

Manganese

"Trace Elements, Hair Analysis and Nutrition"

Passwater and Cranton

Manganese is an underrated trace element. Although it has been deemed "essential" by the Good and Nutrition Board of the National Academy of Sciences, much still remains unknown.

Adults normally contain an average 10 to 20 mg (most of which is in bone, liver and kidney) of manganese in their bodies. This small amount is essential to several critical enzymes involved in energy production, bone formation and protein metabolism.² Manganese is involved in the metabolism of fats and in the production of cholesterol.

Manganese is incorporated into superoxide dismutase and pyruvate carboxylase enzymes and is a co-factor necessary for the activation of many different enzyme systems including glycosyltransferase enzymes which play an important role in the production of cartilage and bone. A manganese deficiency results in abnormal bone and cartilage² and disc degeneration due to inadequate cartilage formation in the disc.³

Other signs of manganese deficiency include impaired glucose intolerance, birth defects, growth retardation, reduced fertility, reduced brain function and inner-ear imbalance.³ Severe manganese deficiency produces convulsions, skipped heartbeats, weight loss, dermatitis and hair colour loss.^{3.5}

Manganese is involved in the building and degrading of proteins and nucleic acid, biogenic amine metabolism⁵ and is necessary for RNA chain initiation.³ Manganese is a key component of the type of superoxide dismutase found in the mitochondria (energy factories) of cells. (Zinc and copper are the trace elements present in another superoxide dismutase.)

The manganese containing superoxide dismutase is an enzyme that protects the fragile mitochondrial membrane from undesirable attack by a very reactive form of oxygen called the superoxide radical. This is perhaps manganese's most significant role.

The role of manganese that deserves further attention is its involvement in energy production. We have mentioned that manganese containing - superoxide dismutase is required to protect the "skin" of the energy factories in cells and that manganese is required for proper glucose tolerance (energy production from blood sugar). The role of manganese in glucose tolerance is not well defined, but it is believed to be due to its involvement with enzymes such as glycosyltransferase and pyruvate carboxylase. The role of manganese in diabetes, hypoglycemia and glucose tolerance will be discussed later in this chapter.

Absorption, transport and storage

Manganese is absorbed slowly and poorly throughout the length of the small intestine.⁴ Most absorbed manganese is rapidly removed from circulation by the liver although a small amount becomes bound to a transporter thought to be transferring or "transmanganin" and passed into systemic circulation.⁶ The amount of manganese absorbed may not increase appreciably with dietary increases above that needed for normal nourishment, and the circulating manganese concentration varies little with changes in dietary manganese concentration.?

However, manganese absorption is dependent largely on the concentration of manganese already in the body.³ Manganese absorption is also decreased by dietary calcium, zinc, phosphorus, soyprotein, iron and cobalt whereas lecithin, choline and alcohol increase intestinal and liver uptake of manganese. Therefore, diets that may *appear* to meet the needs for manganese may not in fact do so due to the influence of other nutrients. Most of the manganese removed by the liver is excreted into the bile. Significant amounts are resorbed. If bile flow is overloaded or blocked, then the body regulates tissue manganese levels by excretion via pancreatic juice or the intestinal walls. Thus the tissue levels of manganese are regulated at the excretory level rather than at the site of absorption. This is an efficient system that minimizes the possibility of manganese toxicity from dietary sources but allows for deficiency because excretion can continue even in deficiency.¹⁶

Manganese and health

The preceding discussion clearly points out how manganese deficiency may cause skeletal abnormalities, slow bone healing, backaches due to disc problems, and sore knees due to cartilage damage. However, there are some less obvious relationships between manganese deficiency and health.

Schizophrenia

Dr. Carl Pfeiffer and his colleagues at the Brain Bio Centre in Princeton have been studying the role of manganese deficiency in schizophrenia and other brain disorders. They have followed leads from the late 1920s that intravenous manganese was effective in treating schizophrenia.^{17,18}

Dr. Pfeiffer noted that in one type of schizophrenia the problem was excessive body copper accumulation and low manganese.¹⁹ By clinical studies, he found that zinc (80 mg daily) and manganese 4 mg daily) were very effective in eliminating the excessive copper via the urine. The two nutrients together are more effective than either alone.³

Epilepsy

Manganese deficiency lowers the threshold that causes seizures,²⁰ and some epileptic patients are found to have low manganese levels.²¹

Membrane instability due to manganese deficiency could account for the lowered seizure threshold, but this has not been adequately tested.

Manganese deficiency produces reduced levels of the neurotransmitter dopamine, and it is possible that manganese is related to other mental processes. Phenothiazine tranquilizers deplete body stores of manganese.

Manganese appears to be of value in treating tardive dyskinesia (see the chapter on aluminium).

