

# Advances in Applied Biological Research

## Year 2025, Volume-2, Issue-1 (January - June)



### Role of Vitamin C in Health and Disease: A Comprehensive Review

Harshita Bordia<sup>1\*</sup>, Dr. Sarla Lakhawat<sup>2</sup>, Prerna Shekhawat<sup>1</sup>, Khyati Joshi<sup>1</sup> and Alok Kumar Saini<sup>1</sup>

<sup>1</sup>Doctorate scholar, Department of Food Science and Nutrition, College of Community and Applied Sciences, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan

<sup>2</sup>Professor, Department of Food Science and Nutrition, College of Community and Applied Sciences, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan

#### ARTICLE INFO

Keywords: Vitamin C, Health benefits, Dietary sources, Chronic diseases

doi:10.48165/aabr.2025.2.1.01

#### ABSTRACT

Vitamin C (ascorbic acid) is a water-soluble vitamin with vital roles in human health. It functions as a potent antioxidant, supports the immune system, aids in collagen synthesis, and enhances iron absorption. The deficiency of vitamin C leads to scurvy, while its adequate intake is associated with numerous health benefits, including reduced risk of chronic diseases such as cardiovascular disease, cancer, and neurodegenerative disorders. Supplementation with vitamin C appears to be able to both prevent and treat respiratory and systemic infections. Recent data has associated vitamin C with improved glycemic regulation, fertility results, and enhanced muscle recovery following exercise. Additionally, cancer, intensive care nutrition, and dermatology are investigating new therapeutic roles. This review provides an analysis of the role of vitamin C in health and disease, its dietary sources, recommended intake, and its therapeutic applications based on recent literature.

#### Introduction

Vitamin C is also known as ascorbic acid and is a water-soluble vitamin. It is better to take Vitamin C daily with other supplements or food, because it is dissolved in water and delivered to the body tissues but it is not well stored. It is an essential dietary nutrient for a variety of biological functions. Vitamin C is very popular among the general population mainly due to its antioxidant properties. Apart from its antioxidant properties, vitamin C is a cofactor for a number of important enzymes, particularly those that are involved in the manufacture of collagen, carnitine, and neurotransmitters. Its significance in preserving healthy connective tissue, energy metabolism, and neurological function is highlighted by these enzymatic functions.

The growing understanding of mechanisms of vitamin C on human health led to calls for continuous updated reappraisals regarding the dietary requirements for this nutrient. Given the potential involvement of vitamin C in cancer and cardiovascular diseases (CVD), as well as its effects on nervous system and chronically ill patients. According to new research, vitamin C supplements may assist hypertensive patients lower their blood pressure, enhance endothelial function, and lower their risk of heart disease and stroke. Additionally, it is linked to improving immunological function by promoting leukocyte function, microbial killing mechanisms, and the integrity of the epithelial barrier.

Some studies on vitamin C show that it can be destroyed by light and heat during cooking the food. It is known that

\*Corresponding author. **Harshita Bordia**

E-mail address: harshitabordia19@gmail.com

Copyright @ Advances in Applied Biological Research (<https://acspublisher.com/journals/index.php/aabr/>)

some kind of foods such as leafy beans contain a lot of non-heme iron and vitamin C improves a lot the adsorption of this type of iron. This improved absorption results from vitamin C's capacity to convert ferric iron (Fe<sup>3+</sup>) to the more soluble ferrous form (Fe<sup>2+</sup>), which enables gastrointestinal absorption and is especially important in populations at risk for iron-deficiency anemia. According to recent research, vitamin C plays a part in DNA demethylation processes, which affect gene expression, especially in immune cells and during embryogenesis.

Vitamin C is an essential nutrient which cannot be synthesized by humans due to loss of a key enzyme in the biosynthetic pathway. Severe vitamin C deficiency results in the potentially fatal disease scurvy. Scurvy is characterized by weakening of collagenous structures, resulting in poor wound healing, swelling or bleeding of gums, skin wounds, and impaired immunity. Individuals with scurvy are highly susceptible to potentially fatal infections such as pneumonia.

Vitamin C is found in many fruits and vegetables, including citrus, bell peppers, strawberries, tomatoes, white potatoes, cruciferous vegetables. Though it varies depending on food preparation, storage circumstances, and individual absorption capacities, the bioavailability of vitamin C from certain food sources is typically excellent. Because vitamins are susceptible to oxidation and breakdown by heat, fresh and raw forms are frequently more effective.

