

Sulphur Metabolism.

V.—The Effect of Elementary Sulphur on Fertility, Reproduction and Lactation in the White Rat.

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WHEN a drug is administered over an extended period of time not only its prophylactic effect but also its influence on reproduction should be considered. Some apparently harmless compounds may, under certain conditions, have disastrous effects on the organism, and the discovery by Waddell and Steenbock (1928) of the destruction of vitamin E in foodstuffs by ferric chloride illustrates again the necessity for collecting information on the effects of compounds in various combinations before they are used in practical applications. Therefore, the object of this experiment is to throw light on the effects of sulphur on reproduction and lactation.

EXPERIMENTAL.

The first generation of animals in this experiment consisted of 48 young rats—24 males and 24 females. They were equally divided into two groups with respect to sex, litter and weight. The rats were started on experiment when they were exactly 28 days of age and kept in individual cages on raised screen bottoms until they were 126 days of age. The screens were then removed, wood shavings added and a male put with every female. In all succeeding generations the rats were kept on wood shavings and weaned and mated when they were 28 and 126 days of age respectively.

The rats were weighed once weekly, fed *ad libitum* and allowed free access to distilled water. In order to study the effect of sulphur on food utilization and gain, which might help to elucidate the ultimate effect of sulphur on reproduction and lactation, an accurate record was kept of the food consumption for the first 14 weeks of the experiment. Both groups received an ordinary stock ration with the exception that three parts of elementary sulphur replaced an

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equivalent amount of maize meal in the food of the one group. Furthermore the diets were made equicaloric by replacement of some of the maize meal with an isodynamic quantity of lard. The composition of the rations and the gains and efficiency quotients of the rats maintained on them are given in tables I and II respectively.

TABLE I.
Composition of Rations in Percentage by Weight.

	Basal Ration.	Sulphur Ration.
Yellow maize meal.....	68	62.6
Linseed Oil Meal.....	10	10
Crude casein.....	5	5
Brewers' Yeast.....	5	5
Lucerne Meal.....	3	3
Butter Fat.....	5	5
Beef Liver (dried at 70°C).....	2	2
Bone Ash.....	1	1
CaCO ₃	0.5	0.5
NaCl.....	0.5	0.5
Flowers of Sulphur.....	—	3.0
Lard.....	—	2.4

TABLE II.
Comparison of Gains and Efficiency Quotients of Rats fed Stock Diet with and without 3 per cent. Elementary Sulphur (equicaloric) for 14 weeks by ad libitum method.

Gain.		Mean Weight.		Total Food.		Efficiency Quotient.	
Range g.	Mean g.	Range g.	Mean g.	Range g.	Mean g.	Range	Mean
CONTROL GROUP.							
<i>Females.</i>							
118—174	141.3	128—175	151.7	1087—1484	1276	4.93—7.20	5.95
<i>Males.</i>							
217—326	272.5	198—284	238.0	1368—1814	1629	1.93—3.17	2.51
SULPHUR GROUP.							
<i>Females.</i>							
111—178	139.0	126—178	149.0	1031—1538	1205	4.45—8.20	5.82
<i>Males.</i>							
180—297	257.5	183—260	227.8	1305—1800	1549	2.25—3.96	2.64

The data in table II seem to show that the animals in the sulphur group consumed slightly less food and gained correspondingly less than their control mates. The weighted means for the males and females show food consumption of 1452 and 1377 g. and gains of 206.9 and 198.2 g. for the control and sulphur groups respectively. These differences, obtained over so long a period, are so small that they can be disregarded. Furthermore, it is clear, that the animals on the control and sulphur rations utilized their food to the same extent. The efficiency quotients, calculated according to the method of Palmer and Kennedy (1929)⁹ were 5.95 and 5.82 for the females and 2.51 and 2.64 for the males of the respective control and sulphur groups. The marked difference obtained between the efficiency index of male and female rats substantiates the results of Palmer and Kennedy (1931).

However, a ration may support good growth yet fail to maintain the weight of lactating animals. That was the experience of Slonaker (1931) whose nursing females lost in weight on diets containing from 10 to 26 per cent. of proteins. In order, therefore, to ascertain whether the females maintained their weight while nursing on the diets used in this experiment, they were weighed at parturition and again after 19 days of lactation. The results are tabulated in table III.

TABLE III.

Comparison of gains of Female Rats during first 19 days of Lactation fed a Stock Diet with and without 3 per cent. of Elementary Sulphur.

Number of Lactating Females.	Number of Suckling Young.		Gain in Weight† by Mother.		Percentage Gain by Mother.	
	Range.	Average	Range-g.	Average-g.	Range.	Average
19.....	4-10	CONTROL GROUP. 1st Generation. 6.5	3-32	19.7	1.1-13.7	8.55
9.....	4-9	SULPHUR GROUP. 1st Generation. 6.2	9-58	25.2	3.2-28.3	11.4
16.....	4-9	2nd Generation. 6.5	2-38	19.7	1.0-18.4	9.6
11.....	2-9	3rd Generation. 6.2	10-40	20.2	5.0-19.8	10.
Average for S group 12.....	—	6.3	—	21.7	—	10.3

* The dry matter only, not the digestible dry matter, was used in these calculations.