Sugar metabolism, diabetes and hypoglycaemia

Chromium and zinc are important to the normal utilization of blood sugar (glucose). However, a deficiency in manganese can also lead to glucose intolerance, which can be reversed by manganese supplementation.²² A

manganese deficiency produces defective cells in the pancreas and a smaller number of pancreas islet cells which contain fewer beta cells that manufacture insulin.^{23, 24} The abnormalities in the pancreatic secretion of insulin caused by manganese deficiency could contribute to diabetes or at least one type of diabetes. In 1964, Dr. L. G. Konsenko found manganese levels in diabetics to be approximately half those of non-diabetics.²⁵

The literature describes one diabetic patient who did not respond to insulin, but who did respond to manganese supplementation.²⁶ Folk remedies have suggested that alfalfa tea helps diabetics, and alfalfa tea contains considerable levels of manganese.

Cancer

Manganese deficiency has also been noted in rheumatoid arthritis and cancer. Most cancer cells are very low in or devoid of manganese-containing superoxide dismutase. An anti-cancer preparation containing manganese as an essential cell component has been described.²⁷

A 1979 article in *Medical World News* alerted physicians that manganese superoxide dismutase seems to be one key to cancer and its therapy. A crucial bio-chemical change that all cancers seem to share and that might be their cause has been identified by researchers at the University of Iowa and Wabash College. In fifty different cancers, some triggered by viruses or chemicals, Iowa's Dr. Larry Oberly and Wabash's Dr. Garry Buettner found a breakdown in cellular defenses against superoxides- destructive free radicals formed during aerobic metabolism. "All cancer cells had little or no manganese-superoxide dismutase, the enzyme that seems to protect the nucleus and mitochondria from superoxides. The fastest growing cancers proved to have the least manganese-superoxide dismutase."²⁸

Heart Disease

Widespread metastatic ionic or precipitated calcium salts throughout the body's intra-and extra-cellular tissues can certainly interfere with metabolism in many ways described in unscientific terms as "sludging."

Manganese is a very specific calcium antagonist at an intracellular

level, by its action on smooth muscle and elsewhere. Dietary manganese deficiencies or manganese malabsorption can enhance the toxic effect of soft tissue calcium. The Assistant Chief of the Department of Cardiology at the Wadsworth VA Hospital in Los Angeles, a faculty member at UCLA School of Medicine, who authored a lead article in *Circulation* on calcium antagonists, stated at an American Academy of Medical Preventics meeting in Los Angeles in October 1980 that manganese was just as effective as the new' and much more expensive prescription calcium antagonists, Nefedipine and Verapamil (soon to be released by the FDA). Because manganese is a mineral, not patentable and not fashionable, we can be sure that manganese will seldom be used in place of these highly expensive and more toxic prescription drugs. Also, absorption problems for manganese pose clinical barriers. Manganese competes with zinc, copper and other minerals for uptake and if oral manganese is given in large amounts it can create iatrogenic deficiencies of other trace minerals. We believe that manganese (preferably as a chelate) can be given on an empty stomach at bedtime or on first arising in the morning and in that way may be absorbed without competing with other minerals taken with meals.

Sources and needs

Due to the poor absorption and rapid excretion of manganese, the relative absorption of a specific form of manganese may be an important factor in low-manganese diets. Good food sources of manganese are nuts, whole grains and legumes. The amount of manganese in each food varies with that amount of manganese available in the soil. Thus tables are only relative indicators of manganese content. Table 12.1 lists typical values of foods grown in good soils.

TABLE 12.1 SOURCES OF MANGANESE

Milligrams (mg) per 100 grams edible portion (100 grams =31/2 oz)

Pecans	3.5	Swiss Cheese	0.13
Brazil nuts	2.8	Corn	0.13
Almonds	2.5	Cabbage	0.11
Barley	1.8	Peach	0.10
Rye	1.3	Butter	0.09
Buckwheat	1.3	Tangerine	0.06
Split peas, dry	1.3	Peas	0.06
Whole wheat	1.1	Eggs	0.05
Walnuts	0.8	Beets	0.04
Fresh Spinach	0.08	Coconut	0.04
Peanuts	0.7	Apple	0.03
Oats	0.6	Orange	0.03
Raisins	0.5	Pear	0.03

Processed foods and daily consumption of manganese-containing supplements in the range of 10-20 mg per day, in addition to increased manganese contained foods, the hair manganese remained below the reference range for eight years and only after ten years of dietary correction and supplementation has it approached what is considered to be the normal reference range.

Because there is no proven clinical correlation between hair manganese and body manganese stores specific case histories will not be given and we must await more published scientific data before we can make more specific statements concerning the clinic correlation between hair concentrations of manganese and the nutritional status of manganese in other body organs.

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