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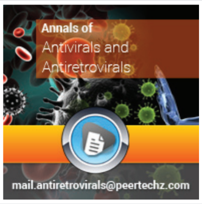

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Perspective

Selenium supplementation in the prevention of coronavirus infections* (*In Memory of Laszlo G. Egyud)

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Abstract

Selenium (Se) is a ubiquitous element akin to sulfur (S) existing in the Earth's crust in various organic and inorganic forms. Selenium concentration varies greatly depending on the geographic area. Consequently, the content of selenium in food products is also variable. It is known that low Se is associated with an increased incidence of cancer and heart diseases. Therefore, it is advisable to supplement your diet with this element albeit in a proper form. Although blood increased concentrations of Se can be achieved with various pharmacological preparations only one chemical form (sodium selenite) can offer true protection. Sodium selenite, but not *selenate*, can oxidize thiol groups in the virus protein disulfide isomerase rendering it unable to penetrate the healthy cell membrane. In this way, selenite inhibits the entrance of viruses into the healthy cells and abolishes their infectivity. Therefore, this simple chemical compound can potentially be used in the recent battle against the coronavirus epidemic.

Selenium (Se) is similar to sulfur (S) [1] but its concentration in Earth's crust is much lower and its distribution is very uneven [2]. Sulfur, by contrast to selenium, is widely present in inorganic and organic compounds, particularly in proteins in the form of intra- or inter-molecular disulfides bridges, that determine their specific properties and functions. It is known, however, that such bridges are susceptible to the so-called disulfide exchange reaction and in this way alter their spatial configuration. A classical example is a limited disulfide reduction of human serum that results in the formation of a huge insoluble copolymer composed of all its proteins [3], that is effectively inhibited by sodium selenite [4].

In nature, Se exists mostly in two forms, namely as selenite with four-valent (Se^{4+}), and as selenate with six-valent (Se^{6+}) cations respectively, from which all other selenium species are derived. Organic forms of selenium are found in plants, fruits, seeds, and particularly in Brazilian nuts in the form of selenides e.g. as selenocysteine and selenomethionine. Human daily intake of Se varies greatly, from 50 to 600 µg/day depending on the geographical location of the soil on which food products are grown. In extreme cases, the very low content of Se in the soil brings about pathologic consequences known as Keshan disease [5]. Grains are also important sources of dietary selenium. However, there are significant differences in the Se content in grains cultivated in North America (0.3-1.3ppm) and those grown e.g. in Sweden (0.0070-022ppm). On the other hand, the selenium concentration in seafood is relatively high (0.1-3.9ppm). It was suggested decades ago that selenium may possess cancer-protecting effects in man, and that the selenium-deficient diet in developed countries may contribute to increased incidence of malignant tumors [6] as well as to the prevention of viral infections [7]. However, it should be strongly emphasized that, due to the specific redox properties of selenite, only this form of selenium can have truly beneficial health effects.

It should be, however, emphasizes that selenium toxicity to humans depends on the chemical form of this element [8]. One should also distinguish between selenium toxicity to normal cells versus neoplastic ones. In general, organic Se compounds are less toxic than inorganic, but the LD_{50} doses vary greatly depending on the duration of exposure, the used model, and the blood levels achieved. More recently it was reported that intravenous administration of sodium selenite at the dose of 500 µg/day was completely non-toxic [9]. At the same time,

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relatively high doses of selenite (up to 2,000µg/day) were reported to be well tolerated in patients with peritonitis [10]. The LD_{50} dose for sodium selenite in rats was established to be 4,100µg/kg bodyweight, which is a hundred-fold greater than that generally accepted for humans. In humans, mild symptoms of toxicity in the form of reversible hair loss and fingernail brittleness start to occur at a dose of 1,000 µg/day during one year of observation. Organic Se compounds are less toxic than inorganic, but the LD_{50} doses vary greatly depending on the duration of exposure, the experimental model, and the blood concentrations achieved. More recently Nuttal [8] indicated that selenium concentration in human serum ranges from 400 to 30,000µg/L, the levels >1,400µg/L being non-toxic. The LD_{50} dose for sodium selenite in rats was established to be 4,1000µg/kg body weight, which is a hundred-fold greater than that accepted for humans. It is generally believed, albeit not confirmed, that the toxic doses of selenite start from 600µg/day. However, symptoms of toxicity in the form of reversible hair loss and fingernails brittleness start to occur at a dose of 1000µg/day in a year. Because of such conflicting data on selenite toxicity, the author of this article had decided to ingest 10,000µg of sodium selenite in one dose. Subsequent tests revealed that neither bleeding time nor the blood coagulation rate performed within 0-24 hours after the ingestion showed any abnormalities (unpublished data). These findings are very significant since the human hemostatic system is very sensitive to the presence of any toxic substance in circulation.

It is generally believed that selenium and its compounds are antioxidants. This confusing notion stems from the observation that selenium is a cofactor in glutathione peroxidase, a biologically powerful antioxidant. It should be noted that the term ‘oxidation’ is somewhat misleading because it does not always involve oxygen atoms. Simply, an oxidant is an atom and/or a molecule that accepts, and a reductant is such that donates electrons respectively. Thus, selenite with a four-valent cation (Se^{4+}) can accept two electrons to become six-valent *selenate* (Se^{6+}) and this way acts as an oxidant. This oxidizing capacity of selenite has very important implications for its antiviral property. Selenite reacts readily with the sulfhydryl groups in the active site of viral Protein Disulfide Isomerase (PDI) converting them to inactive disulfide according to the following formula:

$$PDI\text{-}(SH)_2 + Se^{+4} \rightarrow PDI\text{-}SS\text{-}PDI + Se^{+6}$$

In this way, the viral hydrophobic spike loses its ability to undergo the exchange reaction with disulfide groups of cell membrane proteins and thus prevents virus entrance to the cell cytoplasm [11]. The same mechanism applies to the action of surface disinfection agents that contain oxidizing agents such as phenol, hydrogen peroxide, and hypochlorite [12]. It should be noted that selenium has been implicated as an important factor in aging and aging-related diseases [13], and the prevention of mammary cancer [14]. There are also numerous reports describing the relationship between selenium and other diseases such as type 2 diabetes mellitus [15], asthma [16] and cardiovascular diseases [17]. The significance of selenium in human health was extensively reviewed by Brown&Arthur [18]. Apparently, these diseases are associated with the increased expression of the protein thiol groups (-SH), which are then oxidized by selenium to inactive disulfides (S-S).

