FINAL REPORT SUMMARY

UGC MINOR RESEARCH PROJECT

Chemical Composition and Mosquito Larvicidal Activities of *Salvia* L. (Lamiaceae) in South India

The genus *Salvia* is the largest genera of Lamiaceae, with nearly 1,000 species (Estilai *et al*., 1990), largely cultivated for ornamental, aromatic and culinary usage. The insecticidal effects of *Salvia* species is because of the presence of phenolic acids and flavonoids. Regarding phenolic acids, the majority of these compounds in *Salvia* species are unique to *Salvia* (Lu and Foo, 2002). However, there have not been any thorough investigations on larvicidal effects of essential oils and extracts from *S. coccinea* Buc'hoz ex Etl. 'White', *Salvia dorisiana* Standl., *Salvia elegans* Vahl, *Salvia farinacea* Benth., *Salvia involucrata* Cav., *Salvia leucantha* Cav., *Salvia microphylla* Kunth, *Salvia officinalis* L., *Salvia splendens* Sellow ex J. A. Schult. 'Blue Ribbon' and *Salvia splendens* Sellow ex J. A. Schult. 'Scarlet Sage-Red'. In the light of this, the present investigation was designed to identify the constituents of essential oils and extracts from the aerial parts of ten taxa of *Salvia* and to test their larvicidal efficacy against fourth instar larvae of *Aedes albopictus* and *Aedes aegypti*.

The essential oils and methanolic extracts showed significant larvicidal effects. The ethanol, hexane, water extracts and fractions of extracts didn't show significant results in the bioassay. Among the ten essential oils, *S. officinalis* essential oil showed highest larvicidal efficacy against *A. aegypti* (LC_{50} = 41.3 µg/ml; LC_{90} = 112.7µg/ml) and *A. albopictus* (LC_{50} = 44.3 µg/ml; LC_{90} = 109.7 µg/ml). The methanolic extracts of *S. officinalis* also possessed high larvicidal effect against *A. aegypti* (LC_{50} = 65.2 µg/ml; LC_{90} = 136.4 µg/ml) and *A. albopictus* (LC_{50} = 63 µg/ml; LC_{90} = 144.7µg/ml). Essential oils and methanoilc extracts of *S. microphylla, S. leucantha, S. farinacea* and *S. splendens* 'Blue Ribbon' and essential oil of *S. elegans* also showed high larvicidal efficacy against the fourth fourth-instar larvae of *A. aegypti* and *A. albopictus* in 24 h treatment.

Exploration of essential oil of ten taxa of *Salvia* revealed that the percentage of oil ranges from 0.98% (*S. officinalis*) to 0.13% (*S. coccinea* 'White' and *S. splendens* 'Scarlet sage-Red'). All together 83 components were detected in all the ten taxa of

Salvia in which the major classes were found to be sesquiterpenoids, monoterpenoids, diterpenoids, fatty acid esters, phenols and miscellaneous compounds.

The probable chemotypes based on essential oil analysis are: β-cubebene > phytol > caryophyllene, chemotype in *S. coccinea* 'White'; ledol > 4,4′-[(*p*-phenylene) diisopropylidene] diphenol > phytol in *S. dorisiana*; spathulenol > caryophyllene > pimara-7, 15- dien-3-one in *S. elegans*; phytol > caryophyllene > hexahydrofarnesyl acetone in *S. farinacea;* 1,1,2,3,3-pentamethylindan > caryophyllene > phytol > β-cubebene in *S. involucrata*; caryophyllene > α-gurjunene > calamenene in *S. leucantha*; caryophyllene > γ-Gurjunene > epi-bicyclo sesquiphellandrene in *S. microphylla*; manool > α-caryophyllene > spathulenol in *S. officinalis*; β- cubebene > caryophyllene > phytol in *S. splendens* 'Blue Ribbon' and chemotype in *S. splendens* 'Scarlet Sage-Red' is phytol > cyclooctasulfur > 2, 2′-methylene-bis [6-(1,1-dimethylethyl)-4-methyl]-phenol.

The HPLC analysis revealed that the major components in the methanolic extracts of six potential taxa of *Salvia* are: ascorbic acid, linolenic acid and asiatic acid in *S. farinacea*; diferulic acid, myricetin, betulinic acid and linolenic acid in *S. leucantha*; myricetin, betulinic acid and rosmarinic acid in *S. microphylla*; asiatic acid, carnosol and rosmarinic acid in *S. officinalis*; asiatic acid, vernolic acid and cinnamic acid in *S. splendens* 'Blue ribbon' and in the case of *S. splendens* 'Scarlet Sage - Red', it was synigrin and valerinic acid.

The high larvicidal efficacy of *S. officinalis* may be due to the presence of its components such as manool, α- caryophyllene, spathulenol and β-thujone in the essential oils and betulinic acid, carnosol, ascorbic acid, rosmarinic acid and asiatic acid in the methanolic extracts. In *S. splendens* Blue Ribbon also the presence of β-cubebene, caryophyllene oxide, and caryophyllene may cause high mosquito larvicidal activity. In *S. farinacea,* caryophyllene, patchoulene and hexahydrofarnesyl acetone in the essential oils and betulinic acid, carnosol, myricetin, ascorbic acid, linolenic acid and asiatic acid in the methanolic extract may be responsible for the effective larvicidal potency. Caryophyllene, α-gurjunene, calamenene, β-cubebene, spathulenol and elixene in the essential oils and betulinic acid, carnosol, myricetin, diferulic acid and linolenic acid in methanolic extract might cause larvicidal efficacy

in *S. leucantha.* The reason for larvicidal potential of *S. microphylla* may be the presence of caryophyllene, γ- gurjunene, epi-bicyclo sesquiphellandrene, borneol and β-cubebene in the essential oils and betulinic acid, carnosol, myricetin and rosmarinic acid in the methanolic extracts. Caryophyllene oxide together with linalool, methyl eugenol, aromadendrene, and caryophyllene might be the probable reason for high mosquito larvicidal activity of *S. elegans* essential oil. Such activity has already been reported on these volatile terpenoids (Harbone & Baxter, 1983; Senthilkumar *et al*., 2008). These findings demonstrate that the essential oils and extracts of these *Salvia* species could be considered as the powerful candidates to bring about useful botanicals so as to prevent the resurgence of mosquito vectors.