## 8244 C

# Experimental Goat's Milk Anemia.

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Many reports have appeared, especially in the German literature, concerning a pernicious anemia-like syndrome occurring in infants fed with goat's milk.[1] György[2] has recently reported such cases which responded to liver but not to iron therapy. Rominger, Bomskov, *et al.*,[3] have reported the occurrence of a pernicious anemia picture in young white rats fed on goat's milk. The erythrocyte counts decreased rapidly without corresponding decreases in the hemoglobin. This anemia did not respond to iron therapy but responded to liver extracts effective in pernicious anemia. Von Haam and Beard[4] also have observed a hyperchromic character of the anemia in rats during the first weeks of feeding with goat's milk. György[2] states that he was unsuccessful in producing a hyperchromic anemia in rats by this method. The experiments reported in this paper show no evidence of a specific type of anemia in white rats fed on goat's milk.

Three litters of 6 albino rats each, of the Wistar strain, were weaned at 23 days and put into individual glass cages. Their weights

[1] Korteweg, R., *Nederl. Maandschr. V. Verlosk, Vrouwenz, enz.*, 1916, **5**, 337, and Scheltema, G., *Nederl. Maandschr. V. Verlosk, Vrouwenz, enz.*, 1916, **5**, 407 (Reported by Brouwer); Kleinschmidt, H., *Jahrb. f. Kinderh.*, 1916, **83**, 97; Schwenke, J., *Jahrb. f. Kinderh.*, 1918, **88**, 181; Stoeltzner, W., *Munch. Med. Wchschr.*, 1922, **69**, 4; Blühdorn, K., *Munch. Med. Wchschr.*, 1922, **69**, 1220; Brouwer, E., *Jahrb. f. Kinderh.*, 1923, **102**, 257, 357; **103**, 51; Beumer, H., and Wieczorek, G., *Jahrb. f. Kinderh.*, 1924, **107**, 311; Opitz, H., *Jahrb. f. Kinderh.*, 1925, **108**, 311; Stettner, E., *Monatschr. f. Kinderh.*, 1925, **29**, 587; Ockel, G., *Jahrb. f. Kinderh,.* 1925, **110**, 62; Glanzmann, E., *Jahrb. f. Kinderh.*, 1926, **111**, 127; Grävinghoff, W., and Neuhaus, C., *Monatschr. f. Kindh.*, 1928, **40**, 71; Baar, H., *Jahrb. f. Kinderh.*, 1928, **120**, 242; Hyland, C. M., *Arch. Pediat.*, 1929, **46**, 673; Letterer, E., *Jahrb. f. Kinderh.*, 1930, **130**, 1; Haase, G., *Monatschr. f. Kinderh.*, 1934, **60**, 241; Von Haam, E., *South. Med. J.*, 1935, **28**, 22.

[2] György, P., *Z. f. Kinderh.*, 1934, **56**, 1.

[3] Rominger, E., Meyer, H., and Bomskov, C., *Z. f. d. ges. Exp. Med.*, 1933, **89**, 786; Bomskov, C., and Auffarth, M., *Z. f. d. ges. Exp. Med.*, 1933, **89**, 804; Bomskov, C., and Czerlinsky, H., *Z. f. d. ges. Exp. Med.*, 1933, **89**, 809; Rominger, E., and Bomskov, C., *Z. f. d. ges. Exp. Med.*, 1933, **89**, 818; Rominger, E., and Bomskov, C., *Klin. Wchschr.*, 1935, **14**, 148.

[4] Von Haam, E., and Beard, H. H., PROC. SOC. EXP. BIOL. AND MED., 1935, **32**, 750.

averaged 40-45 gm. They were fed exclusively on goat's milk* which was collected directly into clean glass containers at the dairy and delivered to the laboratory every other day. Erythrocyte counts were performed with Bureau of Standards equipment and the hemoglobins with the Newcomer apparatus standardized by the oxygen capacity technique. Erythrocyte counting pipettes and micro-colorimeter cups were used in the hemoglobin determinations. Reticulocyte counts were performed by the method of Cunningham.[6] Cover slips containing brilliant Cresyl blue and blood were allowed to be in apposition several minutes before making the smears in order to insure complete staining of the reticulocytes.

