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Original Article

Pharmacological properties of *Salvia officinalis* and its components

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ABSTRACT

Salvia officinalis (Sage) is a plant in the family of Labiatae/Lamiaceae. It is native to Middle East and Mediterranean areas, but today has been naturalized throughout the world. In folk medicine, *S. officinalis* has been used for the treatment of different kinds of disorders including seizure, ulcers, gout, rheumatism, inflammation, dizziness, tremor, paralysis, diarrhea, and hyperglycemia. In recent years, this plant has been a subject of intensive studies to document its traditional use and to find new biological effects. These studies have revealed a wide range of pharmacological activities for *S. officinalis.* Present review highlights the up-to-date information on the pharmacological findings that have been frequently reported for *S. officinalis*. These findings include anticancer, anti-inflammatory, antinociceptive, antioxidant, antimicrobial, antimutagenic, antidementia, hypoglycemic, and hypolipidemic effects. Also, chemical constituents responsible for pharmacological effects of *S. officinalis* and the clinical studies on this plant are presented and discussed.

1. Introduction

Salvia officinalis L. (Sage) is a perennial round shrub in the family of Labiatae/Lamiaceae (Fig. 1). Salvia is the largest genus of this family and includes near 900 species. Plants of this genus grow all over the world and the specie of *S. officinalis* is native to Middle East and Mediterranean areas. Today's, it has been naturalized throughout the world particularly in Europe and North America.[1–3] The aerial parts of *S. officinalis* shrub has a long history of use in cookery and traditional medicine. Because of its flavoring and seasoning properties, this plant has been widely used in preparation of many foods. In folk medicine of Asia and Latin America, it has been used for the treatment of different kinds of disorders including seizure, ulcers, gout, rheumatism, inflammation, dizziness, tremor, paralysis, diarrhea, and hyperglycemia.[4,5] In traditional medicine of Europe, *S. officinalis* has been used to treat mild dyspepsia (such as heartburn and bloating), excessive sweating, age-related cognitive disorders, and inflammations in the throat and skin.[6–8] German Commission E has accepted the use of *S. officinalis* for a number of medical applications included inflammation and dyspepsia.

In recent years, many research studies have been conducted to document the traditional uses of *S. officinalis* and to find new biological effects for this plant. These studies have revealed a wide range of pharmacological activities including anticancer, anti-inflammatory, anti-nociceptive, antioxidant, antimicrobial, antimutagenic, antidementia, hypoglycemic, and hypolipidemic, effects. In this review, effort has been made to discuss all pharmacological findings that have been frequently reported for *S. officinalis*. Also, chemical constituents responsible for the biological effects of this plant are presented and discussed. Some of the unwanted effects and toxicity of *S. officinalis* are briefly outlined.

2. Bioactive compounds of *S. officinalis*

The major phytochemicals in flowers, leaves, and stem of *S. officinalis* are well identified. A wide range of constituents include alkaloids, carbohydrate, fatty acids, glycosidic derivatives (e.g., cardiac glycosides, flavonoid glycosides, saponins), phenolic compounds (e.g., coumarins, flavonoids, tannins), poly acetylenes, steroids, terpenes/terpenoids (e.g., monoterpenoids, diterpenoids,

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Fig. 1. Arial parts of *Salvia officinalis* L.

triterpenoids, sesquiterpenoids), and waxes are found in *S. officinalis*.[9–25] Structure of main flavonoids and terpenes/terpenoids isolated from *S. officinalis* is shown in Fig. 2 and Fig. 3, respectively. Most of the phytochemicals which are reported from *S. officinalis* have been isolated from its essential oil, alcoholic extract, aqueous extract, butanol fraction, and infusion preparation. More than 120 components have been characterized in the essential oil prepared from aerial parts of *S. officinalis*. The main components of the oil include borneol, camphor, caryophyllene, cineole, elemene, humulene, ledene, pinene, and thujone.[9,12,13] Alcoholic and aqueous extracts of *S. officinalis* are rich in flavonoids particularly rosmarinic acid and luteolin-7-glucoside. Also the phenolic acids such as caffeic acid and 3-Caffeoylquinic acid have been found in methanolic extract of *S. officinalis*.[17] Several flavonoids like chlorogenic acid, ellagic acid, epicatecin, epigallocatechin gallate, quercetin, rosmarinic acid, rutin, and luteolin-7-glucoside, as well as several volatile components such as borneol, cineole, camphor, and thujone have been identified in infusion prepared from *S. officinalis*.[15,26] Rosmarinic acid and ellagic acid are the most abundant flavonoids in *S. officinalis* infusion extract, followed by rutin, chlorogenic acid, and quercetin.[26] The most abounding carbohydrates described in this plant are arabinose, galactose, glucose, mannose, xylose, uronic acids and rhamnose.[10]

