‘For the Love of Lavender’

NZLGA Conference

2018

How can science ‘Grow the Love’?

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NEW ZEALAND LAVENDER GROWERS ASSOCIATION

Lavender science

- What is known
- How lavender knowledge is used in NZ enterprise
- Oil measurements –quality, GC, GCMS
- What would be good to know to ‘Grow the Love’
- What is/might be allowed– MoH, Medsafe
- Conclusions
- Questions

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Lavender - Biology/Biochemistry

- Genus Macaronesia/Mediterranean/E.Africa/India
- Xerophyte – adapted to sunny, dry climate
- Acclimatised / commercialised world-wide
- Range of inflorescence colours
- Variation in fragrance / chemistry

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Lavender - Genetics/Agronomy

- ***Lavandula*** **genetics:** **39 species**
  24 wild taxa
  16 hybids
  >400 cultivars

  Nuclear DNA extracted and sequenced for 28 *spp*
  Complete chloroplast genome for *L. angustifolia* -153,448 bp
  Phylogenetics, molecular breeding, and genetic engineering

- **Agronomy: Plant selection for soil types and climate, plant nutrition (Tim Denny, Noel Porter).**

- **Harvest, post-harvest & EO distillation practice (Tim Denny, Noel Porter).**

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Lavender processing

- **Steam distillation - essential oil (~0.7%)**
- **Petroleum ether extract – concrete (~1.5%)**
  - **Ethanol extraction of concrete – absolute**
- **Supercritical CO_2 extraction – concrete-like**
- **Water extraction**
- **Ethanol extraction w/wo ultrasound**

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Lavender processing

	Percent			
Compound class	**Essential oil**	**Concrete**	**$ScSO_2$ extract**	**Ethanol extract**
Monoterpene hydrocarbon	5-6	Nil	Nil	3-7
Oxygenated monoterpenes	82-85	90-97	72-75	86-90
Sesquiterpene hydrocarbons	2-3	Nil	3-4	2-3
Oxygenated sesquiterpenes	4-7	Nil	14-16	2-3

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Lavender - Bioactivity

Bioactivity:

	EO	Hydrosol	Extracts: Water	Extracts: Ethanol
• Bacteria	✓	✗	✗	✓
• Yeast	✓			
• Fungi	✓	✗*		
• Protozoa	✓			
• Virus	✗			✗

* Possible fungal growth stimulation !

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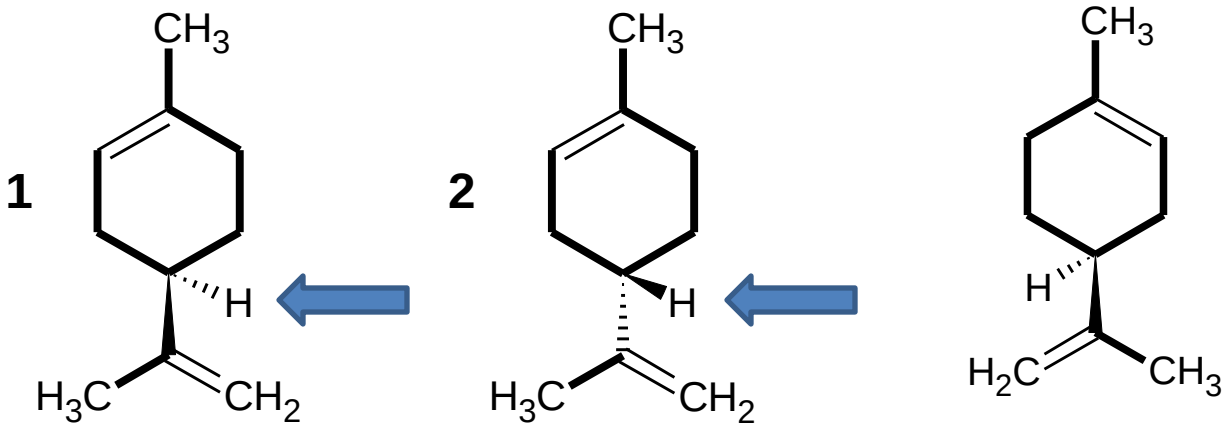
Chemistry & chirality

- **Chemists often communicate with pictures to describe left-handed and right-handed molecules**



(+)-limonene
citrus/lemony

(-)-limonene
pine/turpentine

1. **(4R)-1-methyl-4-prop-1-en-2-ylcyclohexene**
2. **(4S)-1-methyl-4-prop-1-en-2-ylcyclohexene**

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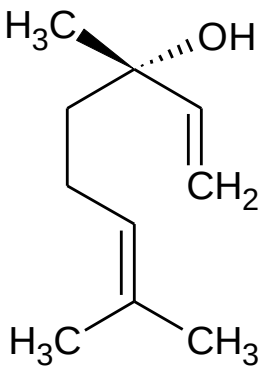
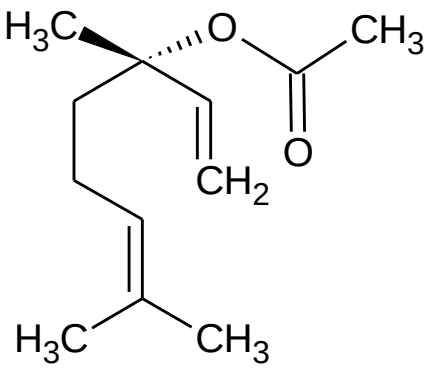
Lavender essential oil

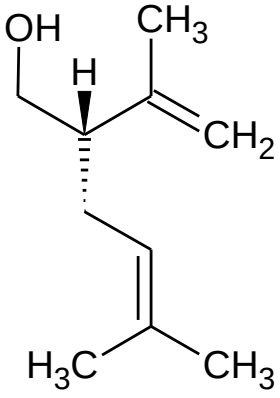
- Composition variable: species/hybrid/cultivar
- Major compounds:



