Vitamin C: Prevention of Chronic Diseases and Optimal Doses

TEXT:
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ABSTRACT

The role of vitamin C in prevention and treatment of scurvy is well accepted. In spite of having long history as the candidate of alternative therapy for the prevention and treatment of cancer, still there is no common conclusion on the topic. However, its biochemical reaction as an antioxidant and its immunostimulating effects drew further attention towards its health beneficial effects. Current official recommended dietary allowance in most of the countries is higher than what is needed for the prevention of scurvy, but research result suggested that it is far less to obtain optimum health. Therefore, especially for the prevention of chronic illness such as cancer, hypertension, Alzheimer's diseases etc., it is recommended to consume more fruits and vegetables together with the vitamin C supplements. Evaluating the vitamin C efficiency and safety with current literature, up to 1 g/day supplement of vitamin C has been suggested to be needed for optimal health. In addition, male population compared to female population, older population compared to younger population, smoking population compared to non-smoking population and stressed population compared to non-stressed population need larger amounts of vitamin C to obtain health beneficial effects.

MAIN MESSAGE

Vitamin C (ascorbic acid) is one of the essential components in human physiology working as a water-soluble antioxidant and enzyme cofactor. Humans do not synthesize ascorbate, therefore we need to administer it through diet or supplements. We must assure a sufficient intake of vitamin C in order to define its role for the prevention or treatment of various diseases.

INTRODUCTION

It has been known for a long time that absence of fresh fruit and vegetables in the human diet leads to scurvy, a fatal disease widely described throughout written history (Lind, 1753). Later, it was discovered that ascorbic acid in fresh fruits and vegetables prevents scurvy and that is why it is a vitamin for humans and must be a part of human diet (Mandl et al., 2009).

Among the long list of people who contributed to the knowledge regarding vitamin C, three Nobel prize-winners are in the fore front. Albert Szent-Györgyi discovered vitamin C as an anti-scorbutic factor (Svirbely and Szent-Györgyi, 1932). Walter Norman Haworth used the material from Szent-Györgyi and elucidated the structure and synthesized vitamin C (Haworth and Hirst, 1933). For their contributions, Szent-Györgyi and Haworth were rewarded with Nobel prizes in medicine and chemistry in 1937, respectively. The third person, Linus Pauling is perhaps the most renowned advocate of vitamin C. Pauling believed that high doses of vitamin C can cure or prevent several mental illnesses, chronic diseases such as heart diseases and cancer, including common cold (Pauling, 1970; Cameron and Pauling, 1973; Cameron and Campbell, 1974; Pauling, 1974; Cameron and Pauling, 1979; Cameron and Pauling, 1993). The knowledge contributed by these three great scientists and many others led to the foundation for research on vitamin C.

Although the role of vitamin C in the prevention and treatment of scurvy is well accepted, immunomodulatory effect of vitamin C, its role as an antioxidant to prevent or treat chronic illness and official recommended dietary allowance (RDA) are under critical discussion (Deruelle and Baron, 2008; Mandl, 2009). In this review, the effect of vitamin C on cancer and other diseases and optimal doses are discussed.

UNIQUE CHEMICAL FEATURE AND BIOLOGICAL FUNCTION OF VITAMIN C

Vitamin C ($C_6H_8O_6$) is named as ascorbic acid because of its anti-scorbutic property (Latin word *scorbutus* = scurvy). In solution, it releases a proton to give an anion called ascorbate. Ascorbate easily transfers one electron and one additional proton and can remains in the stable radical form as semidehydroascorbate (SDA), a state in between dehydroascorbic acid (DHA) and ascorbate in the physiological condition (figure 1).

