet upon Fasting Ketosis.

Group diet	Food intake, g per sq. dm. body surface per day	Body weight		Blood ketone bodies during fasting mg%				Urine N excretion during fasting in mg per sq. dm. body surface per day		
		Start of fasting g	End of fasting g	0 hrs	24 hrs	48 hrs	72 hrs	24 hrs	48 hrs	72 hrs
1. Cottonseed Oil†	1.82	247	230	1.3	20	35	44	19	21	20
2. Cocoanut Oil	1.68	243	230	2.8	20	33	44	16	23	20
3. Corn Oil‡	1.71	277	262	2.3	19	37	39	16	22	20
4. Cod-liver Oil	2.06	263	250	1.4	19	40	36	18	24	20
5. Beef Fat	1.60	243	234	1.4	16	24	40	19	21	23
6. Butter Fat	1.53	269	256	1.3	17	39	35	16	23	21
7. Mutton Fat	1.70	238	228	1.0	16	30	34	15	26	22
8. Pork Fat	1.81	287	271	1.2	13	20	25	23	28	30
9. Cocoa Butter	1.79	281	269	1.0	19	26	22	16	25	27
10. Olive Oil	2.04	260	249	1.2	12	10	17	19	26	30
11. Hydrogenated Vegetable Oil§	2.06	260	250	1.4	18	34	25	19	21	18

*Adult male rats were placed upon the special diets for 20 days after a 6-day period of fasting. The food intake was recorded during the 10-day period preceding fasting and calculated upon the body weight (from which the body surface was computed) on the last day of the feeding period. The diets fed were composed of sucrose 40, casein 5, brewer's yeast 5, Standard salt mixture 5, powdered cellulose ("Cellu Flour") 5, and 40 parts of the respective fats.

†Wesson Oil.

‡Mazola.

§Crisco.

affects the subsequent fasting ketosis only as it may influence the amount of body protein which is catabolized and thus gives rise to antiketogenic material (glucose) during fasting. Our data do not indicate how a difference in the nature of the fat in the diet might influence protein storage and its subsequent rate of catabolism.

The results with a processed fat—hydrogenated vegetable oil (Crisco, Table II, grp. 11)—were interesting. The degree of fasting ketosis was lower than would be expected with such a low level of nitrogen excretion. It would be desirable to compare the ketosis after feeding an untreated and a hydrogenated vegetable oil because of the known peculiar characteristics of the latter.

Summary. The degree of fasting ketosis was influenced by the nature of the preceding protein intake. The ketosis bore an inverse relation to the protein catabolism during fasting, being higher after gelatin than after blood albumen feeding. Casein and edestin produced an intermediate fasting level of nitrogen excretion and ketosis.

Various natural fats fed prior to fasting were without influence upon the degree of fasting ketosis except as the protein catabolism varied. The usual inverse relation between the ketosis levels and the amount of nitrogen excreted was evident.