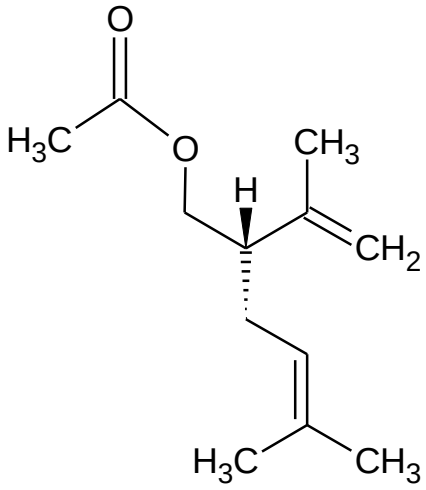
R-(-)-linalool



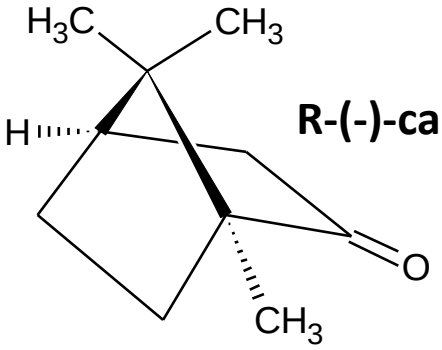
R-(-)-linalyl acetate



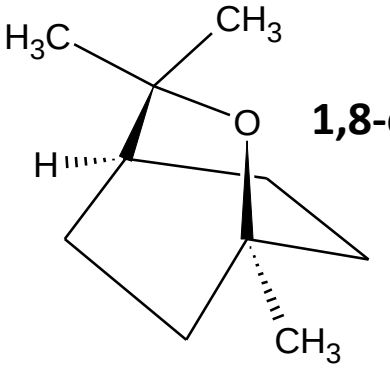
R-(-)-lavandulol



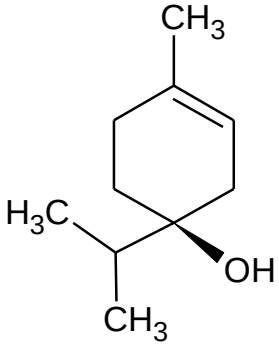
R-(-)-lavandulyl acetate



R-(-)-camphor



1,8-cineol



(R)-terpinen-4-ol

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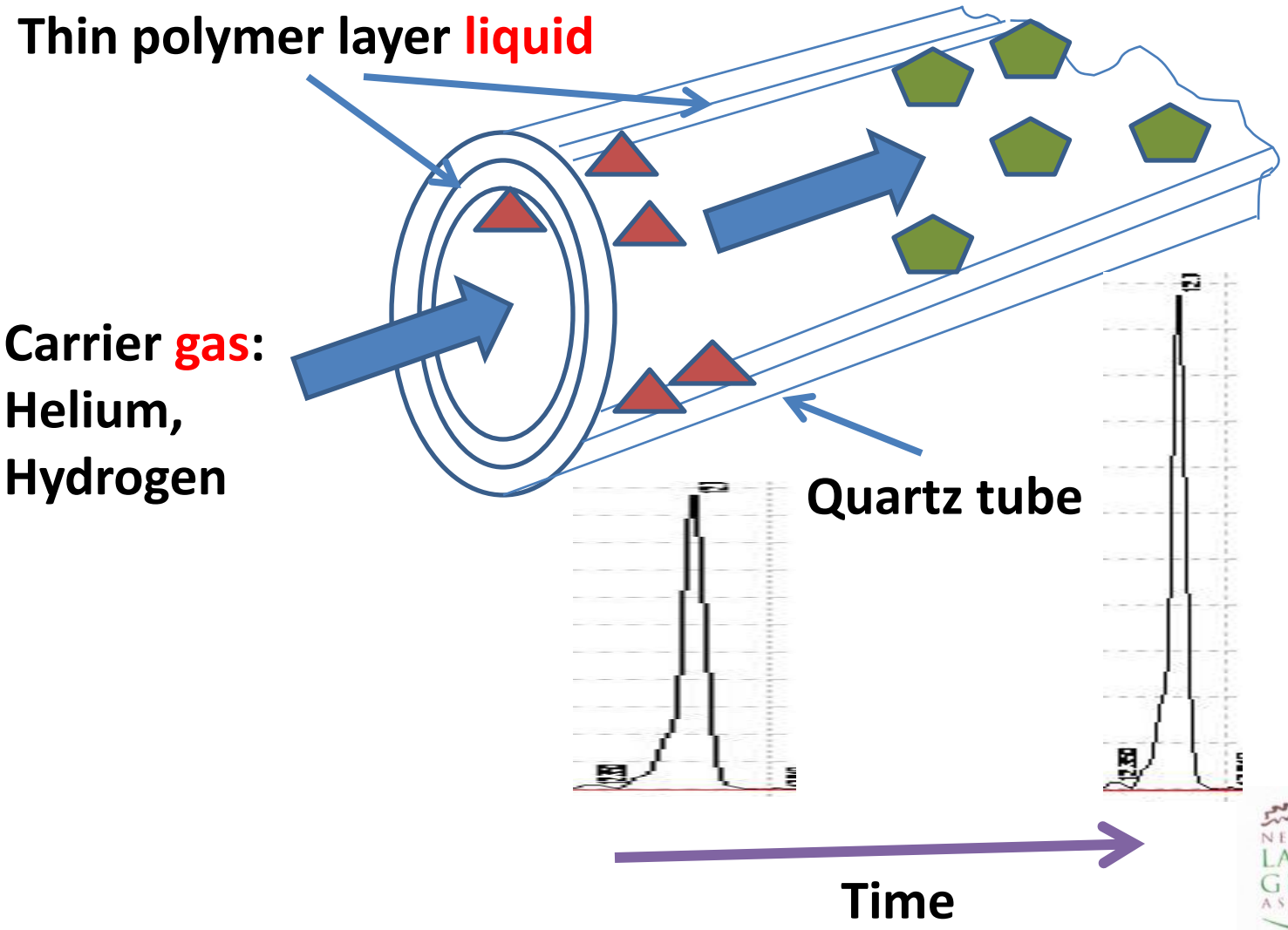
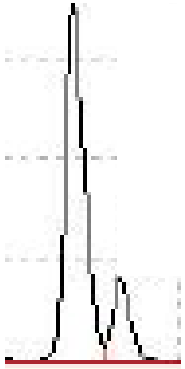
Gas (liquid) chromatography



