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Micronutrients: Vanadium

Dr. Ritamarie Loscalzo


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Vanadium General Info

- ✓ First discovered in the early 1800s
- ✓ Ultra-trace mineral found in the human body and the human diet
- ✓ Named for Vanadis, the Swedish goddess of beauty, youth, and luster
- ✓ In solution produces a number of colors
- ✓ Found primarily as pentavalent V⁵⁺ (yellowish orange)
- ✓ Complexes with amino acids, like alanine and aspartate
- ✓ Not proven to be an essential mineral for humans
 - Body may need it but in only small doses
 - Controversy among researchers regarding its value in human nutrition and whether it's essential



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INE: Micronutrients - Minerals:
Vanadium


Oxidation States of Vanadium

Ion (hydrated)	VO_2^+	VO^{2+}	V^{3+}	V^{2+}
Colour	Yellow	Blue	Green	Violet
Oxidation state	5	4	3	2
Name	Dioxovanadium(V)	Oxovanadium(IV)	Vanadium(III)	Vanadium(II)

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Absorption of Vanadium


- ✓ Varies with its oxidation state
- ✓ Food is mainly vanadate
- ✓ 5% - 10% is absorbed from the intestinal tract
- ✓ Vanadate reduced to vanadyl in the stomach before being absorbed in the upper small intestine
 - Vanadate may be absorbed using the same carrier system as used by phosphate
 - Vanadate is 3 - 5 times more efficiently absorbed than vanadyl
- ✓ In blood cells, plasma, and other body fluids as vanadate or converted to vanadyl using glutathione, NADH, and ascorbic acid as reducing agents
- ✓ In plasma and liver, vanadyl binds to albumin and iron-containing proteins such as ferritin and transferrin
- ✓ Enters cells as vanadate



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Vanadium Transport and Storage


- ✓ Total body pool is about 100 mcg
- ✓ Used fairly rapidly
- ✓ Elimination
 - Feces (most)
 - Urine
 - Small amounts are excreted in the bile
- ✓ Accumulates primarily in organ tissues
 - Highest concentration in kidney after intake
 - Bone appears to be the long-term storage site
 - Liver and spleen - some
 - Accessible stores primarily in fat and lipid serum
- ✓ Composition and chemical form determines how much is absorbed



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Biochemical Function of Vanadium


- ✓ Pharmacologic effects in high doses
- ✓ Definitive roles and biochemistry not yet established
 - Inhibits Na⁺/K⁺ - ATPase, which impacts phosphorylation of ATP
 - Stimulates adenylate cyclase related to cyclic AMP formation from ATP and which stimulates protein kinases
 - Vanadyl ion as an enzyme cofactor in hormone, glucose, lipid, bone, and tooth metabolism
 - Amino acid transport across intestinal mucosa (inhibits alanine at high concentrations)
 - Mimics the action of insulin (as vanadyl sulfate)
 - Stimulates insulin production by islet cells in rats
 - Association with iodine metabolism and thyroid function
 - Growth of red blood cells
 - Lipoprotein activity
 - Oxidation reactions
 - Nitrogenase in bacteria, which reduces molecular nitrogen to ammonia
 - Iodoperoxidase and bromoperoxidase in algae and lichens, which catalyse the oxidation of halide ions by hydrogen peroxide
 - Haloperoxidases, such as thyroid peroxidase - vanadium deprivation in rats affected the response of thyroid peroxidase to changing dietary iodine



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Influences on Vanadium Absorption


Decreases Absorption:	Increases Absorption:
✓ Chromium	✓ Selenium
✓ Chloride	✓ Zinc
✓ Calcium	✓ Fluoride
✓ Potassium	
✓ Iodine	
✓ Sodium	
✓ Sulfur	
✓ Sugar	



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Nutrient Functions of Vanadium

- ✓ Glucose control in type 1 and type 2 diabetes
- ✓ Recommended as an aid in bodybuilding due to possible anabolic effect of vanadyl sulfate similar to insulin – higher liver and muscle glycogen stores
- ✓ Possible anticarcinogenic properties in regards to breast cancer in animal models
- ✓ May promote faster recovery from food poisoning or other infections
- ✓ May help with high blood pressure, cardiovascular disease, and kidney disease
- ✓ Supports bones, teeth, and the reproductive system



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Vanadium and Type 2 Diabetes

- ✓ May improve glucose control in people with type 2 diabetes
- ✓ May improve sensitivity to insulin in type 1 and 2 diabetes
- ✓ High doses of vanadium have been tested as an aid to controlling blood sugar levels in people with diabetes
 - High doses can have impact on gastrointestinal and kidney imp.
 - Recommended to only take for 4 weeks at therapeutic doses
- ✓ Animal studies:
 - Functions similarly to insulin
 - Improving cell membrane insulin sensitivity
 - Alters cell membrane function for ion transport processes
- ✓ Human studies:
 - Daily insulin requirements in type 1 diabetics decreased by as much as 14%
 - Increase in insulin sensitivity in type 2 diabetics
 - Form used- vanadyl sulfate or sodium metavanadate.
- ✓ Vanadium stimulates glucose oxidation and transport in fat cells and glycogen synthesis in liver and muscle
- ✓ Inhibits liver gluconeogenesis
- ✓ Inhibits absorption of glucose from the gut
- ✓ Vanadium enhances the stimulating effect of insulin on DNA synthesis



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Vanadium and Bone Health

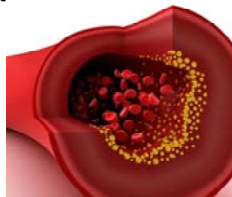
- ✓ In vitro tests on bone cells - vanadate stimulated bone cell proliferation
- ✓ Shown to stimulate collagen synthesis — joints, muscles, and gut
- ✓ Role in calcium metabolism and red blood cell production
- ✓ Enzyme-stimulation role of vanadium may involve it in bone and tooth formation



