NEWER ASPECTS OF NUTRITIONAL ANEMIA.*

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Nutritional anemia is a deficiency disease belonging to the physiological types of anemia. Abderhalden (1) in 1899 was the first to demonstrate this type of anemia in white rats fed a sole milk diet. Bunge (2), a year later, showed that milk was notoriously low in iron content. Nothing of value was developed in this regard until Hart (3) in 1925 reported the remission of the anemia by the feeding of iron and copper. He further stated that inorganic iron alone was ineffective, and that green plant material, an alcoholic extract of this material, or chlorophyll itself was essential for the assimilation of the iron. Hill (4) is also of this opinion.

Beard and Myers (5) in 1931 showed that copper was not a necessary adjunct for the assimilation of iron in opposition to Hart's earlier claims. Beard and Myers further stated that other metals (nickel, germanium, arsenic and zinc) would likewise stimulate hemopoiesis. These authors brought forward another point of considerable importance in that they found by doubling the minimum amounts of iron required for the remission of the anemia the time necessary for recovery to occur was reduced from 4 weeks to 1.8 weeks. This is in agreement with the results of Leichsenring and Flor (6) in their studies on infants.

The problem was further complicated when Osata and Tanaka (7), Furniss (8), and Foster (9), each from separate laboratories, found that ultra-violet light stimulated hemopoiesis.

Scott and Erf (10) in 1930 reported the prevention of nutritional anemia in white rats by a special method of feeding the cattle producing the milk. Essentially it was due to the feeding of hay rich in plant pigments and supplemental factors fed to the cows. These same authors (11) later announced that they were able to show a difference in milk obtained from cows which were pasture-fed and those that were fed the ordinary "winter" dairy ration. Hunt and Krauss (12)

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proved that the milk from cows on a green pasture diet had a higher vitamin G content than cows on a dry feed, and that cows on pasture during a vigorous plant growth produced a milk of a higher vitamin G content than those on pasture that was over-mature. Of interest in this connection is the work of Zih (13), who found that rabbits developed an anemia which was not cured by the addition of vitamin B when chlorophyll-free food was used, and the addition of chemically pure chlorophyll, or green food, to the diet caused a rapid return to normal.

Scott and DeLor (14) in 1933 reported rapid hemopoiesis in milk anemic rats by the use of:

1. An iron and copper-free alcoholic extract of alfalfa.
2. Haliver oil.
3. Milk obtained from cows on a special feed in which the hay contained large amounts of plant pigment.

DISCUSSION

Early in the experimental work on milk anemia it was demonstrated that factors other than inorganic iron are essential for hemopoiesis. It has been demonstrated that chlorophyll is very similar to hemoglobin in chemical composition. Pryde (15), in his "Recent Advances in Biochemistry," has pointed out that both hemoglobin and chlorophyll possess a common structural unit known as porphyrin. Porphyrin is a complex molecule composed of pyrrol rings. Besides pophyrin hemoglobin contains iron and protein which is called globin. Chlorophyll on the other hand possesses magnesium instead of iron and phytol instead of globin. Just what chemical reaction is involved in the relief of hemoglobin deficiency by a supplemental chlorophyll therapy is not known at present. Perhaps it is not the chlorophyll that is concerned; it may be another factor not yet known, or that chlorophyll may be a catalytic agent. In this respect we cannot neglect to mention carotin, which has been shown by Olcott and McCann (16) to be the precursor to vitamin A. Our experience with crude carotin has been that it has a primary depressant action on the blood-forming organs in rats on a *normal* diet, followed by a gradual return of the blood picture to normal. It may be that certain impurities present in the crude preparation prevented the carotin from exhibiting its hemopoietic properties.

The action of ultra-violet light in relieving milk anemia is not altogether clear. We know that wave lengths of light in the 300 uu to 680 uu range are capable of doing three things:

1. Sayre (17) has shown that these rays only are capable of producing chlorophyll.

2. In the presence of ergosterol these rays will produce vitamin D.

3. And as shown by Osata and Tanaka (7), Furniss (8), and Foster (9), these same rays will relieve milk anemia.

The action of halibut liver oil can perhaps better be interpreted when we recall that Simmonds, Becker, and McCollum (18) state that liver fats contain vitamin E in considerable amounts and also much iron. These authors claim that vitamin E in some way is hooked up with iron assimilation. They showed that ferrous sulphate alone in amounts as small as .2% in the food was harmful to rats, whereas, ferric citrate or the addition of wheat germ oil to the ferrous sulphate relieved the condition.

CONCLUSION

1. Plant pigments such as the chlorophylls, the carotins, or possibly the xanthophylls apparently are factors necessary for hemopoiesis in rats suffering from milk anemia.

2. Other factors that will relieve milk anemia are:
   a. Milk from cows that are on a specified green pasture diet.
   b. Halibut liver oil.
   c. Ultra-violet light irradiation.

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