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Aromatic Plants of Mali (I): Chemical Composition of Essential Oils of *Ocimum basilicum* L.

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Abstract

In a study of the chemical composition of oil from 24 samples of fresh or dried *Ocimum basilicum* we identified 53 components. All the oils were of the linalool chemotype, but four subtypes could be identified, unlinked to harvest location: oils containing 60-70% linalool and principally eugenol (5-15%), and oils with less than 60% linalool containing much eugenol, methyl eugenol or methyl chavicol. The often high proportions of these components (20-30%) distinguish these oils from others described previously.

Key Word Index

Ocimum basilicum, Laminaceae, essential oil composition, linalool, methyl eugenol, eugenol, methyl chavicol.

Introduction

Among the 200 species and subspecies attested (1), *Ocimum basilicum*, or sweet basil, native to Asia and acclimatized in temperate zones, comprises some 60 cultivars such as "grand ver," "feuille de laitue," "minimum," "pourpre."

Besides its use as an aromatic, different parts of the plant are used in traditional medicine (2). The leaves are used in macerations, infusions and decoctions to treat ear infections, headache, and stomach complaints, respectively. The flowers and fruits are used in decoctions to relieve rhumatic pain, and the seeds are said to possess an anti-venom activity.

Four chemotypes were defined by Guenther (3), Zola (4), and by the Conservatoire National des Plantes à Parfums, Médicinales, Aromatiques et Industrielles (5):

1. The European type (sweet basil), cultivated in Europe, USA and Africa, and characterized by linalool (approximately 40%) and methyl chavicol (approximately 25%).
2. The Reunion type, located in the Comoros and Seychelles Islands, Africa and Reunion Island, containing up to 85% methyl chavicol.
3. The (E)-methyl cinnamate type has been found in Bulgaria, Sicily, India, Haiti and Africa.
4. The eugenol type found in the Seychelles, ex-USSR and North Africa.

A review of all the work conducted to date on these oils points to a need for a more specifically chemotypic classification into linalool, methyl chavicol, (E)-methyl cinnamate, 1,8-cineole,

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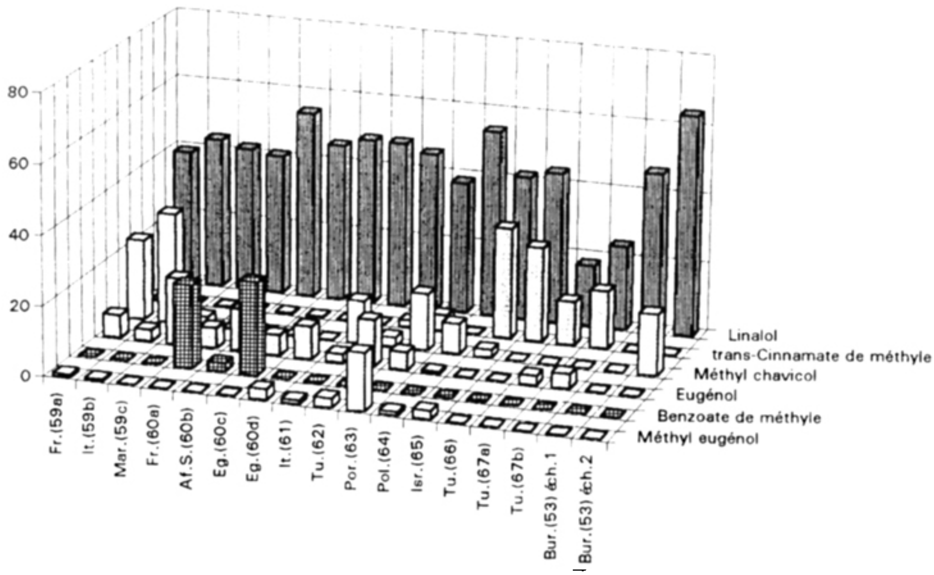

Figure 1. *Ocimum basilicum*, linalool chemotype (literature data)

Table I. Percentage composition of oils of the aerial part of *Ocimum basilicum* of Mali from Garden of Djicoroni and Point G