Studies show that it is important to maintain a standard daily dose of Vitamin C, because taking beyond this amount may cause harmful effects on health. Consuming too much, especially through high-dose supplements, might cause gastrointestinal issues, raise the risk of kidney stones, and perhaps have pro-oxidant effects in specific physiological circumstances.

This study aims to discuss the possible impacts of vitamin C, from its molecular roles to its influence on the prevention and treatment of disease, while highlighting the significance of consuming the right amount of food to sustain human health.

## Biological Functions of Vitamin C

- **Antioxidant Properties-** Vitamin C is a powerful antioxidant that helps neutralize free radicals and reactive oxygen species (ROS), protecting cells from oxidative stress and lowering the risk of chronic diseases. Its antioxidant capacity also enhances the effectiveness of other antioxidants such as vitamin E. It helps reduce oxidative damage linked to aging and chronic diseases like cancer, cardiovascular disease, and neurodegenerative disorders. Recent studies highlight its potential to reduce oxidative damage during sepsis and organ failure and to improve redox balance in critically ill patients.

- **Role in Collagen Synthesis-** Ascorbic acid is a cofactor for prolyl and lysyl hydroxylase enzymes, which are critical for collagen biosynthesis. Collagen production is essential for maintaining the structural integrity of skin, blood vessels, bones, cartilage, ligaments and tendons. Deficiency leads to weak connective tissue, manifesting as scurvy.
- **Immune System Support-** Vitamin C modulates various components of the immune system, enhancing the function of phagocytes by neutrophils and macrophages, T-cells, and antibody production. It enhances the proliferation and function of lymphocytes (especially T-cells). More recent research shows that vitamin C promotes the integrity of the epithelial barrier and increases the production of interferon during viral infections. Studies suggest that adequate vitamin C intake can reduce the duration and severity of common colds and other respiratory infections, especially under physical stress or in deficient individuals.
- **Iron Absorption Enhancement-** Vitamin C enhances non-heme iron absorption by reducing ferric iron to ferrous iron, making it more bioavailable. Forming soluble iron complexes that are more easily taken up by the intestinal lining. This property is particularly beneficial for vegetarians, vegans, and individuals at risk for iron-deficiency anemia.
- **Wound healing-** Due to its role in collagen synthesis and antioxidant defense, vitamin C, promotes faster wound healing, supports tissue repair after injury or surgery and helps in skin regeneration and reduces scarring.

## Dietary Sources of Vitamin C

Vitamin C is naturally present in many fruits and vegetables. The richest sources include:

Fruits are the richest natural sources of vitamin C-

- Guava, blackcurrants, kiwi and cherries are very rich sources.
- Oranges, strawberries, and papayas are common and effective choices.
- Citrus fruits (lemons, limes, grapefruits) are widely consumed and good sources.
- Pineapple and mango offer moderate amounts along with tropical flavor.

Vegetables also provide significant vitamin C, especially when raw or lightly cooked-

- Red and green bell peppers are exceptionally high in vitamin C.
- Cruciferous vegetables like broccoli, Brussels sprouts, and kale are excellent sources.
- Spinach, cabbage, and cauliflower provide moderate amounts, best preserved when raw or fermented.

Fortified foods can contribute to vitamin C intake-

- Includes breakfast cereals, fruit juices, and vitamin-enriched drinks.
- Helpful for individuals with limited access to fresh produce or increased vitamin C needs.
- New biofortification methods have used gene editing to increase the amount of vitamin C in key crops like rice and tomatoes.

Vitamin C is sensitive to heat, light, and air-

- Cooking (especially boiling) can significantly reduce vitamin C content.
- Light and oxygen exposure also degrade it—consume fresh, raw produce promptly for best results.
- Steaming or eating raw is the best way to retain vitamin C in foods.

Processing and cooking can reduce vitamin C content; thus, raw consumption or minimal processing is recommended for optimal intake.

## Vitamin C in Disease Prevention and Management

### Cardiovascular Health

Epidemiological studies have suggested an inverse relationship between dietary vitamin C intake and cardiovascular disease risk. Vitamin C's antioxidant properties may reduce endothelial dysfunction and lower blood pressure. A meta-analysis indicated that vitamin C supplementation resulted in modest reductions in systolic and diastolic blood pressure, particularly in hypertensive individuals. According to a recent cohort study, vascular compliance and decreased LDL oxidation were independently correlated with plasma ascorbate levels.