Because of the unique electron transferring capability, ascorbate plays a vital role in living cells. Our body synthesizes collagen to strengthen connective tissue. For this, prolyl residue must be hydroxylated and the reaction is carried out by the enzyme prolyl hydroxylase with the support of vitamin C (figure 2). The hindrance of this biochemical reaction is the cause of scurvy. In spite of having its vital role in physiology, human is unable to synthesize ascorbate due to the absence of the enzyme, gulonolactone oxidase (GLO) as found in most animals and those animals including human unable to produce GLO, need external supplement of ascorbate as vitamin to carry out normal physiological functions (Linster and Van Schaftingen, 2007).

Besides acting as a cofactor in several metabolic reactions, it serves primarily as a biologic antioxidant and free radical scavenger in aqueous environment. Free radicals produced by enzymatic and non-enzymatic reactions inside and outside cells have been suggested as a major cause of aging process (Harman, 1956; Harman, 1994). This theory was further supported by the discovery of superoxide dismutase (SOD) (McCord and Fridovich, 1969). Since then, a great deal of evidences has been accumulated implicating free radical reactive oxygen and nitrogen species in the pathology of a number of chronic diseases and age associated functional decline (Knight, 1998, Ratten 2006; Viña et al., 2007; Gruber et al., 2008; Ljubunic and Reznick 2009). Ascorbate readily scavenges many physiologically relevant reactive oxygen

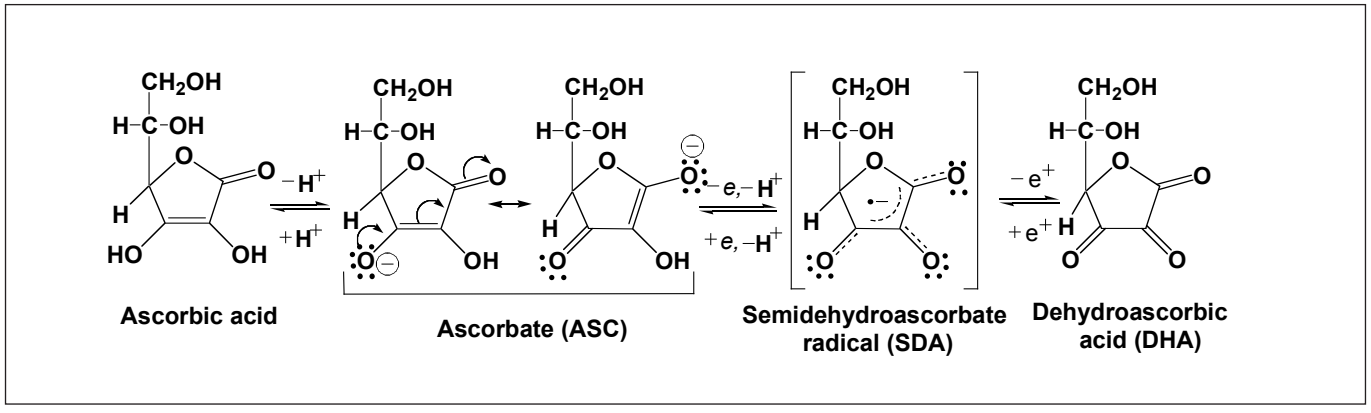

Figure 1. *Structure of ascorbic acid and its fates during physiological reactions.*

and nitrogen species and is the most effective endogenous aqueous phase antioxidant in human plasma under many different oxidizing conditions (Frei et al., 1989). Although other endogenous antioxidants are able to decrease the rate of lipid and protein oxidation in plasma, only ascorbate is reactive enough to intercept oxidants before they can cause detectable oxidative damage. Due to its role as an antioxidant and by having immunomodulatory functions, vitamin C is one of the most promising molecules of health beneficial effects. For this purpose, more than 86,000 metric tons of vitamin C was consumed only in 2003 which is more than 50 % of all the other vitamins. In addition, consumption rate is expected to increase by more than 2000 metric tons per year (Asard et al., 2004).

