

Efficient radical trapping at the surface and inside the phospholipid membrane is responsible for highly potent antiperoxidative activity of the carotenoid astaxanthin

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Abstract

The effects of the carotenoids β -carotene and astaxanthin on the peroxidation of liposomes induced by ADP and Fe^{2+} were examined. Both compounds inhibited production of lipid peroxides, astaxanthin being about 2-fold more effective than β -carotene. The difference in the modes of destruction of the conjugated polyene chain between β -carotene and astaxanthin suggested that the conjugated polyene moiety and terminal ring moieties of the more potent astaxanthin trapped radicals in the membrane and both at the membrane surface and in the membrane, respectively, whereas only the conjugated polyene chain of β -carotene was responsible for radical trapping near the membrane surface and in the interior of the membrane. The efficient antioxidant activity of astaxanthin is suggested to be due to the unique structure of the terminal ring moiety. © 2001 Elsevier Science B.V. All rights reserved.

Keywords: Astaxanthin; β -Carotene; Lipid peroxidation; Antioxidant; Liposome

1. Introduction

Carotenoids have received considerable attention for their possible clinical use in diseases associated with reactive oxygen species such as cancer [1,2].

Abbreviations: BhCL, cardiolipin from bovine heart; EyPC, egg yolk phosphatidylcholine; P_i , inorganic phosphate; TBARS, thiobarbituric acid-reactive substances; MDA, malondialdehyde; DM, dipole moment; MO, molecular orbital; EHTC, 6-ethenyl-3-hydroxyl-1,1,5-trimethyl-5-cyclohexen-4-one; EHC, 6-ethenyl-3-hydroxyl-5-cyclohexen-4-one; HC, 3-hydroxyl-5-cyclohexen-4-one

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Furthermore, procedures for creation of various novel carotenoids having antioxidant activity in bacteria and plants have been developed using new biotechnologies [3–5]. Therefore, carotenoids have been regarded to be of value not only as effective nutrients for the eyes, but also as antioxidants. The antioxidant activities of β -carotene (for chemical structure, see Chart), as a representative carotenoid, in various biological membranes and model membrane systems have been studied extensively [2,6–13]. Other naturally occurring carotenoids such as zeaxanthin (3,3'-dihydroxyl- β -carotene), canthaxanthin (4,4'-dioxo- β -carotene) and astaxanthin (3,3'-dihydroxyl-4,4'-dioxo- β -carotene; see Chart) are also known to inhibit lipid peroxidation significantly [7,10,13–15].