International Journal of Food Science and Nutrition
www.foodsciencejournal.com
ISSN: 2455-4898
Received: 01-04-2022, Accepted: 15-04-2022, Published: 30-04-2022
Volume 7, Issue 2, 2022, Page No. 62-70

Antagonist and analogues of minerals

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Abstract
Appropriate physiological functioning requires optimal nutrition, which needs to be in balance to prevent potential detrimental interactions, especially when administered at pharmacological dosages. Many nutrients function in harmony to complement digestive function and assimilation. Some may hinder these processes and compete for uptake, while others may also be required in tandem to assist in metabolism which may ultimately affect a number biochemical cycles. Many similar synergistic and antagonistic functions exist within human physiology and should be considered, particularly in the health and research arenas, where positive outcomes may be more likely if nutrient preparations are formulated with assistant supplementary nutrients, while nutrient related confounders need also to be accounted for. A variety of these are discussed in detail, with emphasis on relationships in health and disease.

Keywords: antagonist, analogues, appropriate physiological functioning

Introduction

Different foods possess different bioactive compound with varied antioxidant capacities. When foods are conduced together, the total antioxidant capacity of food mixtures may be modified Via synergistic, additive, or antagonistic interactions among these components, which may in turn alter their physiological impacts. The main objective of this study was to investigate these interactions and identify any synergistic combinations. Eleven foods from three categories, including fruits (raspberry, blackberry, and apple), vegetables (broccoli, tomato, mushroom, and purple cauliflower), and legumes (soybean, adzuki bean, red kidney bean, and black bean) were combined in pairs. Four assays (total phenolic content, ferric reducing antioxidant power, radical scavenging capacity and oxygen redial absorbance capacity) were used to evaluate the antioxidant capacities of individual foods and their combinations. The results indicated that within the same food category. Combining specific foods across categories (fruit and legume) was more likely to result in synergistic antioxidant capacity than combinations within food group. Combining raspberry and adzuki bean extracts demonstrated synergistic interactions in all four chemical-based assays. Compositional changes did not seem to have occurred in the mixture. Result in this study suggests the importance of strategically selecting foods or diets to maximum synergisms as well as to minimum antagonisms in antioxidant activity.

- Minerals are divided into two groups:
- Macrominerals-required in large amts. Macrominerals are measured in the diet as a percentage (%).
- Microminerals-required in small amts., also known as “trace elements”. Microminerals are measured in part per million (ppm) or mg/kg.
- Both macro and micro minerals can interact with each other as either antagonists or synergists.

Macro-minerals include

- Calcium, Phosphorus, Magnesium, Sodium, Potassium, Chloride
- Micro-minerals include

Iron, copper, zinc, selenium, iodine, and manganese.

Two relationships exist among the trace elements, antagonistic and synergistic, which occur at two levels, metabolic and absorptive.

- Antagonist is the opposite of agonist. Antagonists and agonists are key players in the chemistry of the human body.

Mineral Antagonisms

- These reactions are defined as the presence of one mineral reducing the transport or efficacy of another.
- Antagonist means that something either decreases or blocks the absorption or metabolic function of the nutrient.

- Antagonism at the absorptive level is due to inhibited absorption; that is, excess intake of a single element can decrease the intestinal absorption of another element. As an example, a high intake of calcium depresses intestinal zinc absorption, while an excess intake of zinc can depress copper absorption.
- Antagonisms at the metabolic level occur when an excess of one element interferes with the metabolic functions of another or contributes to its excretion due to compartmental displacement. This is seen with zinc and copper, cadmium and zinc, iron and copper, calcium, magnesium and phosphorus.
- Examples of mineral antagonism
- **Zinc and Copper:** the gastrointestinal interaction between copper and zinc is well reported. Generally high intakes of copper interfere with zinc status and vice versa.
- The exact location of this interaction is not fully understood, but evidence suggests that zinc may share common transport routes with copper and inhibition may occur within the enterocytes.
- For example, in one study researchers investigated the effects of high intakes of copper on the absorption of zinc using an animal gut model. Rats were fed either high or low zinc diets for a period of time and then the animals were sacrificed and sections of their guts were removed.
- The researchers then used these sections to investigate the transport of copper. The results showed that in the rats fed a low zinc diet, more copper was able to pass through the gut sections to be collected into a medium on the opposite side.
- Therefore the high zinc diet affect the ability of the enterocytes to transport the copper.
  Further investigation revealed that more copper was retained in the mucosal sections of the rats fed low zinc diets.
- The researchers then analyzed the copper in the intestinal sections and found it was bound to a protein of the same molecular weight as metallothionein. The authors speculated that zinc may
  induce mucosal cells to increase production of a thionein protein that is able to bind copper and sequester it from the normal transport routes and thus lower the absorption rates of copper.

