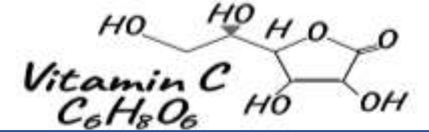


Nutritional Science – Methods for Food and Health (Vitamin C)

Introduction

Severe and long-term vitamin C deficiency can result in fatal scurvy, which is thankfully now considered rare. However, a mild state of vitamin C (Vit C) insufficiency (hypovitaminosis C)—defined as a plasma level below 23 M—is estimated to affect up to 12% of the Western population, albeit clinical manifestations other than scurvy have not been related to Vit C deficiency (Knapik et al., 2021). The brain retains a high Vit C content and levels after insufficiency, demonstrating Vit C's relevance in the brain. Vitamin C shortage is expected to influence various brain targets, including antioxidant and co-factor functioning. It may be especially critical during development, when a high cellular metabolism and an immature antioxidant system may enhance vulnerability (Tveden-Nyborg, 2021). Therefore, this poster will critically evaluate clinical methods used for assessing an element of an individual's nutritional status. And it will assess one of the methods used to determine the nutrient composition of a particular food.

Prevalence, Symptoms, and Risks of Vitamin C Deficiency

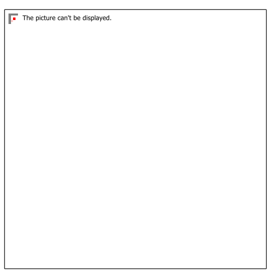
Vitamin C usage is a significant predictor of body state, with the quantity and intensity of consumption associated with plasma status and the occurrence of insufficiency. Fresh fruit and vegetables are the most important dietary sources of vitamin C, with fruit consumption having a stronger correlation with plasma vitamin C status. Oranges and other citrus fruits, guavas, kiwifruit, cranberries, strawberries, plums, papaya, cantaloupe, watermelon, lettuce, Mustard greens, peppers, spears, and Green beans are all high in vitamin C. And cereals (e.g., rice, wheat, flour, maize), certain starchy roots and potatoes, meat (excluding liver), poultry, and milk, on the other hand, contain relatively little vitamin C (Carr & Rowe, 2020). According to NyyssÖnen et al. (1997), low plasma ascorbate concentrations indicate vitamin C deficiency, a risk factor for cardiovascular diseases. Similarly, according to Wang et al. (2018), nutritional techniques point to the possible benefits of a vitamin C-rich diet as a preventative measure for people with skin problems. Vitamin C is non-toxic, easy to get, and inexpensive. As a result, if it can be used for clinical dermatological therapy, the prospects should be up-and-coming. Notably, vitamin C treatment reduced inflammatory cytokine release, decreased melanoma spread, lowered tumour growth, and improved tumour encapsulation after a breast cancer challenge. Moreover, Traber et al. (2019) found the basis for inquiry that low vitamin C status increases endothelial dysfunction, which leads to metabolic disorders that inhibit vitamin C trafficking via a mechanism that involves the gut-liver axis. Their findings highlight the critical need for longitudinal research aimed at justifying therapeutic approaches for managing endothelial dysfunction early but an inflammation-inducing occurrence that not only occurs in Metabolic syndrome but is also predictive of more developed metabolic disorders such as type 2 diabetes mellitus and the increasing severity of the fatty liver disease.

Table 1. Nutritional factors shaping vitamin C status.

Factor	Summary
Dietary intake	Dietary intake, especially fruit intake, corresponds with improved vitamin C status and a lower incidence of insufficiency; this is depending on the quantity ingested, regularity of ingestion, and kind of food consumed, as vitamin C concentration varies. Low vitamin C consumption and status are linked to a high dietary fat and sugar intake.
Staple foods	Cereals (e.g., maize, quinoa, grains, corn) and some carbohydrate stems and tubers are poor in vitamin C; people who eat these foods may have a generally lower vitamin C consumption.
Traditional cooking practices	Water-soluble vitamins may be leached from food during boiling or steaming, and extended cooking can degrade vitamin C, potentially leading to low vitamin C status in particular socioeconomic or cultural groups. Water-soluble vitamins are also reduced when leafy plants are dried.
Supplement use	Users of vitamin C supplements had much greater vitamin C status and a low rate of insufficiency. Non-users have a 2–3-fold increased risk of having low or deficient vitamin C status.