† Except for one female in 3rd generation of sulphur group, all the females gained in weight during the first 19 days of lactation. This female suffered from a lung infection and she and her offspring were therefore not used in the results.

TABLE IV.
*Comparisons of Fertility and Reproduction of Rats fed a Stock Diet with and without 3 per cent. of
 Elementary Sulphur.*

Average Size of Litter Born.	Average Percentage of Litter Weaned.	Average Weight of Males.				Average Weight of Females.				WEIGHT GAINED DURING FIRST 28 DAYS.					
		At Weaning.		At Birth.		At Weaning.		At Birth.		Males.			Females.		
		At Birth, g.	At Weaning, g.	At Birth, g.	At Weaning, g.	At Birth, g.	At Weaning, g.	Total g.	Average Daily g.	Gain, Per Cent.	Total g.	Average Daily g.	Gain, Per Cent.		
8.3	78.31	4.78	55.72	4.47	50.32	CONTROL GROUP, 1st Generation.		30.94	1.819	38.05	45.85	1.637	36.62		
9.1	68.29	4.59	46.00	4.60	45.53	SULPHUR GROUP, 1st Generation.		41.41	1.479	32.22	40.93	1.462	31.78		
7.6	86.78	4.53	50.73	4.45	47.48	2nd Generation.		46.20	1.650	36.42	43.03	1.537	34.54		
8.3	74.72	4.68	42.73	4.34	38.43	3rd Generation.		38.05	1.359	29.04	34.09	1.217	28.04		
Grand Average for S. group. 8.3	76.59	4.60	46.49	4.46	43.81			41.89	1.496	32.52	39.35	1.405	31.50		

It is evident that even after three generations the incorporation of 3 per cent. of elementary sulphur in the stock ration had no appreciable effect on the weight of the nursing mothers. The average number of young nursed for the first 19 days after parturition was 6.5 and 6.3 and the percentage gains in weight by the mothers were 8.55 and 10.3 for the control and sulphur groups respectively. Furthermore, in no case, but one, did the nursing mothers lose in weight. This does not substantiate the observations of Slonaker and the author therefore agrees with MaComber (1934) that Slonaker's diet was probably defective in certain respects.

The results given in table IV show that elementary sulphur had no effect on the fertility and reproduction in rats. The average size of the litters born was 8.3 and 8.3 and the percentages weaned 78.31 and 76.59 for the control and sulphur groups respectively.

Moreover, the weight of the young at birth did not differ appreciably when the two groups are compared. The average weights for the males were 4.78 and 4.60 g. and for the females 4.47 and 4.46 g. for the respective groups. However, the young from control mothers were slightly heavier at weaning than those from mothers fed the sulphur ration. The total gains were 50.94 and 41.89 g. for the males and 45.85 and 39.35 g. for the females for the control and sulphur groups, respectively, with corresponding differences in the average daily gains expressed in grams or percentages. Nevertheless these differences are so small that they seem to be insignificant.

While these experiments were in progress, Daggs (1935) published his technique for studying the lactation in rats. Consequently it was thought of interest also to apply his method in studying the effect of sulphur on lactation. The rats in the control group were from the second and those in the sulphur group from third generation rats fed the respective rations. They were weaned and mated at the ages stated previously. At parturition the litters were reduced to six except for those below this number which were discarded. The results are given in table V.

TABLE V.

Comparison of Lactation in Rats fed a Stock Diet with and without 3 per cent. of Elementary Sulphur.

Ration.	No. of Litters.	K _{1c}		K ₂		Lactation Index.	
		Range.	Average.	Range.	Average.	Range.	Average.
Control....	14	.0410-.0615	.0515	.0213-.0466	.0365	750-1000	880
Sulphur....	10	.0466-.0635	.0523	.0300-.0475	.0370	776-1110	893

The lactation indices were found to be 880 and 893 for the control and sulphur groups, respectively, from which it is evident that the feeding of sulphur had no effect on the lactation in rats.

SUMMARY.

1. Data are presented on the effect of incorporating 3 per cent. of elementary sulphur in a stock ration on the reproduction and lactation in rats.

2. Under the experimental conditions elementary sulphur had no effect on either fertility, reproduction or lactation in rats.

3. There was no difference between the birth weights of young from the control and sulphur groups. However, at weaning the offspring from control rats weighed slightly more than those from sulphur fed animals.

4. The extent to which the food was utilized by the sulphur group was similar to that of the control one. Furthermore, the lactating rats in both groups gained in weight during the first nineteen days after parturition.

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