RECOMMENDED DIETARY ALLOWANCE FOR VITAMIN C

The US Food and Nutrition Board has prepared RDAs for vitamin C since 1941. Initially, the RDA was based on the amount needed to prevent people from getting scurvy with a safety margin but numerous research results suggested that this may not be sufficient for optimal health (Pauling 1974; Levine et al., 1996; Food and Nutrition Board, 2000). Moreover, the RDA for vitamin C is based on estimates of rates of absorption, depletion, turnover and catabolism (Levine et al., 1999; Food and Nutrition Board, 2000). For vitamin C, however, the information is unavailable, incomplete, or flawed. Currently, RDA requirements for vitamin C differ among countries, with the highest value being 110 mg/day (Food and Nutrition Board 2000; Levine et al., 2001). According to Norwegian Social and Health Affair, the RDA for vitamin C are 75 mg per day for the adult and 100 mg per day for the women during

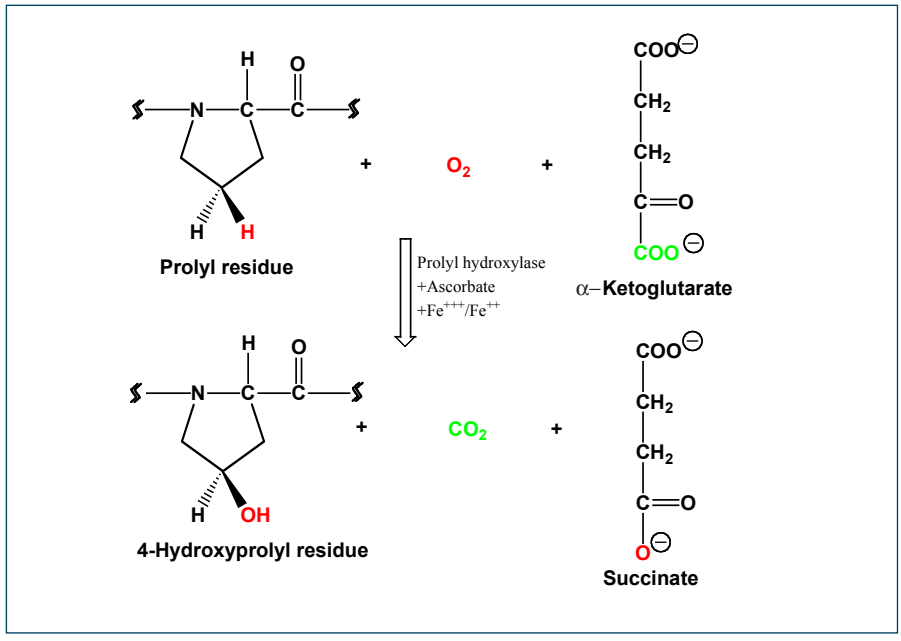

Figure 2. *Hydroxylation of a prolyl residue with the enzyme prolyl hydroxylase. In this reaction, vitamin C acts as an antioxidant by reducing ferric ion which activates prolyl hydroxylase. Hydroxyprolyl residue stabilizes the collagen triple helix by forming interstrand hydrogen bonds.*

lactating period. Pauling suggested the daily intake of vitamin C of 250–4000 mg (Pauling, 1970; Pauling 1974). Challem concluded that the RDAs might be seriously inadequate guidelines for health (Challem, 1999). However, high doses of vitamin C, as proposed by previous authors, are not supported by all literature. A meta-analysis on a potential effect of vitamin C on the common cold showed that there seems no justification for routine mega dose vitamin C supplementation, 1–3 g/day, in the normal population (Hemilä et al., 2007a). Moreover, without reaching the mega doses of vitamin C consumption, numerous reviews suggest that intakes of vitamin C much higher than the RDA may reduce the risk or risk factors for chronic diseases such as heart disease and certain types of cancer (Hathcock, 1997; Ames 2004; Ames 2005; Ames 2006). In this connection, two studies demonstrated that current RDA for vitamin C should be re-evaluated and increased to 200 mg daily (Levine, 1996; Graumlich et al., 1997).