Source (Carr & Rowe, 2020)

Figure 1. Vitamin C content of selected fruits and vegetables was estimated. Data sourced from the US Department of Agriculture (https://fdc.nal.usda.gov/). It should be noted that vitamin C concentration varies according to the plant species, and heating may reduce vitamin C content to varying degrees. Black beans, chickpeas, root crops, black beans, canola, quinoa, groundnuts, and split peas are examples of pulses; nuts include walnuts, pecans, almonds, pistachios, cashews, brazil nuts, and cashew nuts; seeds include chia, flaxseed oil, sesame seeds, sunflower seeds, and sesame seeds; and grains include rice, millet, wheat/cous Meat (excluding liver), eggs, and milk contain small amounts of vitamin C. Dotted lines: the lower line represents daily consumption to avoid scurvy (20 mg/d), whereas the higher line represents daily intake for good health (300 mg/d).



Clinical Tests for Vitamin C Status

According to Abdullah et al. (2021), evaluating risk factors and a physical examination are the first steps in diagnosis. A 5 mm punch biopsy of afflicted regions displaying comparable findings by histology can be utilised to help in the diagnosis, confirming follicular purpura and corkscrew hairs. Serum testing for low plasma vitamin C levels is typically consistent with scurvy, but, as previously indicated, current consumption or supplementation may boost plasma levels and not represent a past long-term shortfall. When examining the limited vitamin C reserves, the amount of vitamin C in leukocytes is more accurate since acute dietary changes less impact it. A vitamin C level of 0 mg/dL in leukocytes indicates latent scurvy. A group of zero to seven milligrammes per deciliter (mg/dL) indicates a deficiency, whereas a level of more than fifteen milligrammes per deciliter is adequate. In addition to measuring vitamin C levels, a check for other vitamin deficits should be performed. Because insufficiency is primarily caused by inadequate consumption, persons affected may also be deficient in other critical vitamins and minerals. Vitamin B12, folate, magnesium, calcium, and iron have all been flawed in this patient group. Furthermore, due to vitamin C's function in iron absorption, persons with scurvy are more prone to bleeding, and iron deficiency, in particular, should be evaluated.

Furthermore, according to Collie et al. (2020), any vitamin C testing process utilised to monitor current plasma concentration, provide information on the pharmacology of therapy, or determine optimal doses necessitates the usage of a protocol. It minimises sample loss or deterioration before analysis. It must also have a dependable, robust measuring method that spans the complete investigatory range of deficiency, hypovitaminosis C, and high-dose supranormal values. Vitamin C has numerous measurands that may be analysed independently or together:

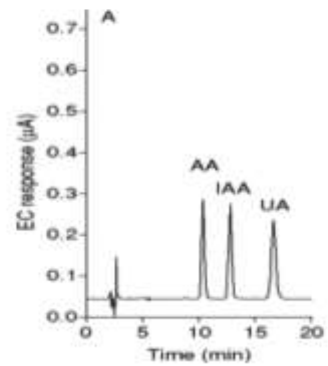
- ascorbic acid alone;
- ascorbic acid and its oxidised form dehydroascorbic acid (DHA) separately;
- total vitamin (ascorbic acid plus DHA), where DHA is converted to ascorbic acid before measurement.

Tests Explanation and Evaluation

Firstly, according to Uchida et al. (2011), it has been proposed that various dietary components, such as bioflavonoids, influence the bioavailability of ascorbic acid in humans. After consuming commercial ascorbic acid or acerola juice, we studied young Japanese guys to compare the amounts absorbed and excreted because little is known about the efficient consumption of this dietary requirement in Japan. A 14-day or longer intervals, healthy Japanese volunteers were given a single oral dosage of ascorbic acid solution and distilled water as a control. All individuals' blood and urine were collected till 7 hours after intake and examined for time-dependent changes in plasma and urinary ascorbic acid levels. After infusion, the area under the graph (AUG) values in plasma and urine rose dose-dependently. Each individual was given a diluted acerola juice containing 200 mg of ascorbic acid. Similarly, the amounts of ascorbic acid in their plasma and urine were determined. The AUC value of ascorbic acid in plasma following intake of acerola juice was greater than that of ascorbic acid alone. In contrast, the urine excretion of ascorbic acid was considerably lower at 2,3 and 5 hours after intake of acerola juice than that of ascorbic acid. These findings suggest that some elements of acerola juice influenced ascorbic acid absorption and excretion.

