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Synergy Effect of Ascorbic Acid and α-Tocopherol in Kinetic Model of Lipid Peroxidation

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Abstract

The synergy effect of α-tocopherol and ascorbic acid (vitamins E and C) is taken into account in the presented theoretical model of the kinetics of the process of lipid peroxidation (LPO). An analysis of the features in the course of the LPO process with the participation of vitamins E and C made it possible to apply the appropriate approximations that simplify the model system of differential equations. For cell membranes, it is characteristic that the lipid substrate and oxygen are in excess, as well as ascorbate, according to experimental data, should be considered in excess. Thus, the concentrations of reagents in excess are constant model parameters. Applying the quasi-stationary approximation to lipid radicals further simplifies the model. The synergy effect is primarily related to the ability of ascorbate to regenerate α-tocopherol, thereby protecting it from both depletion and prooxidant effect. This effect at a given concentration of α-tocopherol is enhanced with increasing concentration of ascorbate, but the ratio of ascorbate and α-tocopherol concentrations should not exceed 100, since at high concentrations the ascorbate is also able to act as a prooxidant. As a result, analytical expressions were obtained for the kinetic curves of vitamin E (in its two forms) and the main LPO product (lipid hydroperoxide). This model is minimal and quite adequately describes the LPO process. The features of the synergy effect of vitamins E and C and its significance for the effective control of the LPO process as a whole are discussed.

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Keywords: cell membranes, lipid peroxidation, ascorbic acid, antioxidants, synergy effect, lipid peroxidation

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