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Carotenoids, it's role in support of Wellbeing: A review

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Abstract
Carotenoids belong to a group of isoprenoid pigments which contains interesting natural capacities to support the human health. Human body cannot synthesize carotenoids, with the consumption of these fruits and vegetables, the requirement for carotenoids can be fulfilled. Shreds of evidences suggest that proper consumption of β-carotene and other carotenoids obtained from foods are associated with lower risk of several chronic diseases. The beneficial effects of carotenoids are due to its ability to be converted to vitamin A, their role as antioxidants, additionally, lutein and zeaxanthin may be protective in eye disease because they absorb damaging blue light that enters the eye. Fruits and vegetables are good food sources of these compounds, although the primary sources of lycopene are tomato and tomato products. Additionally, egg yolk is a highly bioavailable source of lutein and zeaxanthin. These carotenoids are also available in supplement form. The main purpose of this manuscript is to give the right concern about Carotenoids, it's benefits to health.

Keywords: Carotenoids, antioxidents, lutein and Zeaxanthin

Introduction
Carotenoids are fat-soluble pigments which can be synthesized by plants, algae, and photosynthetic bacteria and some other microorganism. Therefore, more than 700 carotenoids have been identified and belong to groups of carotenes (e.g. carotene and lycopene) as well as their hydroxylated derivatives-xanthophylls (e.g. lutein and zeaxanthin, cryptoxanthin and astaxanthin). About 50 of these carotenoids can be found in the human diet, mainly of plant origin, and some are present in dietary supplements (Fiedor and Burda, 2014) [10].

Structure
Carotenoids are isoprenoid compounds, biosynthesized by tail to tail linkage of two C_{20} geranylgeranyl di-phosphate molecules. This produces the parent C_{40} carbon skeleton from which all individual variations are derived. This skeleton can be modified by: Cyclization at one end or both ends of the molecule to give different end groups. Changes in hydrogenation levels. Addition of oxygen containing functional groups. Carotenoids that contain one or more oxygen atoms are known as xanthophylls, the parent hydrocarbon as carotene. The long system of alternating double and single bonds constitutes a conjugated system in which the p electrons are effectively de-localized over the entire length of the polyene chain (Debjani *et al.* 2005) [4].

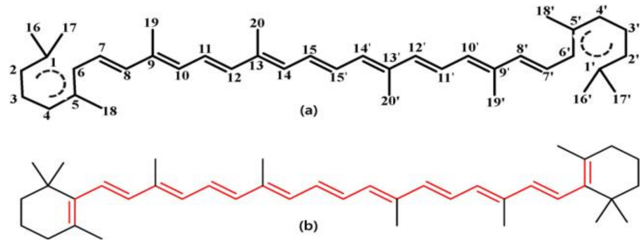

Fig 1: a) Joining style of eight isoprenoid units to form β-carotene, and **b)** molecular structure of β-carotene chromophore

Absorption

Absorption is defined as a movement of dietary carotenoids, or their metabolites to the lymphatic or portal circulation (Erdman *et al.* 1993) [8]. Carotenoids, being fat-soluble, follow the same intestinal absorption path as dietary fat. Release from the food matrix and dissolution in the lipid phase appears to be important initial steps in the absorption process. Carotenoids are thought to be absorbed by the small intestinal mucosa via a passive, diffusion process (During *et al.* 2002; During *et al.* 2005) [7, 6].

Transport

In fasting serum, hydrocarbon carotenes are found primarily in low-density lipoprotein (LDL), while xanthophylls (containing one or more polar functional groups) are more uniformly distributed between LDL and high-density lipoprotein (HDL) (Clevidence and Bieri, 1993) [3]. The carotenes, being lipophilic, are situated in the core of lipoprotein (Massey, 1984) [16]. The xanthophylls, being more polar are probably located on the surface of lipoproteins, and are likely to undergo more rapid surface transfer, resulting in the observed apparent equilibration between LDL and HDL.

Storage

Carotenoids accrue or are stored in tissues. It is supposed that at least in the liver, beta-carotene and other pro-vitamin A carotenoids would be available for conversion to Vitamin A (Kopec *et al*. 2015) [14]. Adipose tissues and liver appear quantitatively to be the main storage sites, whereas adrenal gland, kidney and testes also contain a high per gram concentration (Khachik *et al*. 1997) [13].

Carotenoids as antioxidants

Due to free radicals damage can be occur the body's DNA, RNA, enzymes, carbohydrates, proteins, lipids and cell membranes and therefore natural defenses can decline. DNA damage can cause cancer while damage in arteries may cause hardening and increased the risk of heart attack, several other diseases, premature ageing and death (Rissanen *et al.* 2001) [19]. Antioxidants help to control free radicals by quenching free radicals by donating electrons to molecules before they damage other cells. Antioxidants may have additional activities, such as reducing the energy of a free radical or stopping it from forming by interrupting an oxidizing chain reaction. They may also trap free radicals and lipid peroxides, delaying the onset of lipid per-oxidation, stopping production of further free radicals and inhibiting the damaging effects of certain enzymes that can degrade connective tissues. The mechanisms of reactions between carotenoids and radical species may involve radical addition, hydrogen abstraction and electron transfer, but its precise mechanisms remain unclear (Liebler, 1993; Agarwal and Rao, 1998; Papas, 1999) [15, 1, 17].