Mineral Synergisms/Agonists

- An agonist is actually something that enhances either nutrient absorption or metabolic function inside your body.
- Two minerals reacting in a complimentary fashion by either enhancing biologic function or sparing the other mineral.
- Synergism between the elements occurs largely on a metabolic level.
- As an example, iron and copper are synergistic in that sufficient copper is required for iron utilization.
- Magnesium also functions in concert with potassium by enhancing its cellular retention.
- The synergism between calcium, magnesium and phosphorus is well known due to their requirement in the maintenance and structure of osseous tissue.

Table 1

Mineral	Agonist/Synergist	Antagonist
Calcium	Mg	Fe, K, Mg, Na, P, Zn, Metals: Pb
Chromium	K, Mg, Zn	Ca, Fe, Mn, P, Metals: Pb
Copper	Ca, Co, Fe, Mn, Na, Se, Zn	Fe, K, Zn, Metals: Cd, Hg, Pb
Iron	Cr, Cu, K, Mn, Na, P, Se	Ca, Cu, Mn, P, Zn, Metals: Al, Hg, Pb
Magnesium	Ca, Fe, K, Mg, P, Zn	Ca, Cu, Fe, Mn, Na, P, Metals: Cd, Pb
Manganese	Cu, Fe, Zn	Ca, Cr, Cu, Fe, P, Metals: Cd, Pb
Phosphorus	Ca, Fe, K, Mg, Na, Zn	Ca, Cu, Fe, Mn, Mg, Zn
Potassium	Ca, Fe, Mg, Mn, Na, P, Zn	Ca, Cu, Na
Selenium	Ca, Cu, Fe, K, Mn, Na, Zn	Metals: Al, Cd, Hg
Sodium	Ca, Co, Cu, Fe, K, Mg, P, Se	Ca, K, Mg, Zn
Zinc	Cr, K, Mg, Mn, P	Ca, Cu, Fe, P, Metals: Al, Cd, Hg, Ni, Pb

- **Calcium Antagonists**
- Lead and cadmium antagonize and replace calcium in the bones and elsewhere. Hidden lead toxicity, for example, is an important cause of weak bones and osteoporosis. Tests for toxic metals may not reveal it when it is deeply embedded within the bones. However, a hair analysis often reveals it later as it comes out of the body through the hair and other routes.
- Excessive fluoride replaces calcium in the bones, causing them to become brittle and weak. Sources are fluoride tablets, fluoridated tap water, some mineral waters, foods
  contaminated with fluorides from the soil and foods processed with fluoridated water such as reconstituted fruit juices and soda pop. Some foods are naturally high in fluorides like tea. Drinking fluoridated water or consuming products processed with fluoridated water is a cause of osteoporosis.
- Excess phosphorus binds calcium and impairs its absorption from the intestines. Sources are soda pop and diets very high in animal protein.

- High tissue sodium and potassium tend to dissolve calcium out the bones.

- **Calcium Synergists**
- Magnesium helps keep calcium in solution.
- Chlorine, hydrochloric acid in the stomach and adequate protein in the diet are also required for calcium utilization.
- Potassium is another potent calcium synergist, although in high quantity it can become an antagonist by dissolving calcium from the bones and elsewhere. Potassium is absolutely critical for calcium metabolism in many enzymes.
- Copper is required to fix calcium in the bones and helps raise the hair tissue calcium level. Many people have biologically unavailable copper which causes their calcium problems. In fast oxidizers, copper deficiency contributes to a calcium deficiency. Iodine is required for thyroid activity. Low thyroid activity is associated with biounavailable calcium and calcium deposition in the soft tissues.

