

USANA Technical Bulletin

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Vitamin C

Technical Background

- Vitamin C (also known as ascorbic acid or ascorbate) plays two important roles in the body. First, it is a cofactor or cosubstrate for eight enzyme systems involved in various functions. Second, vitamin C is a potent, water-soluble antioxidant that plays a vital role in protecting cells and tissues from damaging oxidizing agents.^{1,2}
- Vitamin C performs many other related functions. It assists in the regeneration and prolongs the activity of vitamin E, and promotes iron absorption in the intestines. It is also thought to play roles in regulating DNA transcription and protein synthesis.³
- Most mammals synthesize ascorbate from glucose, but humans and other primates have lost this ability. As such, vitamin C is an essential vitamin that humans must ingest to survive.¹
- Vitamin C supplementation has generated considerable controversy. In the 1970s, Linus Pauling and others recommended gram doses of vitamin C to prevent and treat the common cold. Others have since suggested that megadoses of ascorbic acid can be useful in preventing and/or treating numerous degenerative diseases, including cataracts, cancer, atherosclerosis, and AIDS, though there is still a great deal of debate on the subject.
- Epidemiological data suggest that a strong association exists between a diet rich in fruits and vegetables high in vitamin C and reduced risk of cancer, especially cancers of the oral cavity, esophagus, stomach, colon, and lung.⁴
- In contrast, controlled clinical trials have produced inconclusive results concerning the value of vitamin C supplements in preventing coronary heart disease, colorectal cancer, stomach cancer, and cataracts.

Sources and Recommended Intake

- The Recommended Dietary Allowance (RDA) for vitamin C is 75 mg/day for adult women and 90 mg/day for adult men. This amount was selected to provide enough vitamin C to prevent deficiency symptoms (scurvy) and to provide some reserves.⁵ Many feel, however, that this level is well below that required for optimal health.
- Dosages can be increased during times of physiological stress. Infection, injury, surgery, burns, fatigue, alcohol consumption, smoking, pregnancy,⁶ and other stress factors increase the body's need for this vitamin.⁷
- The level of ascorbic acid in the blood reaches a peak 2-3 hours after ingestion and then decreases as it is eliminated in the urine and through perspiration. Most is out of the body in 3-4 hours. Because of this short residence time in the body, it is often recommended that vitamin C supplements be taken several times throughout the day.⁷

- Vitamin C is essentially safe for healthy individuals at doses below 500 mg/day. Some data indicate that doses >500 mg/day may increase urinary oxalate excretion in people with prior history of oxalate kidney stones. However, a prospective clinical study involving men with no history of kidney stones showed no association between a high daily intake of vitamin C (1,500 mg/day) and the risk of kidney stone formation.⁸ Doses of 1,000 mg can produce some side-effects in some healthy individuals, including a burning sensation during urination, diarrhea, intestinal gas, and/or abdominal pain. When such symptoms occur, dosage should be reduced. It may also help to take the supplements with or after a meal.¹
- Vitamin C increases intestinal absorption of iron and may exacerbate iron overload in people susceptible to this disorder. It is not known whether ascorbate induces iron over-absorption in normal people.¹

Abstracts

Fuller CJ, Grundy SM, Norkus EP, Jialal I. Effect of ascorbate supplementation on low density lipoprotein oxidation in smokers. *Atherosclerosis* 1996 Jan 26; 119(2):139-50. The oxidative modification of low density lipoprotein (LDL) may play a role in the pathogenesis of atherosclerosis. Furthermore, evidence of oxidized LDL (ox-LDL) has been found in vivo. Supplementation of some animal models with antioxidants has been shown to retard the formation of aortic atherosclerosis. Ascorbate (vitamin C) is a highly potent aqueous-phase antioxidant in plasma, which has been shown in vitro to retard LDL oxidation. Cigarette smokers have reduced concentrations of ascorbate in their plasma, and their LDL may be more prone to oxidation. Hence, the objective of the present study was to examine the effect of ascorbate depletion and supplementation on the propensity of LDL to oxidize in smokers in a 6-week study. Nineteen healthy smokers followed a low ascorbate diet (< or = 30 mg/day) for 2 weeks, then were randomly assigned to receive placebo or 1000 mg ascorbate per day for 4 weeks. Blood was taken at 0 and 4 weeks of supplementation for study of LDL oxidative susceptibility. LDL was oxidized with 5 $\mu\text{mol/l}$ copper. The ascorbate-supplemented group had significant increases in plasma ascorbate. The placebo group showed no change in the time course of LDL oxidation between 0 and 4 weeks. However, the ascorbate-supplemented group has a significant reduction in LDL oxidative susceptibility as measured by thiobarbituric acid-reactive substances (TBARS) and the formation of conjugated dienes. The ascorbate-supplemented group demonstrated significantly increased lag phase and decreased oxidation rate at 4 weeks compared to 0 weeks. No changes were found in the placebo group. The ascorbate-supplemented group showed no biochemical signs consistent with increased body iron stores. Supplementation of otherwise healthy smokers for 4 weeks with 1000 mg ascorbate per day resulted in increased plasma ascorbate and reduced LDL oxidative susceptibility.

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