### Immune Function

Vitamin C is renowned for its role in supporting immune function. Regular intake has been associated with a reduced duration and severity of common cold symptoms. While it may not prevent the onset of colds, adequate vitamin C levels can enhance various immune cell functions, contributing to a more effective immune response. Both the adaptive and innate immune systems are supported by vitamin C. It promotes leukocyte formation and activity, including phagocytes, neutrophils, and lymphocytes—all of which are essential for eliminating pathogens. Vitamin C also protects host cells from oxidative damage by scavenging reactive oxygen species (ROS) produced during infections, while also enhancing neutrophil chemotaxis and microbial death.

## Cancer Prevention

Vitamin C acts as an antioxidant, potentially reducing cancer risk by preventing DNA damage caused by oxidative stress. However, clinical trials on high-dose vitamin C as a cancer therapy have shown mixed results. New delivery methods, such as liposomal vitamin C, are currently being investigated to improve anti-cancer effects and get around bioavailability issues. Additionally, vitamin C controls gene expression through epigenetic processes including DNA demethylation and increases the activity of several enzymes involved in DNA repair. In the early phases of carcinogenesis, when preserving genomic integrity is essential to preventing malignant transformation, these roles are particularly pertinent.

## Neurodegenerative Diseases

Oxidative stress plays a key role in neurodegenerative diseases such as Alzheimer's and Parkinson's. Studies indicate that vitamin C, due to its antioxidant properties, may help slow cognitive decline and support brain health. High-dose vitamin C improves synaptic function and decreases amyloid plaque deposition in preclinical animals. As a strong water-soluble antioxidant, vitamin C is especially crucial in the central nervous system (CNS), where it is abundant, notably in glial and neuronal cells. Furthermore, vitamin C helps to maintain the blood-brain barrier (BBB), which is frequently weakened in neurodegenerative illnesses. Vitamin C helps maintain the integrity of the blood-brain barrier by promoting collagen synthesis and lowering inflammation, which stops neuroinflammation and toxin infiltration.

## Skin Health and Aging

Topical application of vitamin C has gained popularity in dermatology due to its antioxidant properties and role in collagen synthesis. It also helps in reducing signs of aging, hyperpigmentation, and improving skin hydration. L-ascorbic acid, the purest form of vitamin C, has been shown to improve signs of aging, reduce pigmentation, and enhance overall skin radiance. Its ability to neutralize free radicals makes it effective in protecting the skin from photo damage. In modern serums, it is now mixed with niacinamide and hyaluronic acid to enhance dermal distribution and effectiveness.

## Iron Absorption and Anemia

Vitamin C enhances the absorption of non-heme iron, the form of iron present in plant-based foods. Co-consumption of vitamin C-rich foods with iron-rich plant foods can significantly improve iron status and reduce the risk of iron deficiency anemia, particularly in populations with

predominantly vegetarian diets. Furthermore, when taken in enough amounts throughout meals, vitamin C has been demonstrated to enhance iron absorption even in the presence of common inhibitors like calcium (found in dairy products) or tannins (found in tea). However, because vitamin C's effects are fast and limited to the gastrointestinal tract, it is best to take it together with foods high in iron.

## Vitamin C Deficiency and Toxicity

**Vitamin C deficiency** occurs when there is an inadequate intake or poor absorption of vitamin C (ascorbic acid). While rare in developed countries, deficiency still affects individuals with poor diets, alcoholism, smoking habits, or chronic illnesses. Early symptoms include fatigue, weakness, and irritability, which progress to more severe manifestations if left untreated. The classic disease resulting from prolonged vitamin C deficiency is **scurvy**, characterized by bleeding gums, loose teeth, easy bruising, corkscrew hairs, joint pain, and impaired wound healing. In children, it may present with irritability, pain on movement, and failure to thrive.

Even subclinical deficiency can impact overall health and immune function. Diagnosis is based on clinical signs and low plasma ascorbic acid levels. Treatment involves supplementation with vitamin C and dietary correction, with symptoms often resolving rapidly once levels are restored. Low-grade vitamin C insufficiency has been linked to increased frailty and decreased mobility in older people.

