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MIRACLE NUTRIENT

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Abstract:

Vitamin C is essential micronutrient required for normal metabolic functioning of the body. Humans and other primates have lost the ability to synthesize Vitamin C. Vitamin C must be obtained through diet. It is widely available in fruits and vegetables. A lack of vitamin C in the diet leads to disease scurvy. It is involved in the biosynthesis of collagen, lysine, carnitine, tyrosine, norepenephrine and hormones. Vitamin C exhibits powerful antioxidant activity in both water and lipid soluble environments. It prevents oxidative damage of lipids, proteins and DNA. It is involved in reduction of chronic disease morbidity and mortality. A low plasma level of Vitamin C is associated with number of diseases. Vitamin C is useful in the treatment of almost all Cancers, Cardiovascular diseases, Diabetes, Cataract, Asthma and Viral Diseases. Vitamin C acts as beatifying agent by promoting weight loss and skin rejuvenation.

Keywords: Vitamin C, Ascorbic acid, antioxidant

Historical Perspective

The sea voyager/sailors developed a peculiar disease called scurvy when they were on sea. This was found to be due to eating non-perishable items and lack of fresh fruits and vegetables in their diet. A British naval Physician, Lind [1]documented that there was some substance in citrus fruits that can cure scurvy. He developed a method to concentrate and preserve citrus juice for use by sailors. British Navy was given a daily ration of lime or lemon juice

to overcome ascorbic acid deficiency. Ascorbic acid was first isolated from natural sources and structurally characterized by Szent-Gyorgyi, Waugh and King [2, 3].This vitamin was first synthesized by Haworth and Hirst [4]. Currently ascorbic acid is the most widely used vitamin supplement throughout the world.

Dietary Availability

Ascorbic acid is not synthesized by human body. So humans can obtain ascorbate only exogenously. Humans consume vitamin C by mouth with subsequent gastrointestinal absorption and distribution or receive it parenterally. Although ascorbate is added to enteral and parenteral formulations, we will focus here on ascorbate found in foods and supplements.

Vitamin C is mainly found in fruits and vegetables. Rich fruit sources include cantaloupe, grapefruit, honeydew, kiwi, mango, orange, papaya, strawberries, tangelo, tangerine and watermelon. Fruit juices containing vitamin C in abundance include grapefruit and orange juices. Several fruit juices are fortified with vitamin C, including apple, cranberry and grape juices. Rich vegetable sources of vitamin C include asparagus, broccoli, Brussels sprouts, cabbage, cauliflower, kale, mustard greens, pepper (red or green), plantains, potatoes, snow peas, sweet potatoes and tomatoes and tomato juices.

Recommended Dietary Allowance

The minimal daily intake of vitamin C needed to prevent scurvy is approximately 10 mg; however, this does not provide acceptable reserves of the vitamin. The RDA of 60 mg for adults is based on the amount needed to prevent the onset of scorbutic symptoms for 4 weeks and provide a margin of safety.

Increased intakes of vitamin C are required to maintain normal plasma levels under acute emotional or environmental stress such as trauma, fever, infection, or elevated environmental temperatures. Because of the lower concentrations of ascorbic acid in the serum of cigarette smokers, it is recommended that smokers increase their intake to at least 100 mg/day (Food and Nutrition Board, 1989).Based on literature reports it has been recommended that RDA for ascorbic acid 120 mg/day for optimal risk reduction in case of cardiovascular diseases and cataract. However even higher doses are needed to treat both chronic (500mg/day) and acute (1-3g) form of vasoreactivity. [5]

Biochemistry and Function

Vitamin C (ascorbic acid) is a six-carbon lactone that is synthesized from glucose in the liver of most mammalian species, but not by humans, non-human primates and guinea pigs. These species do not have the enzyme gulonolactone oxidase, which is essential for synthesis of the ascorbic acid immediate precursor 2-keto-l-gulonolactone. The DNA encoding for gulonolactone oxidase has undergone substantial mutation, resulting in the absence of a functional enzyme [6, 7].

