The survival rate and the average weight of the foetus after 250 R whole-body irradiation performed 2 h previous to splenectomy and sham operation dependent on the day of pregnancy

Day of pregnancy	Survival rate	Average weight	Survival rate	Average weight	Survival rate	Average weight
	250 R without operation		250 R 2 h before sham operation		250 R 2 h before splenectomy	
17th day	100.0%	1.41 ± 0.12 g	95.0%	1.36 ± 0.14 g	100.0%	1.33 ± 0.14 g
16th day	100.0%	1.34 ± 0.13 g	76.0%	1.27 ± 0.13 g	81.7%	1.21 ± 0.13 g
15th day	90.5%	1.29 ± 0.13 g	39.0%	1.25 ± 0.13 g	32.9%	1.15 ± 0.12 g
14th day	60.0%	1.16 ± 0.14 g	5.9%	0.98 ± 0.11 g	9.5%	0.99 ± 0.12 g
13th day	32.6%	1.06 ± 0.12 g	0.0%	0.90 ± 0.10 g	0.0%	0.81 ± 0.10 g
12th day	0.0%	0.98 ± 0.11 g	0.0%	0.84 ± 0.11 g	0.0%	0.88 ± 0.11 g

sham-operated mice than for irradiated mice. Damage as a result of operation shock must therefore be assumed.

No definite conclusion as to the diffusibility of the spleen factor can thus be made from the inability of splenectomy to increase the foetal survival rate. Analogous to the 'recovery factor' in non-irradiated spleen[12], however, it can be assumed that there is the question of a diaplacentally non-diffusible macromolecule[13].

Zusammenfassung. Eine Splenektomie 2 h nach einer Ganzkörperbestrahlung von 250 R führt bei graviden Muttertieren zu keiner Verbesserung der fötalen Überlebensrate. In Analogie zum 'recovery factor' der gesunden Milz darf angenommen werden, dass sich in der bestrahlten Milz ein hochmolekularer, diaplazentar nicht diffusionsfähiger Stoff bildet.

R. FRIDRICH[14,15]

Universitätsinstitut für Röntgendiagnostik und Strahlentherapie, Bürgerspital, Basel (Switzerland), August 30, 1965.

[1] R. FRIDRICH, Schweiz. med. Wschr. *93*, 37 (1963).
[2] H. J. MELCHING and O. MESSERSCHMIDT, Naturwissenschaften *48*, 576 (1961).
[3] H. J. MELCHING, O. MESSERSCHMIDT, CHR. STREFFER and U. SHILATA, Strahlentherapie *116*, 395 (1961).
[4] R. BAUER and H. HARTWEG, Fortschr. Geb. RöntgStrahl. *89*, 740 (1958).
[5] L. O. JACOBSON, Cancer Res. *13*, 315 (1952).
[6] F. ELLINGER, Am. J. Roentgenol. *87*, 547 (1962).
[7] L. J. COLE and M. C. FISHLER, Am. J. Physiol. *173*, 487 (1953).
[8] R. BAUER and H. HARTWEG, Fortschr. Geb. RöntgStrahl. *94*, 572 (1960).
[9] P. A. MAURICE and A. JEANRENAUD, Nature *200*, 1221 (1963).
[10] B. NEPPI and M. BERTONCELLI, Minerva med., Roma *51*, 4469 (1960).
[11] J. TRAUTMANN, Strahlentherapie *114*, 147 (1961).
[12] S. KATZ and F. ELLINGER, Nature *197*, 397 (1963).
[13] A. RUGH and E. GRUPP, Radiat. Res. *13*, 657 (1960).
[14] Acknowledgment: The author is indebted to M. SCHÄFER for her technical assistance.
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Effect of Selenium on Food and Water Intake in the Rat

Epidemiological studies among children and work with experimental animals, reviewed recently[1], have shown that selenium increases the susceptibility to caries when consumed during the period of the development of the teeth and incorporated into their structure. On the other hand, administration of selenium to rats after the development of their teeth did not increase caries[2,3]. However, in these experiments the animals on selenium showed evidence of toxicity including retardation of growth which is one of the main symptoms of selenium poisoning resulting from lack of appetite and food intake. Since food intake in rodents is directly related to the development of caries, the present experiment was designed to test the effect of selenium ingestion on both the food and water intake in rats. No such study has been reported previously.

Materials and methods. Thirty male weanling Sprague-Dawly strain rats weighing between 43–50 g were equally divided into a selenium and a control group. The animals were housed individually in metal cages with raised screen bottoms. Selenium, as sodium selenite, in the amount of 3.0 ppm was added to the drinking water of the experimental group and offered ad libitum. It has been shown that, in general, water does not contain appreciable amounts of selenium[4]. The controls were drinking tap water. All animals were fed ground Purina laboratory chow ad libitum. The food was placed in scatter-proof food cups, made of metal, with a cover having a central feeding hole of $1^1/_4$ in. diameter. The water consumption was measured accurately by using non-spillable animal drinking tubes, made of glass, having a capacity of 100 ml, and graduated at intervals of 1 ml. The amount of food consumed daily was measured by a double beam balance. The experiment lasted for 4 weeks and during that period two animals in the experimental group died from selenium poisoning.

[1] D. M. HADJIMARKOS, Arch. environ. Health *10*, 893 (1965).
[2] M. G. WHEATCROFT, J. A. ENGLISH, and C. A. SCHLACK, J. dent. Res. *30*, 523 (1951).
[3] J. C. MUHLER and W. C. SHAFER, J. dent. Res. *36*, 895 (1957).
[4] D. M. HADJIMARKOS and C. W. BONHORST, J. Pediatrics *59*, 256 (1961).

