



UNIVERSITÀ
DI TORINO

Dipartimento
Scienza e Tecnologia
del Farmaco

CORSO DI LAUREA IN TECNICHE ERBORISTICHE

Savigliano,
22 Maggio 2023

Ciclo di incontri:
*L'intelligenza delle piante
e la multidisciplinarietà delle scienze erboristiche*

Tavola Rotonda 2023
Cambiamento climatico, Piante selvatiche, Oli essenziali

Savigliano, 22 Maggio 2023



Tutti parlano di oli essenziali ma.....! *Qualche considerazione generale sulla loro natura* *Parte 1*



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Why essential oils are in the eye of the storm?

..... according to the economic outlook for 2022-2032 of the think tank of a big-pharma:

*..... the market of essential oils is set to grow
from USD 4.5 billion in 2022 to USD 12-13 billion in 2032!*



Indicative costs of some popular essential oils:

- *Peppermint EO:* 25-95 USD/Kg
- *Lavender EO:* 40-120 USD/Kg
- *Tea tree oil:* 30-70 USD/Kg



..... essential oil and quality

..... *the side of the plant*

*What has changed in the natural product research
in the last three decades?*

Chemistry



Biology

Jan Brueghel & Rubens – The garden of Eden with the fall of man (1617) Mauritshuis The Hague (NL)

..... *an ever increasing integration
between chemistry and biology*

Some preliminary considerations

March 2023



*... a plant is a highly effective
chemical & biological
laboratory
producing (biosynthesizing)
an unbelievable number
of molecules
with different structures
and biological activity*

April 2023



Chaenomeles speciosa (Sweet) Nakai - Rosaceae

PhD thesis, tutor Prof. Tina De Tommasi – University of Salerno (Italy)

..... *some preliminary considerations*



*...each specialized metabolite
plays a well defined role
in the plant living cycle ...*

*.... all specialized metabolites
are biologically strictly related
independently on their structure*

*..... and all together concur
to the plant metabolism.....*

*..... a plant provides us
all information we need
... as long as we know how to "read" it*

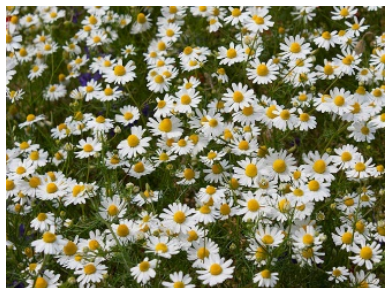


Catherine de Medici's master perfumer, René le Florentin, in his laboratory

..... *the world of essential oils*

*Some definitions to clear this field
of the too many misunderstandings
on which (often) this world relies*

A possible definition of the volatile fraction of a plant....



In biological terms, the volatile fraction emitted from a plant is an important biosensor diagnostic of the changes that take place in its metabolism



In chemical terms, the volatile fraction of a plant is a mixture of compounds that can be recovered as a consequence of their capability to be vaporised both spontaneously and through suitable sampling conditions or techniques.



*The term **volatile fraction** is therefore a framework including a group of approaches and/or techniques that produce samples representative of the volatiles that characterize a plant, **although they may have different and mutually non-comparable compositions**, e.g. headspace, essential oils, extracts obtained by specific techniques, fragrances, aromas and flavours*

*Volatilome and volatilomics**



Plant volatilome is defined as the complex blend of essential oils (EOs) and volatile organic compounds (VOCs) fed by different biosynthetic pathways and produced by plants, constitutively and/or after induction, as a defense strategy against biotic and abiotic stress.



VOCs are released from leaves, flowers and fruits into the atmosphere and from roots into the soil, while EOs are produced by specialized secretory tissues (*ndr: and obtained by dedicated technologies*). VOCs also attract pollinators, seed dispersers, and other beneficial animals and microorganisms, and serve as signals in plant–plant communication. The plant volatilome is also involved in signaling between symbiotic organisms.



The plant volatilome has wide agricultural and industrial applications ranging from the search for sustainable methods for pest control to the economically important production of flavors, fragrances and phytochemicals.