Lavender essential oil analyses

- **Gas chromatography (GC)**



Flame ionisation **detector (FID): quantitative data (how much?)**

Data can be presented as Area percent uncorrected for RRF

….Or Area percent and corrected for RRF

….Or gram/litre or /kg by relative density x area %

Mass spectrometer **(MS): qualitative data (what is it?)**

Quantitative by selected ion monitoring with RRF

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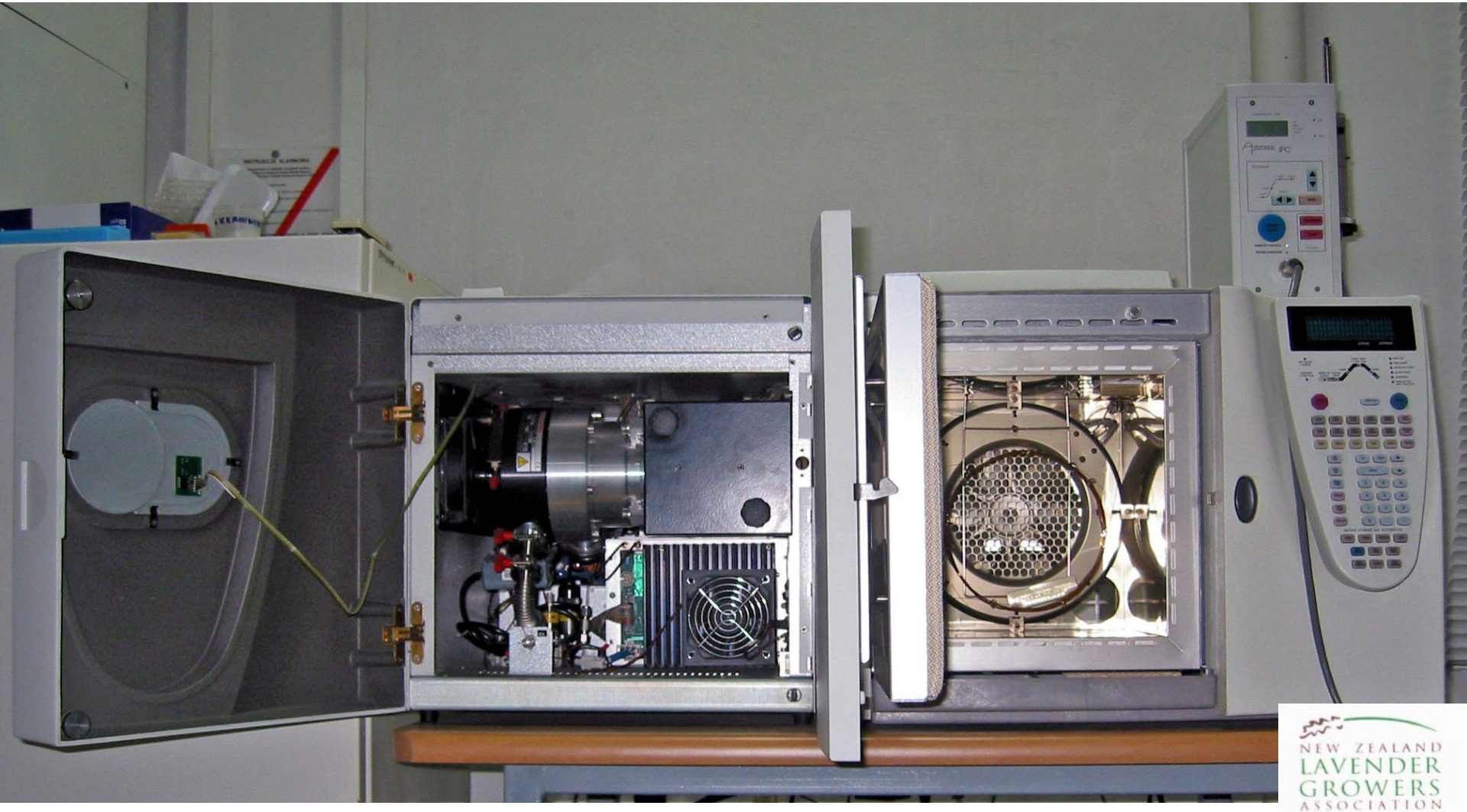
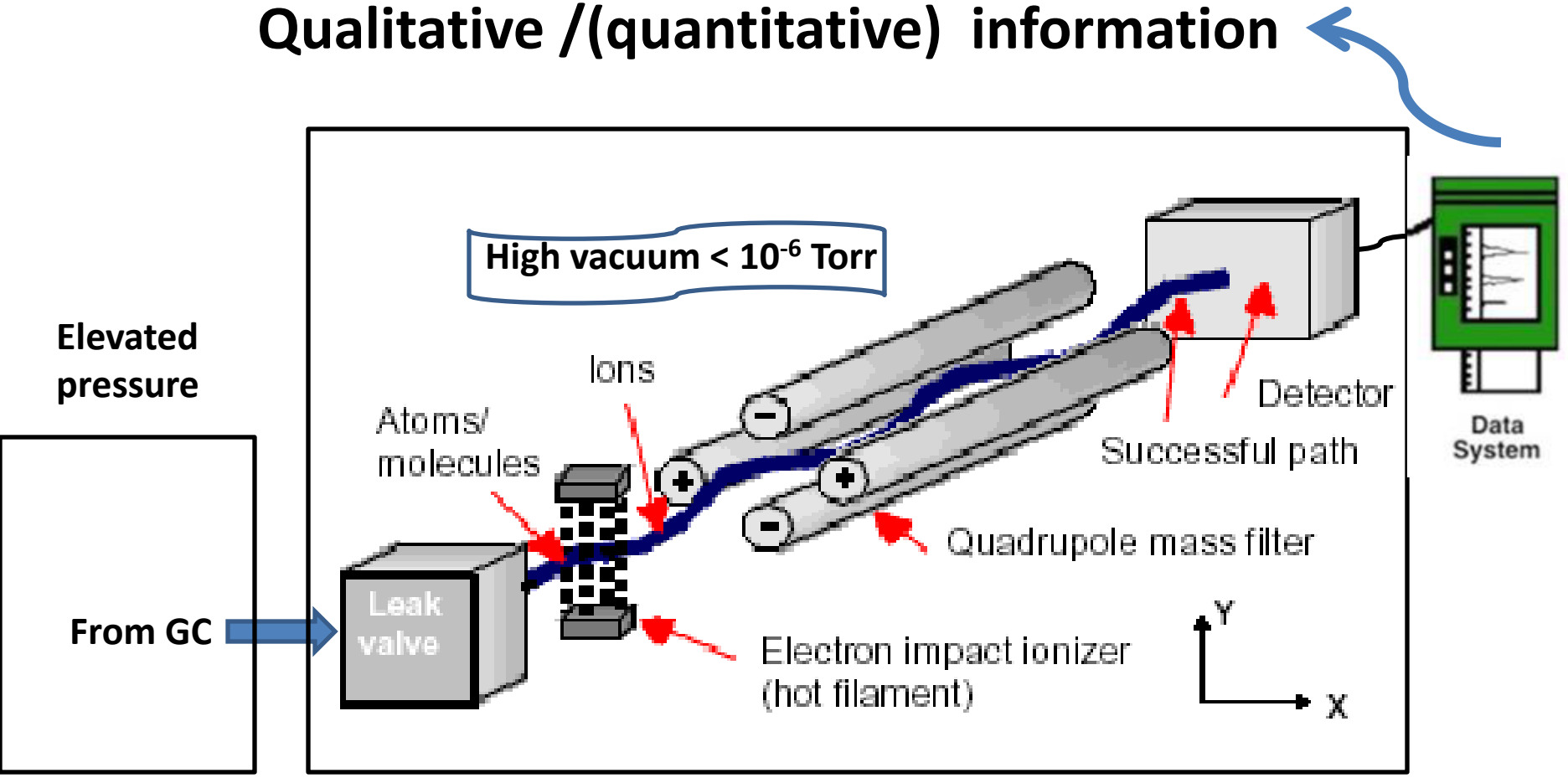
GC-MS quadrupole instrument