Compound	Fresh	Dried	Compound	Fresh	Dried
α-Pinene	0.2-0.8	0.2-0.8	β-Caryophyllene +		
α-Thujene	t-0.1	t-0.2	β-Elemene	4.7-9.5	4.3-8.7
Camphene	t-0.1	t-0.2	α-Farnesene*	2.2-4.7	2.0-5.5
β-Pinene	0.1-0.6	0.2-1.3	α-Humulene	0.1-0.2	0.1-0.2
Sabinene	t-0.4	t-0.4	Methyl Chavicol	0.4-12.4	1.2-12.2
Myrcene	0.2-0.8	0.2-0.9	(E)-β-Farnesene	0.3-0.6	0.3-0.7
α-Terpinene	0.1-0.2	0.1-0.3	(Z)-β-Farnesene	0.4-1.5	0.3-1.7
Limonene	0.4-0.6	0.3-1.0	α-Terpineol	0.8-2.4	0.6-1.7
1.8-Cineole	2.1-5.3	1.8-5.1	δ-Guaiene	0.3-0.6	0.3-0.7
(Z)-β-Ocimene	t-0.2	t-0.5	Geranial	t-1.6	t-0.7
γ-Terpinene	0.3-0.9	0.3-0.5	α-Amorphene	0.7-3.0	1.0-3.1
(E)-β-Ocimene	0.9-3.0	0.8-2.6	Nerol	0.1-0.3	0.1-0.4
p-Cymene	0.3-1.1	0.2-0.4	Geraniol	0.3-1.5	0.5-1.5
Terpinolene	0.1-0.3	0.1-0.5	Methyl Eugenol	0.8-40.5	0.7-10.9
Fenchone	0.5-1.9	1.02	Cubenol	0.2-0.7	0.1-0.5
α-Fenchyl acetate	0.1-0.4	0.2-0.4	Nerolidol*	0.3-0.5	0.3-0.5
Camphor	0.1-0.3	0.2-0.4	Spathulenol	t-0.2	t-0.2
Linalool	20.0-48.5	42.7-60.5	Eugenol	3.4-24.8	2.6-21.2
			T-Cadinol	3.5-4.2	2.6-4.8
			β-Eudesmol	t-0.1	t-0.1

* Correct isomer not identified; t = traces (≤ 0.05%)

Table II. Percentage composition of the oil of the aerial part of *Ocimum basilicum* of Mali (linalool >60%) from Daoudabougou, Boulkassoumbougou and Garden of Djicoroni

Compound	Fresh	Dried	Compound	Fresh	Dried
α-Pinene	0.1-0.2	0.1-0.2	β-Caryophyllene +		
Camphene	0.1-0.2	0.1-0.2	β-Elemene	3.8-4.6	3.2-4.6
β-Pinene	0.1-0.2	0.1-0.2	α-Humulene	0.1-0.3	≈ 0.2
Sabinene	t-0.1	t-0.2	Methyl Chavicol	0.2-1.8	0.3-2.4
Myrcene	0.9-1.4	1.3-1.6	Borneol	0.4-0.6	0.3-1.0
α-Terpinene	t	t	α-Terpineol	0.4-1.1	0.5-0.7
Limonene	0.2-0.4	0.2-0.4	δ-Guaiene	0.4-0.8	0.4-0.8
1,8-Cineole	1.0-1.8	1.2-1.9	α-Terpinyl Acetate	0.4-0.6	0.3-0.7
(Z)-β-Ocimene	0.1-0.2	0.1-0.2	α-Amorphene	1.9-3.5	1.9-3.2
γ-Terpinene	t-0.2	t-0.2	Nerol	0.1-0.2	0.1-0.2
(E)-β-Ocimene	1.5-2.7	1.1 -4.1	Geraniol	0.3-0.9	0.3-0.6
p-Cymene	~ 0.1	~ 0.1	Methyl Eugenol	t-0.4	t-0.3
Terpinolene	0.1-0.2	0.1-0.2	Cubenol	1.4-1.9	1.2-1.8
(Z)-3-Hexenol	t-0.3	t-0.2	Nerolidol*	0.5-0.7	0.5-0.8
α-Fenchyl Acetate	0.2-0.3	0.2-0.4	Spathulenol	0.1-0.2	0.1-0.2
Linalool	63.8-67.5	61.7-73.1	Eugenol	4.5-15.6	3.2-12.8
Bornyl Acetate	0.1-0.2	0.1-0.2	T-Cadinol	4.0-5.2	3.2-5.2
α-Fenchol	0.9-1.4	1.0-1.3			

*correct isomer not determined; t = traces (≤ 0.05%)

dihydrotagetone, camphor, eugenol and geranial chemotypes (4-24). A summary of these earlier reports yields the following information:

