Questions about Vitamin C - Linus Pauling Institute Blog

Have questions about vitamin C? As part of the webinar by our resident expert on vitamin C, Alexander Michels, PhD, answered questions submitted online.

If you have more questions you would like answered, see part 2 of this FAQ or feel free to ask!

Vitamin C in the Body

How long does vitamin C stay in the body?

Vitamin C can stay in the body for weeks. Levels of vitamin C in the blood are controlled by the kidneys through a process known as 'renal reabsorption,' which prevents vitamin C from being lost in the urine. Taking large doses of it can overwhelm this system, so the extra amount is lost in the urine in a matter of hours.

When someone who already has high levels in the blood takes some vitamin C, the increase in the body is only temporary – the majority is lost in the urine. When someone who doesn't have high blood levels of vitamin C takes it, the vitamin stays in the system longer.

How should doses of vitamin C be divided to maximize the blood concentration and the time it stays in my body?

I should start by saying there is no known advantage of keeping plasma levels above the threshold set by your kidney. It may have advantages, but they have not been determined (yet).

That said, if you want to keep plasma vitamin C levels as high as possible over time, it is best to take multiple doses spread out throughout the day. While small doses (under 200 mg) are completely absorbed, only a fraction of a single large dose of ascorbic acid can be absorbed at one time (500 mg or more). Spacing the doses out will increase the overall absorption.

You can take vitamin C every few hours, but it becomes a difficult practice to keep up. Some people recommend taking vitamin C supplements twice a day, and this likely strikes the best balance between practicality and maintaining high levels in the blood.

Just be aware that when ascorbic acid levels are high in the blood for a long period of time, the body tries to remove it by increasing the amount excreted in the urine. Thus, if you take multiple large doses throughout the day (say, every two hours), most will be either unabsorbed or quickly excreted.

Does taking large amounts of ascorbic acid add too much acid to my system? Is buffered vitamin C preferred?

The body can handle the acid in large amounts of ascorbic acid. Remember, the acid in your stomach is much stronger than ascorbic acid, and the body can neutralize that easily. In addition, your cells and blood have buffering systems that prevent the pH from getting too low or too high.

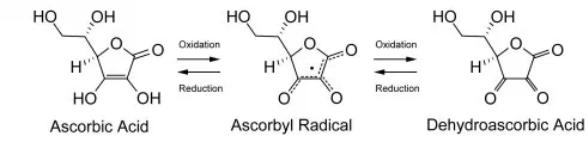
The only reason you might want to consider "buffered" vitamin C is if you have stomach distress or heartburn after taking ascorbic acid. Many buffered preparations aren't buffered at all – they are mineral ascorbates with nearer-to-neutral pH. In other words, they are much less likely to upset your stomach than regular ascorbic acid.

Are there other ways to get high blood vitamin C levels, similar to intravenous injection?

Not orally. Many products may claim to increase bioavailability of vitamin C (like lipospheric formulas) , but currently there is no clinical support for these claims. High doses of ascorbic acid have been administered to rats and mice by injection in the space surrounding the intestines or intro muscles, avoiding the need for finding a vein, but still requiring sterile preparations of ascorbic acid. Not something that is recommended for home use.

Vitamin C Supplements

I have read that vitamin C is not ascorbic acid, and that there are other components that make of vitamin C. Is this true?



Absolutely not.

Ascorbic acid is vitamin C because it can prevent and cure the disease that forms from its deficiency – scurvy. This is part of the definition of a vitamin.

Some people have postulated that vitamin C does not work alone in the body, i.e., that it needs to be present in a “complex” of other factors to work properly. This is contrary to all the scientific literature. At one point in time, the man who discovered the chemical structure of ascorbic acid, Albert Szent-Györgyi, thought he had found that bioflavonoids were necessary for the action of vitamin C and were found in a complex in plants, but this turned out to be a false lead.

Ascorbic acid, as recommended by Linus Pauling over 40 years ago, is sufficient to satisfy your body’s requirements for vitamin C.