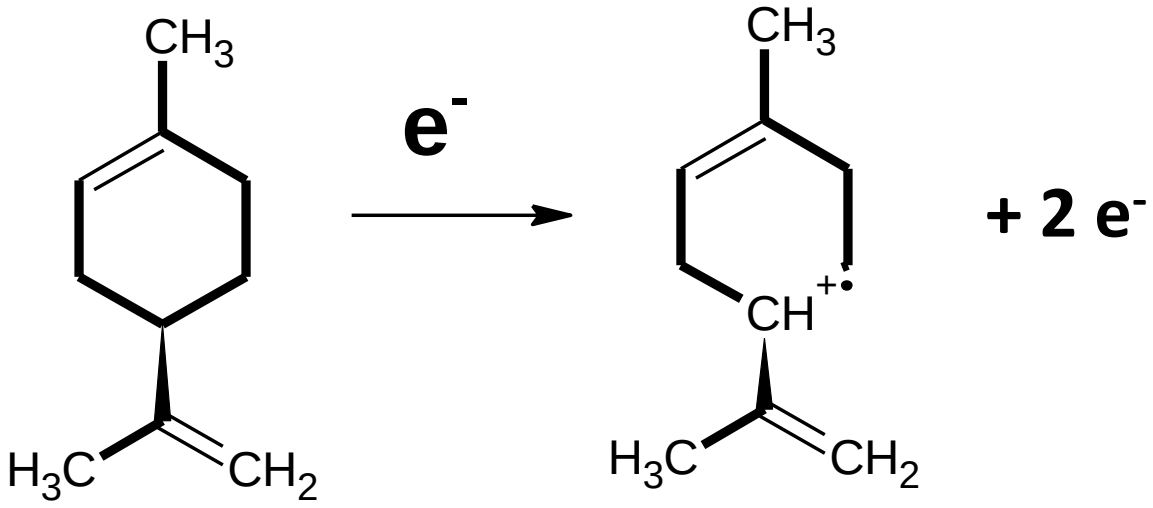
Gas chromatography- mass spectrometry

Qualitative /(quantitative) information



Mass spectrometry

The ion source – electron ionisation



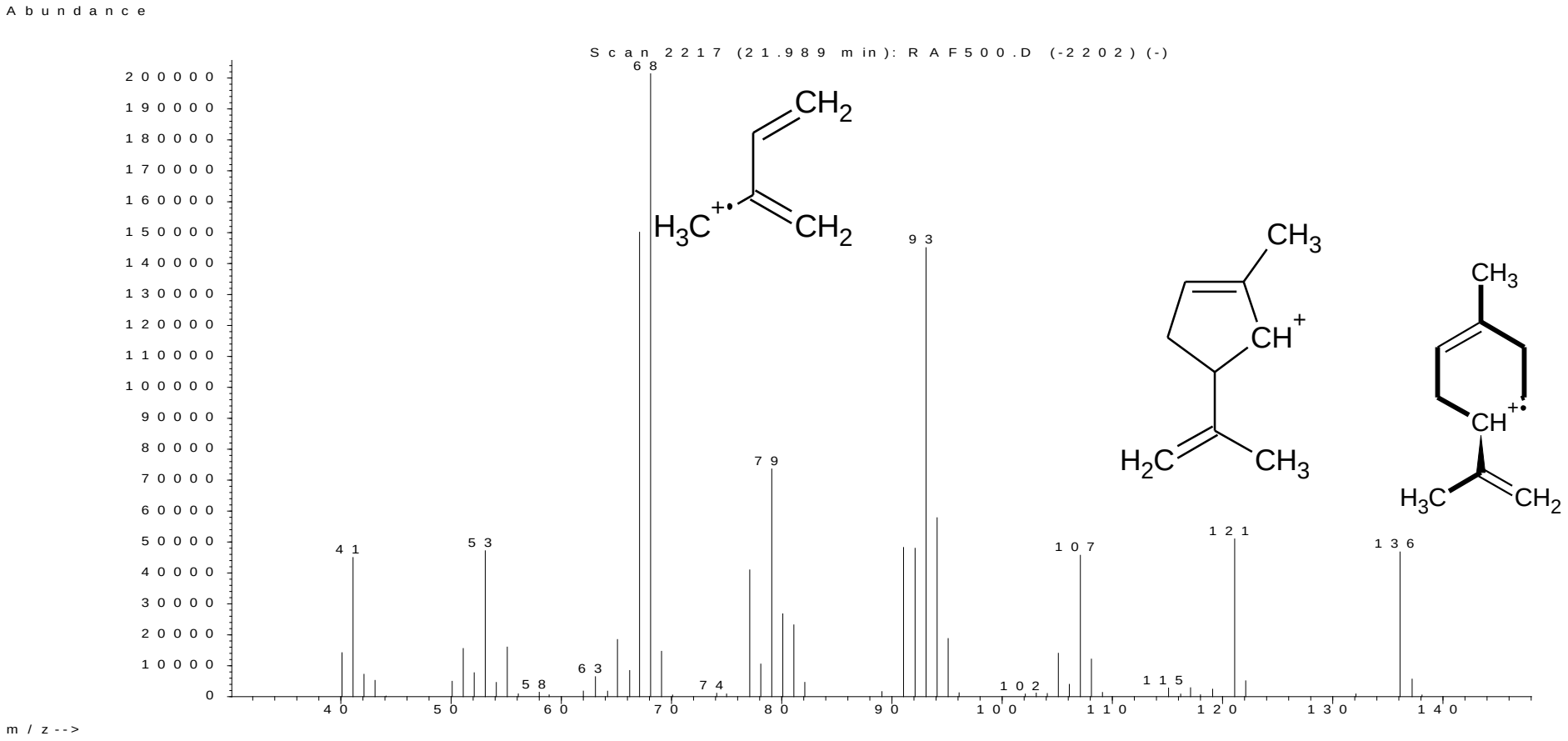
Limonene

MW 136

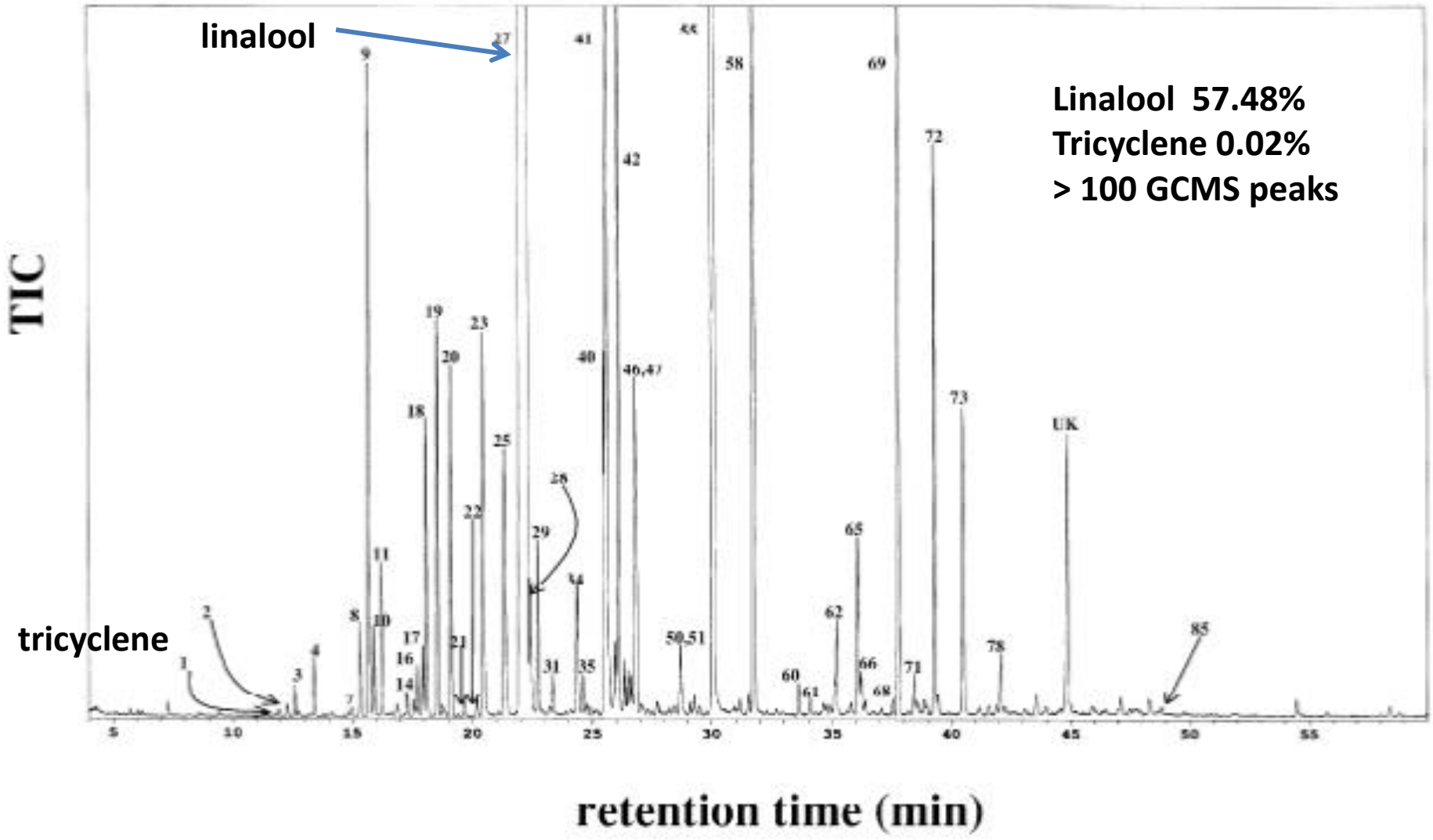
Limonene radical cation

MW 136

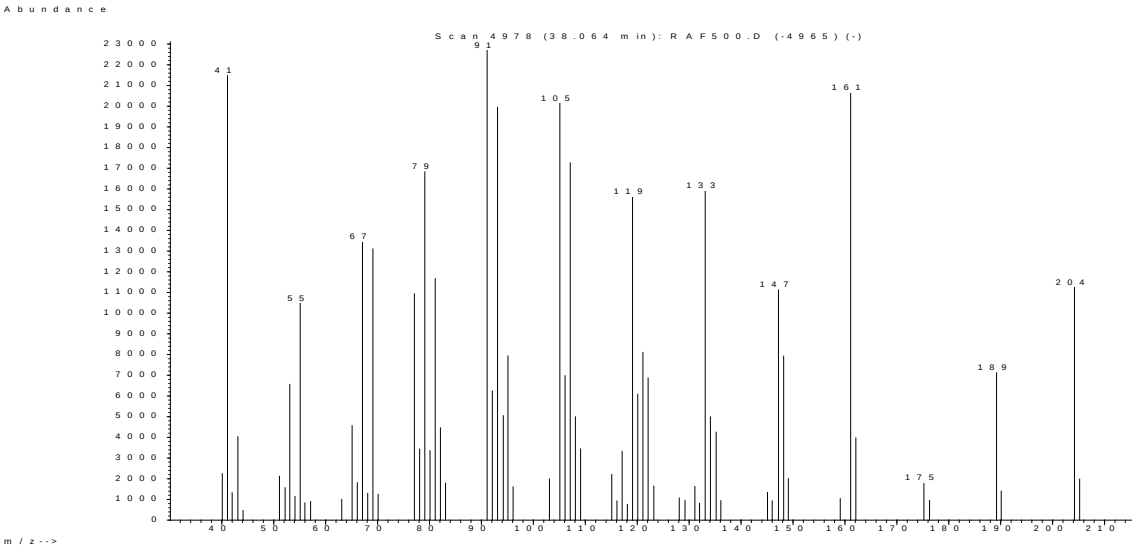
Limonene mass spectrum

