Comprehensive REVIEWS in Food Science and Food Safety

Antioxidant and Antimicrobial Activities of (-)-Epigallocatechin-3-gallate (EGCG) and its Potential to Preserve the Quality and Safety of Foods

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Abstract: Quality deterioration of fresh or processed foods is a major challenge for the food industry not only due to economic losses but also due to the risks associated with spoiled foods resulting, for example, from toxic compounds. On the other hand, there are increasing limitations on the application of synthetic preservatives such as antioxidants in foods because of their potential links to human health risks. With the new concept of functional ingredients and the development of the functional foods market, and the desire for a "clean" label, recent research has focused on finding safe additives with multifunctional effects to ensure food safety and quality. (-)-Epigallocatechin-3-gallate (EGCG), a biologically active compound in green tea, has received considerable attention in recent years and is considered a potential alternative to synthetic food additives. EGCG has been shown to prevent the growth of different Gram-positive and Gram-negative bacteria responsible for food spoilage while showing antioxidant activity in food systems. This review focuses on recent findings related to EGCG separation techniques, modification of its structure, mechanisms of antioxidant and antimicrobial activities, and applications in preserving the quality and safety of foods.

Keywords: antioxidant activity, *Camellia sinesis*, epigallocatechin-3-gallate, food spoilage, green tea

Introduction

Food spoilage is the main cause of economic losses in the food industry. One key spoilage pathway is the oxidation of lipids which causes the formation of volatile compounds associated with undesirable off-flavors or rancidity which reduces shelf-life (Campo et al., 2006; Lund, Heinonen, Baron, & Estévez, 2011; Saucier, 2016). For example, interactions of the breakdown products of lipids such as aldehydes, ketones and alcohols with muscle components such as proteins, amino acids, vitamins, and cholesterol lead to undesirable modifications of muscle components (Goodridge, Beaudry, Pestka, & Smith, 2003; Stapornkul, Prytkova, & Were, 2016). This causes a loss of quality due to unpleasant odors and flavors, discolorations, loss of nutrients, and formation of cholesterol oxidation products (COP) which are toxic to humans (Kanner, 1994; Medina & Pazos, 2010). Spoilage also represents potential human health risks associated with the formation of secondary metabolites, such as from lipid and protein oxidation that may lead to the formation of toxic compounds (Alamed, Chaiyasit, McClements, & Decker, 2009; Estevez & Luna, 2017; Kanner, 2007).

Fresh foods, especially lightly preserved foods, are highly susceptible to microbial spoilage during storage. It has been estimated that about 25% of the total global foods produced are degraded due to microbial spoilage (Bondi, Messi, Halami, Papadopoulou, & Niederhausern, 2014). Food spoilage by nonpathogenic spoilage microorganisms contributes to economic loss to the food industry (Petruzzi, Corbo, Sinigaglia, & Bevilacqua, 2017). The proteolytic action of these microorganisms produces different metabolites that affect the quality attributes, and almost always reduce the nutritional value and organoleptic properties of the product (Ashie, Smith, Simpson, & Haard, 1996; Boziaris & Parlapani, 2014; Howell, 2016). In addition to adverse effects on food quality attributes that lead to rejection of the food by consumers, the possible presence of microbial toxins or pathogenic microorganisms, such as *Escherichia coli*, *Salmonella*, *Bacillus cereus*, *Campylobacter jejuni*, *Clostridium perfringens*, *Staphylococcus aureus*, and *Aspergillus niger* could even endanger consumer safety and contribute to foodborne illness (Rawat, 2015; Saucier, 2016).

To overcome the problems caused by oxidative processes in foods, and to assure the nutritional and organoleptic properties that consumers demand, synthetic food additives have been used to retain quality. The application of synthetic antioxidants, such as butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT),

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