Secondly, according to Pisoschi et al. (2014), at neutral pH, dehydroascorbic acid is reduced to AA by thiol-containing lowering agents such as glutathione, methionine 2-mercaptoethanol, and DTT. DHAA should be quantitatively converted into AA during incubation of the sample extract with a reductant. The introduction of an oxidising agent to the sample extract increases the stability of vitamin C in the extract during the extraction method and the storage duration in the autosampler for HPLC analysis. Ascorbic acid is resistant to oxidation, and because DHAA is converted to AA, it is resistant to hydrolysis to 2,3-diketogulonic acid. Thiol-containing reducing agents, such as AA and DHAA, have limited stability and reducing capability in acidic conditions. MPA excavation at low pH is commonly used for sample preparation, followed by pH correction to neutral and incubation with a reductant. As a result, the pH must be decreased to assure the stability of the AA. This process is more arduous, and because reductants degrade at low pH, the lowering sample environment, and hence the strength of the AA in extracts, is maintained for less than 24 hours. It should be emphasised that equivalent AA and DHAA stability may be produced without the inclusion of a reductant by tailoring the extraction buffer in terms of pH and temperature and the amounts of MPA and chelator. Their research has been described as a potential DHAA reductant in physiological samples. Compared to frequently used reductants, the main benefit of this chemical is its excellent stability and reductive capability at low pH. It has been demonstrated that AA can be stabilised in sample extracts for at least 72 h and that TCEP does not interfere with the chromatographic technique.

Figure 2



Conclusion

This poster gave a brief overview of Vitamin C's health research area deficiency. It goes deep in this area by exploring the symptoms of Vitamin C deficiency and its causes, and it provides a list of food items that help overcome this deficiency. After that, it gave a brief overview of the clinical tests to determine the lack of Vitamin C in different persons and food items. Moreover, it gave a detailed explanation of these tests and critically evaluated them through relevant literature. But lack of literature didn't allow to conduct a more thorough analysis. Therefore, it is recommended that a comprehensive clinical study should be undertaken to dive deep into this area.

Lastly, according to Abeysuriya et al. (2020), The sum of ascorbic acid (AA) and dehydroascorbic acid (DHA) is termed total vitamin C (TVC) (DHA). Dehydroascorbic acid (DHA) is the aromatic hydrocarbon of vitamin c, and it has been discovered that DHA may be reduced reversibly into ascorbate in enzymatic activity. And stored to enhance ascorbate storage in guinea pig tissues; a similar process can be expected in humans. Because fruits are high in metabolising enzymes, DHA recycling can occur within the fruits, mimicking the behaviour of guinea pigs. Scientific research has yet to be directed in this direction. Vitamin C insufficiency is a significant public health concern worldwide, particularly in impoverished nations, with severe shortages culminating in scurvy. Because of the numerous pharmacological properties linked with fruits, natural products and chemical researchers have focused on fruits as preventative strategies for prevalent NCDs. It is widely established that phytochemicals found in plant components, especially fruits, have synergistic pharmacological actions that boost human immune function, directly associated with a lower risk of NCDs. High peroxidation in cells, caused by an imbalance between the formation and quenching of oxidants, specifically reactive oxygen (ROS) and reactionary nitrogen (RNS) species in cells, has been proposed to cause several NCDs. In this sense, natural antioxidants such as flavonoids, which have been recognised as nutraceuticals, and ascorbic acids found in fruits may operate as nonenzymatic routes to quench damaging radicals and, as a result, minimise excess oxidative stress in cells. This investigation confirmed that the locally accessible underused fruits P. emblica, A. occidentale, A. marmelos, and E. serratus are high in ascorbic acid, total vitamin C, phenolic, flavonoid, iron, and antioxidant capacity. P. emblica is the most abundant. As a consequence of these findings, underused fruits may be a helpful alternative or complement to common fruits in promoting and safeguarding better health in human populations and lowering the risk of several NCDs and micronutrient deficiencies.

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