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MANGANESE DISTRIBUTION IN PLANT MATERIAL AND ITS PHYSIOLOGICAL IMPORTANCE IN ANIMAL NUTRITION

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(Abstract)

Recent trends in biological research have stimulated interest in the wide distribution of minor elements in both animal and plant tissue. These elements include copper, zinc, aluminum, manganese and numerous others. Although mangenese was discovered in 1774 by Scheele and shown by him to be a soil constituent assimilated by plants, knowledge of its function in the plant is still incomplete. Manganese is believed to act as a catalyst in plant metabolism and to function with iron in the

synthesis of chlorophyll. In its absence plants are stunted and the leaves lose their green color.

The function of manganese in animal nutrition is even less well established. It catalyzes to some extent the regeneration of hemoglobin in anemic rats and has a favorable effect upon growth. A deficiency of manganese in the diet of rats results in degeneration of the reproductive organs of the males and little or no mammary gland development of the females. Young born to mother rats on manganese deficient diets are usually too weak to survive. Until the past year, however, manganese deficiency had not been regarded as a problem of practical importance in animal nutrition. In 1936 workers at Cornell reported that perosis, a bone deformity in chicks, was due to a deficiency of mangenese in the diet. This report prompted a reinvestigation of the nutritive properties of mangenese.

In a review of the literature on the metabolism of the minor elements a striking similarity was noted between plants and animals in their requirement for mangenese and in their response to a deficiency of this element. It seemed worthwhile to point out the similarity in case it might prove to be of more than passing interest and in hopes it might lead to a new approach to the problem of manganese metabolism in animals. The relation of manganese to chlorophyll synthesis in plants, and to hemoglobin regeneration in animals has already been mentioned.

Manganese is essential for both plant and animal life and cannot be replaced by other trace elements of similar chemical properties. The mangenese content of a single species of plants and that of animals is directly related to the available manganese in the food. The requirements of different species of plants vary and there is indirect evidence that this fact holds true for animals; for example, perosis has been observed only among the avian species. In plants, manganese is concentrated in those organs in which intensive chemical reactions take place and in those parts that are in active vegetation. Buds, leaves and young shoots are high in manganese whereas the larger stems and woody portions contain only small amounts. Leaves are higher than vegetables or fruits and young plants contain a higher percentage of manganese than old ones. Similarly, in animals, manganese is concentrated in organs that are actively engaged in chemical transformation, the liver and kidney, with only small amounts in muscle tissue. Young animals, like young plants, contain a higher percentage of manganese than old ones.

In seeds, manganese is present in largest amounts in the outer coating and in the germ. Sufficient may be present that manganese deficiency even under experimental conditions which tend to produce it may not become apparent during the life of the later developed plant. Likewise, the amount of manganese stored in the bodies of animals at birth may be sufficient that nutritive failure due to a deficiency of manganese is less apparent in the first generation than in the second.

Manganese deficiency manifested by loss of green color in plants is most marked on soils of a high pH and may follow heavy applications of lime. In animals, the conditions resulting from manganese deficiency are intensified by diets of high calcium and phosphorus content. In both groups the deficiency may be corrected either by additional amounts of manganese in the food or by direct injection of soluble manganese salts into the tissues. Likewise, in both groups, factors which retard growth modify the effects of mangenese deficiency.

There is general agreement among workers that the symptoms of mangenese deficiency in plants are essentially an arrest of development, followed by death of the undeveloped tissues at the growing points. In animals (chicks) there is arrested development accompanied by injury to the "growing points" of specific organs. These are the ends of the long

bones. In citrus plants, the roots remain healthy after definite symptoms of manganese deficiency are manifest in the shoots, suggesting that the manganese absorbed by the roots is retained and not surrendered to the leaves and stem until more is supplied. In animals, a somewhat similar situation exists in that the liver maintains its manganese content even at the time the bones are undergoing anatomical changes due to a shortage of manganese. The condition can be corrected only by supplying more manganese in the diet.

Perosis in chicks which can be largely prevented by supplementing their diet with manganese is characterized by swelling of the hock joint and displacement of the Achilles tendon. The leg bones become bent at the joint and crippling results.

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