COMPARATIVE STUDY REGARDING THE IMPORTANCE OF SAGE (Salvia officinalis L.) IN TERMS OF ANTIOXIDANT CAPACITY AND ANTIMICROBIAL ACTIVITIES

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Abstract. Antioxidants prevent the reaction of free radicals with biomolecules and can remind the nutritional values and physiological properties of foodstuffs. Nowadays there is an increasing trend among food technologists to replace the synthetic kind of antioxidants with the natural ones. Spices and herbs have been used not only for flavoring food but also for improving the overall quality of the product and to extend the shelf life of foods due to their antioxidant properties. (Amal A., 2012). The leaves of sage (Salvia officinalis L., Lamiaceae) are reported to have a wide range of biological activities, such as antibacterial, fungistic, virustatic, astringent, eupeptic and anti-hydrotic effects. In this research paper were collected data from several scientific studies with the aim to expose the antioxidant capacity and antimicrobial activity of various extracts of sage (Salvia officinalis) using different methods of analysis and highlighting the importance of both as a medicinal plant and as natural antioxidant in foodstuff.

Keywords: sage (Salvia officinalis); antioxidant capacity; antimicrobial activity; phenolic compound; essential oil.

Introduction

Salvia officinalis (sage, also called garden sage, common sage or jales) is a perennial, evergreen sub shrub, with woody stems, grayish leaves, and blue to purplish flowers. It is a member of the family Lamiaceae and is native to the Mediterranean region, though it has naturalized in many places
throughout the world. Salvia and "sage" are derived from the Latin salvere (to save), referring to the healing properties long attributed to the various Salvia species. (Kintzios et al., 2000). Sage is one of the oldest medicinal plants used by human. It is known the use of sage since ancient times, is considered a universal panacea. (Muntean, 2007). It has a long history of medicinal and culinary use, and in modern times as an ornamental garden plant. There is little specific information concerning the current market statistics for sustainable harvesting of sage. There are certified operators marketing organic wild-collected sage from European countries which requires implementation and inspection of sustainable wild-resource management plans. The European Herb Growers Association (EUROPAM) 2010 update on production of medicinal and aromatic plants (MAPs) in Europe, although not specific, indicates that commercial cultivation increased in Bulgaria while wild collection decreased; that sage remains one of the main medicinal herbs produced in Germany; and that it is still cultivated in Romania and in Greece in cooperatives (EUROPAM).

In the traditional Austrian medicine Salvia officinalis’s herb has been used internally (as tea or directly chewed) for treatment of disorders of the respiratory tract, mouth, gastrointestinal tract, and skin (Vogl S. et al., 2013). It has been recommended at one time or another for virtually every ailment by various herbals. Modern evidence shows possible uses as an anti-sweating agent, antibiotic, antifungal, astringent, antispasmodic, estrogenic, hypoglycemic, and tonic. In a double blind, randomized and placebo-controlled trial, sage was found to be effective in the management of mild to moderate Alzheimer's disease. (Akhondzadeh S. et al., 2003). Salvia officinalis essential oil is applied in the treatment of a large range of diseases such as nervous system, heart and blood circulation, respiratory, digestive, metabolic and endocrine diseases, while the Salvia officinalis infusion is commonly used for the haemostatic, estrogenic, antiperspiration, anti-neuralgic, antiseptic, hypoglycemic and many other therapeutic effects (Istudor, V. 2001). The strongest active constituents of sage are within its essential oil, which contains cineole, borneol, and thujone. Sage leaf contains tannic acid, oleic acid, ursolic acid, cornsole, cornsolic acid, fumaric acid, chlorogenic acid, caffeic acid, niacin, nicotinamide, flavones, flavonoid glycosides, and estrogenic substances (Sutton et al., 2004)
Microbial activity and antioxidant capacity of sage

Regarding the microbial activity, the interest in the possible use of natural alternatives to food additives to prevent bacterial and fungal growth has notably increased. Plants and plant products can represent a source of natural alternatives to improve the shelf life and the safety of food. Also, they are characterized by a wide range of volatile compounds, some of which are important flavor quality factors as evidenced by the specialty literature (Utama, I., 2002). Recently, the interest in the application of essential oils to control plant and postharvest pathogens has increased and their potential role in food preservation has been exploited (Vazquez, B. I. et al., 2001). In 2006, Ileana C. et al., has done research on plant essential oils for their antimicrobial activity against many microorganisms including several pathogens and finally concluded that the compounds from Salvia officinalis essential oil have been shown to exhibit high antibacterial activity against Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, Bacillus subtilis, cytotoxic activity against Vero cells and virucidal activity against herpes simplex virus. Other research shows that common sage (Salvia officinalis L.) is among the plants that are claimed to be beneficial to diabetic patients, and previous studies have suggested that some of its extracts have hypoglycaemic effects in normal and diabetic animals.

