

## Rhubarb and Oxalic Acid

I have never been fond of rhubarb. In fact - I never touch the stuff. Perhaps this is because I grew up during WWII when all fresh food was old, tough, stringy and sour. But I married into a family in which the foods that are in season are cherished. There is a definite season for rhubarb, and it is ubiquitously served during those spring weeks. I still don't eat it, even when it is mixed with strawberries, which it has the grace to come into season with.

Rhubarb contains oxalic acid, a toxic substance that in high enough concentrations can cause stomach irritation and kidney problems. It can also mess up the body's calcium metabolism and leach calcium from the body. Death can also occur, but it is rare. The web is full of sites warning about hazards of over-feeding oxalic acid containing greenery to llamas, iguanas, parrots, and more. I even ran across a food pyramid for parrots as I was searching for information on rhubarb.

Many other green, leafy vegetables contain oxalic acid (or calcium or potassium oxalate) as do coffee, tea, and chocolate; table 1 shows a selection of foods and their oxalic acid contents. Rhubarb leaves are quite high in oxalic acid and are definitely poisonous, but the stalks are safe to eat. Skunk cabbage and the large-leaved house plant dieffenbachia also contain dangerous concentrations of oxalic acid. Indeed, dieffenbachia is called dumbcane because when the leaves are bitten, the crystals of calcium oxalate embed in your mouth and throat causing swelling, making speech and breathing difficult. Indeed, dumbcane can even "shoot" crystals when the specialized cells holding the crystals are broken by biting or chewing. In addition to crystals of oxalate embedding into the soft tissues of the mouth, a protein-dissolving enzyme is part of this little molecular blowdart and it goes to work causing sores and swelling. This is not a pleasant process.

As poisons go, oxalic acid is not lethal in teeny quantities like those from poison darts frogs. The LD<sub>50</sub> orally in rats is reported as 375 mg/kg; the Merck Index reports the LD for dogs as 1 g/kg.

We can only make guesses about the poisonous doses for people. Using the LD<sub>50</sub> figure for rats, a 130 pound (58.9 kg) woman would need to consume about 22 grams of oxalic acid to be in serious danger of death.. Rhubarb leaves contain 0.5-1.0% oxalic acid, so that you would need to eat quite a large serving of the sour leaves, perhaps 10 pounds) to get a lethal dose. However, a fraction of that could nevertheless cause severe symptoms of oxalic acid poisoning..

One neat quote I came across: "A few leaves won't hurt a horse, a wheelbarrow full can kill pigs."

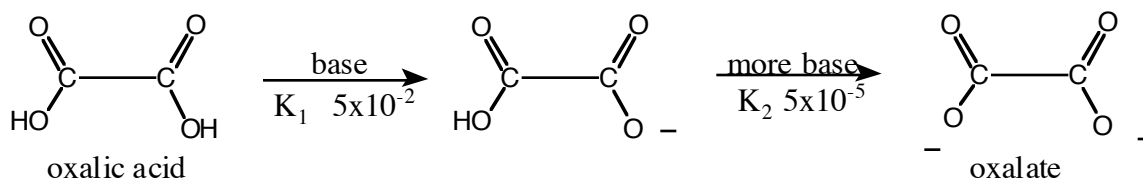
Table I: Oxalic acid content in selected vegetables. These are ballpark numbers, actual content depends on many variables. See note at the end of the article.

Vegetable	Oxalic acid (g/100 g)
Asparagus	0.13
Broccoli	0.19
Lettuce	0.33
Brussels sprouts	0.36
Collards	0.45
Beet leaves	0.61
Spinach	0.97 (0.32-1.26)
Purslane	1.31
Parsley	1.70
Rhubarb	0.3-1.5
leaf	0.59 - 0.72
stalk	0.39 - 0.54

One often repeated story features the English government in World War I. It sent out an advisory encouraging its citizens to eat rhubarb leaves to alleviate food shortages and help the war effort. After sicknesses and deaths were reported, the recommendation was rescinded.

### And now for a word about acids and bases and why the terms oxalic acid and oxalate are used interchangeably

The form oxalic acid is in depends on the pH of the solution.



Present in strongly acidic solutions such as the stomach (pH ~ 2)

Present in moderately acidic to neutral solution; pH of blood 7.4

Present in basic solution. This form binds very tightly to the calcium ion.

Calcium binds very strongly to the oxalate anion, forming calcium oxalate, which is extremely insoluble in water. Because of the strength of the calcium/oxalate pair foods rich in both calcium and oxalate are pretty useless as a source of calcium. In addition, cooking does not wash out oxalate from sources that are high in oxalate and calcium, although it does help in foods that are high in potassium oxalate like skunk cabbage. [That goes for iron also, so spinach is not a good source of iron (Popeye to the contrary) because the iron is tightly bound to oxalate and therefore not available for the body's use.]

### Selected References and Comments

An estimated 80% of kidney stones are made up of calcium oxalate.

Amounts of oxalic acid in various foods:

USDA: Oxalic Acid Content of Selected Vegetables:

<http://www.nal.usda.gov/fnic/foodcomp/Data/Other/oxalic.html>

Food Science, Lincoln University, NZ: Oxalate Containing Foods

[http://www.foodscience.ac.nz/research\\_topics/oxalate/Oxalate\\_containing\\_food.html](http://www.foodscience.ac.nz/research_topics/oxalate/Oxalate_containing_food.html)

Mallinckrodt Baker, Inc. MSDS. Fatal dose figure for oxalic acid:

<http://www.jtbaker.com/msds/englishhtml/o6044.htm>

Shooting crystals:

Dr. T. Ombrello, Union County College: Plant of the Week: Dumbcane

<http://faculty.ucc.edu/biology-ombrello/POW/dumbcane.htm>

Dr. T. Ombrello, Union County College

<http://www.cook.rutgers.edu/~floriculture/publications/dumbc.htm>

Mary C. Smith, DVM: Oxalate Poisoning: Horse and pig quote

<http://www.maltawildplants.com/OXIL/Docs/Oxalate%20Poisoning.htm>

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LD<sub>50</sub> figures can seem to be wildly different as well as notoriously difficult to extend to people. The calculation of the lethal amount of rhubarb leaves above was based on an LD<sub>50</sub> orally in rats of 375 mg/kg and calculates to a fatal dose of oxalic acid of about 22 grams of oxalic acid.. However, another MSDS estimates that the fatal dose would be about 5 to 15 grams. In addition, the amount of oxalic acid in a blade of rhubarb is not a fixed number, but depends on leaf size, soil, developmental stage at the time of picking, the particular species of rhubarb, and more. Clearly, this is not an exact but complicated science!

Likewise – analysis can yield different values for oxalic acid content, depending on the method used and the source of the rhubarb. I use numbers mainly to give ball park reference values.

A simple question I asked myself about rhubarb and oxalic acid ended up being a headache due to of conflicting or absent information in the literature.