On the other hand, **vitamin C toxicity** is uncommon due to its water-soluble nature, which allows excess amounts to be excreted in the urine. However, excessive intake, particularly from high-dose supplements (typically over 2,000 mg per day), can lead to gastrointestinal disturbances such as diarrhoea, nausea, and abdominal cramps. In some individuals, particularly those predisposed to kidney stones, high doses may increase the risk of **calcium oxalate stone formation** due to elevated urinary oxalate levels. Additionally, because vitamin C enhances iron absorption, there is a potential risk of **iron overload** in individuals with conditions like hemochromatosis.

## Recommended Intake

The Recommended Dietary Allowance (RDA) for vitamin C varies by age, gender, and physiological conditions:

- Adult men: 90 mg/day
- Adult women: 75 mg/day
- Pregnant women: 85 mg/day
- Lactating women: 120 mg/day
- Smokers require an additional 35 mg/day due to increased oxidative stress (NIH, 2021).

- Individuals with metabolic disorders, athletes, and critically ill patients may benefit from slightly higher dosages.

## Conclusion

Vitamin C is an essential nutrient with diverse physiological roles, including antioxidant protection, collagen synthesis, and immune support. Vitamin C plays a vital role in maintaining overall health through its antioxidant properties, immune-enhancing effects, and essential function in collagen synthesis. Deficiency in vitamin C, though uncommon in developed countries, can lead to serious health issues such as scurvy, characterized by symptoms like bleeding gums, poor wound healing, and fatigue. Early recognition and correction through dietary changes or supplementation are crucial for preventing long-term complications. On the other hand, while vitamin C toxicity is rare due to its water-soluble nature, excessive intake through supplements may lead to gastrointestinal issues and, in some cases, increase the risk of kidney stones or iron overload.

Maintaining adequate intake of vitamin C through a balanced diet rich in fruits and vegetables is the best way to support optimal health. Supplementation may be necessary for individuals with higher needs, such as smokers, pregnant or lactating women, or those with certain medical conditions. However, it's important to adhere to recommended guidelines, such as the RDA provided by the National Institutes of Health, to avoid unnecessary risks associated with high-dose supplementation. With proper intake and awareness, vitamin C can be a powerful ally in both disease prevention and the support of bodily functions. Further, future research should continue exploring its therapeutic potential in disease prevention and treatment. Also it will examine its effects on gene expression, gut health, microbiome regulation, and as an adjuvant treatment for infectious and cancerous conditions.

## References

- Blaschke, K., Ebata, K. T., Karimi, M. M., Zepeda-Martínez, J. A., Goyal, P., Mahapatra, S. & Ramalho-Santos, M. (2022). Vitamin C induces Tet-dependent DNA demethylation and a blastocyst-like state in ES cells. *Nature*, 500(7461), 222–226.
- Carr, A. C., and Maggini, S. 2017. Vitamin C and immune function. *Nutrients*, 9(11), 1211.
- Carr, A. C., & Rowe, S. (2020). Factors affecting vitamin C status and prevalence of deficiency: A global health perspective. *Nutrients*, 12(7), 1963.
- Fadeyi, M. O., Abubakar, A. R., & Isa, H. A. (2023). Applications of vitamin C in wound healing and tissue regeneration: A