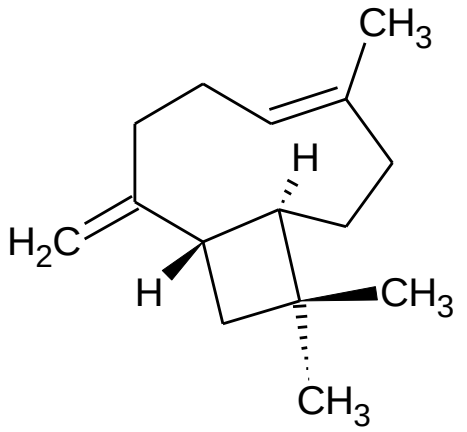


GC-MS of *L. angustifolia* EO

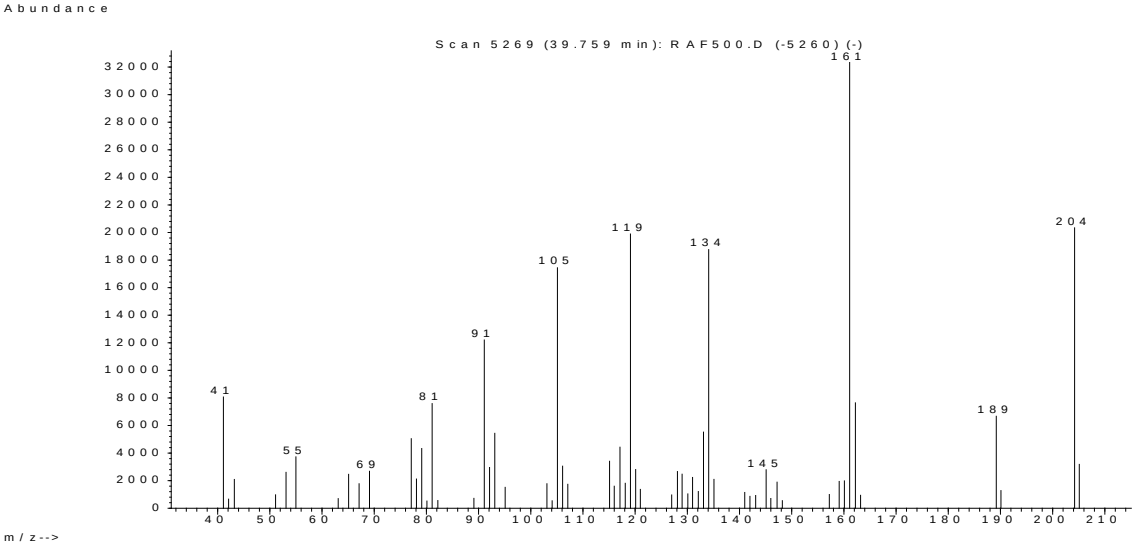


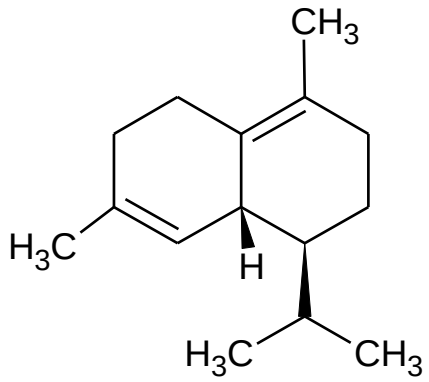
Lavender EO sesquiterpenes





Caryophyllene





Delta-cadinene

Gas chromatograph FID

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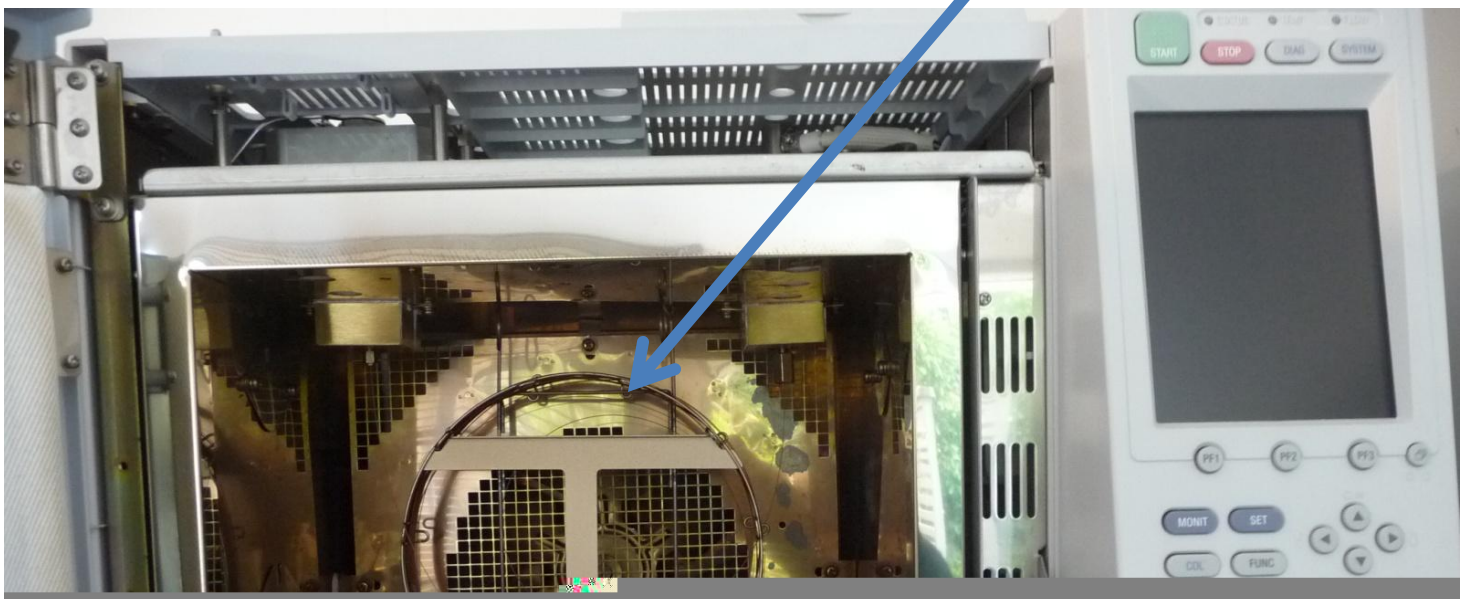
GC oven and capillary column



