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The role of vitamin C: From prevention of pneumonia to treatment of Covid-19

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1. Introduction

Though vitamin C has the main function in improving the immune-system [1], but it is also used in treating COVID-19. Many types of viral and bacterial infections can be avoided by intaking vitamin C. Its effect is not limited to a single virus. Pneumonia, is very common in patients who are deficient in this vitamin. Vitamin C may have a clinical effect in protecting humans from various infections. Vitamin C sources are citrus fruits like orange, lemon, strawberries, and kiwi and other sources are peppers, potatoes, black currants, broccoli (minerals like calcium), etc. we need these sources of vitamin C to protect our cells from damage. Overall, from all sources of vitamin C, kiwi fruit has higher content of vitamin C. However, taking a kiwi fruit every day may be sufficient to soak a muscle vitamin’s concentration in non-smoking people. When its intake is around $200 \times 10^{-6}$ kg per day, the amount of ascorbic acid in the plasma of healthy adults reaches about 70 mol/L [2]. When vitamin C supplement is less than $100 \times 10^{-6}$ kg per day, however, there is a strong correlation between vitamin C levels of plasma and vitamin C doses. Here scurvy can develop when the conc. of vitamin C in plasma drops below 11 mol/liter, which is equivalent to anemia. Daily taking off less than $10 \times 10^{-6}$ kg. As a result, healthy persons with daily consumption of around here, generally no reason to think of a response to this vitamin supplementation at $0.2 \times 10^{-3}$ kg/day. This does not apply to every-one because certain research has indicated that supplements can help [3]. The World Health Organization (WHO) has announced a proposal to examine the COVID-19 pandemic’s origins. The search will begin in Wuhan, China, where the (serve acute respiratory syndrome) SARS-CoV-2 was originally developed in China. In November of this year, the first outbreak began in Wuhan, Hubei, China [4–6]. The global pandemic of coronavirus diseases 2019 (COVID-19) has afflicted about 2.5 million people, with nearly 170,000 deaths reported to date. In patients with COVID-19, we looked at the viability of utilizing vitamin C. Globally, more than 660,000 instances of infection and around 391,000 deaths linked to COVID-19 have appeared in the beginning of June 2020, with the number of cases increasing [7,8]. Vitamin C is a necessary nutrient that is required for survival and helps to build and maintain bones,
blood vessels, and skin while boosting immunity. As expected, COVID-19 has forced people to focus more on protecting against disease and infection by boosting their immunity. Vitamin C always acts as an antioxidant that can help to prevent or reverse the harm to cells in our bodies. Vitamin C is also elaborate in many different processes like biochemical processes which are directly associated with immune health. Vitamin C always fights free radicals in our body because this vitamin behaves as an antioxidant, and always boosts immunity. It’s functions as an immune-stimulating agent, and it is most of the time exists in the epithelial lining of the respiratory system. Due to pneumonia, viral infections can reduce the level of ascorbic acid because viral infections create oxygen (O) and nitrogen(N) species. So, vitamin C can prevent the pneumonia diseases. Numerous studies have demonstrated that taking vitamin C supplements may aid in the treatment and possibly prevention of respiratory infections. For respiratory infections like bronchitis and tonsillitis as well as pneumonia and septic shock, vitamin C (C6H8O6) has been effective for many people. Vitamin C has positive impacts in treating infections, and by enhancing the immune system, it may provide protection from the present COVID-19 epidemic due to its anti-inflammatory and antioxidant effects. (See Tables 1-5).

1.1. Ascorbic acid/vitamin C and ascorbate ion

It is a very vital nutrient that can repair tissues, and maintain our teeth, bones, and skin healthy. Vitamin C act as an antioxidant that can help to extend blood vessels and enhances NO (nitric oxide) and protects from heart diseases. A heavy dose/diet of vitamin C can always help in reducing allergy symptoms. It is a molecule that is charged molecule [9].

After protonated ascorbic acid becomes ascorbate (Fig. 1.) [10] The molecular formula of ascorbic acid is C6H8O6. Ascorbic is sometimes known as hexuronic acid. It is a solid which is white, when dissolved in water (H2 O) to commonly give a moderated acidic solution. So, we can say that ascorbic acid is an organic acid that is water-soluble. Ascorbic acid is generally a reducing agent. As we can see in this figure the ascorbate is a negatively charged anion. Ascorbic acid and the ascorbate anion of them are present in the human body.

