

13671

Red Staining of Paws and Whiskers as in Vitamin B₂-Complex Deficient Rats after Dehydration.

SUSAN GOWER SMITH. (Introduced by David T. Smith.)
(With the technical assistance of Thomas E. Lasater.)

*From the Department of Medicine, Duke University School of Medicine,
Durham, N.C.*

The accumulation of red material on the paws, nose, whiskers and periorbital regions of rats has been attributed to a deficiency of the vitamin G (B₂) complex in these animals.¹ Although originally described as blood staining, recent investigations have shown that this dried red stained material consists primarily of porphyrin compounds,^{2, 3} although a small amount of blood may be present.

The lesions have been described in rats on both riboflavin-deficient diets^{3, 5} and more recently on pantothenic acid-deficient diets.^{4, 6} McElroy² observed that the red material arose from the Harderian (lacrimal) glands and failed to develop in rats deprived of pantothenic acid if the Harderian glands had been previously removed.

Smith and Sprunt⁵ related this phenomenon to dehydration and this observation has been confirmed recently by Figge and Atkinson.⁶ The present investigation was designed to determine whether the B-vitamins fed singly or together could alter the course of the development of these lesions resulting from dehydration.

One hundred and three rats were used and grouped as shown in Table I.

In order to impose the same strain on both groups, Purina Dog Chow was available at all times for the rats receiving no water, and water was available constantly for the rats receiving no food. Individuals in both groups began to die at approximately the same time, although the average longevity was slightly greater in the food starved rats.

The synthetic vitamins were given in water solution but the daily dose per rat including those containing the 7 vitamins was always contained in one drop of solution.

¹ Smith, S. G., *Proc. Soc. Exp. Biol. and Med.*, 1932, **30**, 198.

² McElroy, L. W., Salomon, K., Figge, F. H. J., and Cowgill, G. R., *Science*, 1941, **94**, 467.

³ Chick, H., Macrae, T. F., and Worden, A. N., *Biochem. J.*, 1940, **34**, 580.

⁴ Unna, K., *J. Nutrition*, 1940, **20**, 565.

⁵ Smith, S. G., and Sprunt, D. H., *J. Nutrition*, 1935, **10**, 481.

⁶ Figge, F. H. J., and Atkinson, W. B., *Proc. Soc. Exp. Biol. and Med.*, 1941, **48**, 112.

TABLE I.
Incidence and Severity of Red Staining in Dehydrated Rats With and Without Vitamins in Comparison with Food Starved Rats Receiving Water.

Group	No. of rats	Initial age, avg days	Water regime	Food and vitamin* regime	Average longevity, days	No. showing red staining				
						++++†	+++	++	+	0
A	10	82	No water	Chow	9	1	9	0	0	0
B	16	—	" "	" "	—	1	14	1	0	0
C	13	82	" "	" + P.A.	10	2	10	0	1	0
D	5	125	" "	" + P.A.	11	1	4	0	0	0
E	10	125	" "	" + R.F.	11	1	8	1	0	0
F	10	125	" "	" + B ₁ , R.F., B ₆ , P.A., N.A., Inos., Cho.	13+	0	7	3	0	0
G	10	125	" "	Chow + B.Y.	13	0	8	2	0	0
H	10	82	Water	None	10	0	0	0	0	10
I	14	—	" "	" "	—	0	0	0	0	14
J	5	125	" "	" "	13+	0	0	0	0	5

*P.A. = pantothenic acid, 100 γ /rat/day (C); 300 γ /rat/day (D); R.F. = riboflavin, 40 γ /rat/day (E). B₁, 13.3 γ ; R.F., 16.6 γ ; P.A., 66.6 γ ; N.A. = nicotinic acid, 66.6 γ ; B₆, 66.6 γ ; Inos. = inositol, 666 γ ; Cho. = choline, 666 γ /rat/day (F). B.Y. = brewer's yeast, 0.5 gr./rat/day (G).

†++++ indicates that all 4 sites (nose, whiskers, paws, and eyes) have marked staining as demonstrated by Fig. 1,A. +++, ++ and + are simply graded down from that standard.