GC flame ionisation detector

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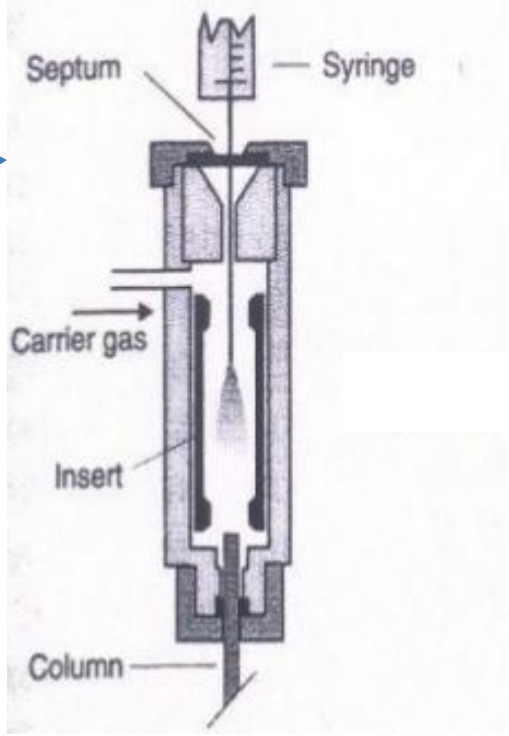
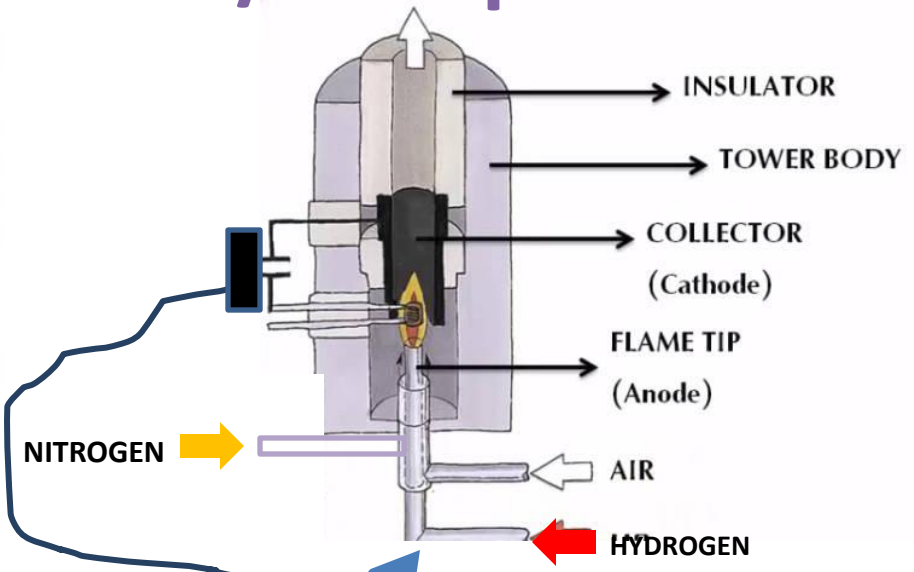
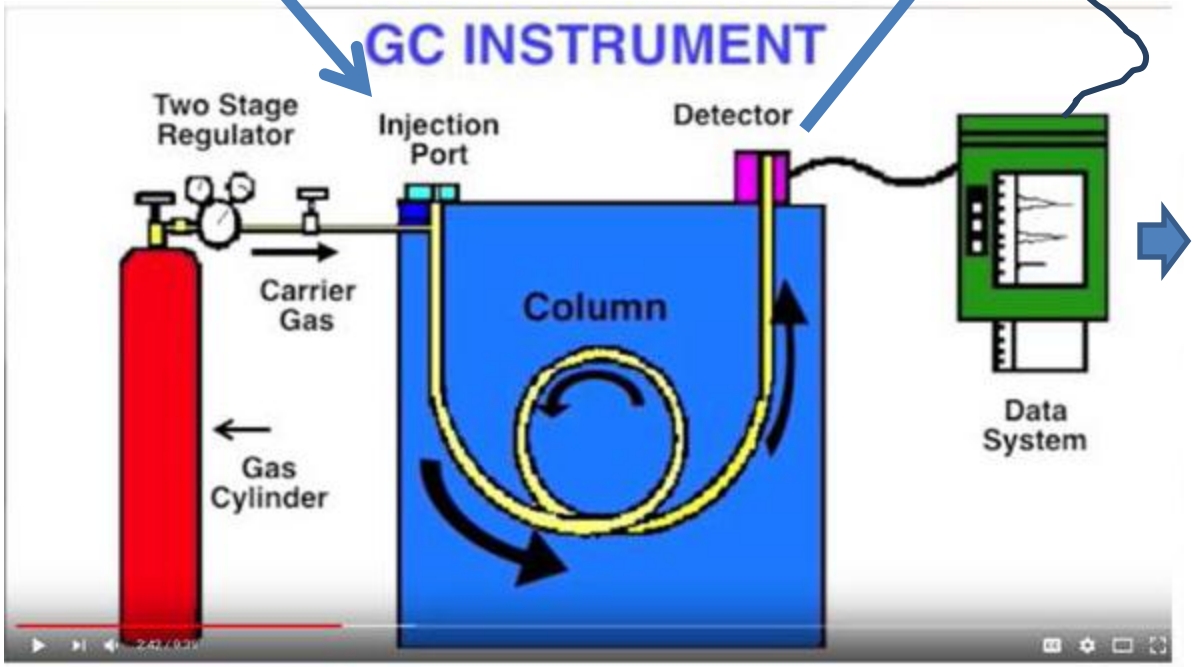
GC /FID operation

Lavender oil sample







Quantitative information

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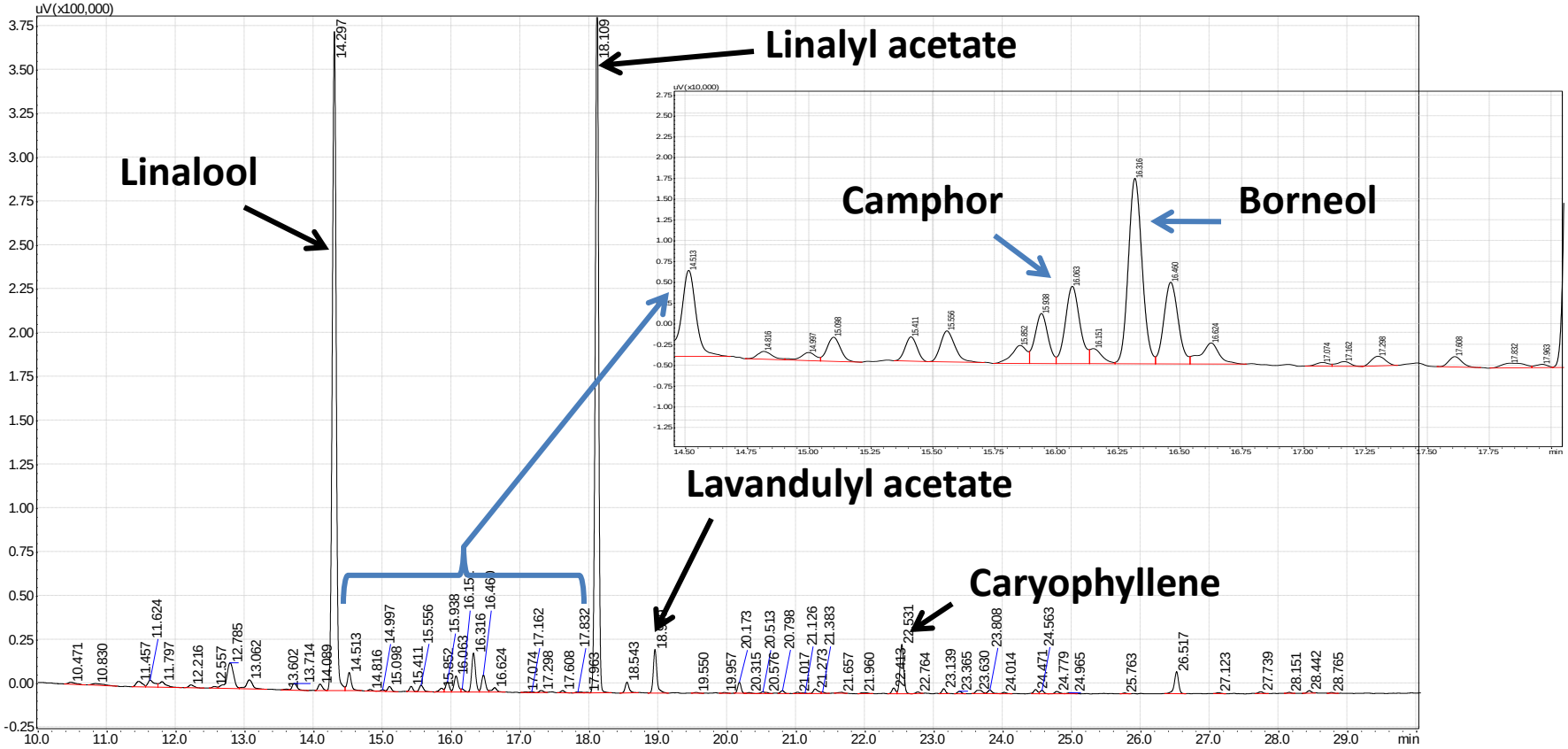
Lavender: GC/FID analysis