Another interesting research suggested that the ethanol extract of sage could be used as natural antioxidant in food industry. This recent study was devised by Amal A. Hassan et al., in 2012, the aim was to evaluate the antioxidant activity of various extracts of Egyptian sage (Salvia officinalis L.) by two complementary test systems (DPPH free radical scavenging and -carotene/linoleic acid systems) and butylated hydroxyanisole (BHA) was used as a comparison as well as the total phenolic content of the extracts was also investigated by them. In addition, the effect of addition of sage ethanolic extract on lipid oxidation of mayonnaise during storage for four months was also studied by them. The results revealed that water and ethanolic extract were more efficient in scavenging free radicals with IC values of 10±1.22 and 14±1.46 µg/ml, respectively and the less effective was the essential 50 oil with IC of 8510±317 µg/ml, while the IC for BHA was 5±0.47 µg/ml. In -carotene / linoleic acid test 50 50 system, ethanolic
extract was superior to the other extracts studied (inhibition value was 95.45%±0.68) and also contained the high level of total phenolic compounds (94.35±1.29 mg gallic acid/g dry extract). Mayonnaise prepared by addition of sage ethanolic extract (at a concentration of 100, 200 and 400 µg/g) was subjected to sensory studies and chemical analysis. Mayonnaise samples treated by sage ethanolic extract (400 µg/g) showed higher (p 0.05) panel scores during storage period than the mayonnaise samples without treated. Their research reveal that the addition of sage ethanolic extract (400µg/g) gave an excellent antioxidant effect on the stability of mayonnaise compared with the effect of BHA, as the % increase in both peroxide and malonaldehyde values after storage period were lower than that of the control and BHA treated samples.

The Romanian researchers (Elena N. et all) in 2011 have demonstrated the antioxidant capacity of some Salvia Officinalis concentrated extracts in different ratios, shown by spectrophotometrical methods. They obtained new extracts from Salvia officinalis – 8%, 10% and 15 % (mass concentration) hydro-alcoholic extracts in 50 % ethanol – which have been processed using an original developed procedure of extract separation and concentration based on porous membranes (ultrafiltration). The extracts were characterized in terms of total polyphenols’, flavones’ content determination and antioxidant capacity assesement. The antioxidant capacity was assessed by two spectrophotometrical methods: 2,2-diphenylpicrylyhydrazyl (DPPH) and 2,2’- azinobis (3-ethylbenzothiazoline-6-sulfonic acid (ABTS). A proportionality between the polyphenols’, flavones’ concentrations and antioxidant capacity was observed, the highest antioxidant activity being found in case of extracts in 50% ethanol with 10% plant mass. The obtained results evidenced that the applied membranous (ultrafiltration) procedures resulted in some concentrated Salvia officinalis extracts having a high antioxidant capacity (89.89 percent of DPPH inhibition).

In the study conducted by Lima et all in 2006, they have verified that the antidiabetic effects of an infusion (tea) of common sage. Replacing water with sage tea for 14 d lowered the fasting plasma glucose level in normal mice but had no effect on glucose clearance in response to an intraperitoneal glucose tolerance test. This indicated effects on gluconeogenesis at the level of the liver. Primary cultures of hepatocytes
from healthy, sage-tea-drinking rats showed, after stimulation, a high glucose uptake capacity and decreased gluconeogenesis in response to glucagon. Essential oil from sage further increased hepatocyte sensitivity to insulin and inhibited gluconeogenesis. Overall, these effects resemble those of the pharmaceutical drug metformin, a known inhibitor of gluconeogenesis used in the treatment and prevention of type 2 diabetes mellitus. In primary cultures of rat hepatocytes isolated from streptozotocin (STZ)-induced diabetic rats, none of these activities was observed. The present results seem to indicate that sage tea does not possess antidiabetic effects at this level. Its effects on fasting glucose levels in normal animals and its metformin-like effects on rat hepatocytes suggest that sage may be useful as a food supplement in the prevention of type 2 diabetes mellitus by lowering the plasma glucose of individuals at risk.

