



## Review

South African *Salvia* species: A review of biological activities and phytochemistryG.P.P. Kamatou<sup>a</sup>, N.P. Makunga<sup>b</sup>, W.P.N. Ramogola<sup>b</sup>, A.M. Viljoen<sup>a,\*</sup><sup>a</sup> Department of Pharmaceutical Sciences, Faculty of Science, Tshwane University of Technology, Private Bag X680, Pretoria 0001, South Africa<sup>b</sup> Department of Botany and Zoology, Stellenbosch University, Private Bag X1, Matieland 7602, South Africa

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## ABSTRACT

The genus *Salvia* (sage) belongs to the Lamiaceae and encompasses 900 species worldwide of which *ca.* 26 indigenous species are found in southern Africa. *Salvia* is the largest genus in this family and constitutes almost one quarter of the Lamiaceae. In South Africa, the majority of *Salvia* species are distributed predominantly in the Cape region. *Salvia* species are used in many parts of the world to treat various conditions. Many sages, if not all, form an integral part of traditional healing in South Africa particularly in regions where they occur in abundance. Several species are used to treat microbial infections, cancer, malaria, inflammation, loss of memory and to disinfect homes after sickness. Despite the extensive traditional use and the general interest in phytoconstituents of *Salvia* it remains ironic that research on the South African counterparts has until recently been neglected. The review aims to collate recent research results on the phytochemistry and pharmacological properties of indigenous species. Bio-active compounds with antiplasmodial and antibacterial activities have been isolated and structurally elucidated from *Salvia chamelaeagnea*, *Salvia radula* and *Salvia verbenaca*. The essential oil composition of *Salvia* showed the dominance of monoterpene hydrocarbons, oxygen-containing monoterpenes and oxygen-containing sesquiterpenes. *Salvia runcinata* is identified as an alternative source of natural  $\alpha$ -bisabolol. Many pharmacological activities are summarised (anti-oxidant, antimicrobial, antiplasmodial, analgesic, antipyretic, anticancer, anti-inflammatory and antinociceptive) as a first attempt to provide scientific support for past and present local traditional uses.

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## 1. Introduction

*Salvia* species (sage) belong to the Lamiaceae family (formerly Labiatae). The genus name *Salvia* L. is derived from the Latin *salvare* meaning 'to heal or to be safe and unharmed' referring to the medicinal properties of some of the species (Blumenthal et al., 2000). It has been used for centuries, especially by the Chinese to promote longevity and in Roman ceremonies as a sacred herb. This name was translated to *sauge* (sage) in French and *sawge* in Old English. Sage encompasses about 900 species, widespread throughout the world and includes several ornamental, culinary and medicinal species (Codd, 1985; Paton, 1991; Gali-Muhtasib et al., 2000). The genus has a sub-cosmopolitan distribution, but is largely absent in the North and most of the low-lying tropical areas of the world such as the Amazon basin and central and west Africa (Paton, 1991). Although Mexico has the highest number of species (about 250), the center of origin of the genus is speculated to be Afghanistan and Soviet Central Asia where a larger range of primitive morphological types occur (Paton, 1991). In Africa, the greatest number of species are found in the north-west and the southern parts (Hedge, 1974). The genus is absent from most of western and central tropical Africa (Jäger and Van Staden, 2000). Southern Africa is home to more than 24,000 higher plant taxa (Arnold and De Wet, 1993) and a large proportion of these are endemic in character (Mulholland and Drewes, 2004). About 30 *Salvia* species have been identified in southern Africa (Codd, 1985; Paton, 1991) but species such as *Salvia coccinea*, *Salvia officinalis*, *Salvia reflexa*, *Salvia sclare* and *Salvia tillifolia* have been introduced and are thus not indigenous to the region. Most of the South African species are confined to the Cape region (Codd, 1985). In the past decade a new and unusual fynbos species, *Salvia thermarum*, (sometimes incorrectly termed *Salvia thermara*) was discovered growing on rocky slopes of quartzitic sandstones around the Citrusdal and Caledon District of the South-Western Cape (Van Jaarsveld, 1999; De la Cruz, 2005).

