Medicine and Medical Sciences 10(5): 049-052, July 2022
DOI: 10.15413/mms.2022.0107
ISSN 2682-5759

Academia Publishing

Research Paper

Seven potential role of Ascorbic acid in prevention and management of communicable and non-communicable diseases

Accepted 23rd May, 2022

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ABSTRACT

Ascorbic acid is a crucial dietary nutrient for the biosynthesis of collagen and is a co-factor in the biosynthesis of catecholamines, L-carnitine, cholesterol, amino acids, and certain peptide hormones. Vitamin C perhaps produces analgesia both indirectly, through calcitonin-dependent modulation of endorphins, and directly through elevated secretion of endomorphins. Ascorbic acid acts as inhibitors to heart disease by suppressing free radicals from injuring artery walls, which could lead to plaque formation. Ascorbic acid nutrient also keeps cholesterol in the bloodstream from oxidizing, and early step in the progression towards heart disease and stroke. Ascorbic acid is considered as protectors against oxidative stress by lowering the levels of free oxygen radicals and preventing low density lipoprotein oxidation and oxidative cell injury. Ascorbic acid shows presumptive mechanisms of action in inhibition and treatment of SARS-COV-2 are that of relevance to severe respiratory infection, involving antioxidant, and anti-inflammatory, antithrombotic, and immuno-modulatory functions.

Key words: Ascorbic acid, communicable and non-communicable diseases, prevention, treatment.

INTRODUCTION

Vitamin C is a water-soluble vitamin which is found in all fruits and vegetables, but is especially concentrated in citrus fruits, green peppers, strawberries, broccoli, green leaves, and potatoes. Since humans do not synthesize ascorbic acid, they are depending on vitamin C dietary uptake to stay alive. Ascorbate, derived from either dietary sources or the liver, enters cells initially through sodium-dependent vitamin C transporters (Kristó et al., 2022). The high-capacity, low-affinity sodium-dependent vitamin C transporters is initially accountable for ascorbate absorption and re-absorption in intestinal and renal epithelial cells. Ascorbic acid is avcrucial dietary nutrient for the biosynthesis of collagen and is a co-factor in the biosynthesis of catecholamines, L-carnitine, cholesterol, amino acids, and some peptide hormones (Van et al., 2022). Vitamin C is a gluconic acid lactone derived from glucuronic acid and a water-soluble ketolactone with two ionizable hydroxyl groups. Vitamin C is reversibly oxidized, forming the stable ascorbic free radical intermediate with the loss of one electron or dehydroascorbic acid with the loss of two electrons. Ascorbic free radical decays by disproportionation to ascorbic acid and dehydroascorbic acid, whereas dehydroascorbic acid spontaneously hydrolyzes under physiological conditions, with the opening of the lactone ring to form diketogulonic acid (Attila et al., 2020). The application of ascorbic acid is discussed as follows:

1) Prevention and treatment of SARS-CoV-2: SARS-CoV-2 infection induces excessive release of proinflammatory cytokines, leading to cytokines storm, and elevates secretion of reactive oxygen species which both cause important lung injury which leads to subsequent development of adult respiratory distress syndrome. Ascorbic acid shows presumptive mechanisms of action in inhibition and treatment of SARS-COV-2 are that of relevance to severe respiratory infection, involving antioxidant, anti-inflammatory, antithrombotic, and