* Maffei, M.E., Gertsch, J., and Appendino, G. (2011) Plant volatiles: Production, function and pharmacology. *Nat.Prod.Rep.* 28, 1359-1380.
Bicchi, C., Maffei, M., (2012) The plant volatilome: methods of analysis- in High-Throughput Phenotyping in Plants: Methods and Protocols Series: Methods in Molecular Biology, Volume: 918, 2012, pages: 289-310, DOI: 10.1007/978-1-61779-995-2_15

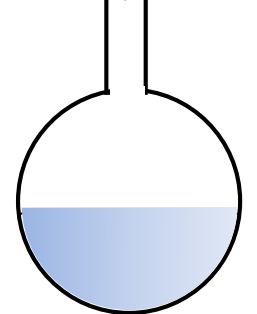
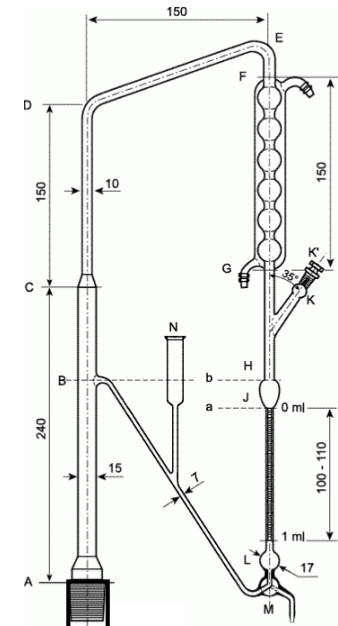
WHAT IS AN ESSENTIAL OIL

.... according to ISO 9235:2013
and European Pharmacopoeia and USP

2.11. essential oil: product obtained from a natural raw material of plant origin, by steam distillation, by mechanical processes from the epicarp of citrus fruits, or by dry distillation, after separation of the aqueous phase (if any) by physical processes

2.12. essential oil obtained by steam distillation: essential oils (2.11) obtained by steam distillation with addition of water to the still (hydrodistillation) or without addition of water to the still (directly by steam)

2.9. dry distilled essential oil: distillation of wood, barks, roots or gums, without adding water or steam



..... essential oils are therefore distillates and not extracts.....

Essential oils and sensory (analysis)

Fragrances

*A fragrance can be defined as a sweet, pleasant scent perceived **orthonasally** from a non-food material.*

..... therefore.....

..... an essential oil per se is not a fragrance.

.... but it can become a fragrance (or a component of it) when sensory evaluated

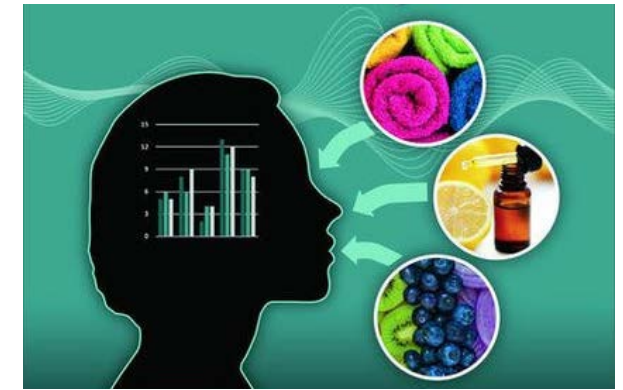


Le parfum delicat François Thevenot (1887)

Essential oils and sensory (analysis)

Aromas and flavours

Flavour is a general term involved with the overall sensation provided by the interaction of taste, odour and textural feeling when a *food* is consumed*.



International Standards Organization (ISO-5492 1992) defined flavour as a “complex combination of the olfactory, gustatory and trigeminal sensations perceived during tasting. The flavor may be influenced by tactile, thermal, painful and/or kinaesthetic effects”.