Vitamin C represents a redox system consisting of 2 L-isomers: ascorbic acid (vitamin C) in the reduced state and dehydroascorbic acid (DHA) in the oxidized state (Fig1).Vitamin C is an electron donor and therefore a reducing agent. All known physiological and biochemical actions of vitamin C are due to its action as an electron donor. Ascorbic acid donates two electrons from a double bond between the second and third carbons of the 6-carbon molecule. Vitamin C is called an antioxidant because, by donating its electrons, it prevents other compounds from being oxidized.

Vitamin C itself is oxidized in the process. It is note worthy that when vitamin C donates electrons, they are lost sequentially. The species formed after the loss of one electron is a free radical, semidehydroascorbic acid or ascorbyl radical. Ascorbyl radical is relatively stable with a half-life of 10^{-5} seconds and is fairly unreactive. This property explains why ascorbate may be a preferred antioxidant. In simple terms, a reactive and possibly harmful free radical can interact with ascorbate. The reactive free radical is reduced, and the ascorbyl radical formed in its place is less reactive. Reduction of a reactive free radical with formation of a less reactive compound is sometimes called free radical scavenging or quenching. Ascorbate is therefore a good free radical scavenger due to its chemical properties [8, 9].

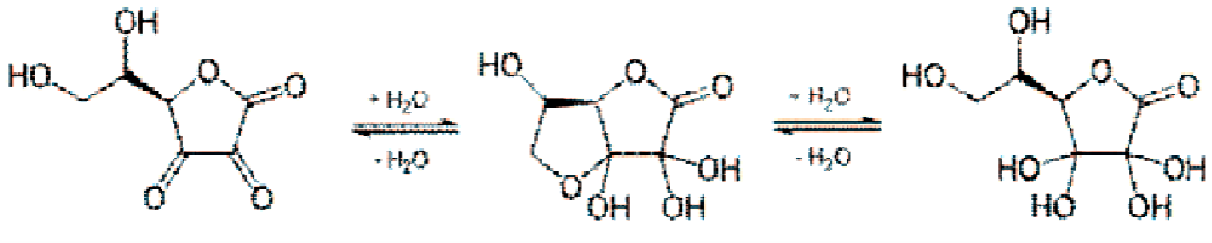

Fig 1: Ascorbic Acid Ascorbyl Radical Dehydro Ascorbic Acid

When used as a cofactor or antioxidant, vitamin C is oxidized to the more unstable dehydro ascorbic acid, which is readily ‘‘recycled’’ back to vitamin C by several enzyme systems, including glutathione dependent systems or reduced nicotinamide adenine dinucleotide phosphate (NADPH)-dependent systems.[10]

Vitamin C can be oxidized by many species that have potential to be involved in human diseases [11]. The relevant species, which receive electrons and are reduced by vitamin C, can be divided into several classes:

1) Compounds with unpaired electrons (radicals) such as oxygen related radicals (superoxide, hydroxyl radical, peroxyl radicals), sulphur radicals and nitrogen-oxygen radicals. With the exception of the sulfur radicals, these compounds are sometimes termed reactive oxygen species and reactive nitrogen species.

2) Compounds that are reactive but are not radicals, including hypochlorous acid, nitrosamines and other nitrosating compounds, nitrous acid related compounds and ozone.

3) Compounds that are formed by reaction with either of the first two classes and then react with vitamin C. An example is formation of the alpha tocopheroxyl radical, which is generated when exogenous radical oxidants interact with alpha tocopherol in low-density lipoprotein (LDL). The tocopheroxyl radical can be reduced by ascorbate back to alpha tocopherol [12].

