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COMPOSITION AND ANTIFUNGAL ACTIVITY OF ESSENTIAL OIL OF *Salvia sclarea* FROM ITALY

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Salvia sclarea L. (clary sage) is a biennial or perennial shrub, native to southern Europe and belonging to the family of *Lamiaceae* [1]. Oil of clary sage has been reported to exert a depressant action on the CNS in mice and a hydrocolerethic effect in rats [2], a topical antiinflammatory activity in porcine buccal mucosa [3], and to act as a stomachic in digestive disorders and in kidney diseases. In Italy *S. sclarea* is traditionally used to cure coughs and as a stomachic or to treat intestinal spasms [4]. The chemical composition of *S. sclarea* essential oils of different origins has been reported [5] and a significant antimicrobial activity against *Escherichia coli, Staphylococcus epidermis, S. aureus,* and *Candida albicans* has been observed. To the best of our knowledge, the antifungal activity of *S. sclarea* oil on phytopathogenic fungi has so far been studied only on three fungi [5].

The aim of this work was to examine the chemical composition of the essential oil of *S. sclarea* collected near Urbino (central Italy) and to evaluate the activity of the oil and two of its major components on the growth of four phytopathogenic fungi, *Fusarium oxysporum, Botrytis cinerea, Rhizoctonia solani,*and *Alternaria solani.*

The chemical composition of the essential oil is reported in Table 1. The major components of the oil were linalool (24.5%), linalyl acetate (20.9%), geranyl acetate (6.3%), (E)-β-ocimene (5.7%), and caryophyllene oxide (5.3%). The *in vitro* antimicrobial activity of the essential oil of *S. sclarea* showed that *R. solani* is totally inhibited at 800 ppm, and *B. cinerea* at 1600 ppm, both by fungistatic effects, and *F. oxysporum* and *A. solani* at 3200 ppm by fungicidal and fungistatic effect, respectively (see Table 2).

Results (expressed as MIC values) obtained from the agar dilution method are respectively 700 ppm for *R. solani*, 950 ppm for *B. cinerea,* and 1800 and 1900 ppm for *F. oxysporum* and *A. solani*, respectively, while MFCs are 1450 ppm for *R. solani*, 3000 for *F. oxysporum* and *B. cinerea,* and more than 3200 for *A. solani* (Table 3). The most sensitive microorganism tested with the lowest MIC value was therefore *R. solani*. Pure commercial linalool and linalyl acetate were then tested independently for their antifungal action on the fungal strains tested and showed different degrees of inhibition. The MIC values obtained for pure linalool on *R. solani*, *B. cinerea*, *F. oxysporum*, and *A. solani* were 200, 300, 800, and 1000, respectively, and MFCs obtained for the same fungi were 2400, 2400, 2800, and 3200 respectively. The MIC value for linalyl acetate, tested on all fungal strains, was over 4000 ppm. Basing on the literature data, [5] it is conceivable that the activity of oil from *S. sclarea* could be due mainly to the presence of linalool.

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TABLE 1. Chemical Composition of the Oil of *Salvia sclarea* Extracted from Flowering Tops

Compound	%	RI
β-Myrcene	8.4	986
Limonene	1.7	1005
(Z)-β-Ocimene	2.6	1013
(E)-β-Ocimene	5.7	1023
Terpinolene	1.03	1062
Linalool	24.5	1084
α-Terpineol	9.8	1169
Geraniol	1.2	1230
Linalyl acetate	20.9	1238
Neryl acetate	3.6	1339
α-Copaene	1.1	1347
Geranyl acetate	6.3	1359
β-Caryophyllene	3.0	1424
Germacrene D	0.9	1468
δ-Cadinene	1.1	1506
Spathulenol	2.0	1560
Caryophyllene oxide	5.3	1566
Sclareol	1.8	2201

TABLE 2. Effect of *Salvia sclarea* Oil Obtained from Flowering Tops on *in vitro* Growth of Selected Pathogens Fungal (% Inhibition)

Fungus	Nystatine 100 ppm	200 ppm	400 ppm	800 ppm	1600 ppm	3200 ppm
F. oxysporum	100*	28.5±2.2	52.7±1.5	70.4±3.1	90.2±2.4	100*
B. cinerea	100*	34.9±1.8	50.3±2.2	80.1±2.5	100°	100*
R. solani	100*	44.2±3.2	71.4±2.5	100°	100*	100*
A. solani	100*	29.5±2.7	51.8±1.8	62.9±1.4	90.4±2.7	100°

*Fungicidal; °Fungistatic.

TABLE 3. Screening of Minimal Inhibitory Concentration (MIC) and Minimal Fungicidal Concentration (MFC) of *Salvia sclarea* Oil Extracted from Flowering Tops

Fungus	Essential oil		Linalool		Linalyl acetate
	MIC, μg/mL	MFC, mg/mL	MIC, μg/mL	MFC, mg/mL	MIC, μg/mL
F. oxysporum	1800±3.2	3000±3.5	800±1.5	2800±2.8	>4000
B. cinerea	950±2.8	3000±3.5	300±1.3	2400±2.5	>4000
R. solani	700±2.3	1450±2.8	200±1.3	2400±2.5	>4000
A. solani	1900±3.5	>3200	1000±2.3	3200±3.2	>4000

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