It is also known as Levo-Ascorbic acid, and it is the most common vitamin which is water-soluble. Ascorbic acids are generally the Scientific name of vitamin C which is firstly given and discovered in the 1930 s. As we know that it is related to the Latin word “Scorbutus” which means scurvy. This vitamin generally helps in preventing and treating scurvy.

1.2. Bioavailability of vitamin C

It is a nutrient for human beings and animals. It must be obtained from the diet of humans because they are still unable to synthesize vitamin C. In the case of animals, it is found in the liver, lungs, and glands of the adrenal, brain, but its level decreases after one week. But in human beings, skeletal muscles represent the major pool of this vitamin. Sources are fruits like lemon, orange, strawberries, kiwi and other sources are peppers, potatoes, black currants, broccoli (minerals like calcium), etc. we need these sources of vitamin C to protect your cells from damage. But from all sources, kiwi fruit is the major source of vitamin C. Half of kiwi fruit each day seems to be enough for non-smoking people.

1.3. Synthesis of ascorbic acid in plants and animals

The Schematic mechanism of biosynthesis of animals. Biosynthesis Animals and plants can synthesize it. The synthesis of this in animals and plants is held by many pathways [9]. Biosynthesis in animals: Most animals synthesize their own vitamin C. In this whole biosynthesis, glucose converts into ascorbic acid in the last step. This biosynthesis is held in animals in kidneys, for birds & reptiles in liver, etc. There are many pathways followed in this synthesis. Firstly, the glucose converts into α-Glucose-6-P, in the first pathway, the α-Glucose-6-P (C6H12O5P) converts into α-Glucose-1-P (C6H12O6), in the second pathway (C6H12O5P) α-Glucose-1-P converts into UDP-Glucose (C15H24N2O17P2), as we can see in this (Fig. 2) how the glucose converts into ascorbic acid. In the synthesis of ascorbic acid in animals, We can say that firstly, α-Glucose or α-Galactose is converted into Glucose –6-Phosphate, it will be converted into Uridine diphosphate glucose, and after that it will be converted into diphosphate glucuronic acid, this will converted into α-glucuronic acid, as this is shown in Fig. 2, after that α-glucuronic acid will converted into l-glucosonolactone, and after that converted into 2-keto-l-glucosonolactone, and when this will oxidised so, we will get l-Ascorbic Acid. (Fig. 3, Fig. 4).

Biosynthesis in Plants: In the biosynthesis of plants glucose converts into ascorbic acid. There are many pathways followed in this synthesis. A biosynthesis way via Guanosine diphosphate mannose (C16H25N3O18P2), GDP-l-galactose (C16H25N3O18P2), l-galactose-1-P these reduced and at last formation of ascorbic acid takes place.

1.4. Recommended dietary allowances

RDA means the average requirements of nutrients in 97 %-98 % healthy people. For keeping passable body stores, RDA (recommended dietary allowance) for this vitamin (ascorbic acid) has been expected over many years. Intake advice for nutrients is on condition that in the (DRI) which is evolved in the FNB of the FNAS [14]. Dietary references intake is the common expression for planning and measuring nutrients taken by healthy people. As we know that the nutrients and vitamin C intake values may vary with different ages, and different gender. For example, if we talk about the recommended dietary allowance for 1–3 years children, they should take 15 × 10⁻⁶ kg/day of vitamin C, for 4–8 years children they should take 25 × 10⁻⁶ kg (142 micro mol)/day of vitamin C. In the case of boys who are under 9–13 years old, they should take 45 × 10⁻⁶ kg/day of vitamin C, and the boys whose age is from 14 to 18 years old should take 75 × 10⁻⁶ kg/day of it. and in the girl’s case the intake of it in comparison to boys is slightly less for example the girls which are under 9–13 years they should take 45 × 10⁻⁶ kg (256 × 10⁻⁶ mol)/day, and those girls which are under 14–18 years, they should take 65 × 10⁻⁶ kg (370 × 10⁻⁶ mol)/day. Today (RDA) Recommended dietary allowance diverges between different places e.g., current approvals in Canada and (the US) United States is 0.09 × 10⁻³ kg per day for adults male and 0.75 × 10⁻³ kg per day of vitamin C for adults females, while in another country like country Italy the recommended supplement is for adult men 0.105 × 10⁻³ kg/day, women are 0.085 × 10⁻³ kg/day. Moreover, the Recommended dietary allowance is different among many kinds of factors that can change the requirements of vitamin C which including age difference, gender difference, smoking people, non-smoking people, pregnancy, and lactation [15].