(i) Alongside high proportions of linalool (25-65%) (Figure 1) in the linalool chemotype, several characteristic components [methyl chavicol, (E)-methyl cinnamate, eugenol] accounting for 20-30% of the total composition.
(ii) The methyl chavicol chemotype (68-88% methyl chavicol) usually contains 1,8-cineole (5%) and linalool (30%).
(iii) (E)-Methyl cinnamate (23-68%) is usually accompanied by its (Z)-isomer (4-12%), methyl eugenol (2-25%) and linalool (4-23%).
(iv) Non-negligible amounts of α-terpineol (4-7%) in the 1,8-cineole chemotype (50-60% 1,8-cineole).
(v) Marked predominance of dihydrotagetone in the Somalian variety.
(vi) Large amounts of linalool and limonene alongside camphor, the main component, in an oil from Burundi.

We studied 24 samples of oils obtained by steam distillation of aerial plant parts, fresh and dried, of *O. basilicum* harvested at three locations. Our purpose was to classify these samples in terms of their oils to evaluate the specific features of oils from Mali of possible commercial value.

Experimental

Plant Material: The samples were harvested in October-December 1994 and January 1995 in the region of Bamako at various locations, at point G, and in the Garden of Djicoroni. The oils were extracted by steam distillation for 6 h from fresh plant material, or from plant material dried for 4 days. The average yields obtained from the fresh and dried plant material were respectively 0.21% and 1.1%.

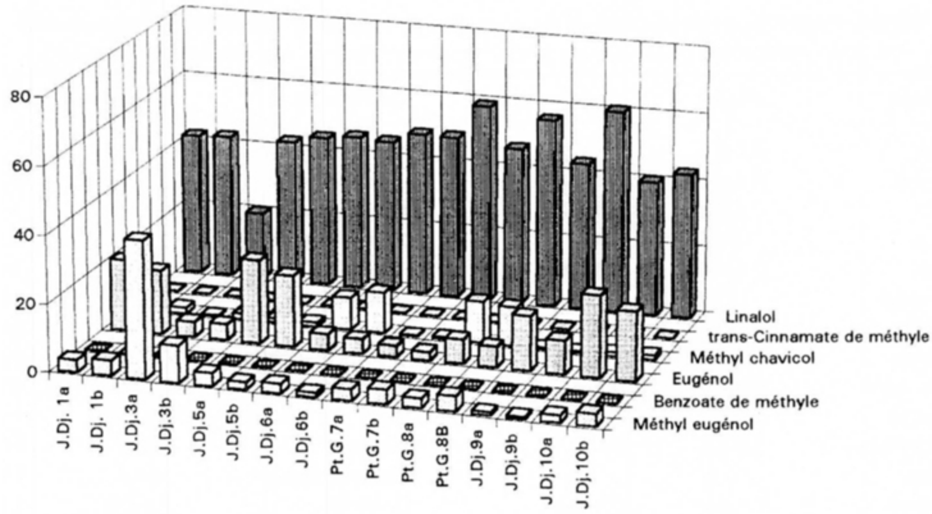

Figure 2. *Ocimum basilicum*, linalool chemotype (≤ 60% lonalool) (our data)

The oils were pale yellow and fluid, with a pleasant characteristic smell. Their yields and physicals constants are comprised between:

Oil yield: 0.19-0.27% (fresh wt)
Density d_{20}^{20}: 0.919-0.946
Ref. Ind (20°C): 1.4874-1.4882
$[\alpha]_D^{25}$: –11.50° to –11.2° (2% $CHCl_3$)

Analysis: GC analyses were performed on a DELSI 121C gas chromatograph (FID) with a fused silica WCOT capillary column (25 m x 0.3 mm; df: 0.15 µm) and CP WAX 52 CB stationary phase. The temperature was programmed from 50°C with 5 min initial hold and then to 210°C at 2°C/min, using N_2 as the carrier gas. GC/MS analyses were performed on a Hewlett-Packard instrument with a fused silica WCOT capillary column (50 m x 0.3 mm ; df: 0.25 µm) CP WAX 51, temperature programmed from 50°C to 230°C at 3°C/min using He as the carrier gas. The oil components were identified by comparing the retention indices of authentic materials with those of substances present in the mixture and by further confirming their identities by MS.

Results and Discussion

Fifty-three constituents were identified in the samples of *O. basilicum* analyzed. All contained large amounts of linalool. The samples were classified into those containing less than 60% linalool and those containing more than 60% (Tables I and II).