4) Reduction of metal ions such as iron or copper by vitamin C in vitro (Eq *1)* can result in the formation of highly reactive hydroxyl radicals via reaction of the reduced metal ions with hydrogen peroxide, a process known as Fenton chemistry (Eq 2) [5].The formed H_2O_2 concentration is more in extracellularly and is showing lethal to cancer cells [13, 14, 15].

$$AH^- + M^{(n+1)} \rightarrow \text{®} \; A^{\bullet -} + M^n + H^+ \qquad (1)$$

$$H_2O_2 + M^n \rightarrow \text{®} \; {}^{\bullet}OH + OH^- + M^{(n+1)} \; (2)$$

Where equation *1* shows the reduction of redox-active metal ions [$M^{(n+1)}$] by reversible 1- and 2-electron oxidation of ascorbate (AH^-) to ascorbyl radical ($A^{\bullet -}$) and the reduced metal M^n. Equation *2* shows the production of highly reactive hydroxyl radical [$^{\bullet}OH$] from the reaction of hydrogen peroxide (H_2O_2) with reduced metal ions.

Vitamin C functions as an enzyme cofactor in a number of hydroxylation reactions in vivo; specifically, vitamin C maintains metal ions within these enzymes in a reduced state which is required for enzyme activity .[16] Three of these

enzymes function in collagen biosynthesis: prolyl 4-hydroxylase, prolyl 3-hydroxylase, and lysyl hydroxylase enzymes. [17]

Carnitine, tyrosine, and certain neurotransmitter and hormone synthesis is aided by vitamin C as well. Trimethyllysine dioxygenase and 4-g-butyrobetaine dioxygenase are both enzymes used in the production of carnitine. In these enzymes, vitamin C again serves as a reducing agent, reducing iron to its ferrous state.[18] In tyrosine synthesis; vitamin C is thought to maintain ferrous iron in the homogentisate dioxygenase enzyme and cuprous copper in p- hydroxyphenylpyruvate. Both enzymes are essential in the conversion of phenylalanine to tyrosine. The production of certain neurotransmitters and hormones require vitamin C to maintain cuprous copper for enzyme activity.

Dopamine b-hydroxylase catalyzes the conversion of dopamine to norepinephrine, requiring vitamin C for the process. [19] In addition, peptidyl-glycine a-amidating monooxygenase catalyzes many reactions through the amidation of peptides. This enzyme is responsible for the synthesis of neurotransmitters and hormones, including calcitonin, oxytocin, vasopressin, cholecystokinin, and gastrin-releasing peptide. [20]

As an effective reducing agent, vitamin C also serves as a powerful antioxidant, scavenging reactive oxygen and nitrogen species in the body. Reactive species are generated by normal cell processes as well as environmental stressors and can cause oxidative damage to lipids, cell proteins, and nucleic acids in DNA. The evidence of biomarkers for oxidative reaction and antioxidant action of vitamin C was also proved in humans [21, 22-31].

Although the direct antioxidant protection afforded by vitamin C is limited to water-soluble environments, vitamin C does play an antioxidant role in lipids through its regeneration of fat-soluble vitamin E. Vitamin C readily donates an electron to the vitamin E radical to regenerate the active form of vitamin E, a-tocopherol. The antioxidant function of a-tocopherol limits lipid -peroxidation in the membranes of cells, mitochondria, and endoplasmic reticulum, and thereby maintains cell integrity. [10]

Histamine promotes blood flow and healing in times of physiological stress. Excess amount of histamine is noted during periods of chronic stress, inflammation, or allergy, and negatively affects immunity and respiration. Vitamin

C destroys the imidazole ring of the histamine molecule, and an inverse relationship has been demonstrated between plasma vitamin C concentrations and blood histamine. [32]

Vitamin C enhances iron bioavailability by maintaining non-heme iron in the ferrous state in the intestinal tract. Vitamin C also promotes duodenal ferric reductase activity further contributing to the absorption potential of dietary iron.[33] Iron absorption increased in a dose– response manner when vitamin C was ingested with a meal[34].Vitamin C up regulates ferritin messenger ribonucleic acid (messenger RNA) translation thereby increasing intracellular iron storage and preventing iron-induced oxidative damage within cells..[11,35]

