

THE RELATION BETWEEN CYSTINE DEFICIENCY IN
THE DIET AND GROWTH OF HAIR IN
THE WHITE RAT.

BY JESSIE R. BEADLES, WINFRED W. BRAMAN,* AND
H. H. MITCHELL.

*(From the Division of Animal Nutrition, Department of Animal Husbandry,
University of Illinois, Urbana.)*

(Received for publication, June 21, 1930.)

The paired feeding experiments described in the preceding paper presented an opportunity to obtain some direct information on a question that has been recently revived by Lightbody and Lewis (1); *i.e.*, the relation between the cystine content of the diet and hair growth. Lightbody and Lewis concluded from their experiments on different groups of white rats receiving rations containing 16.70 per cent of whole milk powder, with graded additions of casein from 0 to 16 per cent, that, "The amount of hair produced, like the general somatic development, was related to the protein (and cystine) content of the diet, but under the experimental conditions of the present study, the demands for protein (and cystine) for the growth of the hair appeared to be secondary in importance to the demands for growth of the body with its more essential tissues." However, these experiments were not planned so as to afford any direct information on the relation between cystine and hair growth, since in no case was cystine a sole variable between any two diets. In fact, the implication that cystine was specifically involved in the greater hair growth obtained on the rations containing the higher concentrations of casein, seems quite inconsistent with the known deficiency of casein in this amino acid.

In the experiments described in the preceding paper, seventeen pairs of rats were fed upon a low protein diet (8 to 9 per cent). The protein mixture in each of the two diets used was demon-

* On leave of absence from the Institute of Animal Nutrition, Pennsylvania State College, State College.

624 Cystine Deficiency and Growth of Hair

strably deficient in cystine. One rat in each of the seventeen pairs received a small cystine supplement, but the intake of food was the same for all pair mates. In each pair the rat receiving

TABLE I.
Growth of Hair on Garden Pea Ration with and without Added Cystine.

Rat No.	Sex.		Body weight.	Surface area.	Weight of hair.		
					Total.	Per gm. body weight.	Per sq. cm. body surface.
			<i>gm.</i>	<i>sq. cm.</i>	<i>gm.</i>	<i>mg.</i>	<i>mg.</i>
1	♂	Control.	93	190	0.7701	8.28	4.05
2	♂	Cystine.	98	196	0.8774	8.95	4.48
3	♂	Control.	99	198	0.7892	7.97	3.99
4	♂	Cystine.	109	209	1.1918	10.93	5.70
5	♂	Control.	83	178	0.7985	9.62	4.49
6	♂	Cystine.	95	193	1.1138	11.72	5.77
7	♂	Control.	88	184	0.6681	7.59	3.63
8	♂	Cystine.	105	205	0.9301	8.86	4.54
9	♂	Control.	109	209	0.7948	7.29	3.80
10	♂	Cystine.	127	229	1.0408	8.20	4.54
11	♂	Control.	96	194	0.8671	9.03	4.47
12	♂	Cystine.	113	214	1.2462	11.03	5.82
13	♀	Control.	89	185	0.9719	10.92	5.25
14	♀	Cystine.	100	199	0.9564	9.56	4.81
15	♀	Control.	92	189	0.9970	10.84	5.28
16	♀	Cystine.	109	209	1.2423	11.40	5.94
17	♂	Control.	187	289	3.0121	16.11	10.42
18	♂	Cystine.	210	310	2.9844	14.21	9.63

added cystine grew faster than its control mate on the same amount of food, a specific result of the cystine addendum.

The purpose of the present study is to report the effects of the cystine supplement on the growth of the hair. The rats were killed with ether, skinned, and the skins depilated by enzyme

digestion according to the method used by Lightbody and Lewis. The hair was collected, washed, dried, and weighed, also in accordance with their directions. The results are given in Tables I and II.

TABLE II.
Growth of Hair on Potato Ration with and without Added Cystine.

Rat No.	Sex.		Body weight.	Surface area.	Weight of hair.		
					Total.	Per gm. body weight.	Per sq. cm. body surface.
			<i>gm.</i>	<i>sq. cm.</i>	<i>gm.</i>	<i>mg.</i>	<i>mg.</i>
1	♂	Control.	102	200	1.1862	11.63	5.93
2	♂	Cystine.	115	216	1.7587	15.29	8.14
3	♂	Control.	94	192	1.1095	11.00	5.78
4	♂	Cystine.	121	224	1.6370	13.53	7.31
5	♂	Control.	96	194	1.2096	12.60	6.24
6	♂	Cystine.	120	224	1.7334	14.44	7.74
7	♂	Control.	109	209	1.3986	12.83	6.69
8	♂	Cystine.	123	225	1.2394	10.08	5.51
9	♂	Control.	124	226	1.3333	10.75	5.90
10	♂	Cystine.	145	247	1.4329	9.88	5.80
11	♂	Control.	102	200	1.2310	12.07	6.16
12	♂	Cystine.	115	215	1.4462	12.58	6.73
15	♂	Control.	80	174	1.0248	12.81	5.89
16	♂	Cystine.	109	209	1.4379	13.19	6.88
17	♀	Control.	125	227	1.5075	12.06	6.64
18	♀	Cystine.	129	230	1.9828	15.37	8.62