ROLE OF VITAMIN C IN CANCER THERAPY

For the prevention of cancer, the US department of Agriculture and the National Cancer Institute has recommended five servings of fruits and vegetables daily. Further analyses have suggested that this consumption should be even higher (Lachance and Langseth,

1994; Guenther et al., 2006). If these recommendations are based on vitamin C and followed, daily intake will be 210 to 280 mg, depending on food type (Levine, 1999). Reports suggest that fresh produce or juice may loose 50–100 % of its vitamin C content due to handling and processing (Severi et al., 1998; Gil et al., 1999; Johnston and Bowling, 2002). Furthermore, more than 500 mg/day of vitamin C would be difficult to obtain from dietary sources alone and therefore would require supplements especially for the prevention of cancer (Levine et al., 1995). In spite of wide use of vitamin C as an alternative therapy for the prevention and treatment of cancer, the potential cancer-therapeutic activity of vitamin C has a long and controversial history (Verrax and Calderon, 2008).

In 1973, Pauling and Cameron postulated that vitamin C inhibits tumor growth with the treatment of high doses (Cameron and Pauling, 1973). Cameron and Campbell reported beneficial effect of vitamin C based on the response of 50 consecutive patients with advanced cancer to continuous *i.v.* infusions (5–45 g/day) and/or oral doses (5–20 g/day) (Cameron and Campbell, 1974). Cameron and Pauling compared survival time between 100 patients with terminal cancer treated with *i.v.* and oral vitamin C, usually 10 g/day and 1,000 comparable patients not given vitamin C (Cameron and Pauling, 1976). Patients treated with vitamin C survived approximately four times longer than controls. A follow-up study reported that patients given vitamin C had a mean survival time almost 1 year longer than matched controls (Cameron and Pauling, 1978).

The National Cancer Institute sponsored two randomized, placebo-controlled, double-blind trials with vitamin C and advanced cancer at the Mayo Clinic (Creagan et al., 1979; Moertel et al., 1985). In both trials, patients were given 10 g/day vitamin C or placebo. Survival rates were essentially the same for all groups. Plasma concentrations of vitamin C were not measured in these studies and vitamin C was given only orally. In retrospect, the Mayo Clinic trials may have failed to properly evaluate the clinical efficacy of vitamin C in cancer because of insufficient plasma concentrations of vitamin C attained with oral supplementation (Padayatty et al., 2004).

In spite of several controversies, two phase I clinical trials with vitamin C have recently been published that demonstrated remarkable tolerance and safety for high *i.v.* doses up to 1.5 g/kg in patients (Riordan et al., 2005; Hoffer et al., 2008). Additionally, a series of case reports indicated that high-dose *i.v.* vitamin C was associated with long-term tumor regression in three patients with advanced renal cell carcinoma, bladder carcinoma, or B-cell lymphoma (Hoffer et al., 2008).

Vitamin C can be taken *i.v.* or orally. Oral absorption of vitamin C can not achieve plasma concentrations comparable to those obtained by *i.v.* administration (Padayatty et al., 2004). Intravenous doses were used as an alternative therapy to treat patients with advanced cancer (Cameron and Pauling, 1993; Padayatty et al., 2004; Riordan et al., 2005; Hoffer et al., 2008). This can be explained by the fact that *i.v.* doses raise plasma concentrations as high as 14,000 µmol/L, with doses of 50–100 g/day and concentrations of 1000–5000 µmol/L were found selectively cytotoxic to tumor cells but not to normal cells *in vitro* (Benade et al., 1969; Bram et al., 1980; Leung et al., 1993; Riordan et al., 1995; Casciari et al., 2001; Padayatty et al., 2006).