Therapeutic Role

Many epidemiologic studies and a limited number of clinical trials have indicated that dietary intake of, or supplementation with, antioxidant vitamins is associated with a reduction in the Incidence of chronic disease morbidity and mortality [36, 37, 38]. Because vitamin C acts as an antioxidant and can ameliorate oxidative damage to lipids, DNA, and proteins, the association of vitamin C with cardiovascular disease, cancer, and cataract, respectively. Many other disease states have been studied in relationship to vitamin C, including age-related macular degeneration, cataract, infectious diseases, asthma, gout, diabetes, and rheumatoid arthritis

Infectious Diseases

Ascorbic acid is widely preferred for the treatment of infectious diseases. Vitamin C is playing a role in immune responses. The high concentration of ascorbate in leucocytes and its rapid expenditure during infection and phagocytosis suggests a role for the vitamin in the immune process. Evidence published to date shows an involvement of vitamin C in the migration and phagocytosis by macrophages and leucocytes, as well as the induction and expression of delayed hypersensitivity. Because of this reason it is widely used in viral infections and some bacterial infections. [39, 40]

Antiviral Activity

Vitamin C at high doses is effective in preventing viral infection and enhancing recovery. [41, 42] several mechanisms are known, including specific viral anti-replication processes and enhancement of many components of the body's cellular immune system. Ascorbate has been shown to have specific antiviral effects in which it inactivates the RNA

or DNA of viruses [43, 44, 45]. A Mega dose of Vitamin C is useful in treatment of cold and flu symptoms [46-60], viral pneumonia, hepatitis, poliomyelitis [61-63], AIDS [64], measles, encephalitis [40], granulomatous disease [65], influenza [66] and shingles.

Cataract

Cataract is a dysfunction of the lens resulting from opacification, which impedes the transmission of light [67]. About 98% of the solid mass of the lens is protein, predominantly crystalline. These proteins are long lived and undergo minimal turnover; as a result, cataract formation is primarily age related. Oxidation of the lens proteins as a result of chronic exposure to ultraviolet light and oxygen has been implicated in this process [67; 68].High intake of vitamin C is useful in the treatment of cataract. Antioxidant property of vitamin C is helps in prevention of lens oxidation [69]. A study was conducted in Mediterranean population and evidenced the protective role for vitamin C on the aging lens. [70]

Asthma

Prevalence of asthma has increased considerably in recent decades throughout the world especially in developed countries. Airway inflammation is thought to be prime cause for repeated episodes of airway obstruction in asthmatics. Several studies have shown that reactive oxygen species (ROS) play a key role in initiation as well as amplification of inflammation in asthmatic airways.[71, 72.] Vitamin C levels are diminished in mild asthma [73]. Vitamin C is having antioxidant property and is associated to reduce oxidative stress. Dietary intake of vitamin C may be associated with reduced risk of asthma[74-76].The Nutritional and Health Survey in Taiwan (NAHSIT) study examined the relationships of nutrient intake and physician diagnosed asthma and allergic rhinitis in 1,116 adolescents 13,17yr. The study showed a marginally significant association between vitamin C intake in the lowest quartile and an elevated risk for asthma[77].

Arthritis

Antioxidant supplements and diets have long been advocated for the treatment of rheumatoid arthritis (RA), osteoarthritis (OA) and other inflammatory arthritis. Arthritis (OA and RA) is caused due to free radicals [78, 79-81] and in particular, via the effects upon lipids and cartilage. [82, 83] Reactive oxygen species also damage cartilage and the

extracellular matrix and inhibit collagen and proteoglycan synthesis [84]. Epidemiological studies have shown that deficient antioxidants in diet may associated with the increased incidence of arthritis or faster disease progression.[80,85]A randomized study was performed by using dietary vitamins and selenium in the treatment of arthritis. The study of vitamin C reported to be useful in the osteoarthritis treatment [78, 86].vitamin C protects and maintains healthy bone mass.[87]

Gout

Gout is a condition caused by elevated levels of uric acid in the body. If levels are high enough, uric acid can end up crystallizing in one or more joint, which typically causes intense pain and inflammation. Gout quite often affects the ball of the foot (the major joint of the big toe), but the condition can affect any joint. Conventional medical treatment is centered on painkillers and uricosuric agents. Studies have found that vitamin C also found to have uricosuric effect [88-91].The role of vitamin C in the risk of gout patients was also studied in group of patients [92-93].