This series of 18 rats received a goat's milk diet for a period of 65 days. The average erythrocyte counts increased gradually from an initial level of 6.8 million to a level of 9.5 million. The average hemoglobin values decreased from 14 gm. to 8 gm. per 100 cc. The reticulocyte percentage at the beginning averaged 5%, increased to 13% in about 10 days, and then decreased. There was a gradual secondary rise reaching to about 10% at the end of the experiment. These results are similar qualitatively but slightly less marked than those observed with cow's milk in this laboratory.[7] The slowness with which the anemia appeared might have been related to storage of hemopoietic materials before weaning since the mothers received meat and vegetable feedings once a week in addition to the regular diet.†

In an attempt to obtain a more severe anemia in a shorter period of time, the method of Elvehjem and Kemmerer[8] was employed. Two litters of 6 rats each were placed in separate glass cages with the mothers 2 days after birth. The mothers were removed for about 4 hours daily and given the stock diet. Goat's milk was available in the glass cages at all times. At 21 days, the young were weaned and were given an exclusive diet of goat's milk. Their average weights at this time were 30-35 gm. The erythrocyte counts

* The goats were of the Alpine type and received complete diets. Analyses of samples of milk were made for copper by the method of Elvehjem and Lindow.[5] Typical results of analyses on different samples of milk: Copper, mg./liter, .20, .20, .23.

[5] Elvehjem, C. A., and Lindow, C. W., *J. Biol. Chem.*, 1929, **81**, 435.

[6] Cunningham, T. D., *Arch. Int. Med.*, 1920, **26**, 405.

[7] Farmer, C. J., and Cory, H. E., PROC. SOC. EXP. BIOL. AND MED., 1932, **29**, 766, and personal communication.

† One-third whole milk powder and two-thirds whole wheat, containing 1% iodized sodium chloride.

[8] Elvehjem, C. A., and Kemmerer, A. R., *J. Biol. Chem.*, 1931, **93**, 189.

averaged from 3 to 5 million and the hemoglobins from 7 to 8.5 gm. per 100 cc. During the next 3 weeks of goat's milk feeding, the erythrocyte counts increased slightly, whereas the hemoglobin values decreased to about 4.5 to 6 gm. per 100 cc. (Table I.)

TABLE I.
Development of Anemia in Rats Receiving Goat's Milk.

| Rat No. | Time in Days | R.B.C. in mill./cc. | Hgb. in gm./100 cc. |
|---|---|---|---|
| 224 | 0 | 3.6 | 6.8 |
| | 7 | 4.2 | 5.8 |
| | 14 | — | 6.8 |
| | 21 | 6.7 | 5.9 |
| 227 | 0 | 4.9 | 8.0 |
| | 7 | 4.5 | 7.4 |
| | 21 | 5.1 | 4.8 |
| 230 | 0 | 3.1 | 8.5 |
| | 14 | — | 4.5 |
| | 21 | 5.2 | 4.5 |

In order to study the effect of anti-anemia therapy, these rats were divided into 3 groups. Group 1 received daily supplements of iron and copper. Group 2 received liver extract containing the anti-pernicious anemia factor‡ plus an iron supplement, and group 3 received an extract containing the hemoglobin-producing factor of Whipple.[9]§ All 3 groups received equivalent amounts of copper while the iron content of the diet containing extract 55 was somewhat higher than the rest. The rats were studied over a 2-week period, and the results are recorded in Table II. The increases in the erythrocyte counts and hemoglobins per 100 cc. were similar in all the animals regardless of the type of therapy. It is apparent that the rats receiving liver extract gained about 2.5 times as much weight in the 2 weeks as the rats which received only the iron and copper supplement. The presence of a growth factor in liver has been reported previously.[11]

The results in general are similar to those that might be expected from the feeding of cow's milk. A hypochromic anemia

‡ Liver Extract 343, Eli Lilly and Company.

[9] Whipple, G. H., Robscheit-Robbins, F. S., and Walden, G. B., *Am. J. Med. Sc.*, 1930, **179**, 628.

§ Liver Extract 55, Eli Lilly and Company.

These liver extracts were analyzed for iron by the method of Hanzal[10] and for copper by the method of Elvehjem and Lindow.[5].

[10] Hanzal, R. F., PROC. SOC. EXP. BIOL. AND MED., 1933, **30**, 846.

[11] Kline, O. L., Elvehjem, C. A., Keenan, J. A., and Hart, E. B., *J. Biol. Chem.*, 1934, **107**, 107.

TABLE II.