Is there a difference between natural and synthetic ascorbic acid? Are there differences in bioavailability between natural sources and synthetic supplements containing vitamin C?

No. Unlike some vitamins, such as vitamin E, the natural and synthetic forms of ascorbic acid are identical. The chemical mirror image of ascorbic acid (an isoform called sodium erythorbate) is not the same as ascorbic acid because it does not have any vitamin activity. It is often used as a food preservative because it has antioxidant activity.

There is currently no evidence that natural source supplements have greater bioavailability than synthetic supplements, or straight ascorbic acid. There is some literature to support that there are differences in animal models (such as mice or rats) in bioavailability when ascorbic acid is presented in a mixture of food or plant-based material, but studies in humans have shown no differences. This is likely due the differences between many animal species (who can make ascorbic acid in the liver) and humans (who are dependent on ascorbic acid from the diet), but the reasons for these differences on a molecular level are not clear.

Should I take ascorbic acid with rose hip flavonoids or other bioflavonoids to increase its absorption or activity?

There is no evidence to suggest that taking vitamin C with flavonoids will increase the absorption or activity of ascorbic acid. On the contrary, there is a study that

suggests taking a large amount of quercetin (a flavonoid in rose hips) inhibits absorption. This inhibitory effect is small and likely insignificant, but it certainly does not suggest any benefit to combining flavonoids with vitamin C.

The man who first characterized ascorbic acid, Albert Szent-Györgyi, thought of flavonoids as a vitamin that worked with vitamin C based on work in guinea pigs. However, after finding out that removal of flavonoids from the diet was not necessary for life (and not a vitamin) or the activity of ascorbic acid, the work did not progress any further. Unfortunately, some use that older work as evidence that flavonoids are necessary for vitamin C activity and absorption.

Studies of this on flavonoids and vitamin C have not yet been performed in humans, making it difficult to say anything conclusively about it.

Is there an advantage to taking liposomal, esterified, time-release, or mineral forms of ascorbic acid compared to taking plain ascorbic acid?

There has been no proven benefit to taking any other form of vitamin C over plain ascorbic acid. Many companies claim their product has a greater bioavailability, but there is little in the scientific, peer-reviewed literature to support such claims. For more specific information about forms of vitamin C, see the Micronutrient Information Center.

I found claims online supporting the consumption of dehydroascorbic acid (DHAA) for superior bioavailability compared to ascorbic acid. Is this true?

While in cells dehydroascorbic acid can be absorbed faster than ascorbic acid, the evidence is not clear in humans. Dehydroascorbic acid is very unstable and can breaks down in a matter of minutes – simply with contact with water. Likely, consuming a large amount of dehydroascorbic acid will do nothing as it will degrade before it has a chance to enter your system. Even if stabilized, it is not advisable to take dehydroascorbic acid, especially in large amounts.

Many regulatory agencies have warnings about dehydroascorbic acid because of reports that it can actually stress or kill cells in culture by placing excessive demands on cellular metabolism. Rats administered intravenous dehydroascorbic acid at levels where ascorbic acid causes no toxic effects has caused death. The toxic levels of dehydroascorbic acid is estimated to be much higher than ascorbic acid in rats, rabbits, and mice.

Furthermore, dehydroascorbic acid degradation products include oxalate – so anyone concerned about oxalate consumption or kidney stones should be aware of that fact. Some reports have linked dehydroascorbic acid breakdown products to protein glycation – a process where small carbohydrates can attach to proteins and cause them to lose function (depending on the site of attachment). There have been reports of kidney damage and diabetes-like symptoms after animals were injected with high amounts of dehydroascorbic acid. This may be due to protein modification, a halmark of diabetes.

What exactly happens to the body after oral consumption of dehydroascorbic acid is still unclear. No adequate amount of testing has been done on high doses of it, but does pose a potential risk and should be regarded with caution.

Should I take ascorbic acid alone or with food? What about over-the-counter, pharmaceutical drugs, or other supplements?

