Progress in Essential Oils

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Schinus molle Fruit and Leaf Oils

Schinus molle L. (syn. *S. areira* L.; *S. bituminosus* Salisb.), which is known locally as Californian, Peruvian or Chilean pepper tree, pepperberry tree or Peruvian mastic tree, is a member of the Anacardiaceae family, the fruit oil of which can be occasionally found in commerce. The name probably originated from the fact that when the deeply fissured trunk bark is damaged, it exudes a sticky latex similar to *Pistacia lentiscus* L. (mastic), which is known in Greek as 'shinos.' The species epithet 'moll' is derived from the ancient Peruvian word 'mulli,' the name given to the tree.

Schinus molle is an evergreen tree native to Argentina and Peru, but is grown as an exotic tree across the subtropical and temperate world. The tree has characteristically weeping (low branching) foliage possessing linear-lanceolate leaves and hanging panicles of clustered pale yellow flowers. The trees contain both male and female flowers, the latter of which yield clusters of small round berries that develop from green to red to black. *Schinus molle* oil is generally produced from the dried black berries that possess a peppery taste and aroma.

Three samples of *Schinus molle* L. fruits were collected from different locations in Peru [Chillon River area, Yasso and Yanfus (near Lima)]. The crushed fruits were separately hydrodistilled to yield oils of an approximate yield of 3.6%. Analysis of the oils by Huaman et al. (2004) using GC-FID and GC/MS revealed that they were quantitatively different, as can be seen in **T-1**. Using chiral GC, four components were examined for their enantiomeric ratios. As the three oils yielded similar results, composite enantiomeric ratios will be presented as follows:

(1R,5R)-(+)-α-pinene (92.6–96.5%):(1S,5S)-(-)-α-pinene (3.5–7.4%)
(4R)-(+)-α-phellandrene (100%):(4S)-(-)-α-phellandrene (0%)
(4R)-(+)-limonene (20.2–20.5%):(4S)-(-)-limonene (79.5–79.8%)
(4R)-(+)-β-phellandrene (0%):(4S)-(-)-β-phellandrene (100%)

A hydrodistilled oil of *S. molle* fruit collected in Artega (Coahuila, Mexico) was the subject of analysis by Perez-Lopez et al. (2011) using GC-FID and GC/MS. The components identified in this oil were:

α-pinene (3.2%)
myrcene (39.7%)
α-phellandrene (7.1%)
p-cymene (19.5%)
limonene (4.1%)
methyl octanoate (2.3%)
trans-verbenyl acetate (1.3%)
β-elemene (0.2%)
α-gurjunene (1.2%)

T-1. Comparative percentage composition of three *Schinus molle* fruit oils of Peruvian origin

Compound	Chillon River oil	Yasso oil	Yangas oil
α-pinene	3.1	3.1	5.7
camphene	0.1	0.1	0.4
sabinene	0.1	0.1	0.2
β-pinene	0.3	0.3	0.4
myrcene	42.0	40.0	26.4
α-phellandrene	25.0	11.2	4.0
p-cymene	3.2	8.0	19.8
limonene	9.8	11.0	19.0
β-phellandrene	8.7	7.7	9.7
methyl octanoate	0.7	1.0	1.9
borneol	0.1	-	0.4
α-terpineol	0.1	-	0.2
α-copaene	0.1	0.5	0.2
β-elemene	0.2	0.7	0.4
cis-α-bergamotene	0.3	0.5	0.4
β-caryophyllene	0.9	0.8	0.5
trans-α-bergamotene	0.1	0.1	0.1
α-humulene	0.3	0.3	0.2
γ-elemene	0.1	0.3	0.2
γ-muurolene	0.1	0.1	-
germacrene D	0.1	0.1	-
bicyclogermacrene	0.7	0.1	-
γ-cadinene	0.1	0.2	0.1
δ-cadinene	0.4	0.4	0.2
spathulenol	0.4	1.0	0.4
(E)-β-cembrene	0.1	0.2	0.2
(Z)-3-cembrene	-	0.1	0.1

β-caryophyllene (0.8%)
α-humulene (0.7%)
γ-muurolene (0.5%)
germacrene D (0.7%)
α-muurolene (1.6%)
γ-cadinene (1.6%)
δ-cadinene (7.8%)
elemol (0.3%)
gleenol (0.6%)
viridiflorol (0.4%)
ledol (0.2%)
T-muurolol (0.2%)
α-cadinol (3.1%)

Although the fruit oil occasionally appears in commerce, it is worth noting that the leaves also possess an essential oil; they can be included in conjunction with fruits to produce a mixed oil. As a result, it is worth noting the differences between the fruit and leaf oils.