Iron Antagonists
- Manganese, copper, zinc, cobalt, nickel, chromium, calcium, magnesium, and cadmium compete with iron for absorption. Phosphates, egg proteins, long-chain fatty acids and phytates found in cereals interfere with iron absorption.
- Manganese Iron competes with manganese for absorption and iron displaces manganese in the liver and in body tissues. Excessive iron ingestion can contribute to a manganese deficiency.
- Copper Iron competes with copper for absorption, and displaces copper from the liver.
- Zinc Iron competes for absorption with zinc.
- Chromium Iron can displace chromium in body tissues.
- Lead is a particularly pernicious element to iron metabolism. Lead is taken up by the iron absorption machinery (DTM1), and secondarily blocks iron through competitive inhibition. Further, lead interferes with a number of important iron-dependent metabolic steps such as heme biosynthesis. This multifaceted influence has particularly dire consequences in children, were lead not only produces anemia, but can impair cognitive development. Lead exists naturally at high levels in ground water and soil in some regions, and can clandestinely attack children's health. For this reason, most pediatricians in the U.S. routinely test for lead at an early age through a simple blood test.
- Minerals Antagonistic To Iron Absorption: the minerals that are antagonistic to iron are Pb, Hg, Cd, Ca, Cr, Cu, Mn, Zn, P, Co. Excessive intake of any one or combination of these trace elements can contribute to siderope-nia and iron deficiency anemia or exacerbate an existing deficiency.
- Antagonism of iron by these minerals occurs either by inhibiting absorption, compartmental displacement, or interfering with cellular iron enzymes.

Iron synergists
- Copper (Cu)
- Chromium (Cr)
- Sodium (Na)
- Nickel (Ni)
- Selenium (Se)
- Potassium (K)
- Manganese (Mn)
- Phosphorus (P)
- Some elements are listed as both antagonistic and synergistic because of a dual relationship of some elements with iron. As an example, copper is considered synergistic due to its requirement in ferroxidase activity. However, excessive intake of copper competes with iron for absorption.

- **Effects of Other Nutrients on Iron**
- Manganese, copper, zinc, cobalt, cadmium and nickel compete with iron for absorption.
- Copper and manganese can replace iron in the liver and other body tissues.
- Lead interferes with heme synthesis.

Copper Antagonists and Synergists
- The synergistic minerals to copper include calcium, cobalt, selenium, sodium, and iron. The rickettsial bone changes that occur with copper deficiency are probably related to the copper-vitamin D-calcium relationship.

Zinc Antagonists and Synergists
Zinc Synergists
- Zinc is synergistic or synergetic with many other trace minerals such as selenium, chromium and others at other levels of metabolism. In other words, having enough zinc present helps these other minerals to be used

properly, including even copper. They work well together at certain functions in the body such as energy production in the Krebs cycle and specifically the electron transport system.

- Zinc, along with calcium and magnesium, are called sedatives because all three help inhibit excessive sympathetic nervous system activity. They all inhibit excessive brain activity. Zinc, in fact, is considered by some authorities to be a calming neurotransmitter in its own right.

Zinc Antagonists

- zinc can inhibit the absorption of the other trace minerals such as manganese, chromium and others. This is due to "competitive inhibition" at the level of the intestines. This means that the same transporters that adsorb zinc through the intestines are used by the body to adsorb the other trace minerals. Therefore, taking extra zinc may inhibit the adsorption of the others.

Phosphorus Synergists and Antagonists

- **Phosphorus synergists**

Minerals and other substances that are essential for the action of phosphorus include most of the trace minerals and hundreds of other nutrients that are involved in energy production, cell membrane formation, protein synthesis, the nervous system and fluid balance. Calcium is absorbed with phosphorus and is a synergist in bone formation. Magnesium is a synergist in energy production and protein synthesis. Vitamin D assists phosphorus absorption, along with calcium absorption and utilization. B-complex vitamins require phosphorus for their activity, in manycases. As stated above, TMG or trimethylglycine, is often synergistic with phosphorus.

- **Phosphorus Antagonists**

These substances block or interfere with the action of phosphorus in the body in some manner. Toxic metals such as aluminum and mercury are powerful antagonists for phosphorus on a hair mineral test.Sodium and potassium are both synergistic and antagonistic with phosphorus. They are needed to absorb phosphates in the intestines. However, they are also powerful solvents that can lower the calcium and phosphorus in the blood and the tissues in some cases. For example, children have more sodium and potassium in the hair and other tissues than adults. For this reason, children often have lower levels of phosphates in their blood and tissues than adults. However, their hair phosphorus level should be about the same as adults at about 15-17 mg%.

