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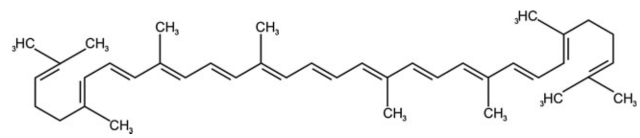
Editorial

Lycopene as a natural antioxidant

A wide range of substances have been identified as antioxidants exerting their oxidation-inhibitory effects by different mechanisms [1, 2]. However, the list of lipophilic natural oxidants is limited. Lycopene is thus an attractive natural compound for lipid scientists and technologist. As a strong singlet oxygen quencher it can stop lipid oxidation at an initiation stage.

From a chemistry perspective, lycopene is a symmetrical tetraterpene assembled from 8 isoprene units, containing 11 conjugated and 2 non-conjugated double bonds between carbon atoms. Lycopene is a member of the carotenoid family, and the predominant source in the human diet comes from tomato and tomato-based products. The antioxidant capacity of tomato strongly depends on the content and bioavailability of lycopene in the fruit. There is strong correlation between lycopene content in tomatoes and antioxidant capacity [3].



Lycopene exhibits a high physical quenching rate of singlet oxygen [4], which is directly related to its antioxidant activity. The rates for other lipophilic antioxidants, namely β-carotene and α-tocopherol, are about twofold and 100-fold lower. Taking into consideration the concentration of lycopene in human plasma (0.7 μM), it is worth emphasizing the high $^1O_2$-quenching potency of this carotenoid. The quenching efficacy of lycopene is related in part to the opening of the β-ionone ring to an open chain form.

Lycopene can also play a role in scavenging hypochlorous acid (HOCl) [5]. This acid contributes to the pathology of atherosclerosis, inflammatory disease, respiratory stress, acute vasculitis, and cancer. The oxidation of lycopene via HOCl is accompanied by a change in its colour from red to colourless; the results of LC-MS analysis showed an increase of HOCl concentration in the sample containing lycopene. In the same sample, however, numerous products of lycopene oxidation were also observed. In the study of Bou et al. [6] in this issue of EJLST free radical scavengers, propyl galate, gallic acid and α-tocopherol all had the ability to decrease lycopene oxidation with α-tocopherol being the most active.

The results of experimental studies suggest that lycopene can reduce the risk of cardiovascular disease by modulating low-density lipoprotein oxidation [7]. Oxidised LDLs are highly atherogenic due to stimulation of foam cell formation. The antioxidant activity of lycopene in multilamellar liposomes is superior to other lipophilic natural antioxidants (e.g. α-tocopherol, α-carotene, β-cryptoxanthin, zeaxanthin, β-carotene and lutein) [8]. It is noteworthy that equimolar mixtures of carotenoids are more effective than any single compound alone. This strong synergistic effect is most pronounced with lycopene and lutein together [8].

The damage of endothelial cells by oxidative stress is an important component to the aetiology of atherosclerosis. In the study of Tang et al. [9], lycopene decreased the oxidative injury of endothelial cells induced by H_2O_2, attenuated the expression of p53 and caspase-3 mRNA in injured cells, and diminished the apoptosis of injured cells. These findings can explain, in part, why lycopene prevents atherosclerotic cardiovascular diseases.

The results of the study of Lee et al. [10] demonstrated that the consumption of tomato products with olive oil, but not sunflower oil, increased the antioxidant activity of human plasma. According to the FRAP assay, the antioxidant activity increased from 930 to 1118 μmol/L as an effect of consumption of tomato products with olive oil. Endogenous antioxidative enzymes such as superoxide dismutase, glutathione peroxidase and glutathione reductase can also be stimulated by lycopene [11].

Lycopene in association with α-tocopherol enhances acyl platelet-activating factor (acyl-PAF) biosynthesis in endothelial cells during oxidative stress. Acyl-PAF exerts its beneficial role during the initiation and progression of atherosclerosis [12]. Based on the study of Polidori et al. [13], the fraction of blood pumped out of the right and left ventricles with each heart beat in patients suffering from congestive heart failure (CHF) was directly correlated to plasma lycopene levels. Oxidised lycopene (i.e. a mixture of apolycopenones and diapocarotenedials) exhibited biological activity in terms of induction of detoxication phase 2 enzymes, such as glutathione-*S*-transferases (GSTs), NADPH (a quinine acceptor) oxidoreductase (QR) and UDP-glucuronsyltransferase activation via the activation of electrophile/antioxidant response element transcription system (EpRE/ARE) [14].

The effect of lycopene on lipid peroxidation in CV1-P monkey cells exposed to ferric nitrilotriacetate (Fe-NTA) plus ascorbate was investigated by Matos et al. [15]. Cells supplemented with lycopene showed a strong reduction in lipid peroxidation, suggesting that lycopene can protect mammalian cells against membrane damage and possibly play a protective role against tumour promotion associated with oxidative damage.

In summary, there is strong evidence suggesting that the consumption of tomatoes and tomato-based products in our daily diets affords many health benefits, particularly from the perspective of assisting endogenous processes at reducing the oxidative stress in its various forms.

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