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Antioxidant and antimicrobial activities of green tea extract loaded into nanostructured lipid carriers

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ABSTRACT

In this paper, the preparation and characterization of some novel nanostructured lipid carriers for drug delivery are reported. They are obtained by mixing two solid lipids, cetyl palmitate and glyceryl stearate, with three types of vegetable oils: grape seed oil, St. John's wort oil (*Hypericum perforatum* oil) and sea buckthorn oil. In order to increase their antioxidant and antimicrobial properties, they are co-loaded with green tea extract by using a modified high shear homogenization technique. Size distribution and polydispersity index of the developed nanostructured lipid carriers determined by the dynamic light scattering, and corroborated with the results obtained by the transmission electron microscopy analysis, confirmed that the structures obtained are at nanoscales. The crystallinity behavior of the prepared nanostructured lipid carriers has been studied by differential scanning calorimetry; zeta potential measurements show that all loaded nanostructures present excellent physical stability. Their antioxidant and antimicrobial properties evaluated by an appropriate in vitro analysis using the chemiluminescence method, and the diffusion disc method, respectively, show that green tea extract could be utilized as a valuable natural source of antioxidant and antimicrobial agent. These new nano-formulations proved to have significant potential for nutritional and pharmaceutical applications.

1. Introduction

Results of many researches developed on the health benefits of green tea for a wide variety of applications, including different activities, such as antimicrobial [1], antioxidant [2], antiviral [3], and anti-mutagenic [4] activities, are already available. In the past few years, special attention has been paid to the antioxidant activities of the polyphenolic compounds present in green tea due to their pharmaceutical properties. The performed studies report that green tea extract (GTE) shows many health beneficial properties, particularly against the damage caused by pollution, stress, cigarette smoke and other toxins [5], prevention of cardiovascular diseases [6], cancer [7–9], diabetes [10].

The beneficial health effects of green tea have been attributed to the presence of antioxidants that act as receptors of free radicals. Green tea is an excellent source of polyphenols, which are natural antioxidants that can be used as alternatives to synthetic antioxidants, as they are typically less harmful and appear to have an equivalent effect upon the inhibition of oxidation [11]. These antioxidants, which inhibit oxidation of organic molecules, are very important, not only for living systems, but also for food preservation [12]. There are several polyphenol catechins present in GTE, such as epicatechin (EC), epicatechin-3-gallate (ECG), epigallocatechin (EGC), and epigallocatechin-3-gallate (EGCG), with beneficial effects on health [13]. Fig. 1 presents the chemical structure of these polyphenols.

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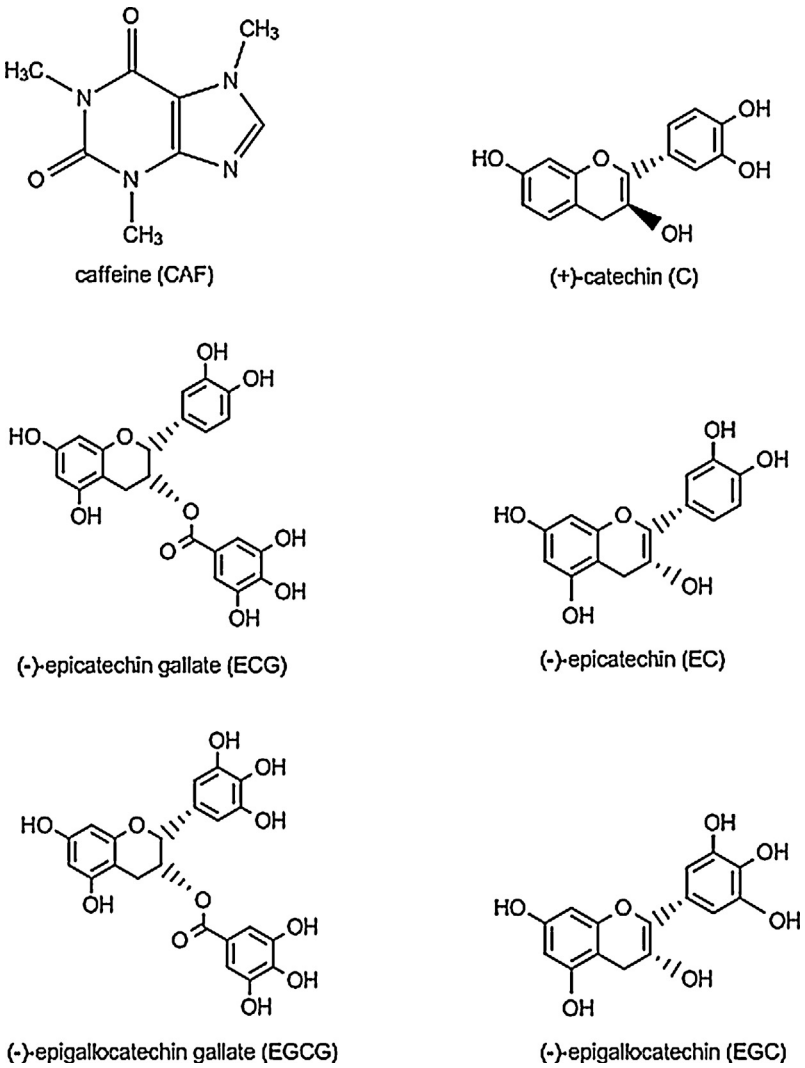

Fig. 1. Chemical structures of common bioactive molecules present in green tea extract.

Synthetic chemicals are often used as antimicrobials in food processing and storage to eliminate the food-borne pathogens, many of which contributing to increase the resistance to antibiotics and having side adverse effects, even carcinogenic.

It is generally known that current research in the field of targeting drug delivery systems is focusing on the development and marketing of nanomaterials for both passive and active targeting. Among the first developed delivery systems are liposomes, which are considered to be adequate for encapsulation of both hydro- and liposoluble compounds, and to control their delivery rate, degradation and bioavailability [14–16]. Liposomes exhibit a series of advantageous effects, for instance for direct administration in tissues associated with reticuloendothelial system, as auxiliaries in vaccine formulations, etc. However, formulations based on liposomes have numerous weak points related to complex and rather expensive preparation conditions, difficulties during sterilization, low stability on storage, limitations caused by low capacity of solubilization of hydrophobic drugs and in drug delivery control. In contrast, the new drug delivery systems for topical medications, such as solid lipid nanoparticles (SLNs) and nanostructured lipid carriers (NLCs), have demonstrated to enhance follicular targeting, to allow high concentrations of the active drug and to penetrate the skin [17], to allow controlled release and gradual distribution of therapy compounds.

As referring to antioxidant compounds encapsulated, attempts have been made in the recent past by several researchers toward effective topical delivery of retinoids by employing various vesicular and non-vesicular carriers, like liposomes and mixed vesicles [18], nanocapsules [19] and lipid nanoparticles. In this context, new types of nanostructured lipid carriers containing natural oils as matrix components and cetyl palmitate and glyceryl stearate as safe accepted surfactants [20] could be developed for encapsulating green tea extract