Magnesium Synergists and Antagonists

- **Magnesium Synergists**

These are similar to those for calcium. They include vitamins A, D, E, K and perhaps a few others. Vitamin D, for example, appears to assist magnesium metabolism, not just calcium absorption. Vitamin B6 or pyridoxine has a close relationship with magnesium. Magnesium is thought to help vitamin B6 to be incorporated into some enzymes. Vitamin B1 or thiamin is a synergist with magnesium in glucose metabolism. Vitamin C is a synergist in connective tissue synthesis. Tetraiodothyronine or T4 increases cellular magnesium levels. In fact, many nutrients are synergistic with magnesium because magnesium is involved in almost all body functions.

- **Magnesium Antagonists**

Magnesium antagonists tend to be somewhat similar to those for calcium. Important ones include calcium, sodium, potassium, phosphates, fluoride, all toxic metals and others. Alcohol severely depletes magnesium. This is due, at least in part, to the fact that metabolizing alcohol uses up many magnesium-dependent enzymes. This requires them to be reconstituted, using up a lot of magnesium. Alcohol is also a diuretic that can remove magnesium from the body through the kidneys.

Sodium Synergists and Antagonists

- Sodium is involved with every other mineral in the body. It can be both synergistic and antagonistic with most of them at one time or another.
- Zinc tends to lower sodium, while copper tends to raise sodium in relationship to potassium.
- Potassium always moves higher and lower with sodium in healthy people. However, sodium and potassium also antagonize each other electrically, for example, as explained above.
- Calcium and magnesium are synergists in many biochemical reactions involving energy production and other body functions. However, in terms of the oxidation rate, they are sodium antagonists. They are divalent elements while sodium is a monovalent element. When they decrease, sodium tends to increase in the hair tissue, and vice versa.
- Phosphorus and other trace elements are also closely related to sodium in many ways. They are synergists at some times and antagonists at others.

Potassium Synergists and Antagonists

- **Potassium Synergists**
- Potassium works closely with sodium, calcium and magnesium to regulate metabolism. Other synergists include most vitamins. These assist kidney activity and may therefore help regulate the potassium level in the blood and the tissues. Most of the important trace minerals are also synergists because they all regulate

potassium levels to a degree. Dr. Paul Eck emphasized that zinc appears to raise potassium in the mineral system of the body. Phosphorus, along with zinc, are synergists in protein synthesis.

- **Potassium Antagonists**
- Calcium and magnesium tend to rise in the hair as potassium falls. Sodium is pumped out of the cells and potassium must be pumped in to maintain the electrical balance of the cells. This antagonism with sodium is particularly important.

- Copper, in the mineral balancing system, lowers potassium to some degree. In fact, a low hair potassium level is an indicator for hidden copper toxicity. Vitamin D can raise the calcium level, which tends to lower potassium, as can too much vitamin A, in some people. All the toxic metals, once again, are antagonistic to all of the vital minerals in the body.

Copper Synergists and Antagonists
- Copper Antagonists / Inhibitors:
- Sulfur, molybdenum, zinc, nickel, Vit B6, Vit C, iodine, Vitamin B12, rutin, sugar, alco-hol, fat, chromium, tin, hesperidin, insoluble fiber,

Zinc Synergists and Antagonists
- Zinc Synergists
  Magnesium, chromium, cobalt, Vitamin B2, Vit E
- Zinc Antagonists / Inhibitors
  Iron, calcium, phosphorus, selenium, sodium, nickel tin, copper, Vitamin A, Vitamin B1, Vitamin C, niacin ni-acinamide, folic acid, choline, lecithin, alcohol

Iodine Antagonists and Synergists
- **Iodine Antagonists**
  A very important topic related to iodine deficiency and thyroid disease is to understand the iodine antagonists. Iodine is a member of the halogen family of elements. Besides iodine, the halogens include *fluorine, bromine and chlorine*, among others. This is very important because:

1. The halogens *compete with each other* for absorption and even utilization in iodine binding sites in the thyroid gland and everywhere else in the body. This occurs because all of the halogens "look alike" at an atomic level, so they tend to bind to receptors similarly and can replace each other.
2. Our environment is literally swimming in the iodine antagonists:

Bromine and bromides: These toxic chemicals are used in baking, by law, of all the breads in America and many nations. It definitely interferes with iodine uptake and also iodine utilization. Often, when iodine is supplemented, people start eliminating large quantities of bromine from the body. This can be measured, to some degree, in the urine and hair. In fact, it is the cause of some healing reactions associated with taking iodine or kelp supplements.