Results and discussion. Table I presents the results of the study. It is evident that the ingestion of selenium by rats affected greatly their food and water intake. The animals in the experimental group consumed 3.5 g less food and 9.0 ml less water as compared with the controls. These figures represent a reduction of 21.6% in food intake and 29.6% in water intake by the selenium group of rats. The differences in the mean values of food and water consumption between the selenium and control animals were tested by the 't' test and were found to be highly significant. The mean final weight of the animals ingesting selenium was about 34 g less than that of the controls as a result of selenium intoxication.

Another interesting observation from the data in Table I is the difference in the ratio of food to water intake between the two groups of animals. Whereas the controls maintained the normal food to water ratio, which is in a relation of about 1 to 2, in the selenium treated rats the ratio was down to 1:1.7. This demonstrates that ingestion of selenium upsets the physiological balance by which water intake is quantitatively related to food intake. Such an observation on the effect of selenium has not been reported before. The depression in water intake could not be attributed to a dislike on the part of the animals to drinking water containing selenium. It has been shown that selenium given to rats by injection produces the same systemic manifestations of chronic selenium intoxication as that when mixed in food or water[5–7].

The material presented in Table II reveals for the first time that ingestion of selenium by rats produces important changes in the pattern of food and water consumption. This was made possible by calculating the amount of food and water consumed by weekly intervals. At the end of the first experimental week, the selenium group of rats ate 24.5% less food and drank 26.3% less water in comparison with the controls. However, in subsequent weeks, there was a gradual increase in food consumption but a considerable decrease in water consumption by the rats on selenium. By the end of the fourth and final week, the difference in food intake between the two groups of animals was down to 20.0% whereas that of water intake increased to 33.3%.

Reduction of food intake in rats is known to be associated with reduced caries activity, and recently a highly significant decrease in caries was reported in a group of rats eating 20% less food than their controls[8]. In the present study, ingestion of selenium by rats decreased their food intake by 21.6%. In the experiments mentioned previously[2,3], ingestion of selenium by rats after the development of their teeth produced an incidence of caries similar to that of the controls. This actually may represent an increase in caries by the rats on selenium, because although their food intake was reduced considerably their susceptibility to caries was as high as that of the controls eating normally. In view of the results of the present study, it is proposed that the substantial decrease in water consumption of rats ingesting selenium enhances the caries-inducing potential of the diet by favoring the retention of food particles on the surfaces of the teeth which are responsible for the initiation of carious lesions. Reduction in the quantity of salivary secretion may be also involved.

In a previous work[9], ingestion of selenium by rats during the developmental period of their teeth produced a statistically significant increase in caries which was proportionate to the amount of selenium ingested. It is believed that this resulted mainly from incorporation of selenium into the structure of the teeth making them more susceptible to caries. It is known, for example, that incorporation of fluoride into the teeth during development decreases caries. Thus it appears that administration of selenium to rats either during the period of development of the teeth or after their formation produces an increase in caries although the mechanism through which this is accomplished seems to be different.

The following conclusions may be drawn from this work: (1) Ingestion of selenium by weanling rats reduces substantially their food and water intake, and also disturbs the physiological balance by which water consumption is quantitatively related to food consumption. (2) No valid conclusions can be drawn regarding the effect of selenium ingested after the development of the teeth on caries in rats without taking into consideration the amount of food and water consumed[10].

Table I. Effect of selenium on food and water intake in male rats

Item	Group Control	Group Selenium
No. of animals	15	13
Mean initial weight (g)	47.2	46.4
Mean final weight (g)	226.1	192.5
Mean food intake (g/day)	16.2 ± 0.31[a]	12.7 ± 0.32
Mean water intake (ml/day)	30.4 ± 0.73	21.4 ± 0.51
Ratio food/water intake	1:1.9	1:1.7

[a] Standard error.

Table II. Consumption of food and water by weekly intervals in rats receiving selenium

Time interval	Food intake (g/day)			Water intake (ml/day)		
	Se	Control	% Dif.	Se	Control	% Dif.
First week	7.1	9.4	24.5	13.2	17.9	26.3
Second week	12.0	15.6	23.1	20.8	28.6	27.3
Third week	15.0	19.2	21.9	24.3	35.6	31.7
Fourth week	16.5	20.6	20.0	26.4	39.6	33.3
Total	12.7	16.2	21.6	21.4	30.4	29.6

Zusammenfassung. Verabreichung von Selen verändert das Stoffwechselgleichgewicht bei 21-Tage alten Ratten, bei denen der Wasserverbrauch proportional zur Nahrungsaufnahme erfolgt, ebenso besonders die freiwillige Futter- und Wasseraufnahme. Diese Befunde sind bei der Untersuchung der Wirkung von Selen auf die Zahnkaries im Rattenversuch zu berücksichtigen.

D. M. HADJIMARKOS

University of Oregon Dental School, Portland (Oregon USA), August 27, 1965.

[5] M. I. SMITH and R. D. LILLIE, National Institute of Health Bull. No. 174, Washington, D.C. (1940).
[6] I. ROSENFELD and H. F. EPPSON, Am. J. vet. Res. *18*, 693 (1957).
[7] I. ROSENFELD and O. A. BEATH, *Selenium* (Academic Press, 1964), p. 141.
[8] J. H. SHAW, J. Nutrition *85*, 338 (1965).
[9] W. BUTTNER, J. dent. Res. *42*, 453 (1963).
[10] This investigation was supported by the General Research Support Grant from the National Institute of Dental Research, United States Public Health Service.