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# JOHN'S CORNER:

## MINERALS - The Elements and What They Do (Part 22)

by John Ferguson

**30) Zinc (Zn) -** Zinc is a blue-white metal that is brittle when cast, it tarnishes easily, and it chemically reacts with both acids and alkalis.

Zinc was first recognized as a separate element in 1764 and as an essential nutrient for plants, humans, and animals in 1869. However, statues made of zinc have been dated to the time of Christ.
Most pennies used in currency today are made of zinc as the value of the copper in a penny would be worth more than the penny itself. Zinc is often associated with galvanizing steel to prevent rusting and in its use to protect ships propellers and hulls from corrosion. Zinc is found in hundreds of products like paint, rubber, plastic, other chemicals, batteries, automotive equipment, computers, and many household devices. Zinc is used in sunscreens in the form of zinc oxide (ZnO).

Zinc is listed in the Periodic table as a metal of Group 15, which includes mercury (Hg) and cadmium (Cd). Zinc occurs mainly in nature at its +2 electrical (oxidation state).

Zinc is found in igneous rocks at 70 ppm, shale at 95 ppm, limestone at 20 ppm, freshwater and seawater at 0.01 ppm. In soils, zinc is found at 50 ppm, in marine plants at 150 ppm and land plants 100 ppm. In marine animals, it can range from 6-1,500 ppm and land animals at 160 ppm. In some coals, zinc levels can reach 19,000 ppm. Zinc weathers easily hence is readily available in most natural soils. In the soil, zinc may occur in many forms from microbial bodies to over a dozen of different chemical compounds. A couple common forms of zinc in rocks (minerals) are sphalerite, which is zinc sulfide (ZnS) and zinc carbonate ($ZnCO_3$).

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Over 300 enzymes in humans require zinc to function properly and zinc is part of the RNA molecule. Zinc deficiency in humans is associated with numerous health effects and is the fifth leading cause of death in the developing world (800,000 people die annually from zinc deficiencies according to the World Health Organization).

Symptoms and diseases of zinc deficiency are pica (geophagia), loss of sense of smell and taste, infertility, failure of wounds and ulcers to heal, immune status failure, poor growth, high infant mortality, small and poorly functioning ovaries and testes, child remains in a pre-puberty state, anemia, hair loss, acrodermatitis enteropathica, frizzy hair, diarrhea, depression, paranoia, oral and perioral dermatitis, anorexia nervosa, prostate enlargement, severe body odor, anorexia and bullemia.

Congenital birth defects associated with zinc deficiency: Down' syndrome, cleft palate, brain defects, small or absent eyes, micro- or agnathia, spina bifida, clubbed limbs, webbed toes and fingers, hiatal hernias, umbilical hernias, heart defects, lung defects, and urogenital.

Zinc is an important mineral for proper nervous system function and zinc has antioxidant properties and anti-inflammatory properties. A paper in the Journal Biological Trace Element Research found an association between higher zinc levels in people and reduced inflammation.

Zinc combined with the amino acid carnosine (zinc-carnosine) provides powerful actions against Helicobacter pylori infections that cause so many stomach and digestion problems (H. pylori is known to cause stomach cancer). Reported in the winter edition of Life Extension 2016, it has been found that zinc-carnosine heals ulcers (inhibits growth of H. pylori), repairs damaged mucus linings, and reduces inflammation.

Additionally, zinc is required for proper functioning of our digestive and immune systems. Excesses of copper and iron or high vegan diets reduce the availability of dietary zinc. Milling and processing of grains removes over 50% of what little zinc was in the grain. Heavy losses of zinc occur in sweat hence zinc deficiency in un-supplemented diets can occur in athletes and those whom work outside in hot summers.

Food sources for zinc are oysters, beef liver, nuts (cashews, almonds, pecans), and seeds.

**Gardening and Landscaping Problems Associated with Zinc (Zn)**

In soil, clays and organic matter help the soil hold onto zinc so it does not leach. As soil temperature increases zinc becomes easier to leach out of our soils. Another good reason to keep all our flowerbeds covered with several inches of quality mulch.

