

Monarda Species

Subjects: [Plant Sciences](#)

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The genus *Monarda* (family Lamiaceae) contains 22 species of which three are native to southern Alabama, *M. citriodora*, *M. fistulosa*, and *M. punctata*. Several species of *Monarda* have been used in traditional medicines of Native Americans, and this present study is part of an ongoing project to add to our understanding of Native American pharmacopeia.

Monarda citriodora

Monarda fistulosa

Monarda punctata

essential oil

thymol

carvacrol

p-cymene

1. Introduction

The Plant List [\[1\]](#) shows 22 different *Monarda* L. (Lamiaceae) species, 18 of which occur in the United States [\[2\]](#). There are three *Monarda* species native to south Alabama, namely *Monarda citriodora* Cerv. ex Lag., *Monarda fistulosa* L., and *Monarda punctata* L. (see [Figure 1](#)) [\[2\]](#).



Monarda citriodora

Monarda fistulosa

Monarda punctata

Figure 1. *Monarda* species discussed in this work (photographs by S. K. L).

Several *Monarda* species have been used by Native Americans as medicinal plants [\[3\]](#). For example, *M. fistulosa* was used by the Blackfoot, Navajo, Lakota, and Winnebago people to treat boils, cuts and wounds; the Cherokee, Chippewa, Flathead, Ojibwa, and Tewa used the plant to treat colds, fever, and influenza; the Crow, Lakota, Menominee, and Ojibwa used the plant for coughs, catarrh, and other respiratory problems. *Monarda*

punctata was used by the Delaware, Mohegan Nanticoke, and Navajo tribes to treat colds, fever coughs, and catarrh.

2. Essential oil from *Monarda* species

Monarda citriodora and *M. fistulosa* have been introduced throughout temperate regions of the world as popular herbal medicines as well as ornamentals [4][5][6]. The volatile phytochemistry has shown wide variation depending on geographical location (Table 4). The essential oils of *M. citriodora* in the present study were rich in both thymol and carvacrol, whereas essential oils from Europe and Asia were dominated by thymol with much lower concentrations of carvacrol. *Monarda fistulosa*, in particular, showed wide variation with at least three different chemotypes (carvacrol-rich, thymol-rich, and geraniol-rich, see Table 4). The essential oils of *M. fistulosa* (samples #1 and #2) in this study fit into the thymol-rich chemotype. Interestingly, there was a high concentration of thymoquinone in *M. fistulosa* sample #3, with concomitant lower concentrations of thymol and carvacrol. Thymol was reported as the major component of *M. punctata* in two old reports [7][8]. Consistent with these reports, a floral essential oil of *M. punctata* from China was rich in thymol (75.2%), which is in agreement with the aerial parts essential oils from Alabama.

Table 4. Major essential oil components of *Monarda* species from geographical locations around the world.

<i>Monarda</i> spp.	Plant Tissue	Collection Site	Composition (Major Components)	Ref.
<i>M. citriodora</i>	Aerial parts	Jammu, India (cultivated)	Thymol (82.3%), carvacrol (4.8%)	[9]
<i>M. citriodora</i>	Aerial parts	Imola (BO) Italy (cultivated)	Thymol (19.6%), <i>p</i> -cymene (15.6%), γ -terpinene (13.5%), carvacrol (9.3%), α -terpinene (9.2%), myrcene (5.7%)	[10]
<i>M. citriodora</i>	Not reported	Commercial (India)	(<i>E</i>)- β -Caryophyllene (19.2%), citral ^a (13.3%), limonene (11.8%), <i>cis</i> -verbenol (11.4%), geraniol (7.6%), citronellal (5.6%)	[11]
<i>M. citriodora</i> var. <i>citriodora</i>	Leaves	Liverpool, UK (cultivated)	Thymol (50.7%), <i>p</i> -cymene (22.8%), carvacrol (3.6%)	[12]
<i>M. citriodora</i> var. <i>citriodora</i>	Flowers	Liverpool, UK (cultivated)	Thymol (61.8%), γ -terpinene (13.3%), <i>p</i> -cymene (4.2%), carvacrol (3.8%)	[12]
<i>M. citriodora</i> var. <i>citriodora</i>	Aerial parts	Liverpool, UK (cultivated)	Thymol (56.9%), <i>p</i> -cymene (13.0%), α -terpinene (10.0%), carvacrol (4.3%)	[13]
<i>M. citriodora</i> var. <i>citriodora</i>	Aerial parts	Commercial (unknown)	Thymol (70.6%), <i>p</i> -cymene (10.6%), carvacrol (6.1%)	[14]

