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# A review on microbial volatile biomolecules

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**Abstract**
Microbial volatile organic molecules (MVOMs) are produced by a number of microbes starting from bacteria to fungi. These molecules are eco-friendly and can be utilized as a cost-effective sustainable strategy for agricultural practice as agents which enhance crop growth, yield, and disease management/control. They have potential as possible alternatives to toxic chemicals (bactericides, fungicides, and pesticides) as well as genetic variations. They also play role in inducing phenotypic plant responses and their potential physiological effects on crops. The bacteria and fungi produce the microbial volatile organic compounds during the intermediary metabolism. Some of the important examples of volatile componds include 2-heptanol,2-methylfuran, 2-pentadecanone, 2-pentanone, 2-pentylfuran, 2-tridecanone, 2-undecanone, 4-heptanone, aromadendrene, azulene, naphthalene, tetrahydofuran, α-phellandrene and β-phellandrene. These molecules are capable to induce tolerance to drought and salinity as well. They also regulate sulfur and iron nutrition in plants.

**Keywords:** Microbial volatile organic molecules, bactericides, fungicides, pesticides

## Introduction
Modern agricultural practices are based on the use of chemical fertilizers, pesticides and herbicides [6]. Drastic Increase in demand for organic products also favours the reduced chemical use. Therefore, it is the need of the day to develop novel sustainable strategies for crop protection and enhancement that do not rely on harmful chemicals which ultimately leads to genetic modifications [5]. Although bio-pesticides, bio-fertilizers, and bio-control agents derived from living microbes are becoming suitable replacements for the hazardous synthetic pesticides and fertilizers, their reduced efficiency, still high costs and inconsistent field performance generally relegate them to niche products. Bacterial and fungal microbial volatile organic molecules might provide an alternative to the use of chemicals to protect plants from pathogens and provide a platform/base for better crop welfare [7].

## Microbial volatile organic molecules (MVOMs)
These are Lipophilic in nature, Low-molecular weight (<300 Da) compounds with Low boiling point. These are the products of the primary and secondary metabolism and are produced during the metabolism of the microbes [9].

## Classification
They are regrouped in six classes (Fig 1), including hydrocarbons (I), ketones/alcohols (II), nitrogen-containing compounds (V), Organic acids (III), sulfur compounds (IV) and terpenes (VI) [5].

## Bioactive Bacterial molecules
- Bacterial volatile molecules play an vital role in various interactions like Bacterial–bacterial; Bacterial–fungal and plant – microbial interactions.

## Role during Bacterial–Plant Interactions
The rhizospheric bacteria live in the soil closely associated with the plant roots, utilizing the rich exudates which plants release into the soil. Two volatile molecules *i.e.* 3-hydroxy-2-butanone and 2, 3-butanediol are released by *B. subtilis* GB03 and *B. amyloliquefaciens* IN937a whereas these molecules are not released by other strains studied so far. These volatiles have been found to enhance canopy of *A. thaliana*. In *Arabidopsis*, seedlings

exposed to bacterial volatile blends from *Bacillus subtilis* GB03 and *Bacillus amyloliquefaciens* IN937a have been found able to induce ISR. Disease severity by the pathogen *Erwinia carotovora* subsp. *Carotovora* is significantly reduced compared with untreated seedlings [8].

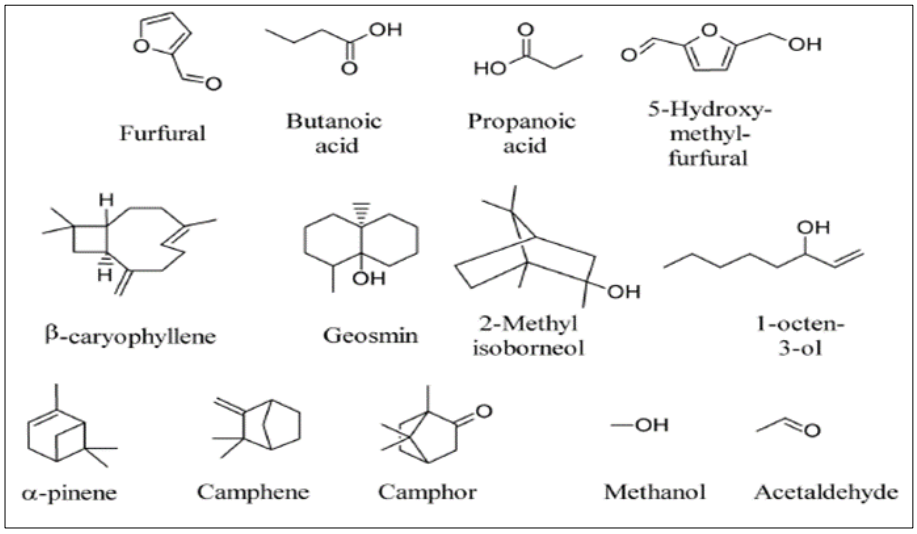


**Fig 1:** Some important Microbial volatile organic molecules (Courtesy – Kanchiswamy *et al*., 2015)

**Plant bio-stimulant and bio-protectant volatile molecules from bacteria**

**Indole**

- Isolated from soil-borne bacteria
- Increase plant biomass
- *Promote lateral* root growth

**Dimethyl disulfide**

- *Nicotiana attenuata and root-associated Bacillus* sp. B55 give response during their interactions and produce this molecule.
- Plant sulfur content is increased which help as plant growth promoting molecule.

**Pentylfuran:** The total biomass of *Arabidopsis* can be increased upto two times after treatment.

**Dimethylhexadecylamine**

*Medicago sativa* seedlings growth is increased *i.e.* plant biomass, root and stem length.

**Tridecane**

- plant biomass is increased
- Phytopathogens are controlled
- *Arabidopsis* against *Pseudomonas syringae* pv. *maculicola* ES432 the induced systemic resistance is observed [3].

**Pentanol**

- Controls the disease caused by *X. axonopodis* and Cucumber mosaic virus.

**1-Octen-3-ol**

- Mushrooms are the main source
- Disease caused by *Botrytis cinerea* can be controlled.
- Also reduces germination of *Lecanicillium fungicola*, (due to dry bubble disease) [1].

**Role during Bacterial–Bacterial Interactions**

- The molecules produced by *Collimona spratensis* and *Serratia plymuthica* stimulate the growth of *Pseudomonas fluorescens* responsible for plant growth promotion.
- Tomato plants treated with *Serratia plymuthica* strongly suppresse *Agrobacterium* growth by releasing DMDS
- *Pseudoalteromonas* is able to inhibit the growth of *Burkholderia cepacia* complex *(*Bcc*)* strains [2].

**Role during Bacterial–Fungal Interactions**

- *Staphylococcus pasteuri* shows antifungal activity against *T. borchii* mycelium through production of volatile molecules.
- The volatile molecules O-anisaldehyde has been found to exert the effective inhibition on the mycelial growth of *Botrytis cinerea* produced by *Bacillus atrophaeus.*
- *Bulkholderia gladioli* pv. *Agaricola* produce volatile molecules responsible for the inhibition of *F. oxysporum* and *Rhizoctonia solani* growth [4].

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