A rosy picture came forward with the recent series works of Chen et al. which showed that high doses (pharmacologic doses) of vitamin C decreased the growth and weight of human, rat, and murine tumor xenografts in athymic nude mice (Chen et al., 2005; Chen et al., 2007; Chen et al., 2008). The results suggested that millimolar concentrations of extracellular vitamin C selectively kill cancer cells but not normal cells in a hydrogen peroxide (H_2O_2)-dependent manner. Such millimolar concentrations of vitamin C can be achieved in humans by i.v. infusion but not by diet or supplements (Padayatty et al., 2004). Hence, vitamin C is postulated to exert local pro-oxidant effects in the interstitial fluid surrounding tumor cells, killing them or inhibiting their growth, while leaving normal cells intact.

According to Frei and Lawson, ascorbate (ASC^-), which is regarded as antioxidant in general, can act as a pro-oxidant by donating an electron to redox-active transition metal ions, such as ferric (Fe^{3+}) or cupric (Cu^{2+}) ions, reducing them to ferrous (Fe^{2+}) or cuprous (Cu^+) ions, respectively (**Eq. 1**) (Frei and Lawson, 2008). In fact, reduction of iron or copper in the catalytic site of certain enzymes underlies ascorbate's well known biological function as a co-substrate in procollagen, carnitine, and catecholamine biosynthesis (Englard and Seifter, 1986). Reduced transition metal ions, in contrast to ascorbate, readily react with O_2, reducing it to superoxide radicals (**Eq. 2**), which in turn dismutate to form H_2O_2 and O_2 (**Eq. 3**) (figure 3).

In addition, the reaction of ascorbate with iron and H_2O_2 produces the extremely reactive pro-oxidant hydroxyl radical (Halliwell 1987). Although scientific rationale for the production of H_2O_2 and radicals in initiation with ascorbate as shown in figure 3 might be a matter of discussion, it is evident that ascorbate causes cancer cells to undergo apoptosis, pyknosis, and necrosis by H_2O_2-dependent pathways (Chen et al., 2005). In contrast, normal cells are considerably less vulnerable to H_2O_2. The reason for the increased sensitivity of tumor cells to H_2O_2 is not clear but may be due to lower antioxidant defences (Oberley and Oberley, 1997). Whatever may be the exact mechanism, the increased sensitivity of tumor cells to H_2O_2 may provide the specificity and «therapeutic window» for the antitumor effect of extracellular millimolar concentration (higher doses) of vitamin C.

IMMUNE RESPONSE AND OTHER BIOLOGICAL FUNCTIONS OF VITAMIN C

White blood cells store higher quantities of vitamin C even when levels in the surrounding plasma are low (Hornig,

$$ASC^- + Fe^{+++} \rightarrow SDA^{\bullet-} + Fe^{++} + H^+ \quad (1)$$
$$Fe^{++} + O_2 \rightarrow O_2^{\bullet-} + Fe^{+++} \quad (2)$$
$$2O_2^{\bullet-} + 2H^+ \rightarrow H_2O_2 + O_2 \quad (3)$$
$$\mathbf{2ASC^- + O_2 \rightarrow 2SDA^{\bullet-} + H_2O_2 \text{ (total reaction)}}$$

Ascorbate (ASC^-); Semidehydroascorbate ($SDA^{\bullet-}$)

Figure 3. *The possible pathways of vitamin C to generate H_2O_2 by the reduction of Fe^{+++} (Frei and Lawson).*

1975; Omaye et al., 1986; Moser, 1987; Jacob, 1990). In fact, vitamin C has been defined as a stimulant of leukocyte function, especially of neutrophil and monocyte movement (Maggini et al., 2007). Vitamin C supplementation was shown to improve many indices of human immune responses, such as antimicrobial and natural killer cell activities, lymphocyte proliferation, chemotaxis, and delayed-type hypersensitivity response, and the concentration of vitamin C is found to be higher in activated neutrophils and macrophages (Wolf, 1993; Jacob et al., 1991; Washko et al., 1991; May et al., 2005). Moreover, in older people (over 70 years), known to have reduced vitamin C plasma and leukocyte concentrations, vitamin C supplementation (500 mg/day for 1 month) enhanced the proliferative response of T lymphocytes (Kennes et al., 1983). Furthermore, in healthy people and neutrophil motility defective patients, with higher concentrations of ascorbate (supplementation of 1 g/day), white blood cells became more active and could move toward infection or inflammation more quickly (Anderson, 1981; Anderson, 1981a; Anderson, 1982).