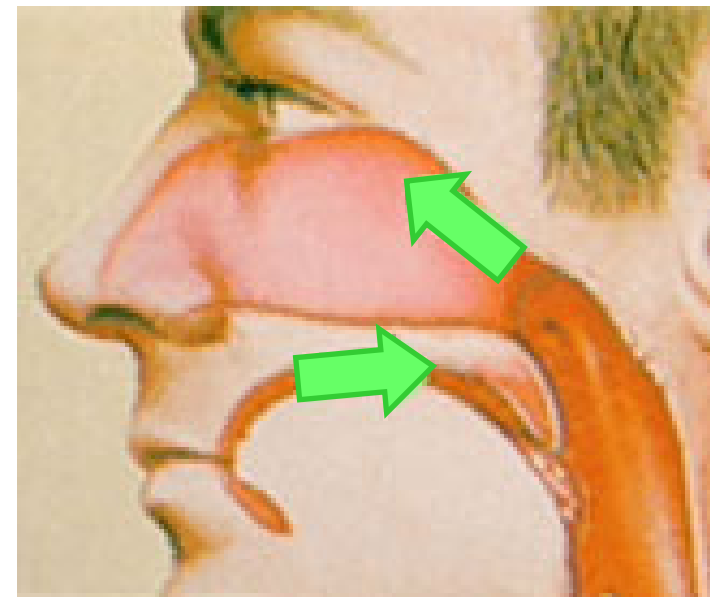
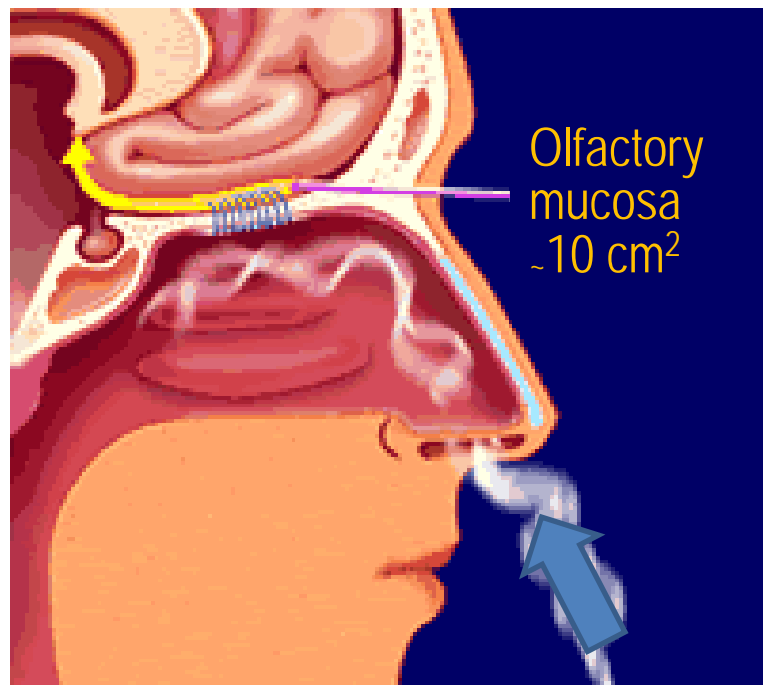
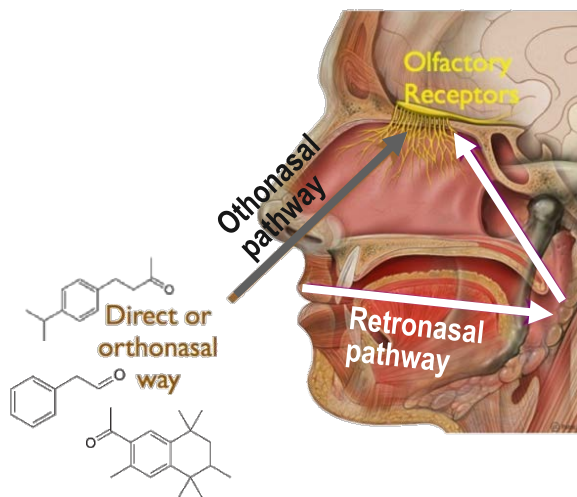
Aroma substances are volatiles that can be perceived *orthonasally* and *retronasally* by the odor receptor sites of the smell organ, i.e. the olfactory tissue of the nasal cavity



* from: Belitz, H. D; Grosch, W.; Schieberle, P. Food Chemistry, 4th revised and extended ed.; Springer-Verlag: Berlin Heidelberg, 2009; Chapter 5, p 340-400.

.... the basic distinction between aroma and fragrance

The olfactory sense



Retronasal pathway (indirect)

Orthonasal pathway (direct)