Cardiovascular disease

Cardiovascular disease is multifactorial with many identifiable risk factors, including diet, tobacco smoking, diabetes, and hypertension.[94] Major risk factors associated with cardiovascular disease are age, male sex, smoking, hypercholesterolemia, hypertension, family history, obesity, and physical inactivity [95,96]. Cardiovascular complications are mainly alterations endogenous substances level like cholesterol, lipoproteins, coagulation factors and endothelial dysfunction. Vitamin C is controlling alterations of these endogenous substrates and maintains proper functioning of the heart.

Hypercholesterolemia is a significant risk factor for cardiovascular disease [96]. The relation between vitamin C supplementation, or plasma vitamin C concentrations, and total serum cholesterol has been investigated in several studies. [96, 97]One putative pathway is through vitamin C's role as a cofactor for cholesterol 7a-monooxygenase, an enzyme involved in the in vivo hydroxylation of cholesterol to form bile acids [98]. Vitamin C may also modulate the activity of hydroxymethylglutaryl-CoA reductase, the rate-limiting enzyme in the biosynthesis of cholesterol [95].

The plasma lipoprotein profile is also an important consideration for cardiovascular disease, with decreased concentrations of HDL and increased concentrations of LDL being significant risk factors [95, 96]. Studies have found a

significant association between elevated plasma vitamin C concentrations and increased concentrations of HDL cholesterol and reduced concentrations of LDL cholesterol [96, 99]. Vitamin C may modulate the activity of lipoprotein lipase [95], although the mechanism is unknown.

The thrombotic risk of cardiovascular disease is associated with increased concentrations of the coagulation factor fibrinogen. [100] There is an inverse association between serum vitamin C concentrations and coagulation factors as well as a positive association between low serum vitamin C and elevated fibrinogen and coagulation activation markers. [100,101,102]. Low concentrations of vitamin C are also associated with increased concentrations of plasminogen activator inhibitor 1, a protein that inhibits fibrinolysis [103].

Impaired vascular function and relaxation are highly relevant to the clinical expression of atherosclerosis, i.e., angina pectoris and myocardial infarction. Vitamin C concentration in plasma is very low in hypertension [104–108], indicating the role of Vitamin C in hypertension. Several studies have shown that administration of Vitamin C is associated with vasodialation.[15] The vasodialatory acitivity of Vitamin C is due to the antioxidant activity, which is required to scavenge superoxide radicals in competition with NO. Vitamin C can also maintain intracellular concentrations of glutathione by a sparing effect or regeneration of thiols from thiyl radicals, which may enhance the synthesis of NO or increase the stabilization of NO through formation of *S*-nitrosothiol species [109].

Cancer

Intravenous administration of Vitamin C is improving the quality of cancer patient's life in cancer [110, 111]. Cancer patients are deficient in Ascorbic acid level. [112,113,114]. Although it was evidenced from the past laboratory experiments, vitamin C has been shown to have a range of effects that could be beneficial to cancer patients, including tumor regression, the inhibition of tumor growth and increased survival of animals with implanted tumors[115,116] as well as promotion of cell differentiation and stabilization of gene transcription. Results of some studies also suggest that ascorbic acid may have a direct cytotoxic effect on tumor cells [117,118,119] and that it may decrease the toxicity and enhance the cytotoxic effect of some chemotherapeutic drugs.[117, 119-122].

The cytotoxic effect of vitamin C may be due to generation of reactive oxygen species via H_2O_2 (Eq1&2) .[30,15] Some studies suggest that malignant cells are more sensitive than normal cells to the cytotoxic effects of ascorbic acid.