Except for one sample from Garden of Djicoroni, which showed a wide and unexplained difference between the amounts of eugenol obtained from fresh and dry plant material (10% and 40%), the results were mostly consistent and close ranging. However, the oils can be grouped into different categories according to the concentrations of certain secondary components (Figures 2 and 3). Oils containing less that 60% linalool (Figure 2) could be distinguished according to whether they were:

(a) Methyl chavicol-rich: samples from the Garden of Djicoroni and point G (fresh: 9.7% and 12.3%, dried: 12.2% and 11.7%).
(b) Eugenol-rich; samples from the Garden of Djicoroni (fresh: 16.1-24.8%, dried: 9.9-21.1%) and at Daoudabougou and Boulkassoumbougou (fresh: 12.2% and 15.6%, dried: 11.4% and 12.7%).
(c) Methyl eugenol-rich; samples from Djicoroni (fresh: 40.4%, dried: 10.9%).

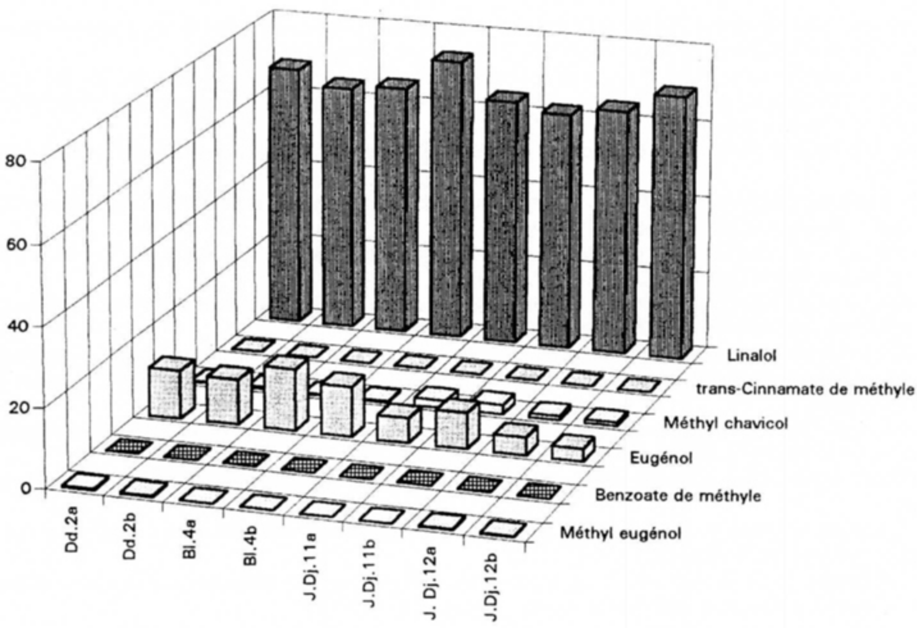

Figure 3. *Ocimum basilicum*, linalool chemotype (≤ 60% lonalool) (our data)

Oils containing more than 60% linalool (Daoudabougou, point G, and the Garden of Djicoroni) contained 5-15% eugenol (Figure 3).

These results illustrate the diversity of the linalool chemotype. Four subtypes can be distinguished:

1. Linalool, with no other characteristic component present in large amounts.
2. Linalool-eugenol, with amounts ranging from >60% linalool-<15% eugenol to <60% linalool-16-25% eugenol. This subtype covers samples from Morocco (4), South Africa (6) and Turkey (8) in which eugenol concentrations range between 9% and 19%.
3. Linalool-methyl chavicol, analogous to oils found in France and Italy (3) and Portugal (9).
4. Linalool-methyl eugenol. The concentration of methyl eugenol found in the fresh sample harvested in the Garden of Djicoroni (approx. 30%) is exceptional. Although the difference between this figure and that for the dry sample (approx. 10%) is wide, the amounts of methyl eugenol recorded previously did not usually exceed 3% (4,7,8,10,11). Only one sample from Portugal (9) was unusual in containing more than 16%.

None of the samples harvested was of methyl benzoate or methyl cinnamate chemotypes. Overall, these results further illustrate the broad diversity of chemical composition in varieties of *O. basilicum*. The heterogeneity observed in a particular location may be due to the effects of insect pollination. If a linalool-rich, or any other variety, proves commercially valuable, the selected plant must be grown in a location that is not prone to such "pollution."

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