Effect of Various Therapeutic Measures on the Anemia from Goat's Milk.

| Rat No. | Time in Weeks | R.B.C. in mill./cc. | Hgb. gm./100 cc. | Weight in gm. |
|---|---|---|---|---|
| | | Group I. | | |
| Daily Supplement: 0.5 mg. iron (as $FeCl_3$), 0.04 mg. copper (as $CuSO_4$). | | | | |
| 225 | 0 | 4.4 | 4.7 | 65 |
| | 2 | 9.6 | 12.7 | 77 |
| 226 | 0 | 5.2 | 6.2 | 59 |
| | 2 | 9.3 | 14.8 | 71 |
| 231 | 0 | 4.5 | 5.1 | 72 |
| | 1 | | 12.9 | |
| | 2 | 6.9 | 12.7 | 93 |
| 232 | 0 | 5.7 | 4.6 | 71 |
| | 1 | | 11.5 | |
| | 2 | 7.3 | 13.7 | 85 |
| Aver. increase 2 wks. | | 3.3 | 8.3 | 15 |
| | | Group II. | | |
| Daily Supplement 1 gm. Liver Extract 343 (contained .139 mg. iron, .043 mg. copper), 0.35 mg. iron (as $FeCl_3$) | | | | |
| 223 | 0 | 4.8 | 4.7 | 66 |
| | 2 | 8.7 | 15.2 | 108 |
| 224 | 0 | 6.7 | 5.9 | 59 |
| | 2 | 10.1 | 15.6 | 91 |
| 229 | 0 | 5.1 | 5.1 | 71 |
| | 1 | | 11.9 | |
| | 2 | 9.5 | 13.9 | 103 |
| 230 | 0 | 5.2 | 4.5 | 78 |
| | 1 | | 12.0 | |
| | 2 | 9.0 | 14.1 | 125 |
| Aver. increase 2 wks. | | 3.9 | 9.6 | 38 |
| | | Group III. | | |
| Daily Supplement: 1 gm. Liver Extract 55 (contained 3.30 mg. iron, 0.039 mg. copper.) | | | | |
| 221* | | | | |
| 222 | 0 | 6.3 | 8.4 | 57 |
| | 2 | 8.9 | 13.4 | 98 |
| 227 | 0 | 5.1 | 4.8 | 73 |
| | 1 | | 13.1 | |
| | 2 | 9.2 | 14.5 | 108 |
| 228 | 0 | 4.6 | 4.3 | 77 |
| | 1 | | 13.0 | |
| | 2 | 8.7 | 15.3 | 113 |
| Aver. increase 2 wks. | | 3.6 | 8.6 | 37 |

*Data omitted because rat obtained food.

occurred from the exclusive feeding of goat's milk, which showed a maximum response to iron and copper therapy. The difference in these results, as compared to those reported by Rominger, *et al.*, and by Von Haam and Beard might possibly be attributed to variations in the goat's milk or/and in the condition of the rats used. For example, the above observers used rats that weighed about 20-30 gm.

at the beginning of the experiments, whereas those used by György and by us averaged about 10 gm. heavier. Further experimental and clinical data are necessary before the specific character of a goat's milk anemia can be established.

*Conclusions.* 1. Exclusive feedings of goat's milk to young white rats produced an anemia that was not significantly different from the type of anemia produced with cow's milk. 2. The anemia from goat's milk showed maximal responses to iron and copper therapy.

## 8245 C

### Phagological Identification of Streptococcus epidemicus.

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Davis and Rosenow[1] described the streptococcus which caused the Chicago epidemic of septic sore throat of 1911-12. They considered the disease to be a definite clinical entity like the Boston epidemic of 1911. The latter epidemic was described by Winslow,[2] who regarded it as the first of its kind to be described in this country. It was distinguishable from the throat disease which resembles atypical scarlet fever and which may be associated with definite scarlet fever cases.

Davis[3] gave the streptococcus of the Chicago epidemic the specific name *epidemicus*. Only 2 characters have been mentioned by investigators of this organism by which it may be differentiated from other hemolytic streptococci of human origin—the appearance of a capsule in young, moist cultures and the marked moisture and rapid drying of the colonies. Rosenow and others who studied *Streptococcus epidemicus* soon recognized the indefiniteness of capsule formation and moistness of colonies as specific characters. Rosenow reported that on artificial cultivation the epidemic sore throat strains assumed the characters of *S. pyogenes;* and that when cultivated in unheated milk *S. pyogenes* became modified so as to correspond with the streptococcus of epidemic sore throat. Ward and Lyons[4] and other investigators cited by them have recently

1 Davis, David J., and Rosenow, E. C., *J. A. M. A.*, 1912, **58**, 773.

2 Winslow, C.-E. A., *J. Inf. Dis.*, 1912, **10**, 73.

3 Davis, David J., *J. A. M. A.*, 1912, **58**, 1283.

4 Ward, Hugh K., and Lyons, Champ., *J. Exp. Med.*, 1935, **61**, 515.