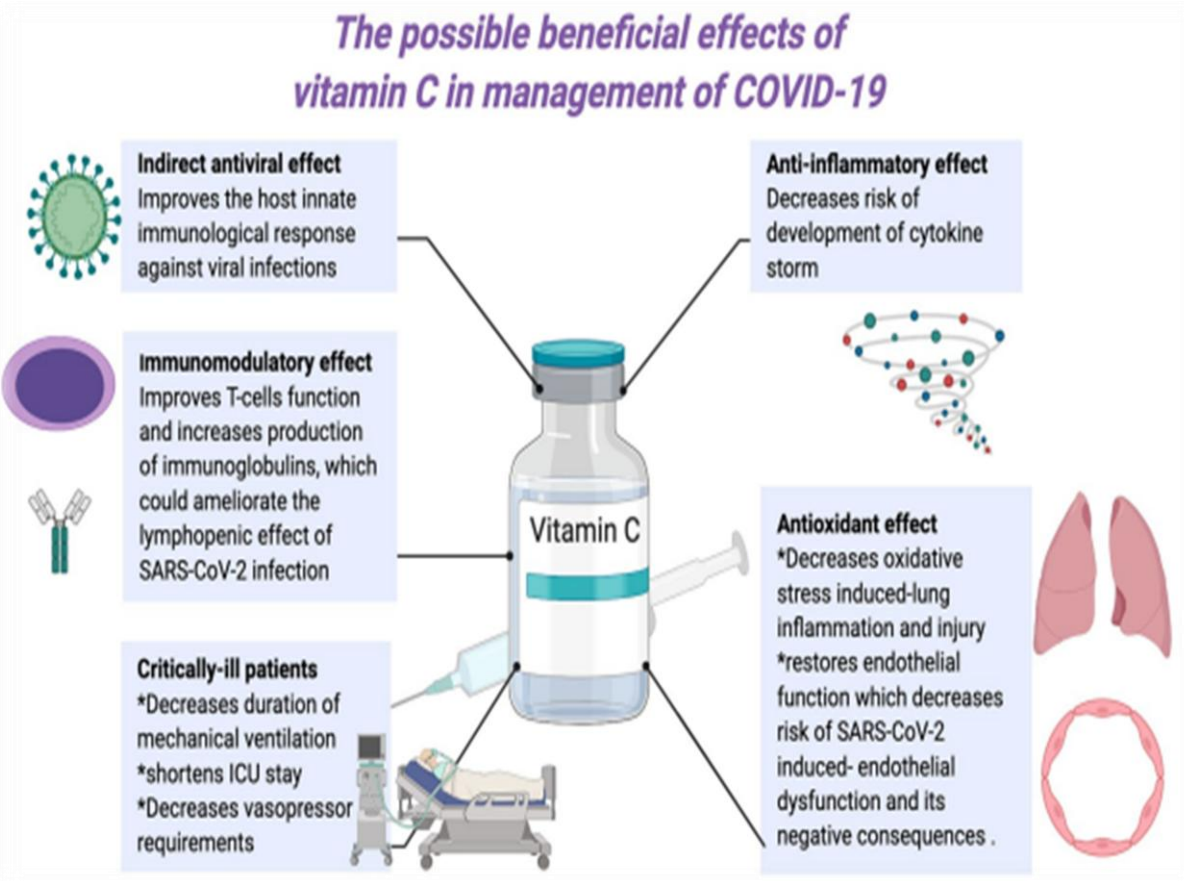

Figure 1: The beneficial effects of vitamin C in management of COVID-19.

immuno-modulatory functions (Gorkom et al., 2018).

2) Pain management: Pain can be expressed as an unpleasant sensory and emotional experience correlated with actual or potential tissue injury.Vitamin C perhaps produces analgesia both indirectly, through calcitonin-dependent modulation of endorphins, and directly through elevated secretion of endomorphins.Vitamin-C has been found to exert several regulatory effects on cells of the skeletal system, involving osteogenic, chondrogenic and osteoblastogenic. Vitamin C act in bone cells initially include up-or down regulation of the expression of specific genes through regulation of transcription factors and epigenetic marks. Ascorbic acid is a potent antioxidant which can scavenge a wide range of reactive oxygen species and, thus, is capable of protecting cells and tissues from oxidative injury and also exhibits anti-inflammatory properties, providing marked reduces in markers of inflammation such as C-reactive protein and pro-inflammatory cytokines, e.g. tumor necrosis factor, interferon, and interleukins. The secretion of catecholamine neurotransmitters is involved in neuromodulation. Vitamin C is a cofactor for the enzyme dopamine β-hydroxylase, which converts dopamine into norepinephrine and also facilitates the secretion of dopamine through recycling the cofactor tetrahydrobiopterin, which is needed for optimal activity of the rate-limiting enzyme tyrosine hydroxylase. Tetrahydrobiopterin recycling mechanism has been suggested for ascorbic acid in the biosynthesis of the monoamine neurotransmitter serotonin. Both serotonin and norepinephrine reuptake inhibitors show efficacy in control of pain (Liping et al., 2020). The beneficial effects of vitamin C in management of COVID-19 are seen in Figure 1.