In analyzing the significance of these results, the differences in total weight of hair, and in weights per gm. of body weight and per sq. cm. of body surface (2), between pair mates have first been obtained. The mean of each set of eight or nine differences has then been computed, as well as the standard deviation. "Student's" method (3) has then been applied. In this method the

626 Cystine Deficiency and Growth of Hair

ratio of the mean of the set of differences between paired observations to their standard deviation is obtained and is designated z . Then with the number of differences (eight or nine in this experiment) and the value obtained for z , one may enter "Student's" table and find the probability of getting a mean difference as large or larger than that obtained by the operation of chance only.

These calculations have been made for the data of this experiment, and the results summarized in Table III.

The positive signs of the average differences indicate that the rat fed cystine has produced the greater average weight of hair. The significance of these averages is measured by the values of P

TABLE III.
Estimation of Significance of Differences in Hair Weight between Pair Mates by Method of "Student."

Hair weight.	No. of differences. <i>N</i>	Mean difference. <i>M</i>	Standard deviation. <i>s</i>	Ratio <i>M:s</i> <i>z</i>	Probability. <i>P</i>
Rats on garden pea ration.					
Total.....	9	+0.2127	0.149	1.43	0.0019
Per gm. body weight.....	9	+0.80	1.49	0.54	0.084
" sq. cm. surface.....	9	+0.65	0.77	0.84	0.023
Rats on potato ration.					
Total.....	8	+0.3335	0.242	1.38	0.0041
Per gm. body weight.....	8	+0.98	1.99	0.49	0.12
" sq. cm. surface.....	8	+0.94	1.06	0.89	0.026

in the last column of Table III. The smaller the value P the less likely is it that the average difference in hair weight was the result of chance factors only, and hence the more significant it becomes as a specific effect of the cystine addition.

As regards total hair weight there can be no question but that the added cystine has favored a more rapid growth of hair, as it did of the total body tissues measured in body weight. The odds are only 2 and 4 in 1000 that chance produced the large average differences in total hair weight in the two experiments.

The average differences in hair weight per gm. of body weight between pair mates are evidently not significant. Chance alone

could have produced the same result once in eight trials in the case of the experiment with potato, and once in twelve trials in the case of the the experiment with garden pea.

On the other hand, when the hair weight is computed per sq. cm. of body surface and the pairs compared on this basis, it appears that the average differences are of such size that chance could hardly have produced them. With $P = 0.023$, as in the first experiment, an average difference as large or larger than that obtained, $+0.65$, would have resulted from chance only once in forty-three trials. With $P = 0.026$, as in the second experiment, an average difference as large or larger than $+0.94$ mg. of hair per sq. cm. of surface would have resulted from chance only once in thirty-eight trials. These probabilities are so small that it becomes practically certain, especially on the combined weight of evidence of the two experiments, that the cystine added to the basal diet has produced a heavier coat of hair per unit of body surface.

CONCLUSIONS.

The addition of cystine to a diet whose protein content is so low as to be the limiting factor in growth and is deficient in this amino acid, increases its value in the promotion of hair growth in the albino rat.

The coat of hair produced on such rations when supplemented with cystine is not only heavier *in toto*, as compared with that produced on the same amount of the unsupplemented ration, but it is heavier per unit of surface area. Hence it appears that, under these conditions, the growth of hair has been stimulated to a greater extent by the cystine supplement than has the growth of all tissues as measured by increase in body surface. There is no indication that the demands of the more vital tissues for cystine have taken precedence over the demands of the hair follicles.

BIBLIOGRAPHY.

1. Lightbody, H. D., and Lewis, H. B., *J. Biol. Chem.*, **82**, 485 (1929).
2. Lee, M. O., *Am. J. Physiol.*, **89**, 24 (1929).
3. Student, *Biometrika*, **6**, 1 (1908).

**THE RELATION BETWEEN CYSTINE
DEFICIENCY IN THE DIET AND
GROWTH OF HAIR IN THE WHITE
RAT**

Jessie R. Beadles, Winfred W. Braman and H.
H. Mitchell

J. Biol. Chem. 1930, 88:623-627.

Access the most updated version of this article at
<http://www.jbc.org/content/88/2/623.citation>

Alerts:

- [When this article is cited](#)
- [When a correction for this article is posted](#)

[Click here](#) to choose from all of JBC's e-mail alerts

This article cites 0 references, 0 of which can be accessed free at
<http://www.jbc.org/content/88/2/623.citation.full.html#ref-list-1>