Table 1

| pH (Potential of H atom) | Low conc. | High conc. | Low conc. |
|--------------------------|-----------|------------|-----------|
| Acid pH                   | High conc.| Low conc.  | Low conc. |
Vitamin C is a necessary nutrient that is required for survival and helps build and maintain bones, blood vessels, and skin while boosting immunity. This is found generally in different kinds of foods, fruits (kiwi, orange, papaya, guava, strawberry, etc.) and in many vegetables (green bell peppers, lemon, broccoli, etc.). In addition of these, the vitamin C supplements are also obtainable. As expected, COVID-19 has forced people to focus more on protecting against disease and infection by boosting their immunity. Vitamin C always acts as an antioxidant. Vitamin C is also elaborate in many different processes like biochemical processes which are directly associated with immune health. Vitamin C always fights free radicals in our body because this vitamin always behaves as an antioxidant, and always boosts immunity. It always keeps our body healthy and makes our skin brighter [16].

It especially helps in the formation of mRNA collagen generally increasing collagen proteins for repairing skin damage. Vitamin C maintains our healthy teeth, bones, skin, and blood vessels, and the main common benefit of vitamin C is enhancing wound healing. Vitamin C reduces lower blood pressure in people having hypertension. Vitamin C act as an antioxidant that can help to extend blood vessels and enhances NO (nitric oxide) and protects from heart diseases. As we know that heavy diets of ascorbic acid can always help in decreasing symptoms of allergy. Vitamin C helps in energy production by enzymes, because these are involved in the burning of fat from the body. Vitamin C helps in the formation of skin barriers because normal skin always requires a heavy dose of this vitamin / high concentration of it. It helps in possessing an anti-microbial property by preventing the growth of bacteria. And addition to these vitamin C helps in preventing the replication of fungi and viruses [16].
lower respiratory tract infection (RTI) is the infection of the lungs which means the lower airways in our lungs, the lower respiratory tract infection common caused by a virus, it can be caused by bacteria or another organism. So according to GBDS, RTI is the leading cause of death by diseases. In 2015, the RTI (lower respiratory tract infection) leads around 2.74 million deaths or millions of disorder-regulate lives were recognized to (LRTI) 2015. Under-five years aged children, there were 704,000 deaths in this age in the year of 2015. According to GBDS (Global Burden of Disease Study), people aged over 70 years have a high possibility of pneumonia. As we know that the disease pneumonia is commonly caused by different viruses, fungi, bacteria, and other organisms. At all ages, two pathogens are commonly responsible for pneumonia that are Hemophilus influenzae and Streptococcus pneumoniae.

Vitamin C (ascorbic acid) is a substance that our bodies cannot produce and that plays a critical function in our immune system's modulation. Vitamin C protects the body from oxidative damage by providing electrons.

As we discussed above that the RDA of ascorbic acid for young men is $0.09 \times 10^{-3}$ kg/day (kilogram per day) for women it is $0.075 \times 10^{-3}$ kg/day, and $0.015 \times 10^{-3}$ kg/day of vitamin C to $0.075 \times 10^{-3}$ kg/day (kilogram per day) for children under 1–18 years. If the conc. of ascorbic acid is lower than $11 \times 10^{-6}$ mol/L that it shows lack, if the concentration of vitamin C is $(11–28) \times 10^{-6}$ mol/L then it shows expending. GSE (Geographic-specific epidemiological) studies advise that seven percent of the United State of America's citizens is Vitamin C lacking. In other countries like China, India, and Malaysia around (0.7 %–11 %) of women are vitamin C deficient, and around (14 %–17 %) of men are vitamin C deficient. Rates of vitamin C deficiency are higher in Mexico, that is 23 % of children are vitamin C deficient and its deficiency affects 39 % of women. This review considers the effect of this vitamin on the occurrence, the frequency of a cold virus does not affect the occurrence of a cold [18].
1.7. How ascorbic acid helps in treating pneumonia and sepsis

It’s functions as an immune-stimulating agent, and it is most of the time exists in the epithelial lining of the respiratory system. Due to pneumonia, viral infections can reduce the level of ascorbic acid because viral infections create oxygen (O) and nitrogen (N) species. Normal cell metabolic and immunological activity in response to bacteria, viruses, and toxins, vitamin C as antioxidant function destruction from oxygen and nitrogen produced [19]. Phagocytes transfer oxidized ascorbic acid to cells, here, it is changed by reactive species of an oxygen atom, varying in the chain production of free radicals (oxygen and nitrogen). Nicotinamide adenine dinucleotide phosphate help to kill pathogens when the production of species of reactive O during the immune response. It promotes the preservation of the cells’ redox integrity and protects them against reactive O species. Vitamin C levels for prevention and therapy may differ, and there is also the possibility of side effects. The overall treatment of pneumonia would need a heavy diet of it. Numerous studies have demonstrated that taking vitamin C supplements may aid in the treatment and possibly prevention of respiratory infections. For respiratory infections like bronchitis and tonsillitis as well as pneumonia and septic shock, vitamin C (C6H8O6) has been effective for many people.

