HARMFUL EFFECTS OF OXALIC ACID IN BIOLOGICAL SYSTEMS

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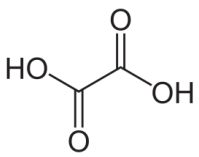
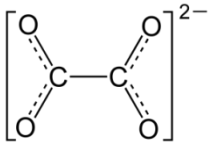
INTRODUCTION

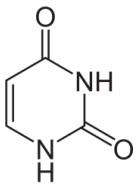
Oxalic acid is the simplest dicarboxylic acid and occurs as the dihydrate $C_2H_2O_4 \cdot 2H_2O$. It is a colourless crystalline solid soluble in water. It is a reducing agent and its deprotonated species, oxalate ion ($C_2O_4^{2-}$), is a chelating agent for metal cations[1]. Its main applications include cleaning or bleaching, especially for the removal of rust due to the formation of a stable, water-soluble ferrioxalate ion. Hydrated lanthanide oxalates are formed readily in very strongly acidic solutions in a densely crystalline, easily filtered form, largely free of contamination by non-lanthanide elements. Thermal decomposition of these oxalates gives the oxides, which is the most commonly marketed form of these elements. Oxalic acid is required in our body for the formation of uracil and orotic acid[2].



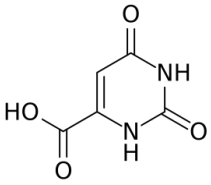
Oxalic acid



Oxalate dianion



Uracil



Orotic acid

ROLE OF OXALIC ACID IN BIOLOGICAL SYSTEM

More than 90% of the oxalic acid consumed is normally excreted through urine. Organic form of oxalic acid, in low concentration, is essential to maintain peristaltic motion in our body. However, when it is processed or cooked, it becomes inorganic form, and may have certain negative effects on the body. Oxalic acid in concentrated form can have harmful effects through contact and ingestion. It is not identified as mutagenic or carcinogenic; there is a possible risk of congenital malformation in the fetus; may be harmful if inhaled, and is extremely destructive to tissue of mucous membranes and upper respiratory tract; harmful if

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swallowed; and causes burns if absorbed through the skin or is in contact with the eyes. Symptoms and effects include a burning sensation, cough, wheezing, laryngitis, shortness of breath, spasm, inflammation and edema of the larynx, inflammation and edema of the bronchi, pneumonia and pulmonary edema. In humans, ingested oxalic acid has an oral LD_{Lo} (lowest published lethal dose) of 600 mg/kg. It has been reported that the lethal oral dose is 15 to 30 grams[3].

When oxalic acid combines with calcium and other minerals it creates oxalate crystals, which can contribute to kidney stones, gout *etc*[4]. Oxalic acid can also interfere with the absorption of minerals in our diet such as calcium, potassium, and magnesium. Hence, it is advisable for people with certain health conditions to limit its intake through the diet. Oxalic acid can also cause joint pain due to the formation of similar precipitates in the joints[5].

Normally, calcium and small amounts of oxalate are present in the urinary tract at the same time, but they remain dissolved and cause no problems. However, sometimes they bind to form crystals. In some people, these crystals can lead to the formation of stones, especially when oxalate is high and urine volume is low. Small stones often don't cause any problems, but large stones can cause severe pain, nausea and blood in the urine as they move through the urinary tract. Although there are other types of kidney stones, about 80% are made up of calcium oxalate. For this reason, people who have had one episode of kidney stones may be advised to minimize their consumption of foods high in oxalate. However, oxalate restriction is no longer recommended to every person with kidney stones. This is because most of the oxalate found in urine is produced by the body, rather than absorbed from food. Most urologists now only prescribe a strict low-oxalate diet (less than 50 milligrams per day) for patients who have high levels of oxalate in their urine[6].

Some claim that a high oxalate intake may be linked to the development of autism[7]. Others say oxalates may be linked to vulvodynia, which is characterized by chronic, unexplained vaginal pain. Elevated levels of oxalate have been found in the urine of patients who have had gastric bypass surgery or other surgeries that alter gut function. This suggests that people who have taken antibiotics or suffer from gut dysfunction may benefit more from a low-oxalate diet.

While many people think about oxalates as some rare and undesirable component of food, oxalates are naturally occurring substances found in a wide variety of foods and they play a supportive role in the metabolism of many plants and animals and in our human

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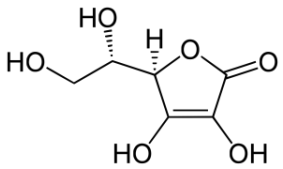
metabolism as well. So in term of our overall health and diet, oxalates are neither rare nor undesirable.