Gas chromatography with flame-ionisation detector



Lavender EO Mont Blanc Haute Provence

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Lavender EO: summary

- Over 100 compounds known
- 12 compounds for reporting for EO quality
- GC with MS for identifying compounds/qualitative
- GC with FID for quantitative analysis
- Bioactivity
- Aroma

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Lavender hydrosol

Compound	% of total
Linalool oxides	18
Linalool	40
Borneol	8
Terpinen-4-ol	6
α-Terpineol	11
Total	83

Hydrosol concentration in water 0.097 g/100 g, = 970 ppm

Claims of bioactivity of lavender hydrosols open to question

Risk of non-sterile hydrosols supporting fungal growth on storage

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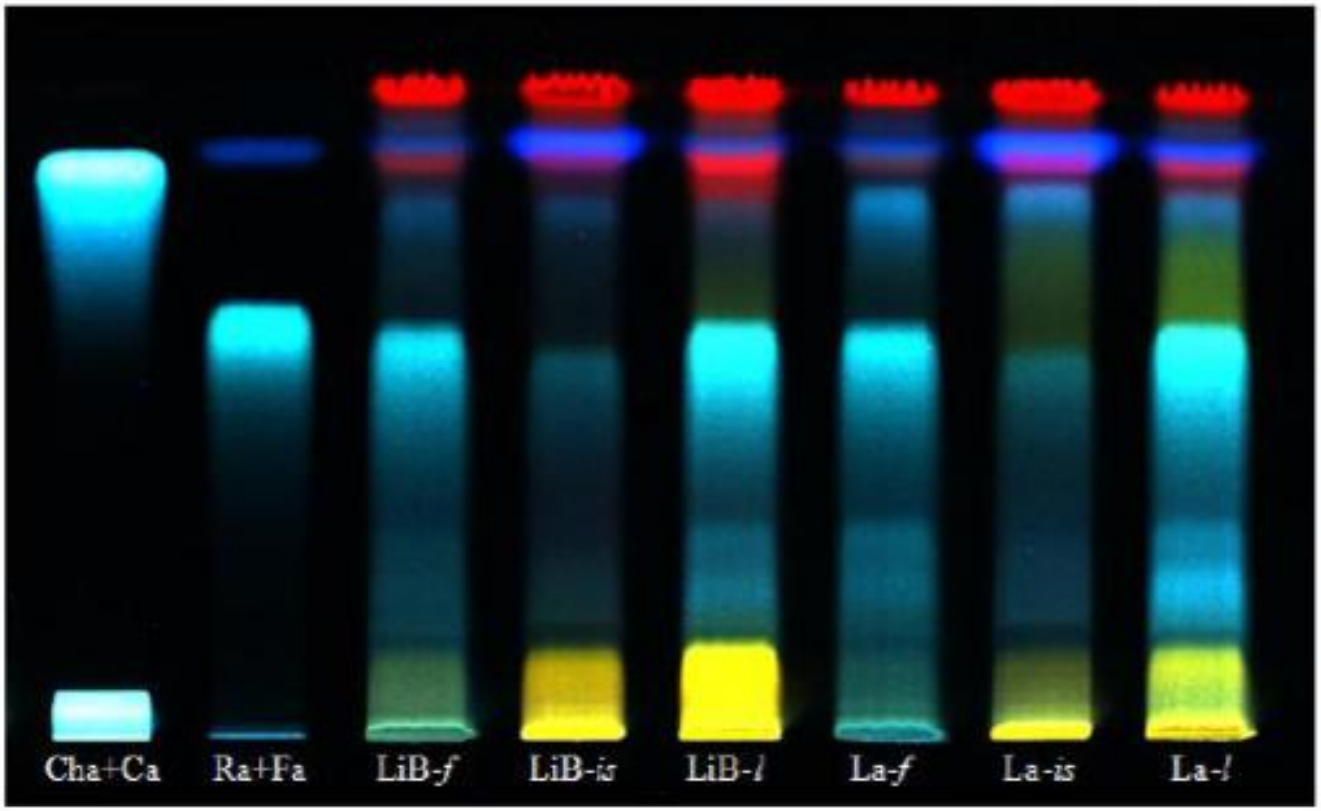
Lavender ethanol extracts

Flower, Inflorescence stalk and leaf phenolic acids

Thin-layer chromatography



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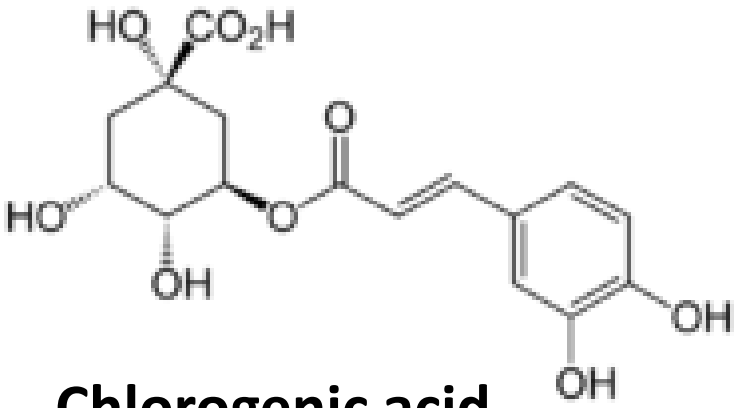
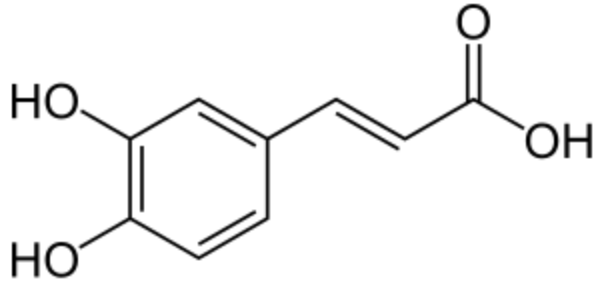
Lavender phenolic acids