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Vanadium and Cholesterol

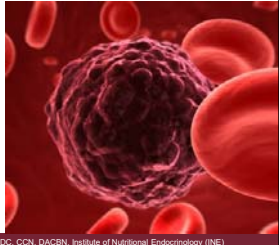
- ✓ Inhibits cholesterol synthesis in animals and humans leading to decreased plasma levels of cholesterol and reduced aortic cholesterol
- ✓ Initiates an increase in the contractile force of heart muscle - inotropic effect
- ✓ Involved in catecholamine and lipid metabolism
- ✓ Involved in the production of coenzyme A in fat metabolism



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Vanadium and Cancer

- ✓ Anticarcinogenic properties
- ✓ Induction of mouse mammary tumor growth was blocked by feeding 25 mcg of vanadium per gram of diet
 - Reduced tumor incidence
 - Reduced average tumor count per animal
 - Prolonged median cancer free time without inhibiting overall growth or health of the animals



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Things That Deplete Vanadium

- ✓ High sugar intake
- ✓ Malabsorption disorders



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Vanadium and Nutrient Interactions

- ✓ **Avoid** taking vanadium and chromium at the same time of day
- ✓ Excessive copper plus low vanadium associated with greater occurrence of spinal degeneration



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Cause of Vanadium Deficiency

- ✓ Vanadium deficiency is very rare
- ✓ Deficiency of vanadium in the soil



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Impact of Deficiency

- ✓ Spinal degeneration
- ✓ Stunted growth
- ✓ Ankylosing spondylitis (with elevated molybdenum, calcium, and magnesium)
- ✓ Elevated cholesterol and triglycerides
- ✓ Reduced growth and reproductive ability in animals
 - Human deficiencies have not been reported, but goats fed a low-vanadium diet have developed birth defects
- ✓ Increased infant mortality
- ✓ Hypoglycemia
- ✓ Hyperinsulinemia
- ✓ Diabetes
- ✓ Cardiovascular disease
- ✓ Obesity



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Excess Vanadium: 1 (> 2 mg per day)


- ✓ Possibly impacts those with bipolar disorder from increased vanadium intake due to its causative or aggravating impact on reduced sodium pump activity
- ✓ Blood levels may be high during times of depression
- ✓ Potentiation of insulin or oral diabetes medications
- ✓ Kidney damage
- ✓ Gastrointestinal problems
 - Nausea
 - Flatulence
 - Cramps
 - Diarrhea
 - Discoloration of the stool



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Excess Vanadium: 2 (> 2 mg per day)


- ✓ Weakened immune system
- ✓ Fatigue
- ✓ Lethargy
- ✓ Weight loss
- ✓ Dehydration
- ✓ Green discoloration of tongue
- ✓ Trabecular bone loss
- ✓ Arthritis
- ✓ Aching bones, teeth, tonsils, ears, jaw
- ✓ Chronic colds



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Chronic Toxicity of Vanadium


- ✓ Chronic toxicity of vanadium is seen in miners
- ✓ Manifestations include:
 - Hypertension
 - Neurological disorders
 - Hepatic, cardiac, and renal damage
- ✓ Humans get vanadium contamination through the air from burning petroleum
- ✓ With age, it may accumulate somewhat in the lungs



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Assessing Status of Nutrient


- ✓ Methods to assess vanadium have not been established
- ✓ Blood vanadium concentrations typically range from about 0.4 to 2.8 ng/mL in those ingesting vanadium supplements
- ✓ Urinary excretion of vanadium averages about 8 µg per day



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RDA for Vanadium


- ✓ Estimates range from 10 to 30 mcg daily - about one millionth of the amount of calcium needed
- ✓ Safe upper intake level for adults set at 1.8 mg
- ✓ Maximum safe doses for children not yet determined



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Food Sources of Vanadium

- ✓ Mushrooms
- ✓ Radishes
- ✓ Corn
- ✓ Green beans
- ✓ Soy
- ✓ Fish
- ✓ Olives
- ✓ Carrots
- ✓ Garlic
- ✓ Sunflower seeds
- ✓ Olive oil
- ✓ Most fats and oils
- ✓ Shellfish
 - Oysters
- ✓ Cereals and grain products
 - Buckwheat
 - Oats
 - Rye
- ✓ Eggs



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Herbs High In Vanadium



Parsley


Dill Weed

Black Pepper

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Forms of Supplementation of Vanadium


- ✓ Vanadyl sulfate
- ✓ Sodium metavanadate
- ✓ Sodium orthovanadate
- ✓ Best time to take vanadium:
Anytime, with food (avoid taking at the same time as chromium)
- ✓ Some sources recommend to take vanadyl sulfate on an empty stomach



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Resources

- ✓ *Advanced Nutrition and Human Metabolism – Gropper, Smith and Groff*
- ✓ <http://www.drRitamarie.com/go/VanadiumOverview>
- ✓ J Altern Complement Med. 1999 Jun;5(3):273-91. Vanadium: a review of its potential role in the fight against diabetes. Badmaev V1, Prakash S, Majeed M. <http://www.drRitamarie.com/go/PMID10381252>
- ✓ The effects of vanadium treatment on bone in diabetic and non-diabetic rats; Facchini DM, Yuen VG, Battell ML, McNeill JH, Grynepas MD; Bone. 2006 Mar;38(3):368-77. Epub 2005 Oct 26. <http://www.drRitamarie.com/go/PMID16256449>



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