However, it is clear that cytotoxic effects occur at the concentrations of ascorbic acid achievable by intravenous administration of vitamin C not by oral supplements in humans[123]. High intakes of vitamin C have been associated with decreased risk of certain cancers, particularly cancers of the pharynx, oral cavity, esophagus, lung, stomach [124], pancreatic cancer [123], mesothelioma[124], hepatoma, colon cancer, sarcoma and leukaemia. Phase II Clinical studies have begun that will test the effect of mega doses of Vitamin C for solid tumors Sarcoma, Adenocarcinoma, Multiple Myeloma and Desmoplastic Small Round Cell Tumor treatment (see clinicaltrials.gov)

Diabetes Mellitus

Diabetes is a metabolic disorder characterized by increased glucose levels and decreased utilization of glucose. Type 2 diabetes is considered to be the epidemic of the 21st century and its prevalence is worldwide. Dietary supplements such as multivitamin have been commonly used for disease prevention. Evidence from basic research and observational studies has suggested that adequate intake of antioxidant vitamins or minerals may protect against the development of type 2 diabetes via reduction of oxidative stress and its associated abnormalities, including systemic inflammation, endothelial dysfunction, hypertension and dislipidemia. These metabolic abnormalities act individually or synergistically to impair pancreatic β-cell insulin secretion and Interfere with glucose disposal in peripheral tissues. Increased glucose levels forms advanced glycatation end products (AGE), which are responsible for micro and macro vascular Complications, cataract and hepatocytes injury in diabetes. Vitamin C has associated with significantly lower risk in diabetes. [125]

Vitamin C shown to affects on glycation of proteins, for example in a research Akhilender showed that all forms of vitamin C can cause decrease in the process of glycation of various proteins such as collagen [126]. Also, Davie et al [127] and Oian et al [128] reported that oral vitamin C inhibited the glycosylation of proteins. Several studies have shown. Vitamin C supplementation is effective in reducing sorbitol accumulation in the erythrocytes of diabetics. Ascorbic acid inhibits the aldose reductase activity. [129] Researchers found that patients with higher levels of vitamin C in their bodies had a less chance of developing Diabetic Retinopathy [130] .The combination of insulin to control blood sugar together with the use of Vitamin C, stopped blood vessel damage caused by the disease in patients with poor glucose control.[131]

Smokers

A significant amount of research has indicated that smokers have a higher requirement for vitamin C than do nonsmokers. Vitamin C concentrations are lower in smokers than in nonsmokers and are inversely related to cigarette consumption. The lower vitamin C status of smokers is most likely due to increased turnover of the vitamin as a result of increased oxidative stress. In one study, vitamin C supplementation significantly reduced the amount of urinary F2-isoprostanes, an indicator of oxidative stress that is elevated in smokers. The RDA for smokers should be 2–3-fold more to current RDA of 60 mg/d to maintain plasma vitamin C concentrations.[5]

Effects of Vitamin C on Skin

Vitamin C, being an antioxidant, reduces the sun damage caused on the skin by neutralizing free radicals. It thus reduces sun damage to an extent. Though it cannot be used as a sunscreen, but if formulated with sunscreens, it adds to the property of protection against sun damage. Vitamin C also stimulates collagen and elasti production in the skin. As we age we lose collagen. We also lose collagen because of sun exposure. Vitamin C helps reduce this loss of collagen. Vitamin C topicals are therefore used to reduce age lines and sun damage. It may also protect against sunburn to a certain extent [news from American chronicle 27 July 2007]

A new research discovery suggest that treatments for disorders that cause accelerated aging, particularly Werner's syndrome, might come straight from the family medicine chest. In the research report, a team of Canadian scientists shows that vitamin C stops and even reverses accelerated aging in a mouse model of Werner's syndrome. [132] Vitamin C supplementation is evidenced to unregulate the DNA repair. The vitamin C may improve wound healing by stimulating quiescent fibroblasts to divide and by promoting their migration into the wounded area [133,134]. Vitamin C could also protect the skin by increasing the capacity of fibroblasts to repair the potentially mutagenic DNA lesions.[135] According to the Canadian study the vitamin C also stops premature aging. Because of skin protecting activity now-a-day's extensive research is going on topical formulations of vitamin C.