- There is an antagonism between iodine and what are called "the amigos". These are oxides of iron, manganese, aluminum, nickel, copper and at times other minerals. When iodine is deficient, the amigos may build up in the body.

Factors that Deplete Minerals from the Body
- **Soil Depletion:** This is the number one reason that most Americans are mineral deficient. Soil depletion has been well documented since the US Senate made their study back in 1936. Even organically grown vegetables are lacking in minerals – organic farming only addresses the pesticide/chemical issues most typically. The best way to get mineral rich grown fruits and vegetables is through bio-dynamic produce, local CSA"s that practice crop rotation and soil supplementation through compost and other means, and of course growing your own garden you can work on the integrity of the soil. Not to mention, the animals we consume also need to be raised on good quality pastures with good soil conditions as well.

- **Antacids & Acid blockers:** deplete calcium, but often people are unaware as testing is done on blood levels and only 1% of the calcium in the body is in the blood. This doesn"t indicate the loss in the bones/tissues. Antacids/Acid Blockers contain aluminum hydroxide which prevents the absorption of calcium from the intestinal tract.

- **Low Stomach Acid/Hypochlorhydria:** the body needs appropriate stomach acid in order to break down minerals, namely calcium. Also, low stomach acid can be a sign of low zinc because zinc is needed in the body to help produce stomach acid.

- **Cortisone** – used for pain and inflammation can contribute to severe calcium loss with prolonged use. It also depletes potassium.

- **Pharmaceutical Drugs:** this is too vast to go into, suffice it to say all drugs deplete the body of a vast amount of nutrients.

- **Birth Control Pills:** deplete magnesium and zinc, along with numerous other vitamins. And since they have a direct impact on our hormones this also plays with our ability to get the minerals needed. They cause excess copper in the body, which can be toxic, this is why zinc becomes depleted as these two minerals are antagonistic to each other.

- **Coffee:** calcium/magnesium are lost in our urine with coffee. It‟s a diuretic. You will be losing potassium and sodium as well. The same goes for caffeine in general.

- **Alcohol:** speeds up the excretion of magnesium through the kidneys. It can also deplete, calcium, zinc, iron, manganese, potassium and chromium.

- **Soda consumption:** contains excess phosphorous which leads to reduced body storage of calcium because they compete for absorption in the intestines. Soday also causes potassium loss.

- **Sugar:** for every molecule of sugar our bodies use 54 molecules of magnesium to process it. Insulin surges use up our zinc. Sugar also depletes magnesium, potassium and robs your bones of minerals in general. A high sugar diet results in increased losses of chromium through the urine.

- **Excess Insulin:** causes calcium to be retained by the body through re-absorption by the kidneys.

- **Excess Estrogen:** decreases calcium excretion. Same effects as birth control also apply.

- **Hyperthyroidism:** causes increased calcium losses and increased calcium resorption from the bone. Creates the need for more magnesium. Often more copper is needed, along with iodine. Perhaps it would be better stated that deficiencies of selenium play a role in low thyroid hormone production.

- **Stress:** depletes magnesium.

- **The Standard American Diet (S.A.D diet):** the typical diet of minimal fresh foods, higher amounts of refined and processed foods, foods grown on poor/depleted soils, excess phosphorous in these foods depletes calcium and has been shown to cause bone loss. Magnesium and chromium, (and all minerals really) are also lost in processing and due to poor soil.

- **Excess Grains:** phytic acid binds with the minerals in the intestine and blocks absorption, causing them to be excreted unused.

- **Oxalates:** oxalic acid is a substance which binds with calcium in the intestinal tract and actually prevents calcium absorption. (oxalates are found in spinach, beet greens, rhubarb and chard).

- **Dietary Insufficiency:** source of food, how it‟s prepared, is it processed or whole real natural foods. And of course, was the food raised properly on mineral rich soils.

- **Athletes/Excessive exercising:** taxes magnesium reserves.

- **Pregnancy:** it takes a lot of nutrients to make a baby, and minerals are no exception. If mother is already low in mineral stores she will become further depleted as her body takes the nutrients to build a healthy baby. Iron is one common mineral deficiency in pregnant and breastfeeding women, namely because the needs for it increase immensely during this time.

- **Vegetarian/Vegan Diet:** the best sources of many minerals are in animal foods. Plant foods grown in poor soil are not enough to supply the dietary needs of minerals. Vegetarians are more vulnerable to iron deficiency as well.