→ **Fragrance**

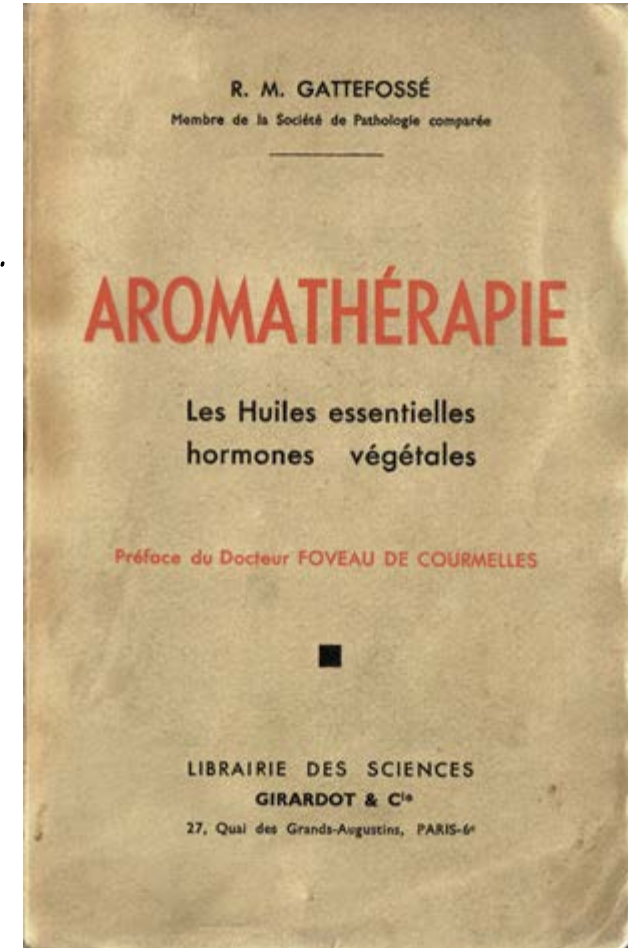
→ **Aroma**

Aromatherapy and essential oils



René-Maurice Gattefossé

- ❑ *Aromatherapy* bases on the use of *aromatic materials* (mainly essential oils) and *other aroma compounds* to improve psychological and physical well-being.
- ❑ It is a *complementary therapy* or a form of *alternative medicine*.
- ❑ *Not definitive medical evidence* is given that aromatherapy can either prevent, treat or cure any disease.
- ❑ Blends of supposed therapeutic essential oils can be used as *topical application, massage, inhalation* or *water immersion*.
- ❑ The use of volatile products (essential oils) for therapeutic, spiritual, hygienic and ritualistic purposes goes back to ancient civilizations such as Indian, Chinese, Egyptian, Greek, Persian, Arab and Roman
- ❑ Modern aromatherapy was introduced in medicine by *René-Maurice Gattefossé* in 1937 the with the book "*Aromathérapie: Les Huiles essentielles, hormones végétales*".





Bulgarian rose or Rosa
damascena, Castillian rose
(Artificial hybrid
R. gallica × *R. moschata*)



Rosa × centifolia L.
(Artificial hybrid *R. canina*,
R. gallica and *R. moschata*)

an extract is

*.....the product of **maceration with solvents** of different characteristics, with different technologies and under different conditions of a plant or some parts of it.*