Given the facts mentioned above, it seems logical to assume that sodium selenite could represent an ideal agent for the prevention of viral infections including coronavirus, according to the mechanism suggested for the Ebola virus [19]. It should be mentioned that this chemical reagent is rather inexpensive and readily available online. It is only unfortunately that physicians, having limited knowledge of this mineral, cannot understand that such a simple chemical substance can have such dramatic health effects.

References

1. Wessjohann LA, Schneider A, Abbas M, Brandt W (2007) Selenium chemistry and biochemistry in comparison to sulfur. J Biol Chem 388: 997-1006. **Link:** https://bit.ly/3Ji0DyM
2. Duntas LH, Benvenga S (2014) Selenium: An element for life. Endocrine 48: 756-775. **Link:** https://bit.ly/3DFgtCi
3. Lipinski B, Egyud LG (1992) Thiol-induced crosslinking of human blood proteins. Implications for tumor immunity. Bioorg Med Chem. Lett 2: 919-924. **Link:** https://bit.ly/35Htvm5
4. Frenkel GD, Falvey D, MacVicar C (1991) Products of the reaction of selenite with intracellular sulhydryl groups. Biol Trace Elem Res 30: 9-18. **Link:** https://bit.ly/3KaGOdK
5. Chen J (2012) An original discovery: Selenium deficiency and Keshan disease (an endemic heart disease). Asia Pac J Clin Nutr 21: 320-326. **Link:** https://bit.ly/3LIWdlX
6. Spallholtz JE (1994) On the nature of selenium toxicity and cancerostatic activity. Free Radic Biol Med 17:45-64. **Link:** https://bit.ly/3uaeFOl
7. Beck MA, Nelson HK, Shi Q (2001) Selenium deficiency increases the pathology of an influenza virus infection. FASEB J. 15: 1481-1483. **Link:** https://bit.ly/3r4DCsx
8. Nuttal KL (2006) Evaluating selenium poisoning. Ann Clin Lab Sci 36: 409-420. **Link:** https://bit.ly/3r5f5DI
9. Wang Z, Vincent JL, Forceville X (2010) A large bolus injection, but not continuous infusion of sodium selenite improves outcome in peritonitis. Shock 33: 554-555. **Link:** https://bit.ly/38v1G1u
10. Forceville X (2007) Effects of high doses of sodium selenite in septic shock patients: a placebo controlled, randomized double blind, multicenter phase II study: selenium and sepsis. J Trace Elem Med Biol 21: 62-65. **Link:** https://bit.ly/37nzg9e
11. Diwaker D, Mishra KP, Ganju L (2013) Potential role of protein disulfide isomerase in viral infections. Acta Virol 57: 293-304. **Link:** https://bit.ly/3NP60J6
12. Kampf G, Todt D, Pfender S, Steimann E (2020) Resistance of coronavirus on inanimate surfaces and their inactivation with biocidal agents. J Hosp Infect 104: 246-251. **Link:** https://bit.ly/3j4H3v0
13. Cai Z, Zhang J, Li H (2019) Selenium, aging and aging-related diseases. Ageing Clin Exp Res 31: 1035-1047. **Link:** https://bit.ly/3DGQYQU
14. Jiang C, Jiang W, Ip C, Ganther H, Lu J (1999) Selenium-induced inhibition of angiogenesis in mammary cancer chemopreventive levels of intake. Mol Carcinog 26: 213-235. **Link:** https://bit.ly/3KaxGFT

Citation: Lipinski B (2022) Selenium supplementation in the prevention of coronavirus infections* (*In Memory of Laszlo G. Egyud). Ann Antivir Antiretrovir 6(1): 001-003. DOI: https://dx.doi.org/10.17352/aaa.000015

15. Stranges S. et al. (2010) A prospective study of dietary selenium intake and risk of type 2 diabetes. BMC Public Health 10: 564-576. **Link:** https://bit.ly/3LHraH5

16. Gazdzik F, Pijak MR, Gazdzikova K. (2004) Need of complementary therapy with selenium in asthmatics. Nutrition 20: 950-952. **Link:** https://bit.ly/3J777Ad

17. Tanguy S, Grauzam S, ds Leiris J, Boucher F (2012) Impact of dietary selenium intake on cardiac health: experimental approaches and human studies., Mol Nutr Food Res 56: 1106-1121. **Link:** https://bit.ly/38vIwIT

18. Brown KM, Arthur JR (2001) Selenium, selenoproteins and human health: a review. Public Health Nutr 4: 593-599. **Link:** https://bit.ly/3NRpoVW

19. Lipinski B (2015) Can selenite be an ultimate inhibitor of EBOLA and other viral infections? Br J Medic Med Res 6: 319-324. **Link:** https://bit.ly/36XaDAb

Citation: Lipinski B (2022) Selenium supplementation in the prevention of coronavirus infections* (*In Memory of Laszlo G. Egyud). Ann Antivir Antiretrovir 6(1): 001-003. DOI: https://dx.doi.org/10.17352/aaa.000015