- **Heavy Metal Toxicity**
- **Mercury:** amalgam fillings, in certain fish, vaccines. Blocks magnesium and zinc. Mercury binds with magnesium and renders it void. Supplementing won‟t be enough, must detoxify the metals.
- **Aluminum:** Antacids/Anti-perspirants/Cosmetics – aluminum foil – aluminum penetrates the blood brain barrier and is very difficult to detoxify. Impedes the utilization of calcium/magnesium/phosphorous. Neutralizes pepsin.
- **Lead:** binds with calcium and makes it unusable for the body.

Also an excess of certain minerals in the body can antagonize other minerals and cause depletion. For example, excess sodium depletes potassium. Excess calcium depletes magnesium by dominating over it. Too much of one will dominate the other. Iron and copper need to be in the right proportion and work together. They are co- factors. Potassium deficiency it‟s not enough to just take potassium, you also need magnesium. Potassium inside the cell needs magnesium to maintain it. Copper/zinc – copper tells the body to retain estrogen. Copper toxicity is commonly known in hyperactive violent individuals. It is a primary cause of miscarriages and susceptibility to postpartum depression

Interactive Mineral Wheel

- **Interactive Chart:** Select Parameters
- **Show me the antagonizing effects of the following minerals**
  Calcium, Copper, Manganese, Arsenic, Magnesium, Potassium, Phosphorous, Cadmium, Cobalt, Zinc, Sodium, Iron.
- Show me which minerals antagonize the following minerals
- Calcium, Copper, Manganese, Arsenic, Magnesium, Potassium, Phosphorous, Cadmium, Cobalt, Zinc, Sodium, Iron.

Table 2: Fat soluble vitamin

Vitamin	Best sources	Function	Deficiency Symptoms	Daily Amount
A	Liver, dairy products, egg yolks, fish oils, dark green leafy vegetables, yellow vegetables, yellow fruits	Repair & maintenance of cells. Maintenance of immune system. Essential for normal eyesight	Dry skin, shortness of breath, weakened bones, depressed immune system, night blindness	1,250 IU, 2x daily
E	Vegetables oils, whole grains, wheat germ, liver, dark green leafy vegetables, nuts, legumes	Powerful antioxidant. Protects the walls of red blood cells from becoming fragile	Anemia, breakdown of red blood cells	200 IU, 2x Daily
D (D3)	Fish liver oils, fortified milk, exposure to sunlight	Necessary for the formation of bones and teeth. Aids in the absorption and utilization of calcium	Weakened bones, enlarged joints, muscle spasms	500 IU, 2x daily
K	Liver, egg yolks, dark green leafy vegetables	Controls 4 of the proteins needed for blood to clot	Long blood clotting time	40 mcg