Lenton et al. demonstrated that 13 weeks with vitamin C supplementation (500 or 1000 mg/day) promoted an increase in lymphocyte glutathione level, suggesting that vitamin C may also be of value in the treatment of glutathione deficiency (Lenton et al., 2003). For example, during aging, ascorbate and glutathione in lymphocytes were found to be decreased, and low concentrations caused a higher risk of cancer, particularly lung cancer, and chronic illnesses such as ischemic heart disease, diabetes, cataract, chronic renal failure, and leukaemia (Kharb et al., 2000; Loria et al., 2000).

Men with low serum ascorbate concentrations may have an increased risk of mortality (Loria et al., 2000). Fletcher et al. have measured that men (mean age 80 years) with 100 mg/day vitamin C intake presented a mortality risk nearly half that compared to men with a consumption of 50 mg/day (Fletcher et al., 2003). A large body of evidence demonstrates that increased dietary vitamin C intake can enhance resistance to and improve recovery from infectious, degenerative diseases, and certain types of cancer (Hemilä, 1992; Hoffer and Pauling, 1993; Carr and Frei, 1999). Many biological, clinical, and epidemiological studies have indicated that higher intakes of vitamin C, 1–3 g daily, may be required to reduce risk of chronic diseases such as cardiovascular disease, cancer, or cataract (Carr and Frei, 1999a; Frei and Traber, 2001; Li and Schellhorn, 2007). Furthermore, the oxidative stress associated with many diseases may increase ascorbate requirements (Harman, 1994; Mezzetti et al., 1996). Large doses of ascorbate have been found to reduce cardiovascular disease risk, lengthen the lifespan of patients with cancer (Cameron and Pauling, 1979; Enstrom et al., 1992, Myint et al., 2008). Supporting this fact, the epidemiological studies have confirmed an inverse relationship between serum ascorbate level and blood pressure. A decrease in plasma vitamin C level has been observed in both type 1 and type 2 diabetes (Asard et al., 2004). Moreover, the literature has demonstrated that men might require more vitamin C than women (Jacob, 1990; VanderJagt et al., 1989) and that the elderly might require more ascorbate than younger people (Blanchard et al., 1990; Blanchard, 1991; Heseker and Schneider, 1994).

SAFETY OF VITAMIN C SUPPLEMENTATION

It has been suggested that vitamin C alone or mixed with N-acetyl-cysteine could be toxic, acting as a pro-oxidant (Podmore et al., 1998; Childs et al., 2001). However, the literature shows that ascorbic acid is not a pro-oxidant *in vivo*, even with iron co-supplementation (Carr and Frei, 1999a; Gomez-Cabrera et al., 2008).

The literature has also evoked the potential adverse effects of high doses of vitamin C, especially as regards the increase in oxalate and kidney stone formation (Levine et al., 1996; Levine et al., 1999). Indeed, Auer et al. demonstrated that 8 g/day, for 8 consecutive days, can cause harmful calcium oxalate crystalluria secondary to relative hyperoxaluria in persons who have a predisposition for increased crystal aggregation (Auer et al., 1998; Auer et al., 1998a). Wandzilak et al. observed a modest increase in urinary oxalate after administration of high doses of vitamin C (5 and 10 g/day for 5 days) (Wandzilak et al., 1994). Moreover, other work by Auer et al. using 4 g/day of ascorbic acid for 5 days, concluded that ingestion of these doses did not affect the principal risk factors associated with calcium oxalate kidney stone formation (Auer et al., 1998; Auer et al., 1998a). Furthermore, large doses of vitamin C (1.5 g or more) did not produce kidney stones and the doses of vitamin C above 1.5 g in fact reduced the risk of kidney stones (Curhan et al., 1996; Curhan et al., 1999; Gerster, 1997). Evidence indicates that high intakes of vitamin C do not increase oxalate excretion or induce the potential formation of kidney stones (Hathcock, 1997; Hathcock, 2005).