In the water-deprived rats food consumption fell off in a short while. This includes, of course, the consumption of brewer's yeast in Group G, which naturally obscures the full effect of this source of natural B-complex vitamins. The group receiving the 7 synthetic vitamins and the brewer's yeast experienced only slightly greater longevity, and the severity of the lesions was modified to only a slight extent.

The sites at which the red porphyrin material accumulates are the paws, nose, whiskers and eyes, as shown by photograph A, Fig. 1. In all the water-deprived rats this accumulation began to appear on the third day and tended to grow progressively worse during the experiment.

Due to weakness before death the food-deprived rats often failed to consume water for 24 to 48 hours before death, resulting in a moist pink staining of paws and nose. In no case, however, were the lesions extensive enough to be confused with the picture presented by the water-deprived rats.

Under the conditions of our experiment the administration of neither riboflavin nor pantothenic acid has any appreciable effect on the lesion. The combination of the synthetic vitamins (B₁, B₆, riboflavin, pantothenic acid, nicotinic acid, inositol, choline) and the combination of natural vitamins in brewer's yeast had only a minimal effect on the longevity and severity of symptoms.

The characteristic red stained incrustations on nose, whiskers,

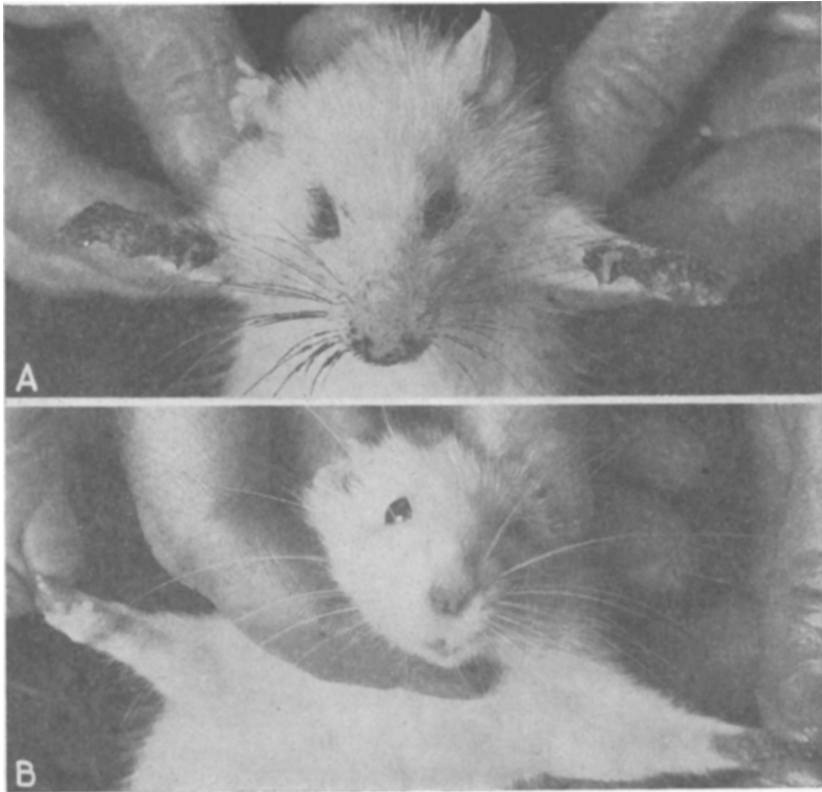


FIG. 1.

- A. Rat deprived of water for 7 days but receiving food.
B. Rat deprived of food for 7 days but receiving water.

paws and eyes, observed in riboflavin or pantothenic acid deficiencies are very similar, if not identical, to those observed when dehydration is directly induced. Although the vitamins tested under the conditions imposed in these dehydration experiments were negligible in their effectiveness against the characteristic symptoms, it is still probable that these vitamins, particularly pantothenic acid and riboflavin, are concerned with water metabolism.

We wish to thank Merck and Company, Rahway, N.J., for generously supplying us with the vitamin B₆ and calcium pantothenate used in this work.