Zinc is considered a micronutrient and plant tissue contains 3-100 ppm depending on the species. Zinc is required for enzyme activity, carbohydrate, starch, and seed formation. Many plant enzymes systems require zinc to work properly. Adequate zinc helps plants withstand hot and dry conditions and helps plants be more resistant to bacterial and fungal diseases. Zinc is required for healthy plants, as it is involved with a plants immune system in many ways.

When zinc is supplied in an organic form, it increases its bioavailability to plants. Plants can absorb zinc in many forms from elemental, oxidized ($Zn^{+2}$) and chelated states.

A few functions or activities of zinc are: required by azotobacteria non-symbiotic nitrogen-fixing bacteria, acts in the formation of chlorophyll, aids in the prevention of chlorosis in some plants, stimulates plant growth, aids in bud development, prevents the occurrence of mottled leaf in citrus, white bud in corn and other disorders. It aids in the formation of plant enzymes and hormones, and is important for the sweet taste in vegetables and fruits. Zinc is required for certain physiological processes such as enzyme and co-enzyme systems. These include alcohol dehydrogenase, superoxide dismutase, carbonic anhydrase, RNA polymerase. Zinc is also used as an enzyme activator.

Zinc availability increases in acidic soils and in soils with high organic matter. Soils that are well aerated also have more bio-available zinc.

Zinc deficiencies in soils and plants are common. However, a plants response to deficiencies vary widely hence the diagnosis is rather complex. It takes visual, plant tissue analysis, and soil testing together to properly diagnose the deficiency.

Deficiencies are most evident in younger leaves as chlorosis, necrosis, or mottling. It occurs mainly in high pH soils, sandy soils low in organic matter, and organic soils of peat and muck. Too much phosphorous fertilizer induces deficiency along with distorted or puckered leaf margins and short internodes. Onions are sensitive to zinc deficiency and shows as striping, bending and twisting of the tops.

Other deficiency symptoms are the terminal leaves are small, bud formation is poor, and leaves have dead areas, yellow interveinal in mottled regions. Rosetting of terminals is another deficiency symptom.
Many of the plant species we call weeds often grow to correct soils problems hence weed populations tend to increase in soils deficient in Zinc.

Application of water soluble phosphorous (P) from artificial fertilizers prevents the soil from holding adequate zinc which then leads to deficiencies in the plant. This often results in low levels of zinc in our food supply and the health problems mentioned above. This action then prevents microbes like *Rhizobium* from fixing nitrogen from the air to the soil. Excess calcium (Ca) in the soil can also lead to deficiencies. This is common in agricultural fields where the use of artificial fertilizers has acidified the soil, which then requires repeated liming with calcium products to increase the pH.

Too much nitrogen in the soil (think artificial fertilizers again) elevates certain amino acids and proteins in a plants root system disturbing the absorption and transport of zinc in and into plants.

Artificial fertilizers have destroyed soil structure in many of our agricultural areas resulting in poor drainage. Farmers have to install drain tiles to correct this problem. Soils with poor drainage decrease zinc availability (lack of zinc in our food supply) and conversely well-drained soils increase availability.

Another factor in zinc shortages in our food supply is caused by glyphosate (Round-Up) as it ties up and prevents the absorption of essential minerals, especially those with a +2 electrical state. This is a reason eating genetically modified foods (GMO's) which have extremely high

levels of glyphosate on them causes many kinds of health problems like zinc deficiency and cancer.

In soils, levels of zinc above 500-ppm cause problems as it prevents the plant from the absorption of other critical elements.

Poultry manure may contain 495 ppm of zinc and repeated use of poultry manure fertilizers can lead to zinc toxicity issues. Human sewage sludge (Biosolids) can have 131 ppm to over 1,670 ppm of zinc and repeated usage will cause problems as will fertilizers made from sewage sludge (ex. Milorganite, Hou-Actinite, etc.).

Rubber mulches from tires can cause severe zinc contamination of one's' soil as they contain up to 2% of their mass as zinc. When iron is exposed to excess zinc (Zn) it forms the mineral franklinite a zinc iron oxide ($ZnFe_2O_4$) which decreases the availability of both metals to plants. This has been proposed as one of the mechanisms as to why "rubber tire" mulch is so toxic to plants.

**Sources:** compost, native mulches, kelp meal, seaweed and its extracts, zinc sulfate, basalt sand