Gastrointestinal distress seems to be the most common adverse effect of higher doses of vitamin C intake (Miller and Hayes, 1982). When these symptoms occur, the vitamin C dosage is usually more than 2 g/day. The symptoms generally disappear within a week or 2 with no further consequences, and may have been produced by other components such as sorbitol (Hill and Kamath, 1982).

Other studies and recent phase I clinical trials showed that large doses of vitamin C are safe (Hemilä, 1999; Hanck, 1982; Johnston, 1999; Garewal and Diplock, 1995; Riordan et al., 2005; Hoffer et al., 2008). A recent review demonstrated that vitamin C supplements of 2 g/day are safe for most adults (Hathcock et al., 2005). These authors also supported the claim that intakes of up to 4 g/day are well tolerated in the general population. No consistent and compelling data demonstrating serious adverse effects of vitamin C in humans have been established (Frei and Traber, 2001), although the tolerable upper limit intake has been estimated to 2 g/day (Food and Nutrition Board, 2000).

CONCLUSIONS

Vitamin C is an essential component of human physiology and should be supplied either through fresh fruits and vegetables or through supplements. The clinical benefit of vitamin C known so far is the prevention of scurvy. Intake of as little as 10 mg/day is sufficient for this purpose. In order to potentiate immune function or prevent chronic illnesses such as cancer, hypertension etc., higher doses of vitamin C are needed. Recent clinical updates on the role of vitamin C in tetanus (Hemilä and Koivula 2008) pneumonia (Hemilä and Louhiala 2007), asthma (Kaur et al., 2009), diabetic retinopathy (Lopes de Jesus et al., 2008) and pregnancy (Rumbold and Crowther 2005) are available as Cochrane reviews. Most of these reviews conclude that present knowledge does not allow a strong conclusions on the role of vitamin C, however the weakness of research methodology in vitamin C clinical trial has to be considered before further conclusion (Lykkesfeldt and Poulsen, 2009). →

We need more research to explain some of the facts associated with vitamin C such as: lack of vitamin C supply causes decrease number of leukocytes, tobacco smoking lowers the plasma and leukocyte vitamin C level, refined carbohydrate seems to be accelerated the process of depleting vitamin C, women's vitamin C plasma levels are approximately 20 % higher than men's for any given dietary intake, vitamin C plasma level decreases by aging, etc. in order to get a clearer picture of the biological functions of vitamin C.

A recommendation of five servings of fruits and vegetables daily for the cancer prevention is not sufficient to obtain optimal benefit based on the current reviews. In addition, because of modern farming, handling and processing, more than 500 mg/day vitamin C would be difficult to obtain from dietary sources alone. It should be noted that pharmacokinetics and physiologic responses to vitamin C are known to vary considerably between individuals and optimal intakes for children, older adults and those suffering from acute and chronic diseases remains to be determined. Many studies have demonstrated that higher doses than the RDA for vitamin C can potentiate the immune system and prevent as well as treat a wide range of pathologies.

The need of vitamin C is higher to those who are in continuous oxidative stress. Oxidative stress is the focal point for chronic illnesses in human. The direct evidence and mechanism of action for the role of vitamin C in treating chronic illnesses could not be correlated yet, but results of epidemiologic and indirect studies are in strong support (Myint et al., 2008).

Consequently, even if vitamin C requirements vary greatly among individuals, it is suggested that vitamin C supplementation is not only safe but also necessary to achieve optimal health. Therefore, in agreement with the current literature, it can be suggested, especially to the older population to consume more than five servings of fruits and vegetables daily, added to 1 g of vitamin C supplementation divided in two or three doses during the day, in order to ensure an optimal health. Moreover, male population compared to female population, older population compared to younger population, smoking population compared to non-smoking population and stressed population compared to non-stressed population may need higher consumption of vitamin C to obtain health beneficial effects.