1.8. Helpful effect of vitamin C in the case of COVID-19 diseases

Coronavirus is a huge virus family that causes infections like the cold, SARS, and MERS. A new disease COVID-19 outbreak broke out in Wuhan, China [20]. COVID-19 is a disease that affects both humans and animals, as we all know. Coronavirus can cause pneumonia, which can be very serious. The symptoms of coronavirus disease-2019 are problems with the breath, fever, cough, sore throat, and headache. Generally, three illnesses by virus recorded are as given: The first most common illness is SARS which means severe acute respiratory syndrome [21]. It is an illness that is deadly respiratory, this is developed in China in 2002, the second most common illness is MERS, this is developed in Saudi Arabia country in 2012, and the third most common illness is COVID-19 (coronavirus disease 2019), which is erupting in the city of China that is Wuhan in 2019, now this virus has spread in almost all over the world [22]. Multiple therapy schemes have been attempted under sympathetic use indications since the commencement of the Covid virus illness 2019 “COVID-19” sickness. Micronutrient supplementation, including vitamin C, has become an essential consideration in the therapy of COVID-19. Clinical research has shown that taking a high dose of ascorbic acid supplements reduces the strictness and duration of viral diseases (respiratory diseases). According to these observations, vitamin C could be used to treat COVID-19 by improving the immune response to the recent coronavirus (SARS-CoV-2). A heavy dose reduced/decreases the chances of a cytokine storm [23]. According to reports, a better diet may have an important role in the control of COVID-19. Medicine of vitamin C plus curcumin improved innate antimicrobial immunity and decreased unnecessary inflammatory reactions, minimizing the risk of inflammation-related cellular damage. According to the researcher, they have effectively treated more than 50 patients with COVID-19 in China with significant concentrations for 7 to 10 days. As a result, we can say that vitamin C treatment improved the clinical outcome [24].

Ascorbic acid stimulates phagocytosis in neutrophils by causing them to go to the infection site. Natural killer and T-cell development are controlled by ascorbic acid. Additionally, four
days after an infection, vitamin C has been demonstrated to reduce inflammatory cytokine levels in the blood. In addition, vitamin C has been demonstrated to reduce pro-inflammatory cytokine levels four days after an infection. High intake of intravenous vitamin C may also be beneficial for patients with moderate (10 g daily) and severe (20 g daily) COVID-19, which may assist them to improve their clinical results. Additionally, studies have indicated that taking extra vitamin C can reduce the period of stay in the hospital (3–5 days). Apart from that, experiments have shown that taking vitamin C with other drugs can be advantageous. There are other vitamins that are very helpful in the treatment of COVID-19 diseases. According to recent research, we can say that vitamin D is very effective in anti-inflammatory effects, antioxidant effect which decreases oxidative stress and restores endothelial which decreases SARS-CoV-2, Immunomodulatory effects, critically-ill patients these are some benefits of vitamin D.

2. Conclusion

Vitamin C appears to have several actions that appear to help patients with severe respiratory infections like pneumonia and the potentially fatal illness sepsis. Observational studies show that, despite recommended intakes, patients with problems with breathing, and sepsis had decreased status of vitamin C, with a significant rate of insufficiency. Vitamin C has positive impacts in treating infections, and by enhancing the immune system, it may provide protection from the present COVID-19 epidemic due to its anti-inflammatory and antioxidant effects. Vitamin C requirements have been confirmed in limited interventional trials. One 1 g dosage of vitamin C is required to bring critically ill patients’ vitamin C levels back to normal patients. Although adequate vitamin C dietary intakes (i.e., $0.2 \times 10^{-3}$ kg per day) may reduce/decreased the incidence of coronary artery disease, becoming sick with a respiratory illness. To conclude vitamin C, we need it regular in our diet to protects our body from various diseases even from the deadly virus COVID-19.

Data availability

Data will be made available on request.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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