

# 2

## *Synthesis and Pharmacological Activities of Monoterpenoids*

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DOI: [10.1201/9781003008682-2](https://doi.org/10.1201/9781003008682-2)

### CONTENTS

#### [2.1 Introduction](#)

##### [2.1.1 Factors Affecting Production of Monoterpenoids](#)

#### [2.2 Synthesis of Monoterpenoids](#)

##### [2.2.1 Synthesis of Acyclic Monoterpenoids](#)

###### [2.2.1.1 Synthesis of Myrcene](#)

###### [2.2.1.2 Synthesis of Citral](#)

###### [2.2.1.3 Synthesis of Geraniol](#)

###### [2.2.1.4 Synthesis of Citronellol](#)

###### [2.2.1.5 Synthesis of Citronellal](#)

###### [2.2.1.6 Synthesis of Linalool](#)

###### [2.2.1.7 Synthesis of Ocimenes](#)

##### [2.2.2 Synthesis of Monocyclic Monoterpenoids](#)

###### [2.2.2.1 Synthesis of Menthol](#)

###### [2.2.2.2 Synthesis of \(-\)-Isopulegol](#)

###### [2.2.2.3 Synthesis of p-Cymene](#)

###### [2.2.2.4 Synthesis of Thymol](#)

###### [2.2.2.5 Synthesis of Carvacrol](#)

###### [2.2.2.6 Synthesis of Eucalyptol](#)

###### [2.2.2.7 Synthesis of Piperitone](#)

###### [2.2.2.8 Synthesis of Carvone](#)

###### [2.2.2.9 Synthesis of \$\alpha\$ -Terpineol](#)

###### [2.2.2.10 Synthesis of Pulegone and Isopulegone](#)

###### [2.2.2.11 Synthesis of Limonene](#)

###### [2.2.2.12 Synthesis of Perillyl Alcohol](#)

###### [2.2.2.13 Synthesis of Phellandrene](#)

###### [2.2.2.14 Synthesis of Carveol](#)

###### [2.2.2.15 Synthesis of Catalpol](#)

###### [2.2.2.16 Synthesis of Thymoquinone](#)

###### [2.2.2.17 Synthesis of Eugenol](#)

###### [2.2.2.18 Synthesis of Sobrerol](#)

###### [2.2.2.19 Synthesis of Aucubin](#)

##### [2.2.3 Synthesis of Bicyclic Monoterpenoids](#)

###### [2.2.3.1 Synthesis of Ascaridole](#)

###### [2.2.3.2 Synthesis of Pinene](#)

###### [2.2.3.3 Synthesis of Camphor](#)

###### [2.2.3.4 Synthesis of Borneol](#)

###### [2.2.3.5 Synthesis of Sabinene Hydrate](#)

###### [2.2.3.6 Synthesis of Fenchone](#)

###### [2.2.3.7 Synthesis of Verbenol](#)

#### [2.3 Pharmacological Activities of Monoterpenoids](#)

## [2.3 Pharmacological Activities of Monoterpenoids](#)

### [2.3.1 Antimicrobial Activity](#)

### [2.3.2 Antidepressant Activity](#)

### [2.3.3 Antiviral Activity](#)

### [2.3.4 Analgesic and Anti-Inflammatory Activity](#)

### [2.3.5 Antioxidant Activity](#)

### [2.3.6 Anticancer Activity](#)

### [2.3.7 Anti-Proliferative Activity](#)

### [2.3.8 Anticonvulsant Activity](#)

### [2.3.9 Sedative and Hypnotics](#)

### [2.3.10 Treatment of Neurodegenerative Disorders](#)

### [2.3.11 Cardiovascular Effects](#)

### [2.3.12 Herbicidal Activity](#)

### [2.3.13 Antidiabetic Agents](#)

### [2.3.14 Miscellaneous](#)

## [2.4 Conclusion](#)

### [Abbreviation](#)

### [References](#)

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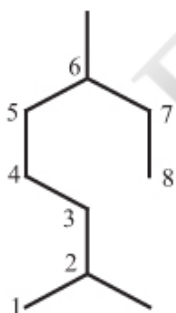
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## 2.1 Introduction

Monoterpenes are major components of essential oils which belong to the group of isoprenoids containing ten carbon atoms (two isoprene units). These are categorized into two subgroups: acyclic and cyclic (monocyclic and bicyclic). Among each group of monoterpenoids, these are structurally unsaturated hydrocarbons with various functional groups such as alcohol, aldehyde and ketone [1].

Acyclic monoterpenoids are comparatively few and possess the carbon skeleton of 2,6-dimethyloctane (Figure 2.1). The commonly available acyclic monoterpenes include myrcene, citral, ocimene, citronellal, citronellol, nerol, geraniol, linalool, etc. Acyclic monoterpenoids are formed by the linkage of two isoprene units. Out of four double bonds present in two isoprene units, one double bond is consumed and the remaining three double bonds are present in the structure of acyclic monoterpenoids.



**FIGURE 2.1** Skeletal structure of acyclic monoterpene.

The acyclic monoterpenoids are easily cyclized to produce monocyclic monoterpenoids by utilizing one more double bond in the linkage. So, acyclic monoterpenoids possess three double bonds, and monocyclic monoterpenoids have two double bonds in their structure. Similarly, bicyclic and tricyclic monoterpenoids possess one and zero double bonds, respectively (Table 2.1).

### TABLE 2.1

Types of Monoterpenoids with General Formula

Types of Monoterpenoids	General Formula	Number of Double Bonds
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Acyclic	$C_nH_{2n+2}$	3
Monocyclic	$C_nH_{2n}$	2
Bicyclic	$C_nH_{2n-2}$	1
Tricyclic	$C_nH_{2n-4}$	0

Various monocyclic monoterpenoids are  $\alpha$ -terpineol, pulegone, piperitone, limonene, thymol, menthol, carvone, ionone and eucalyptol, etc. The bicyclic monoterpenoids may be categorized into three types based on the size of the second ring. In each class of bicyclic monoterpenoids, the first ring is a six-membered while the second ring can be either a three, four, or five-membered ring. Thujane and carene are examples of the group containing (6 + 3)-membered rings,  $\alpha$ - and  $\beta$ -pinene represent the (6 + 4) group where as borneol and camphor are considered under (6 + 5) membered rings system [2].

There is progress in the development of analytical instruments to analyze the chemical structure of various components of terpenoids. A large number of lipophilic or hydrophobic monoterpenoids are identified and isolated by solvent extraction of essential oils. In general, monoterpenoids exhibit characteristic odor and taste depending on the presence of different types of chemical constituent. Hence, these are used as cosmetic materials, food additives, insecticides, insect-repellent and medicinal agents. Various chemical reactions, synthetic procedures and microbial transformation are carried out to produce diverse functionalized compounds of monoterpenoids [3]. The successful production of monoterpenoids by microbial transformation is not only dependent on sufficient expression levels of soluble and active recombinant enzymes but also on some other factors. Various factors play a key role during the production of monoterpenoids as outlined below [4].

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