Green Tea Polyphenols: Antioxidative and Prooxidative Effects

Chung S. Yang, Jungil Hong, Zhe Hou, and Shengmin Sang

Department of Chemical Biology, Ernest Mario School of Pharmacy, Rutgers, State University of New Jersey, Piscataway, NJ 08854-8020

EXPANDED ABSTRACT

Tea consumption has been suggested to have many beneficial health effects, including the prevention of cancer and heart diseases (1). The polyphenolic catechins in green tea, such as (−)-epigallocatechin-3-gallate (EGCG), have been shown to be potent antioxidants in many chemical and biochemical studies (2). Some antioxidative effects of catechins have been demonstrated in vivo, for example, the prevention of 8-hydroxydeoxyguanosine formation. The general antioxidative functions of tea catechins in the plasma and other tissues following tea ingestion, however, are not strong and sometimes are not significant (1). One of the reasons for this is the rather low bioavailability of tea catechins in animals and humans. Tea catechins are readily methylated, glucuronidated, sulfated, and effluxed out of the cells (2). Many of the cancer preventive activities of tea and related signal transduction pathways have been attributed to antioxidative mechanisms, but direct evidence of this proposal is sparse. In fact, many of the reported effects of EGCG in cell culture could be the consequences of oxidative or prooxidative reactions involving these polyphenolic compounds (3,4). The stability of EGCG varies with the cell-culture conditions (pH 7.0–7.4). Under many cell-culture conditions, the half-life of EGCG is <2 h in the presence of cells and even shorter in the absence of cells (5). It is oxidized and dimerized; H$_2$O$_2$ and other compounds are also formed. Some of the apoptotic effects and gene-expression changes caused by EGCG may be mediated by H$_2$O$_2$, because they are prevented by coincubation with catalase. Some of the reported EGCG effects on receptors may not be due to EGCG directly. They may be caused by superoxide radical or oxidized EGCG species, because the effect is abolished in the presence of superoxide dismutase, which stabilizes EGCG. The presence of superoxide dismutase increases the effectiveness of EGCG in inhibiting cell growth, suggesting that the growth inhibition effect is caused by EGCG directly. Depending on the experimental conditions, EGCG and other polyphenolic compounds can function as either antioxidants or prooxidants. The prooxidative effect may be due to the high oxygen tension used in the cell-culture conditions. The autooxidation of polyphenols leads to the formation of radical and quinone species, which may dimerize or form thiol adducts. These types of reactions may not occur in vivo from normal tea consumption. The possible occurrence of these reactions, for example when large amounts of tea are ingested or at certain inflammation sites or organ sites, needs to be investigated. It is a challenge to determine the importance of the antioxidative and prooxidative activities of catechins after tea consumption.

LITERATURE CITED