Belhamel et al. (2008) produced a leaf oil of *S. molle* using hydrodistillation from leaves collected in Bejaia (Algeria). The authors used a combination of GC-FID and GC/MS to determine that the oil possessed the following composition:

α-thujene (0.1%)
α-pinene (0.2%)
camphene (0.3%)
sabinene (0.2%)
1-octen-3-ol (0.1%)
myrcene (4.1%)
3-octanol (0.1%)
α-phellandrene (26.5%)
p-cymene (3.8%)
limonene (8.6%)
β-phellandrene (12.4%)
terpinolene (0.1%)
linalool (0.5%)
α-campholenal (0.1%)
camphor (2.1%)
borneol (1.8%)
terpinen-4-ol (0.1%)
α-terpineol (0.1%)
nerol (0.2%)
bornyl acetate (0.4%)
thymol (0.5%)
benzyl butyrate (0.3%)
α-terpinyl acetate (0.8%)
hexyl hexanoate (0.2%)
1-tetra-decene (0.6%)
β-elemene (0.3%)
γ-cadinene (0.4%)
bicyclogermacrene (4.1%)
germacrene A (0.3%)
δ-cadinene (1.9%)
elemol (10.8%)
spathulenol (1.4%)
caryophyllene oxide (0.1%)
1,10-di-epi-cubenol (3.8%)
α-eudesmol (6.1%)
β-eudesmol (4.2%)
α-cadinol (0.1%)

A leaf oil produced by hydrodistillation of *S. molle* from Campo Grande City (Mato Grosso, Brazil) was analyzed using GC-FID and GC/MS by Simionatto et al. (2011). The constituents characterized in this oil were as follows:

α-pinene (1.9%)
α-phellandrene (2.9%)
1,8-cineole (7.6%)
terpinen-4-ol (6.1%)
piperitone (1.5%)
allo-aromadendrene (1.7%)
trans-β-guaiene (0.8%)
γ-cadinene (9.1%)
spathulenol (8.6%)
caryophyllene oxide (10.5%)
guaiol (1.9%)
cedrol (1.7%)
himachalene epoxide[*a] (0.8%)
T-cadinol (27.3%)
7-epi-α-eudesmol (2.3%)

[*]correct isomer not identified; [a]probable misidentification

As can be seen, this leaf oil possesses a significantly different composition to the other reported analyses. This difference could indicate the existence of infraspecific differences (i.e. chemotypic forms) on the genetic level.

Vargas et al. (2012) produced a fresh leaf oil (in 0.4% yield) of *S. molle* obtained from trees growing in Sao Francisco de Paula (Rio Grande do Sul, Brazil) using steam distillation. The composition of the oil, which was determined by GC/MS only, was found to be as follows:

α-thujene (0.8%)
α-pinene (5.0%)
sabinene (36.7%)
β-pinene (1.2%)
myrcene (1.6%)
α-phellandrene (0.1%)
isoamyl isobutyrate (1.3%)
p-cymene (0.2%)
limonene (7.2%)
1,8-cineole (0.1%)
(Z)-β-ocimene (0.1%)
(E)-β-ocimene (1.4%)
γ-terpinene (2.0%)
cis-sabinene hydrate (0.3%)
terpinolene (0.5%)
linalool (0.2%)
cis-p-menth-2-en-1-ol (0.3%)
borneol (0.1%)
terpinen-4-ol (4.0%)
p-cymen-8-ol (0.3%)
α-terpineol (0.1%)
trans-p-mentha-1(7),8-dien-2-ol (0.1%)
cis-dihydrocarvone (0.2%)
trans-carveol (0.1%)
carvone (0.2%)
piperitone (0.1%)
bornyl acetate (0.1%)
trans-linalool oxide acetate (0.1%)
thymol (0.1%)
carvacrol (0.2%)
α-cubebene (0.3%)
β-caryophyllene (2.7%)
trans-α-bergamotene (0.1%)
α-humulene (0.4%)
allo-aromadendrene(0.4%)
trans-cadina-1(6),4-diene (0.1%)
γ-muurolene (0.1%)
germacrene D (2.5%)
bicyclogermacrene (6.1%)
germacrene A (0.2%)
γ-cadinene (0.6%)
cis-calamenene (1.9%)
α-cadinene (0.1%)
germacrene B (0.1%)
palustrol (0.2%)
spathulenol (4.6%)
caryophyllene oxide (1.9%)
viridiflorol (0.4%)
rosifoliol (0.5%)
1-epi-cubenol (0.1%)
α-cadinol (0.8%)
shyobunol (6.1%)

[p]pyranoid form

Y. Huaman, O.A. dela Cruz, A. Bosilcov and I. Batiu, *Essential oil from the fruits of* Shinus molle *L. from Peru.* J. Essent. Oil Bear. Plants, **7**, 223–227 (2004).

K. Belhamel, A. Abderrhamin and R. Ludwig, *Chemical composition and antibacterial activity of the essential oil of* Schinus molle *L. grown in Algeria.* Internat. J. Essent. Oil Therapeutics, **2**, 175–177 (2008).

E. Simionatto, M.O. Chagas, M.T.L.P. Peres, S.C. Hess, C.B. da Silva, N. Ré-Poppi, S.S. Gebara, J. Corsino, A.F. Morel, C.Z. Stuker, M. de Fatima, C. Matos and J.E. de Carvalho, *Chemical composition and biological activities of leaves essential oil from* Schinus molle *(Anacardiaceae).* J. Essent. Oil Bear. Plants, **14**, 590–599 (2011).

A. Perez-Lopez, A. Torres Cirio, V.M. Rivas-Galindo, R. Salazar Aranda and N. Waksman de Torres, *Activity against* Streptococcus pneumonia *of the essential oil and δ-cadinene isolated from* Schinus molle *fruit.* J. Essent. Oil Res., **23**, 25–28 (2011).

R.M.F. Vargas, A.M. Lucas, M.S.T. Barroso, D.V. Dutra, M.V. Becker, C.A. Mondin and E. Cassel, *Mathematical modeling of essential oil extraction by steam distillation for native plants from southern Brazil.* J. Essent. Oil Bear. Plants, **15**, 839–846 (2012).