There are no known advantages or disadvantages to taking ascorbic acid alone or with food in terms of how much reaches your bloodstream. People who want to maximize their iron absorption should take vitamin C with iron-rich foods or supplements. If you have hemochromatosis (iron overload disease) you should avoid taking vitamin C with iron sources in your diet, and do not take more than 500 mg/day of vitamin C supplements.

It is possible that calcium (or calcium contianing foods)can inhibit absorption slightly, but it might not make a noticeable difference.

Great care should be taken when taking vitamin C with drugs of any sort. This will likely not affect the amount your body absorbs, but there may be interactions between the drug and ascorbic acid that could inadvertently decrease the effectiveness of the drug. Many of these have been documented on databases online, so check your medication. See the Micronutrient Information Center for more information.

Does GMO corn or other GMO crops used as a source of glucose have any effect on ascorbic acid synthesized from these materials?

No. The process of synthesizing ascorbic acid removes other materials from the source of glucose. Multiple manufacturing steps are needed to isolate and purify ascorbic acid. In some cases, the vitamin comes from a living organism that performed intermediate steps in the transformation of glucose into ascorbic acid. During these many levels of production, all traces of the material from the previous step have to be eliminated to result in pure vitamin C.

Vitamin C in Food

If heat destroys vitamin C, is the consumption of raw fruit and vegetables the only way to get vitamin C?

Heat destroys vitamin C in a time- and temperature-dependent fashion. The hotter the cooking temperature, the more vitamin C is destroyed, and the amount of vitamin C lost will increase the longer the heat is applied. That is not to imply that raw fruit and vegetables are the only good sources of the vitamin. Some fruits and vegetables contain enzymes (like ascorbate oxidase) that will slowly oxidize ascorbic acid after they are chopped, crushed, or chewed. Brief cooking can destroy these enzymes and stabilize ascorbic acid. Additionally, the fibrous

nature of raw vegetables makes the bioavailability of ascorbic acid low in their uncooked (not softened) form. 

Frying at high temperatures destroys ascorbic acid. Baking can also destroy some, but that is highly dependent on time and temperature. Steaming is preferable to boiling because it destroys less, and cooking in the microwave is considered to be preferable to either method. Ascorbic acid is most stable in acid, so that may help prevent the loss of ascorbic acid during any cooking method. For example, the addition of vinegar or lemon juice to a fruit or vegetable purée when heated may preserve it even when it is cooked for a short period of time.

How much variation is seen in fruit and vegetable vitamin C? Does it vary with season?

There is a tremendous amount of variability in the fruit and vegetable content of vitamin C. Of course, different types of fruit and vegetables contain different amounts of ascorbic acid, but variation can also occur from region to region and from plant to plant. Stage of maturation, growth conditions, seasonal variations, and storage conditions also are likely to contribute, but the magnitude of these effects are not well documented.

How well does vitamin C fare in food that is stored, or kept on the shelf?

This can depend greatly on the method of storage. Vitamin C levels in most foods are affected by excessive heat, light, alkaline conditions, and oxygen exposure. Vitamin C that has exposed to light for long periods of time will begin to degrade over time. This has been demonstrated in orange juice on the shelf in a supermarket.

Pasteurization or irradiation of foods (to destroy bacteria) tends to destroy ascorbic acid as well – one reason there is no appreciable vitamin C content of store-bought milk. Some packaged foods are processed with acid and oxygen-free conditions to limit the loss of the vitamin. Often, manufacturers will add ascorbic acid to foods to prevent oxidation, and those that claim to have a particular amount of vitamin C on the label will add more than is stated to account for some loss over time.

Frozen fruit and vegetables are good sources, as the freezing process destroys some of the enzymes that would otherwise degrade vitamin C in fresh fruit and vegetables. Also, the cold temperatures tend to preserve ascorbic acid. Canned fruit has also been shown to be a good source of vitamin C – likely because the products are canned shortly after harvest with minimal additional processing, and the use of brief amounts of heat in the canning process can destroy enzymes that would otherwise degrade it.

More questions about vitamin C?

See the Linus Pauling Institute's webinar by Alexander Michels, PhD or part 2 of this FAQ.