Monarda spp.	Plant Tissue	Collection Site	Composition (Major Components)	Ref.
<i>M. fistulosa</i>	Aerial parts	Krasnodarsk Krai, Russia (introduced, wild)	<i>p</i> -Cymene (32.5%), carvacrol (23.9%), thymol (12.6%), carvacrol methyl ether (5.5%), unidentified aliphatic aldehyde (6.3%)	[15]
<i>M. fistulosa</i>	Aerial parts	Casola Valsenio, Italy (cultivated)	Thymol (26.5%), β -phellandrene (17.0%), α -phellandrene (13.7%), <i>p</i> -cymene (13.5%), myrcene (8.1%)	[16]
<i>M. fistulosa</i>	Aerial parts	Saint-Jean-sur-Richelieu, QC, Canada (cultivated)	Geraniol (61.8%), geranyl formate (16.6%), geraniol (10.6%), neral (6.6%)	[17]
<i>M. fistulosa</i>	Aerial parts	Poplarville, MS, USA (cultivated)	Carvacrol (39.1%), <i>p</i> -cymene (35.4%), (-)-1-octen-3-ol	[18]
<i>M. fistulosa</i>	Aerial parts	Imola (BO) Italy (cultivated)	Thymol (31.6%), β -phellandrene (18.1%), α -phellandrene (14.2%), <i>p</i> -cymene (13.1%), myrcene (8.8%)	[19]
<i>M. fistulosa</i>	Aerial parts	Imola (BO) Italy (cultivated)	Thymol (28.4%), β -phellandrene (16.9%), α -phellandrene (13.7%), <i>p</i> -cymene (13.3%), myrcene (8.7%)	[20]
<i>M. fistulosa</i>	Aerial parts	Imola (BO) Italy (cultivated)	Thymol (33.4%), β -phellandrene (18.0%), α -phellandrene (14.0%), <i>p</i> -cymene (13.2%), myrcene (8.6%)	[20]
<i>M. fistulosa</i>	Aerial parts	Ravenna, Italy (cultivated)	γ -Terpinene (25.2%), carvacrol (24.3%), <i>p</i> -cymene (11.0%; reported as <i>o</i> -cymene), thymol (8.4%), α -terpinene (5.0%), thymol methyl ether (4.7%)	[21]
<i>M. fistulosa</i>	Aerial parts	Chişinău, Republic of Moldova (cultivated)	Carvacrol (54.8%), <i>p</i> -cymene (23.2%), carvacrol methyl ether (5.9%)	[22]
<i>M. fistulosa</i>	Flowers	Gallatin Valley, MT, USA (wild)	Carvacrol (45.7%), <i>p</i> -cymene (25.6%), γ -terpinen (6.8%), thymol (3.1%)	[23]
<i>M. fistulosa</i>	Leaves	Gallatin Valley, MT, USA (wild)	Carvacrol (71.5%), <i>p</i> -cymene (13.1%), γ -terpinen (2.5%), thymol (3.3%)	[23]
<i>M. fistulosa</i>	Aerial parts	Moscow, Russia (cultivated)	α -Terpineol (37.7%), 1-octen-3-ol (10.5%), geraniol (10.4%), thymol (9.3%), <i>p</i> -cymene (4.9%)	[24]
<i>M. fistulosa</i> cv. Fortuna	Aerial	Kherson, Ukraine	Thymol (77.3%), carvacrol methyl ether	[6]

<i>Monarda</i> spp.	Plant Tissue	Collection Site	Composition (Major Components)	Ref.	nal uses
[29]	parts	(cultivated)	(4.9%), carvacrol (3.8%) [30][31]	[27]	acrol [28], ng activity
[32] <i>M. fistulosa</i> [33] Premiera	Aerial parts [34]	Kherson, Ukraine (cultivated) [36]	Thymol (78.3%), carvacrol methyl ether (4.8%), carvacrol (3.6%) [37]	[6]	loquinone ve shown
<i>M. fistulosa</i> var. <i>menthifolia</i>	Aerial parts	Morden, Manitoba, Canada (cultivated) [38]	Geraniol (86.8%)	[25]	
<i>M. punctata</i>	Flowers	Xi'an, China (cultivated?)	Thymol (75.2%), <i>p</i> -cymene (6.7%), limonene (5.4%), carvacrol (3.5%)	[26]	a species. eported in

the literature, however. There seems to be much variation in the enantiomeric distribution of monoterpenoids across the family. Consistent with what was observed in *Monarda* essential oils, (+)- α -pinene was the major enantiomer found in *Coridothymus capitatus* [39], *Rosmarinus officinalis* [40], *Lepechinia heteromorpha* [41], *Ocimum canum*, and *Ocimum kilimandscharicum* [42]. Likewise, (+)- β -pinene predominates over (-)- β -pinene in *C. capitatus* [39] as well as the *Monarda* essential oils. On the other hand, (-)- β -pinene dominates in *R. officinalis* [40] and *Lepechinia mutica* [43]. The essential oils of peppermint (*Mentha × piperita*) and spearmint (*Mentha spicata*) have shown nearly racemic mixtures of α - and β -pinenes [44]. (+)- α -Phellandrene and (-)- β -phellandrene were the dominant enantiomers in the *Monarda* essential oils. In marked contrast, however, (-)- α -phellandrene and (+)- β -phellandrene predominated in *L. mutica* essential oil [43]. (-)-Limonene predominates in *M. fistulosa* essential oil, peppermint (*M. piperita*) and spearmint (*M. spicata*) essential oils [44] whereas (+)-limonene is the major enantiomer in *C. capitatus* [39], *O. canum*, and *O. kilimandscharicum* [42], and a nearly racemic mixture was found in rosemary (*R. officinalis*) essential oil [40]. (+)-Linalool was the predominant enantiomer in *C. capitatus* [39], *Salvia schimperi* [45], *Pycnanthemum incanum* [46], *O. canum*, and *O. kilimandscharicum* [42], whereas (-)-linalool was the major stereoisomer in *Lavandula angustifolia* [47] and *R. officinalis* [40].

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