Pregnancy

Some past studies have found a connection between vitamin C deficiency and an elevated risk of preterm birth [136,137,138] including those caused by what's known as premature rupture of membranes, where a woman's "water

breaks" before the pregnancy has reached full-term and labor has begun. Vitamin C has been thought to play a role in maintaining the placenta and the membranes that surround the fetus during pregnancy, possibly by limiting so-called oxidative stress. Pregnancy associated hypertension (pre-eclampsia) also treated by Vitamin C [139,140,141].Recent clinical study performed using ascorbic acid alone for pre-eclampsia and complications of pregnancy shown negative results.(Clinical Trials.gov number NCT00135707)

Scientists from the Faculty of Life Sciences at the University of Copenhagen demonstrated that guinea pigs with moderate vitamin C deficiency develop 30 percent fewer hippocampus neurons, a type of brain cells, and have significantly worse spatial memory than those fed a normal diet. Suggesting that pregnant women need to have sufficient intake of vitamin C or L-ascorbic acid to prevent their fetuses from becoming victims of brain impairment that is associated with memory and learning capability later in their childhood.[142]

Role of Vitamin C in weight loss

Obesity is a burden on health systems, with health care expenditure for an obese person at least 25% higher than for someone of normal weight. Since the 1980s, obesity has spread at an alarming rate. According to Organization for Economic Cooperation and Development (OECD), one in 2 adults is currently overweight and 1 in 6 is obese. The rate of overweight people is projected to increase by a further 1% per year for the next 10 years in some countries (www.oecd.or/health). Maintenance of proper BMI is very much essential for obese people. Now-a-days most of the people are in the search for treatment of obesity and ways for weight loss. Carnitine system plays role in the control and regulation of fuel partitioning. This includes both metabolism of fatty acids and the capacity for fatty acid utilization.

Vitamin C is required for the biosynthesis of carnitine, a small molecule responsible for shuttling long chain fatty acids across the mitochondrial membrane for β–oxidation and subsequent fat oxidation. Reduced tissue carnitine, and the associated impact on fat oxidation, is considered the cause of the fatigue of scurvy. Since impaired fat oxidation has been implicated in the development of obesity and in failed weight loss attempts, vitamin C depletion may create a metabolic perturbation that could potentially impact body mass. Several studies have reported a significant inverse relationship between plasma vitamin C concentrations and degree of obesity[143] .Vitamin C is

also evidenced in reducing the cholesterol level in the body [95, 99,102.Thus] dietary intake of more vitamin C may thus help in weight loss.[143]

Known or potential therapeutic uses:

- Recently, medical research at John Hopkins University discovered that Ascorbate Supplements, in conjunction with vitamin E, significantly reduces the risk of Alzheimer's by 78% and provided an 88% reduction in cognitive dementia. (Zandi and others 2004).
- Highest concentrations of Vitamin C in blood were found to have a 42 percent lower stroke risk.
- Injections of vitamin C into the brain can enhance the conversion of dopamine to epinephrine. It may be valuable in the treatment of schizophrenia, chorea, dyskinesia. VanderKamp found that schizophrenics metabolize Vitamin C ten times faster than normals.

Summary and Conclusion

Vitamin C is required for the optimal activity of several important biosynthetic enzymes and is therefore essential for various metabolic pathways in the body. A deficiency of this vitamin results in the symptoms of scurvy and death. Vitamin C acts as a cosubstrate for several mono- and dioxygenases and oxidases and maintains the active-site metal ions of these enzymes in the reduced state. Vitamin C also acts as an efficient scavenger of aqueous radicals and oxidants, thus protecting other biomolecules from oxidative damage. The role of vitamin C in lowering disease incidence is most likely result of its antioxidant activity, apart from well established mechanisms. Vitamin C is associated with reduction in the incidence of chronic disease morbidity and mortality. It improves the quality of life. As such, the potential of adequate vitamin C nutriture to benefit public health and reduce the economic and medical costs associated with these chronic diseases is enormous. Thus it can be seen as well researched observation that usage of this vital vitamin C in regular dietary requirements can surely be termed a panacea for all body inflictions**.**

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