Conflict of interest: None

For references, see www.farmatid.no/id/4002

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NORSK FARMASØYTISK SELSKAP
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FARMASIDAGENE 2010
arrangeres 28.–30. oktober med hovedtema «Riktig legemiddelbruk – for hvem?».

Program og påmeldingsskjema finner du på *www.nfs.no*. Som NFS-medlem sparer du mye på deltakeravgiften, og melder du deg på før 26. september blir det enda rimeligere.

Satellittsymposiet 28. oktober omhandler «Bruk og misbruk av rusmidler; legemidlers andel av problemet og plass i rehabiliteringen». Her vil blant annet utvalgsleder Thorvald Stoltenberg snakke om hva «Utvalg for å utrede de mest hjelpetrengende rusmiddelavhengige» har sagt i sin innstilling.

I disse dager begynner også seksjonsforedragene å bli klare. De legges fortløpende ut på hjemmesiden vår. Jan Egeland kommer på Internasjonal seksjon – gjør du?

70 TH FIP-KONGRESS I LISBOA
28. august til 2. september gikk årets FIP-kongress av stabelen. Årets tema var *From Molecule to Medicines to Maximising Patient Outcomes*. 32 norske farmasøyter hadde funnet veien til Portugal.

Styreleder Britt Wolden var offisiell representant fra Selskapet, og reiste sammen med undertegnede.

I tillegg støttet Selskapet, via stipendfondet, deltakelse for Helle Håkonsen og Stein Lyftingsmo, som begge bidro med innlegg og poster. Se hjemmesiden for mer informasjon om dette.

NYE BØKER INNEN FARMASIEN
Selskapet har, sammen med flere andre, ytet støttet til to nye «farmasibøker».

I starten av august ble den nye læreboken i samfunnsfarmasi tilgjengelig. Boken heter «Samfunnsfarmasi – legemiddelbruk og farmasøytisk profesjonsutøvelse». Redaktører er Kjersti Bakken og Anne Gerd Granås. Den 6. september inviterte Fagbokforlaget, forfatterne og Selskapet til *Release-party* i Apotekforeningens lokaler på Majorstuen. Etter et kort program med informasjon om boken og innholdet kunne redaktørene, medforfatterne og andre interesserte feire bokutgivelsen med sprudlende drikke og hyggelig «mingling».

I midten av august ble boken «Riktig medisin? En historie om apotekvesenet» utgitt. Forfatter er Olav Hamran (forfatter av «Farmasøytenes historie i Norge 1858–2008», NFFs jubileumsbok), og er historien om de store endringene apotekvesenet gjennomgikk rett før, under og etter den nye apotekloven kom i 2001.

ETIKKRÅDSMØTE
Det nye Etikkrådet hadde sitt andre møte 8. september. Etikkrådet for farmasøyter i Norge er det faste organ i spørsmål som angår farmasøytisk yrkesetikk. Det gjelder både i forhold til enkeltsaker og spørsmål av generell karakter. For mer informasjon om hvem som sitter i Etikkrådet og arbeidet som gjøres, kan du gå inn på menyvalget «etikk» på *www.nfs.no*.

DATAKRØLL FOR SELSKAPET
I løpet av sensommeren har Selskapet skiftet server og dermed også måttet skifte e-postsystem. Dette har dessverre resultert i en del datakrøll. Dersom du har sendt en e-post med forespørsel til Selskapet i juli/august og ikke fått svar på denne, kan dette være årsaken. Fint om du da tar kontakt med Selskapet igjen. (Dette gjelder ikke påmeldinger til Farmasidagene, da disse går i et annet system.)

Rønnaug Larsen,
daglig leder i NFS