### 1.1. Morphological description

*Salvia* species are easily recognized by their square stems and opposite, simple pairs of leaves that are usually velvety or hairy. Leaves are often rugose, entire, toothed and lobed. Flowers are clustered in racemes, spike-like racemes, spikes and panicles are usually large and brightly coloured, depending on the species. Flowers and stems are key diagnostic characteristics for identification of the genus (Hedge, 1974; Codd, 1985). There are four stamens, but only two bear anthers. *Salvia* grows optimally in full sun and needs well-drained soil.

### 1.2. Traditional uses of *Salvia* species in South Africa

The positive benefits of *Salvia officinalis* (common sage) to health are reputed throughout Ancient Romans times and the Middle Ages. A quote such as: 'Cur moriatur homo cui *Salvia* crescit in horto?' – 'Why should a man die whilst sage grows in his garden?' epitomizes the impact of this sage on that society at the time. Apart from general scientific curiosity, understanding the chemistry of *Salvia* plants is important for several commercial industries because these plants are utilized for flavouring food, used in cosmetic formulations, aromatherapy and insecticides.

Most *Salvia* species are inherently linked to local traditional medicine systems in their country of origin (Codd, 1985). *Salvia* species are used to treat various conditions which are summarized in Table 1. Historically, European descendants in South Africa have utilized the species endemic to the Western Cape in a comparable fashion to *Salvia officinalis* for treating colds, coughs and bronchial infections. Amongst the African tribes, sages are used for a wide variety of ailments including ethnoveterinary purposes and as disinfectants. For instance, *Salvia africana-lutea* (beach or brown dune sage) which mainly grows along the coast, extending from Namaqualand to the Cape Peninsula and eastwards to the Eastern Cape Province in Port Alfred (Codd, 1985) is still an ethnoherbal product commonly found in informal markets in the Western Cape today, particularly in Cape Town.

*Salvia africana-lutea* was used by early Europeans settlers in the Western Cape as an infusion to treat colds (Watt and Breyer-Brandwijk, 1962). Before the discovery of antibiotics, it was frequently prepared as a component of herbal tea mixtures, to treat tuberculosis and chronic bronchitis (Watt and Breyer-Brandwijk, 1962). The cultural use still continues today, for example, *Salvia africana-lutea* is collected fresh when needed or sold in dried or semi-dried bundles comprising mainly of leaves or occasionally flowers and fruits. The traditional healers in the Western Cape Province prescribe a decoction of *Salvia africana-lutea* to treat respiratory ailments, influenza, gynaecological complaints (Watt and Breyer-Brandwijk, 1962), fever, headaches and digestive disorders (Amabeoku et al., 2001). Leaves of *Salvia runcinata* are administered to infants as a purgative (Gerstner, 1941). Van Wyk and Wink (2004) reported that *Salvia africana-caerulea* and other *Salvia* species are used as cold and flu medicines. *Salvia repens* is added to a bath to treat sores on the body, while a decoction prepared from the roots is taken orally to treat stomachache and diarrhoea. The smoke obtained through burning the plant is used to disinfect a hut and also used as an insect repellent (Clebsch, 2003). A decoction of *Salvia runcinata* has been used by Europeans for the relief and the treatment of urticaria. The Zulu use a paste of crushed leaves as a purgative for infants, while the Xhosa administer extracts of the leaves to newly born babies (Watt and Breyer-Brandwijk, 1962).

So far only three species (*Salvia africana-caerulea*, *Salvia africana-lutea* and *Salvia chamelaeagnea*) have been documented in the South African Pharmacopeia Monographs Project (South Africa Health Info, 1999) which was recently established due to a lack of documentation of medicines used traditionally.

## 2. Chemical constituents of *Salvia* species

### 2.1. Volatile compounds (essential oils)

Limited work has been carried out on the volatile components of indigenous *Salvia* species. The essential oils of 11 species were isolated by hydrodistillation and analyzed by GC and GC-MS (Kamatou, 2006; Kamatou et al., 2006a,b, 2007b). The oil yield was relatively low compared to that reported in literature for exotic *Salvia* species. Bellomaria et al. (1992) reported the yield of *Salvia pomifera*, *Salvia willeana* and *Salvia fruticosa* to be 1.30, 2.80 and 5.30%, respectively. Pitarevic et al. (1984) found that the yield of *Salvia officinalis* collected at various seasons throughout the year varied from 1.80 to 3.10%. The relatively high yield obtained for

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