Comparing the phytochemicals in flowers, leaves, and stem of *S. officinalis*; linalool is the most present phytochemical in the stem; the flowers have the highest level of α-pinene and cineole; and bornyl acetate, camphene, camphor, humulene, limonene, and thujone are the most present phytochemicals in the leaves.[22] However, it should be considered that, like other herbs, the chemical composition of *S. officinalis* would be varied depending on the environmental conditions such as climate, water availability, and altitude.[20]

3. Pharmacological activities

Experimental and clinical studies on pharmacological properties of *S. officinalis* are presented and discussed in the following sections. Table 1 summarizes clinical studies on *S. officinalis*.

3.1. Anticancer and antimutagenic effects

Potential antitumor activity of *S. officinalis* has been studied on several cancerous cell lines and on animal models of cancer. It has

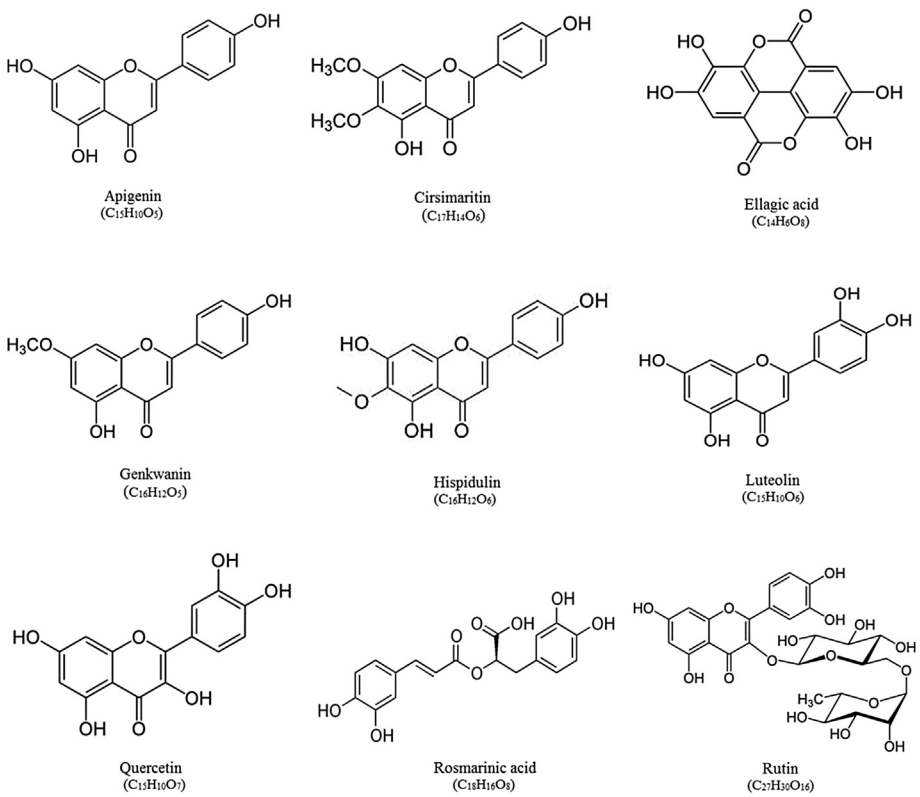

Fig. 2. Structure of main flavonoids isolated from *Salvia officinalis*.

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