7272 C

Utilization of Inulin from Arctium Lappa and Certain Soluble Inulins by the Rat.

C. JELLEFF CARR* AND JOHN C. KRANTZ, JR.

From the Department of Pharmacology, School of Medicine, University of Maryland.

Since 1874[1] inulin-containing plants have been suggested for use in the diabetic diet as substitute carbohydrates. Okey,[2] studying the influence of digestive juices on inulin, found it to be hydrolyzed partially by the hydrochloric acid of the stomach and subject to marked decomposition by the intestinal flora, and concluded that human feces contains an enzyme capable of hydrolyzing inulin into a reducing sugar.

The authors showed that the inulin from *Arctium lappa* (Burdock root) was utilized by demonstrating its protein-sparing action on the diet of dogs[3] and its capacity to store additional glycogen in the liver of the rat.[4] A physicochemical study of the inulin from *Arctium lappa* was also conducted in conjunction with this investigation.[5]

Yanovsky and Kingsbury[6] prepared inulin from 3 new sources, 2 plants of the Liliaceae and one of the Compositae family, and observed that the inulins obtained from these sources were soluble in water and dilute alcohol. They later submitted quantitative data on the solubility of these inulins.[7]

It occurred to the authors that it would be interesting to compare the absorption and utilization of the soluble inulins with the insoluble inulin obtained from *Arctium lappa.* The authors are indebted to Doctors Yanovsky and Kingsbury of the Carbohydrate Division, Bureau of Chemistry and Soils, United States Department of Agriculture, for a liberal supply of inulin from Camas roots *(Quamasia quamash)* and from the Wild Onion *(Allium nuttallii).*

* Emerson Fellow in Pharmacology.

1 Külz, E., *Beitrage zur Pathologie und Therapie des Diabetes Mellitus,* Marburg, 1874, 130.

2 Okey, R., *J. Biol. Chem.,* 1919, **34**, 149.

3 Krantz, J. C., Jr., and Carr, C. J., *J. Pharm. and Exp. Therap.,* 1931, **43**, 187.

4 Krantz, J. C., Jr., and Carr, C. J., *J. Pharm. and Exp. Therap.,* 1931, **41**, 83.

5 Krantz, J. C., Jr., and Carr, C. J., *J. Phys. Chem.,* 1931, **35**, 756.

6 Yanovsky, E., and Kingsbury, R. M., *J. Am. Chem. Soc.,* 1931, **53**, 1597.

7 Yanovsky, E., and Kingsbury, R. M., *J. Am. Chem. Soc.,* 1933, **55**, 3658.

Each of these substances served as food in the diet of the North American Indian.

Male white rats from 75 to 150 gm. were fasted for a period of 48 hours and then placed in small individual cages. The control rats were fed cacao butter for a period of 72 hours. The experimental rats were fed mixtures of inulin and cacao butter containing one-third inulin. After this period the amount of food ingested was determined by difference. The rats were then killed by exsanguination. The liver-glycogen was determined immediately by Pflüger's[8] method. The tissue-glycogen was determined by the method used by Cori and Cori[9] modified by Carr *et al.*[10] The reducing sugars formed by hydrolysis, as well as the carbohydrate in the alimentary tract and feces, were determined by the Munson, Walker method.[11] The results are given in Tables I and II.

TABLE I.
Control Rats.

Group No.	No. of Rats	Wt. of Rats, gm.	Food Ingested: Type	Food Ingested: Amount	Reducing Sugar After Hydrolysis Tract, gm.	Reducing Sugar After Hydrolysis Feces, gm.	Wt. of Livers, gm.	Wt. of Tissues, gm.	Liver-Glycogen, %	Tissue-Glycogen, %	
1	2	138- 73	Cacao Butter	12.5	.00	.00	6.90	161	.09	.20	
2	2	150-147		14.1	.00	.02	8.90	234	.36	.11	
3	2	102-101		12.4	.04	.05	8.20	165	.03	.09	
4	2	107- 97		10.5	.01	.01	6.80	171	.11	.10	
5	1	108		8.2	.00	.03	3.50	78	.24	.04	
6	2	115-148		17.5	.08	lost	8.50	192	.12	.15	
									.16	.12	Mean

In Table II no correction was made for the tissue-glycogen as these values obtained when the animals were fed the inulins were practically identical with the control animals.

An examination of Tables I and II indicates the capacity of all 3 types of inulin to be absorbed and utilized. The amount of glycogen present in the livers is unusually high for animals fed inulin. Bodey

[8] Cole, S. W., Practical Physiological Chemistry, Baltimore, 7th Edition, 1926, 171.