therefore: an extract is not a distillate

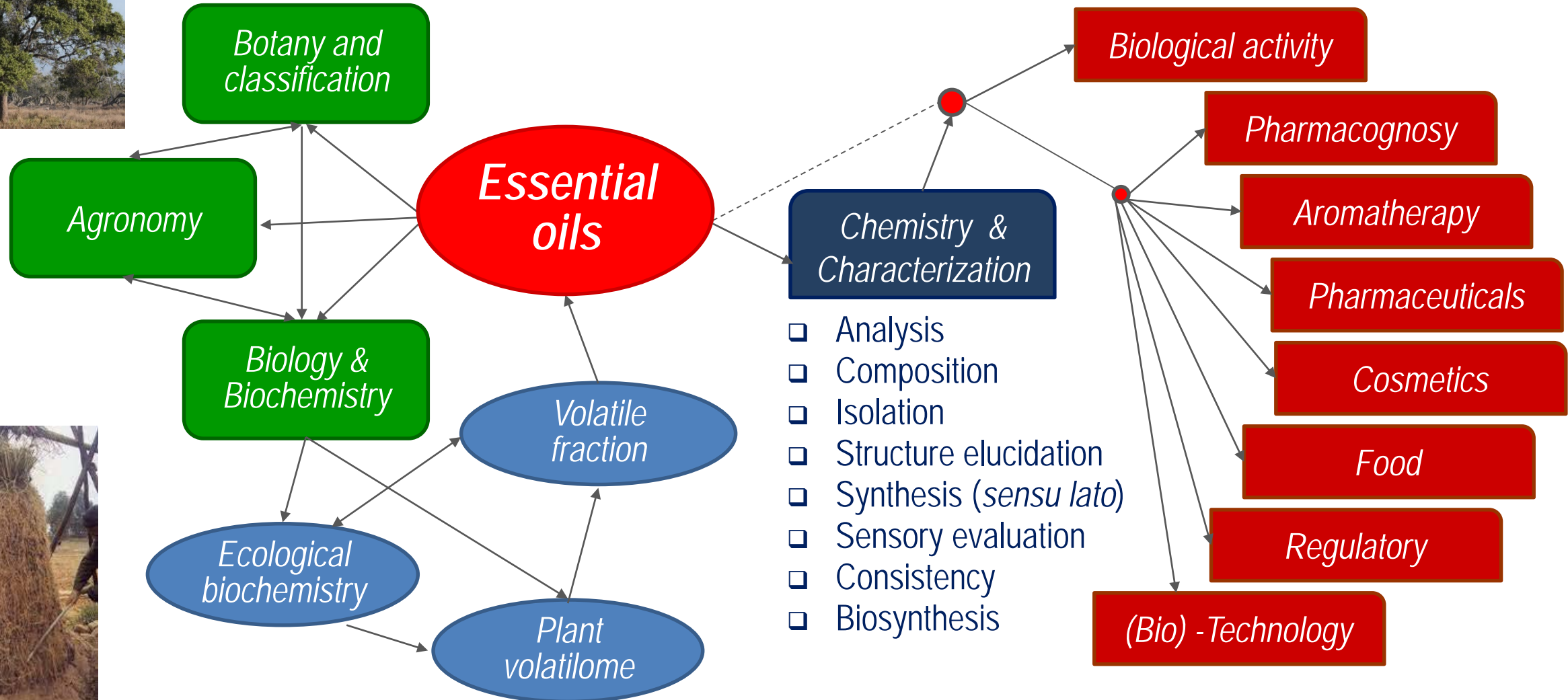


*Why should essential oil field
be considered
as a self-consistent multitask
sub-discipline?*



The multiplicity of disciplines involved with essential oils

the plant the product their composition their use





Essential oils and quality



Why does quality matter so much?

The concept of *quality* was introduced by *Aristotle* in the *Categories*.

The philosophical definition of *quality* is still controversial, but it has been generally seen as an attribute or a property characteristic of an object*



*Aristotle. *Categories*. Cargile J. *The Oxford companion to Philosophy*. Ted Honder. 1995.

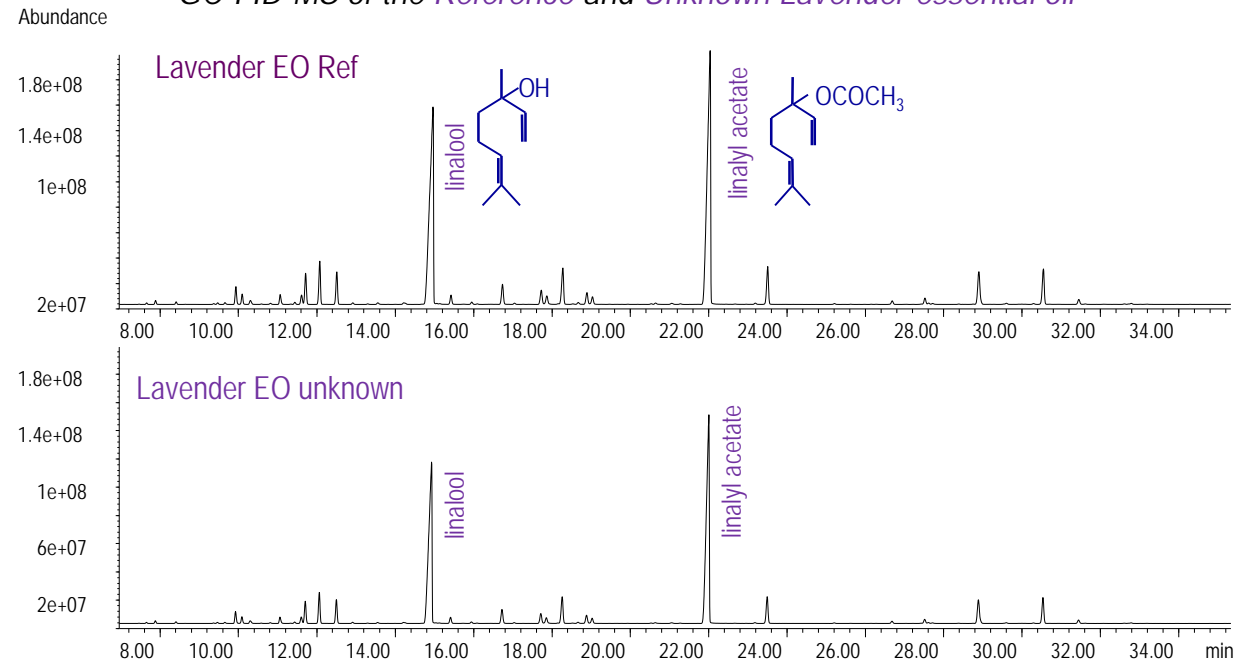
Essential oils and quality

Lavender essential oils and "invisible" adulterants





GC-FID-MS of the Reference and Unknown Lavender essential oil



	<i>Linalool</i>		<i>Linalyl acetate</i>	
<i>Sample</i>	<i>Area %</i>	<i>Average area</i>	<i>Area %</i>	<i>Average area</i>
EO-St.	31.9	10346490899	36.3	11790276760
EO-Unk.	32.3	6710236137	36.8	7574204348