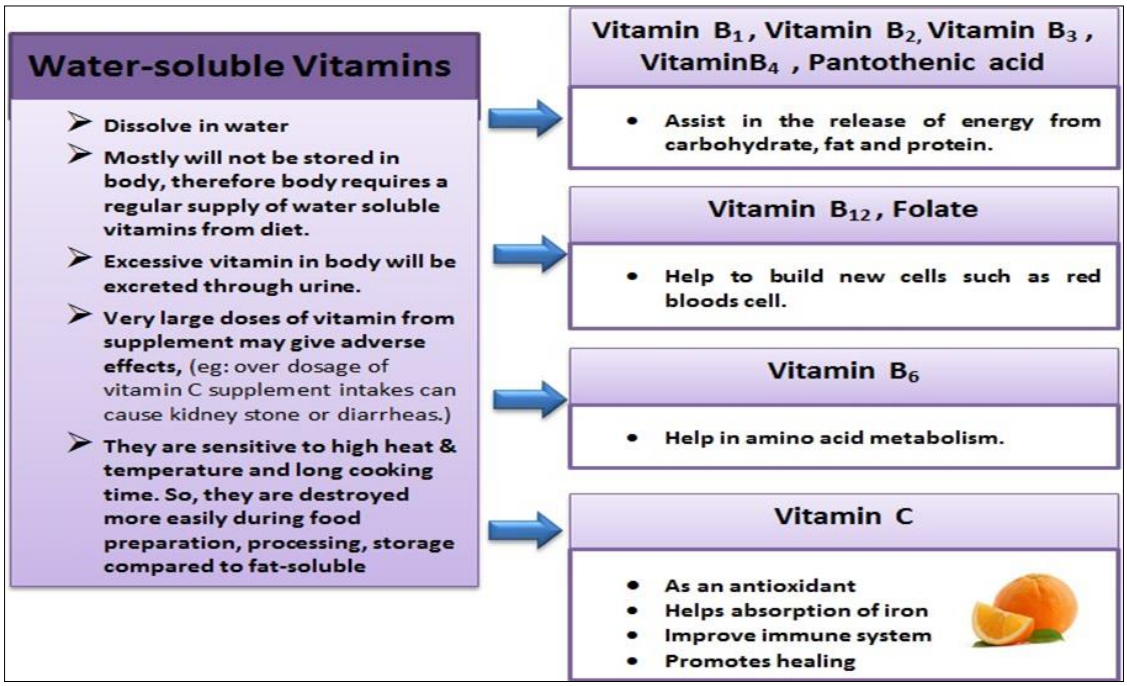

Fig 1: Water soluble vitamin

Vitamin Antagonism

- Vitamins have synergistic and antagonistic relationships.
- The antagonism may not be direct but, as a result of excessive intake, may increase the requirements of other vitamins.
- When applied to nutrients (like vitamins and minerals), an agonist is actually something that enhances either nutrient absorption or metabolic function inside your body. on the other hand, antagonist means that something either decreases or blocks the absorption or metabolic function of the nutrient.
- In other words, certain vitamins and minerals can either inhibit or enhance the absorption or function of other vitamins and minerals.
- Some nutrients are great buddies when the right amounts of each are taken, but they can fall out with each other when one massively out numbers the other.
- An example of this is calcium and magnesium. They are best taken in a ratio of 2:1 (calcium to magnesium), but if the ratio is 8:1 then the calcium inhibits the absorption of the magnesium and you may become deficient.

Table 3: Vitamin A

Synergistic Nutrients	Antagonistic Nutrients
Vitamin E	*Vitamin E*
Vitamin E enhances vitamin A intestinal absorption at medium to high concentrations, up to 40 percent. Vitamin A and E together lead to increased antioxidant capabilities, protect against some forms of cancer, and support a healthier gut.	High levels of beta carotene might decrease serum levels of vitamin E.
	Vitamin K
	Vitamin A toxicity inhibits the synthesis of vitamin K2 by intestinal bacteria and interferes with hepatic actions of vitamin K. Vitamin A interferes with absorption of vitamin K.
Iodine	
Retinoic acid is involved in iodine uptake. Severe vitamin A deficiency decreases the uptake of iodine and impacts thyroid metabolism. Iodine deficiency and vitamin A deficiency leads to a more severe case of primary hypothyroidism compared to iodine deficiency alone.	

Synergistic Nutrients

- **Iron**
- Iron is required for converting beta-carotene into retinol. Vitamin A increases iron absorption, especially non-heme iron. Iron increases the bioavailability of pro-vitamin A carotenoids, including alpha-carotene, beta-carotene, and beta-cryptoxanthin.
- Supplementing with vitamin A might help reverse iron deficiency anemia in children, and vitamin A deficiency might contribute to anemia.

- ***Zinc***
- Zinc is required for vitamin A transport. Supplementing with vitamin A and zinc in children led to a reduced risk of infection and increased linear growth. Zinc along with vitamin A helps maintain eye health

Table 4: Vitamin C (Ascorbic Acid)

Synergistic Nutrients	Antagonistic Nutrients
Vitamin E	*Vitamin B12*
Vitamins C and E work synergistically for antioxidant defense, with vitamin C regenerating vitamin E. Works in synergy, so large supplementation of one needs large supplement of other.	In aqueous solution, vitamin C might degrade B12, especially with B1 and copper also present.
	Copper
Copper	
Post-absorptive, vitamin C can stimulate uptake and metabolism of copper. Vitamin C deficiency could lead to symptoms of copper deficiency.	High levels of vitamin C inhibits absorption of copper, possibly through increasing iron absorption, which is a copper antagonist.
Iron	*Iron*
Increases absorption of non- heme iron, even in the presence of inhibitory substances; vitamin C also regulates uptake and metabolism of iron.	Excess vitamin C could increase iron overload risk.
Selenium	*Selenium*
A diet high in vitamin C led to increased percent of absorption of sodium selenite and retention of the absorbed selenium	Converts sodium selenite to elemental selenium which inhibits absorption but only when supplements are taken

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