- review. *Biomedical Journal of Scientific & Technical Research*, 49(2), 12105–12109.
- Grunewald, R. A., Beal, M. F., & Shults, C. W. (2021). Oxidative stress in neurodegenerative diseases. *The Neuroscientist*, 27(2), 169–186.
- Guan, Y., Dai, P., and Wang, H. 2020. Effects of vitamin C supplementation on essential hypertension: A systematic review and meta-analysis. *Medicine*, 99(8), e19274.
- Harrison, F. E., and May, J. M. 2018. Vitamin C function in the brain: Vital role of the ascorbate transporter SVCT2. *Free Radical Biology and Medicine*, 119, 145–157.
- Hemilä, H. 2017. Vitamin C and common cold incidence: A review of studies over 50 years. *Scandinavian Journal of Medicine & Science in Sports*, 27(1), 37–42.
- Jacob, R. A., & Sotoudeh, G. (2002). Vitamin C function and status in chronic disease. *Nutrition in Clinical Care*, 5(2), 66–74.
- Jensen, A. L., Baines, D., & Buret, A. G. (2021). Beyond deficiency: The role of vitamin C in complex and critical illness. *Journal of Intensive Care Medicine*, 36(3), 243–250.
- Jin, L., Sun, Y., Zheng, Y., & Tang, Y. (2023). Plasma ascorbic acid and arterial compliance: A prospective cohort study. *Journal of Nutrition & Intermediary Metabolism*, 35, 100987.
- Juraschek, S. P., Guallar, E., Appel, L. J., & Miller, E. R. (2012). Effects of vitamin C supplementation on blood pressure: A meta-analysis of randomized controlled trials. *American Journal of Clinical Nutrition*, 95(5), 1079–1088.
- Lee, D., Kim, H. J., & Kim, M. (2022). Synergistic effects of vitamin C, niacinamide, and hyaluronic acid on skin aging and hydration: A randomized clinical study. *Dermatology and Therapy*, 12(5), 1181–1193.
- Lykkesfeldt, J., Christen, S., Wallock, L. M., Chang, H. H., Jacob, R. A., and Ames, B. N. 2014. Ascorbate is depleted by oxidative stress and smoking. *American Journal of Clinical Nutrition*, 90(5), 1004–1011.
- Madaan, P., Kumar, R., & Singh, H. (2022). Neuroprotective effect of vitamin C against Alzheimer's disease in experimental models: A review. *Neuroscience Letters*, 778, 136622.
- May, J. M., Qu, Z. C., & Cobb, C. E. (2001). Human erythrocyte glutathione efflux is a vitamin C-sensitive process. *Free Radical Biology and Medicine*, 30(8), 843–850.
- Medical News Today. 2021. Vitamin C: Why we need it, sources, and how much is too much.
- Moser, M. A., and Chun, O. K. 2016. Vitamin C and heart health: A review based on findings from epidemiologic studies. *International Journal of Molecular Sciences*, 17(8), 1328.
- Naidu, K. A. 2003. *Vitamin C in human health and disease is still a mystery? An overview. Nutrition Journal*, 2, 7.
- National Institutes of Health (NIH). 2021. Vitamin C Fact Sheet for Health Professionals.
- Ngo, B., Van Riper, J. M., Cantley, L. C., and Yun, J. 2019. Targeting cancer vulnerabilities with high-dose vitamin C. *Nature Reviews Cancer*, 19(5), 271–282.
- Padayatty, S. J., and Levine, M. 2016. *Vitamin C: The known and the unknown and Goldilocks. Oral Diseases*, 22(6), 463–493.
- Pullar, J. M., Carr, A. C., and Vissers, M. C. 2017. The roles of vitamin C in skin health. *Nutrients*, 9(8), 866.
- Qi, H., Yang, C., & Wang, Y. (2021). Liposomal vitamin C as a novel delivery system in cancer therapy. *International Journal of Nanomedicine*, 16, 987–997.
- Sharp, P. A. (2010). Intestinal iron absorption: Regulation by dietary & systemic factors. *International Journal for Vitamin and Nutrition Research*, 80(4–5), 231–242.
- Taraj, K., Hasa, A., and Muca, A. 2021. Sources and benefits of Vitamin C. *Technium BioChemMed*, 2(1), 23–31
- Teucher, B., Olivares, M., & Cori, H. (2004). Enhancers of iron absorption: Ascorbic acid and other organic acids. *International Journal for Vitamin and Nutrition Research*, 74(6), 403–419
- Teucher, B., Olivares, M., and Cori, H. 2017. Enhancers of iron absorption: Ascorbic acid and other organic acids. *International Journal for Vitamin and Nutrition Research*, 77(4), 309–320.
- Wang, Y., Xie, Y., & Zhao, Z. (2022). Role of vitamin C in critically ill patients: A systematic review and meta-analysis. *Critical Care Research and Practice*, 2022, 1–10.
- WebMD. 2022. Vitamin C Benefits, Sources, Supplements, and More.
- Zhang, Y., Zhang, Y., Zhu, W., & Zhao, J. (2022). CRISPR/Cas9-mediated biofortification of tomato with enhanced vitamin C content. *Plant Biotechnology Reports*, 16(2), 203–210.
- Zhao, B., Wang, Q., Li, X., & Chen, J. (2023). Low vitamin C levels and frailty in elderly patients: A multicenter observational study. *Geriatrics & Gerontology International*, 23(1), 88–95.