Eye Health

Two carotenoids, Lutein and zeaxanthin are renowned in the human crystalline lens (Yeum *et al.* 1995) [24]. Like the antioxidant enzymes found within the lens, the lipid-based lutein and zeaxanthin, are primarily found in the metabolically active epithelium/outer cortex of the lens (Yeum *et al.* 1999) [25], and therefore, may have a preferential role in protecting against UV-induced oxidative damage. This function would be similar to the role that lutein and zeaxanthin play in the retina, where they are optimally located to reduce risk from blue light (Snodderly, 1995) [22].

Cardiovascular Effects

Oxidative stress and a persistent chronic low level inflammation in the cardiovascular system, certainly contribute to the development of cardiovascular diseases. Oxidatively modified low-density lipoproteins (LDL) are involved in the initiation and promotion of atherosclerosis and coronary heart disease. Atherogenesis seems to be due to foam cell production by the introduction of a source of free radicals that cause LDL oxidation. Thus, protection from LDL oxidation by antioxidants may lead to protection against human coronary heart disease. Considering that β-carotene and lycopene are primarily transported in LDL, it has they are in the central position to protect LDL from oxidation (Sesso, 2013) [20].

Shabbir and Nuzhat, (2018) [21] found similarly, low levels of α-carotene in serum shows reverse relation in occurrence of coronary artery disorder and development of arterial plaque, through which α-carotene projected as a potential marker for atherosclerosis in human. Moreover, carotenoids those possess higher levels of provitamin A activities have ability to reduce hazards of angina pectoris disease. The higher levels of lutein and β-cryptoxanthin in plasma have shown lower hazard of cardiac infraction for those people suffering from cardiac disorders.

Cancer

According to World Health Organization, cancer is the second leading cause of deaths globally and deaths due to tumors were 8.8 million in 2015. Nearly 1 out of 6 deaths are due to cancer (Global Burden of Disease, 2015) [12].

Among carotenoids, lycopene is considered as the most potent agent against tumor. The preclinical studies summarize multiple possible ways of lycopene action, claiming, at the same time, its importance in the enrichment of the oxidation stress defense system. Further investigations supporting the mentioned studies have been taken from meta-analysis of the observational studies on the role of lycopene and tomato products in the hindrance of prostate cancer and lungs cancer.

Sources of Carotenoids

Because plants are able to synthesize carotenoids, they are widely distributed in plant-derived foods and the composition is enriched by the presence of small amounts of biosynthetic precursors and derivatives of the major carotenoids. In general the level of carotenoids is directly proportional to the intensity of colour. Egg yolks, dairy products, fruits, vegetables, legumes, grains and seeds are their major food sources. In green leafy vegetables, b-carotene is predominant while in the orange-coloured fruits and vegetables such as carrots, apricots, mangoes, yams, winter-squash, other carotenoids typically predominate. Yellow vegetables have higher concentrations of xanthophylls with a low pro-vitamin A activity, but some of these compounds, such as lutein, may have significant health benefits. The red and purple vegetables and fruits such as tomatoes, red cabbage, berries and plums contain a large portion of non-vitamin A active carotenoids. Tomato and watermelon are major sources of lycopene (Del Campo *et al.* 2007) [5].

Marine carotenoids: the prevention coming from sea

Recently there was a impressive increase in the global-market demand for carotenoids, thus determining a significant rise in algae exploration. Well-known marine entities, such as astaxanthin, β- cryptoxanthin, zeaxanthin and fucoxanthin are recognized antioxidant, undoubtedly helpful in cardiovascular prevention. In particular, astaxanthin improves blood lipid profile by increasing high density lipoprotein cholesterol, decreasing LDL-cholesterol, triglycerides, as well as lipid per-oxidation (Fassett, 2012) [9].

Oral administration of astaxanthin for 5 weeks showed to delay the incidence of stroke in spontaneously hypertensive rats (Park *et al.* 2011) [18]. Also a diet rich in fucoxanthin could be protective through the augmentation of thermogenesis, with subsequent overweight inhibition, through the regulation of cytokine secretions from white adipose tissue and through the promotion of docosahexaenoic acid synthesis (Gammone, 2015) [11]. Fucoxanthin supplementation also decreased mRNA expression of fatty acid synthase (FAS), a multi-enzyme protein that catalyzes fatty acid synthesis, which has been investigated as a chemotherapeutic target, but it may also be implicated in the production of an endogenous ligand of the nuclear receptor PPAR-α, the target of the fibrate drugs against hyperlipidemia (Virmani *et al.* 2005) [23], which is an important cardiovascular risk marker too. In addition, new and rare sea-derived resources are emerging. Among these, siphonaxanthin is a specific keto-carotenoid, found in edible green algae such as Codium fragile, Caulerpa lentillifera and Umbraulva japonica (Berni *et al*.2015) [2].

Conclusion

Carotenoids are natural pigments. While providing colouring property, additionally, these compounds exhibit health promoting effects on consumer health. In fact, carotenoids show the property of antioxidants, directly involved in the mechanism of scavenging the free radicals. Literature had demonstrated the high impact of carotenoids on different life style related disorders, including, cardiovascular diseases and cancer. The antioxidant property of carotenoids is the key involved in the prevention of all disorders.

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