3) Sepsis treatment: Sepsis is a medical emergency that occurs due to a dysregulated host response to infection, resulting in life-threatening organ dysfunction. Ascorbic acid has significant role in individuals with sepsis because its key antioxidant properties, scavenging reactive oxygen species, repletion of other essential body antioxidants vitamin E and glutathione, and cardiovascular benefits by supporting endogenous norepinephrine, dopamine, and vasopressin production. Additionally, ascorbic acid protects against the loss of epithelial and endothelial barriers and elevates neutrophil function in a multidimensional way. Ascorbic acid promotes lymphocytic and neutrophilic activity while decreasing neutrophil necrosis and neutrophil extracellular trap, which contributes to

multiorgan failure and regulates nuclear cellular responses to stress and hypoxia by regulating HIF-1α, secretes NF-κB epigenetic modifications through its capability to de-methylate histones, regulates pro-inflammatory and coagulation gene expression, and orchestrates the immune system and circulating cytokine homeostasis in pleotropic ways (Tan et al., 2019).

4) For proper function of vascular endothelium: Vitamin-C inhibits apoptosis of endothelial cells in culture induced by high glucose conditions, tumor necrosis factor-a, and LPS because of its key cellular antioxidant, which serves as an initialantioxidant by detoxifying exogenous radical species that have entered cells or which have arisen within cells due to excess superoxide production by mitochondrial metabolism, by nicotinamide adenine dinucleotide phosphate oxidase, xanthine oxidase, or by uncoupled nitric oxide synthase. The low millimolar concentrations of ascorbate probably to exist in endothelial cells, vitamin-C will help superoxide dismutase in scavenging superoxide and its more toxic breakdown products. Ascorbic acidis act to prevent the elevated activity of protein phosphatase type 2A in cultured initial endothelial cells exposed to a septic insult and spares endothelial cell-derived nitric oxide by recycling tetrahydrobiopterin and by inhibiting the function of protein phosphatase type 2A. Ascorbic acid may also preserve nitric oxide by several mechanisms such as direct inhibition of nitrite to nitric oxide, release of nitric oxide from nitrosothiols and as noted earlier, by scavenging superoxide that would otherwise react with nitric oxide to form peroxynitrite (Huijskens et al., 2016).

5) Inflammatory bowel diseases: Inflammatory bowel disease can be described as a group of inflammatory conditions of the colon and small intestine. Vitamin-C has antioxidant and anti-inflammatory effects which is necessary for treatment of inflammatory bowel disease. The decreased antioxidant defenses may severely compromise the inflamed mucosa, rendering it more susceptible to oxidative tissue damage, hindering recovery of the mucosa and return of epithelial cell layer integrity. The loss of chemical antioxidant components provides a strong rational for developing novel antioxidant therapies for the IBD treatment (Huijskens et al., 2014).

6) Cardiovascular diseases: Cardiovascular disease is a class of diseases that include the heart, the blood vessels or both. Vitamin-C helps to inhibit heart disease by reducing free radicals from injuring artery walls, which could lead to plaque formation. Ascorbic acid nutrient also keeps cholesterol in the bloodstream from oxidizing, another early step in the progression towards heart disease and stroke and considered as to protect against oxidative stress by decreasing the levels of free oxygen radicals and preventing low density lipoprotein oxidation and oxidative cell damage (Huijskens et al., 2015).

7) Regulate obesity: Obesity is emerging as one of the major health threats. Beneficial effects of vitamin-C on obesity-related can be described as the modulation of adipocyte lipolysis, glucocorticoid release from adrenal glands, hyperglycemia improvement and an inhibition of the inflammatory response (Strohle et al., 2011).

CONCLUSION

Vitamin C is a water-soluble vitamin which is found in all fruits and vegetables, but is particularly concentrated in citrus fruits, green peppers, strawberries, broccoli, green leaves, and potatoes. Ascorbic acid has significant role in individuals with sepsis because its key antioxidant properties, scavenging reactive oxygen species, repletion of other essential body antioxidants vitamin E and glutathione, and cardiovascular benefits by supporting endogenous norepinephrine, dopamine, and vasopressin production. Vitamin C perhaps produces analgesia both indirectly, through calcitonin-dependent modulation of endorphins, and directly through elevated secretion of endomorphins.

ACKNOWLEDGMENTS

The author is grateful to anonymous reviewers for the comments that increase the quality of this manuscript.

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Cite this article as:

Bereda G (2022). Seven potential role of Ascorbic acid in prevention and management of communicable and non-communicable diseases. Med. Med. Sci. 10(2): 049-052.

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