In 2006, Miura K. et al., has done research about the antioxidant activity of chemical components from sage (Salvia officinalis L.) measured by the oil stability index method. A new abietane diterpenoid, 12-O-methyl carnosol (2), was isolated from the leaves of sage (Salvia officinalis L.), together with 11 abietane diterpenoids, 3 apianane terpenoids, 1 anthraquinone, and 8 flavonoids. Antioxidant activity of these compounds was evaluated by the oil stability index method using a model substrate oil including methyl linoleate in silicone oil at 90 degrees C. Finally concluded that the carnosol, rosmanol, epirosmanol, isorosmanol, galdosol, and carnosic acid exhibited remarkably strong activity, which was comparable to that of alpha-tocopherol. The activity of miltirone, atuntzensin A, luteolin, 7-O-methyl luteolin, and eupafolin was comparable to that of butylated hydroxytoluene. The activity of these compounds was mainly due to the presence of ortho-dihydroxy groups. The 1,1-diphenyl-2-picrylhydrazyl radical scavenging activity of these compounds showed the similar result.

Miguel G. et al., in 2011 have shown the effect of hydrodistillation time on the chemical composition, antioxidant and antimicrobial activities from Salvia officinalis L. essential oils analysed by gas chromatography and gas chromatography-mass spectrometry and antibacterial activity was determined by the agar diffusion method. These oils were isolated from the plant's commercial dried aerial parts, by hydrodistillation, with different distillation times. The antioxidant ability was measured using a free radical scavenging activity assay using 2,2-diphenyl-1-picrylhydrazyl (DPPH), a
thiobarbituric acid reactive substances (TBARS) assay, a deoxyribose assay for the scavenging of hydroxyl radical, an assay for site-specific actions and a 5-lipoxygenase assay. Antibacterial activity was determined by the agar diffusion method. 1,8-Cineole, α-pinene and camphor were the dominant components of all the essential oils. The different hydrodistillation times did not affect the oil yield nor the relative amount of the oil components. The time of hydrodistillation influenced the antioxidant activity. With the DPPH method, the oils isolated for 2 and 3 h were stronger free radical scavengers, while with the TBARS method, the highest antioxidant values were obtained in the oils isolated for 30 min, 2 and 3 h. Hydroxyl radical scavenging and lipoxygenase activity assays showed the best results with oils isolated for 1 and 3 h. With the deoxyribose method, sage oils at concentrations <1000 mg L(-1) showed better activity than mannitol. In conclusion the researchers claimed that the essential oil of S. officinalis showed very weak antimicrobial activity.

The sage plant materials from which essential oil had been recovered were proven to be valuable source of natural products with potential application in the protection and preservation of certain foods and nutraceuticals. The use of this secondary priceless raw material from essential oil production is expected to have technological, economical and ecological justification, as safer alternative food preservation additives as shown in research by Dragut T. Veličković et. al. in 2011. In this case were studied antioxidant and antimicrobial activities as well as total phenols and flavonoids contents of Salvia glutinosa L. (glutinous sage) and Salvia officinalis L. (sage) extracts. Methanol and aqueous ethanol (70% v/v) were used for extraction of bioactive compounds, both in the presence and the absence of ultrasound, from herb and the spent plant material remaining after the essential oil hydrodistillation. The ratio of plant material to extracting solvent was 1:10 g/mL. Antioxidant and antimicrobial activities of the extracts were found to depend on the type of plant material and the extraction conditions. All extracts obtained by the ultrasound-assisted extraction showed weaker antioxidant, compared to the extracts obtained by classical extraction. In addition, the spent plant material extracts were shown to have a higher antimicrobial activity than the herbal extracts.

Conclusions
• The compounds from *Salvia officinalis* essential oil have been shown to exhibit high antibacterial activity against *Staphyloccocus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Bacillus subtilis*, cytotoxic activity against Vero cells and virucidal activity against herpes simplex virus.

• Some of its sage extracts have hypoglycaemic effects in normal and diabetic animals.

• The ethanol extract of sage could be used as natural antioxidant in food industry.

• A proportionality between the polyphenols’, flavones’ concentrations and antioxidant capacity was observed.

• The sage plant materials from which essential oil had been recovered were proven to be valuable source of natural products with potential application in the protection and preservation of certain foods.

**References**