The effects of oxalic acid in the human body, when ingested in foods, flow from its ability to combine chemically with certain metals commonly found in and importance to the human body, such as magnesium and calcium. When oxalic acid combines with such metals, the result is oxalates. Since oxalic acid is not so far as is known today a useful nutrient, it is like all such unneeded components of diet processed by the body to convenient form, those oxalates, and that byproducts is then eventually excreted in the urine.

Some proponents of low-oxalate diets say people are better not consuming foods rich in oxalates, since they may have negative health effects. However, it's not that simple. Many of these are healthy foods that contain important antioxidants, fiber and other nutrients. Therefore, it's not a good idea for most people to completely stop eating high oxalate foods.

Oxalic acid is toxic because of its acidic and chelating properties. It may cause burns, nausea, severe gastroenteritis and vomiting, shock and convulsions. It is especially toxic when ingested, as little as 5 to 15 grams (71 mg/kg) may be fatal to humans.

Oxalic acid can kill by lowering the calcium level in our blood below a critical level. The antidote is calcium gluconate solution. Although foods high in oxalic acid can be avoided, we cannot exclude it entirely from our body because there are other sources. For example, surplus Vitamin C, which the body cannot store, is turned into oxalic acid, and a side effect of effect of taking massive doses of this vitamin may be kidney stones[8].



Vitamin C

While oxalic acid is a product of the breakdown of vitamin C and may, theoretically, accumulate to form kidney stones, doses of as much as 10 g of vitamin C have not been associated with the increased oxalate stone formation. Some experts caution that anyone who is at increased risk for forming calcium oxalate stone should avoid high doses of vitamin C.

Oxalic acid is a poison that can cause a range of potentially life threatening symptoms. It cause abdominal pain, convulsions, kidney problems, low blood pressure, mouth and throat pain, shock, tremors, vomiting and weak pulse as possible sign of oxalic acid poisoning. First

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aid treatment includes drinking water or milk, unless the person is experiencing symptoms that make it difficult to swallow, such as vomiting, convulsions, or decreased alertness. Seek emergency care if these symptoms appear suddenly.

FOODS CONTAINING OXALIC ACID

Oxalic acid occurs naturally in high levels in many common foods, including several vegetables like potatoes, beets, broccoli, carrot and food likes fruits, nuts and legumes and grains, chocolates, beer *etc*[9]. In some of these food items, it tastes pleasantly sour, and in other it's essentially tasteless. Because it binds with some nutrients making them unavailable, for this reason the oxalic acid is often described as an anti-nutrient.

1. *Fruits:-* Blackberries, blueberries, raspberries, strawberries, currants, kiwifruit, concord (purple) grapes, figs, tangerines and plums.
2. *Vegetables:-* Spinach, Swiss chard, beets (root part), beet greens (leaf part), collards, okra, parsley, and leeks are among the most oxalate-dense vegetables. Celery, beans, rutabagas and summer squash are considered moderately dense in oxalates.
3. *Nuts and seeds:-* Almond, cashew and peanuts.
4. *Legumes:-* Soybeans, tofu and other soy products.
5. *Grains:-* Wheat bran, wheat germ, quinoa (a vegetable often used like a grain).
6. *Others:-* Coca, chocolate and black tea.

HOW TO DO A LOW OXALATE DIET

Eat fewer high-oxalate foods

The more oxalate that is absorbed from our digestive tract, the more the oxalate in our urine. High-oxalate foods to limit are spinach, bran flakes, rhubarb, beets, potato chips, French fries, nuts and nut butters.

We do not need to cut other healthy foods that provide some oxalate. In fact, oxalate is practically unavoidable, because most plant food items have some. Often a combination of calcium from foods or beverages with meals and fewer high oxalate foods is required.

Increase the amount of calcium in our diet

Low amounts of calcium in our diet will increase the chances of forming calcium oxalate kidney stones. Many people are afraid to eat calcium because of the name "calcium

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oxalate stones". However, calcium binds oxalate in the intestines. A diet rich in calcium helps reduce the amount of oxalate being absorbed by our body, so stones are less likely to form. Eat calcium rich foods and beverages every day (2 to 3 servings) from dairy foods or other calcium rich foods.

Also, eating high calcium foods at the same time as high oxalate food is helpful; for example have low fat cheese with a spinach salad or yogurt with berries. If we take a calcium supplement, calcium citrate is the preferred form.

Limit the vitamin C content of our diet

Oxalate is produced as an end product of vitamin C (Ascorbic acid) metabolism. Large doses of Vitamin C may increase the risk of kidney stone formation. If we are taking a supplement, do not take more than 500 mg of Vitamin C daily.

Drink the right amount of fluids every day

It's very important to drink plenty of liquids. Our goal should be 10-12 glasses a day. At least 5-6 glasses should be water. We may also want to consider drinking lemonade. Research suggests that lemonade may be helpful in reducing the risk of calcium oxalate stone formation[10].

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