Lavender EO adulteration with “fatty oils”

Economic considerations

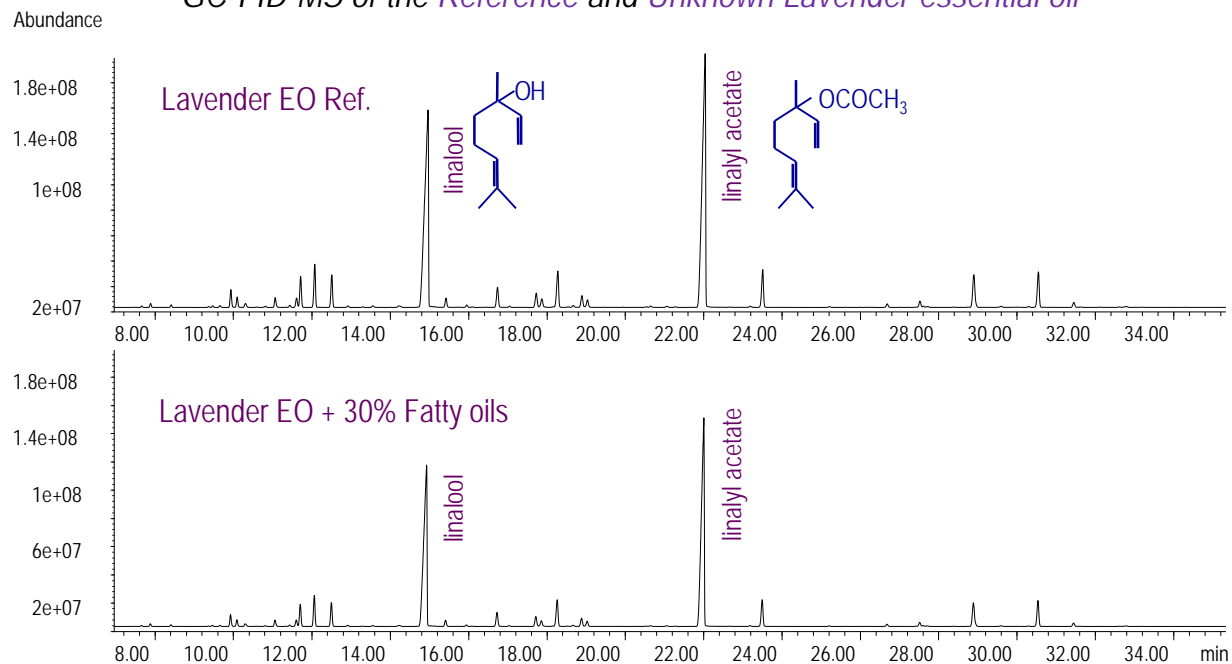
- Lavender EO: 100-120 \$/kg ● Deodorized fatty oil 1-4 \$/kg
- Average difference of cost for a 30% fatty oil adulteration: 30-40 \$/kg
 - Entity of the lot: 100 kg
 - Difference: 3000\$



Lavender EO adulteration with "fatty oils"



GC-FID-MS of the Reference and Unknown Lavender essential oil



Sample	Linalool		Linalyl acetate	
	Area %	Average area	Area %	Average area
EO-St.	31.9	10346490899	36.3	11790276760
EO-Unk.	32.3	6710236137	36.8	7574204348

Sample	Linalool			Linalyl acetate		
	Area %	Average area	Am. (mg/mL)	Area %	Average area	Am. (mg/mL)
EO	31.9	10346490899	27.20	36.3	11790276760	19.5
EO + 5% Fat	32.4	9924459238	26.09	36.8	11188863989	18.5
EO + 10% Fat	32.2	9373035712	24.64	36.8	10629123543	17.6
EO + 20% Fat	32.1	8754987176	23.01	37.2	10062940335	16.6
EO + 30% Fat	32.3	6710236137	17.64	36.8	7574204348	12.5



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