[9] Cori, C. F., and Cori, G. T., *J. Biol. Chem.*, 1926, **70**, 557.

[10] Carr, C. J., *et al.*, *J. Biol. Chem.*, 1933, **102**, 721.

[11] Munson, T. S., and Walker, P. H., *J. Am. Chem. Soc.*, 1906, **28**, 163.

TABLE II.
Experimental Rats.

Group No.	No. of Rats	Wt. of Rats, gm.	Food Ingested gm. Type	Amount	Inulin in Feces	Inulin in Tract	Inulin equivalent of liver Glycogen	Liver-Glycogen %	Tissue-Glycogen %	Inulin Utilized by Difference	Inulin Utilized %	Inulin Absorbed %	
1	2	120-122	Inulin* from	6.6	.43	.40	.29	3.11	.12	5.50	83.2	87.3	
2	2	125-125	*Arctium lappa*	6.9	.68	.46	.34	3.86	.16	5.45	78.6	83.3	
3	2	128-126	and Cacao Butter	6.0	.24	.17	.24	2.79	.14	5.35	89.2	93.2	
4	2	122-124		5.5	.24	.23	.29	2.42	.08	4.73	86.0	91.4	
5	2	120-122		4.3	.11	.09	.20	2.20	.13	3.93	90.8	95.4	
								2.87	0.13		85.7	90.1	Mean
1	2	144-118	Inulin from	10.8	.45	.95	.15	1.61	.12	9.25	85.5	87.1	
2	2	130-123	Allium and	8.3	.09	.80	.10	1.06	.08	7.31	88.2	89.2	
3	2	150-141	Cacao Butter	10.7	.55	.00	.07	0.68	.19	10.10	94.4	94.8	
4	2	140-147		10.4	1.34	.00	.11	1.04	.17	8.95	86.0	87.2	
								1.10	0.14		88.5	89.5	Mean
1	2	104-112	Inulin from	10.3	.55	.12	.18	1.77	.10	9.45	91.6	93.4	
2	2	124-104	Camas and	6.9	.23	.08	.23	2.76	.09	6.36	92.3	95.4	
3	2	113-127	Cacao Butter	10.4	.69	.22	.19	1.68	.09	9.30	89.3	91.2	
4	2	119-105		10.6	.43	.30	.23	2.40	.10	9.64	90.7	93.1	
5	2	113-120		8.7	.29	.05	.40	3.82	.07	7.96	91.5	96.2	
								2.48	0.09		91.2	93.7	Mean

*The inulin used was extracted from *Arctium lappa* for the authors by Burroughs Bros. Co. of Baltimore, Md. The product was purified to meet the standards set forth by the authors in reference 5.

et al.[12] found the inulin from the Jerusalem artichoke produced additional glycogen-storage in the white rat. The average glycogen content found by these workers was 0.69%. It will be observed that the percentage of liver-glycogen in the experiments with rats fed the inulin from Allium are less than half the values obtained when the Camas and Burdock inulins were fed. Owing to the tremendous variations inherent to the experiment the authors do not interpret this as meaning that Allium is less capable of forming liver-glycogen than the other 2 inulins.

In all cases, however, the high percentage of absorption from the alimentary tract, accompanied with a high percentage of utilization is significant. With feeding experiments on dogs the authors found 86% absorption when Burdock inulin was fed.

Summary. In the white rat, the absorption and utilization of the insoluble inulin from Burdock and the soluble inulins from Camas and Allium, show no significant difference.

7273 P

Further Studies Concerning Testicular Function.

D. ROY MCCULLAGH AND EUGENE L. WALSH.

From the Cleveland Clinic, Cleveland, Ohio.

Fifty-four albino rats were divided into 4 groups: (1) normal controls, (2) castrated animals, (3) castrated animals injected with androtin (male sex hormone prepared from urine) and (4) normal animals injected with androtin. The androtin was prepared by extracting male urine with fat solvents. The injected rats each received from 8 to 10 bird units of androtin daily.

The results are shown in Table I. The weights of these animals are expressed in grams and the weights of the formalin-fixed organs as percentages of the total body weight. In the glands other than the sex glands, the difference between the weights of the glands in the control animals and of those in the injected normal animals is not sufficiently great to be of any significance. The seminal vesicles, the ventral and dorsal prostates all show an increase in weight of approximately 100% after the injection of androtin into normal rats. Other workers have stated that hormone prepared from the testes causes

[12] Bodey, M. G., *et al.*, *J. Biol. Chem.*, 1927, **75**, 715.