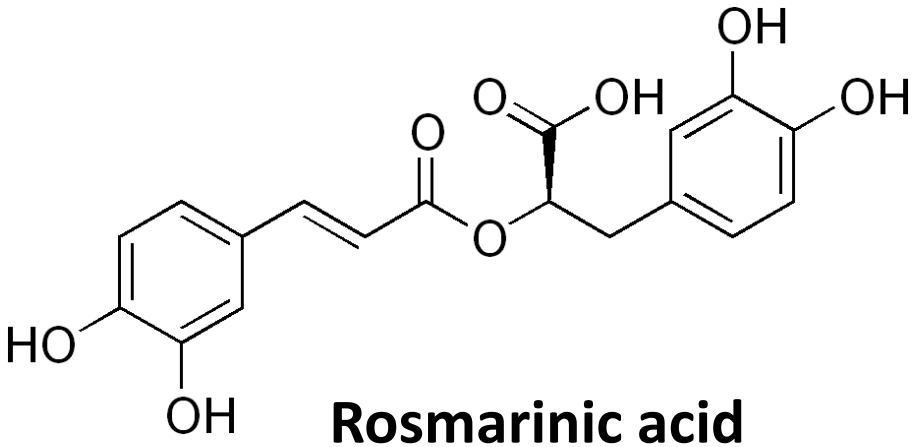
Lavender phenolic compounds from flowers, stalks and leaves



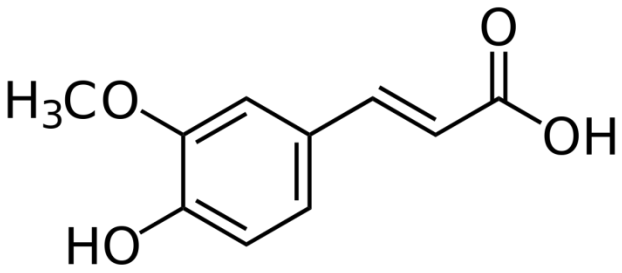
Chlorogenic acid



Caffeic acid



Rosmarinic acid



Ferulic acid

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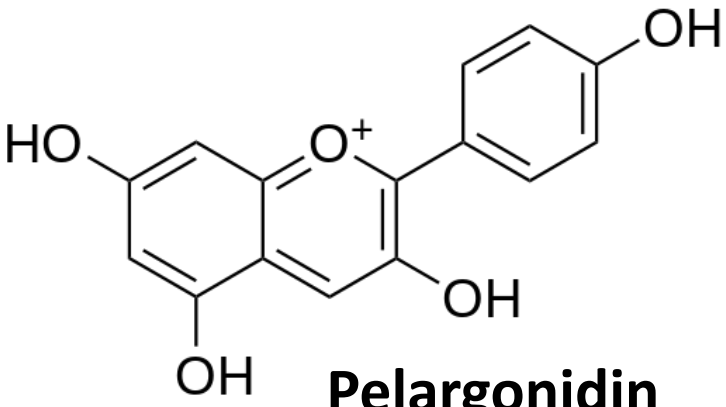
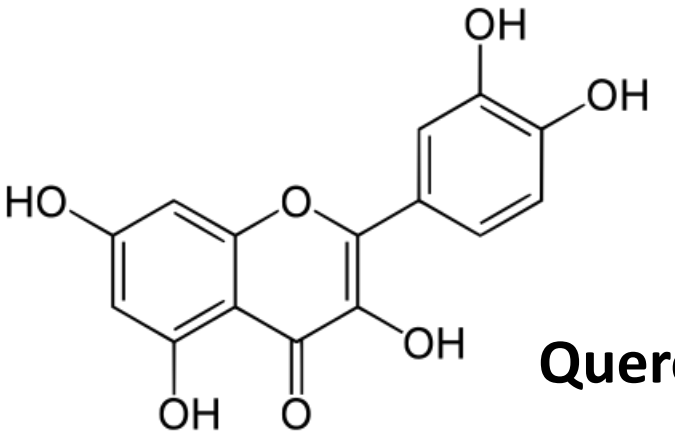
Lavender flavanoids

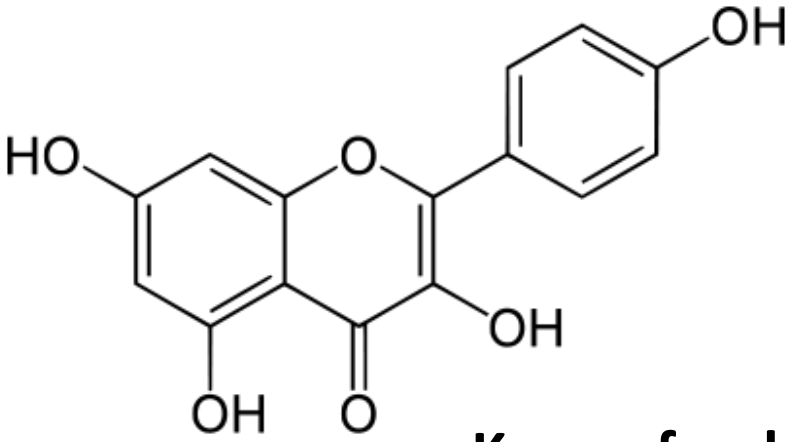
Lavender flavanoids – anthocyanidins flower colours



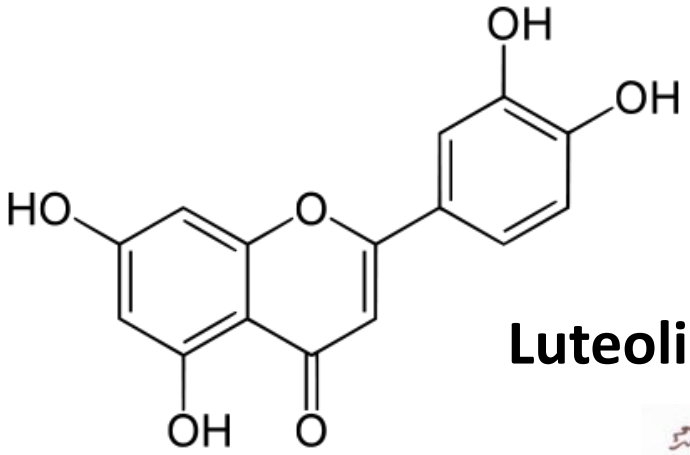
Pelargonidin



Quercitin



Kaempferol



Luteolin

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Lavender flavanoid content

Phenolic acids and flavanoids / cyanidins and tannins content of extracts from *L.angustifolia* and *L. x intermedia*

Extracts		Contents (%)					
		Phenolic acids	Flavonoids	Anthocyanins	Procyanidins	Total tannins	Total polyphenols
LiB	flower	3.42 ± 0.09	0.10 ± 0.01	0.02 ± 0.00	1.13 ± 0.07	2.02 ± 0.01	6.65 ± 0.14
	stalk	1.62 ± 0.12	0.22 ± 0.01	-	0.86 ± 0.02	1.01 ± 0.04	3.09 ± 0.11
	leaf	3.80 ± 0.04	0.26 ± 0.01	-	1.30 ± 0.05	2.21 ± 0.03	7.05 ± 0.15
La	flower	5.00 ± 0.11	0.09 ± 0.01	0.03 ± 0.00	1.32 ± 0.08	2.77 ± 0.05	8.46 ± 0.05
	stalk	2.41 ± 0.06	0.19 ± 0.02	-	1.02 ± 0.03	1.38 ± 0.19	4.54 ± 0.22
	leaf	5.32 ± 0.14	0.25 ± 0.01	-	1.44 ± 0.02	3.18 ± 0.22	9.20 ± 0.17

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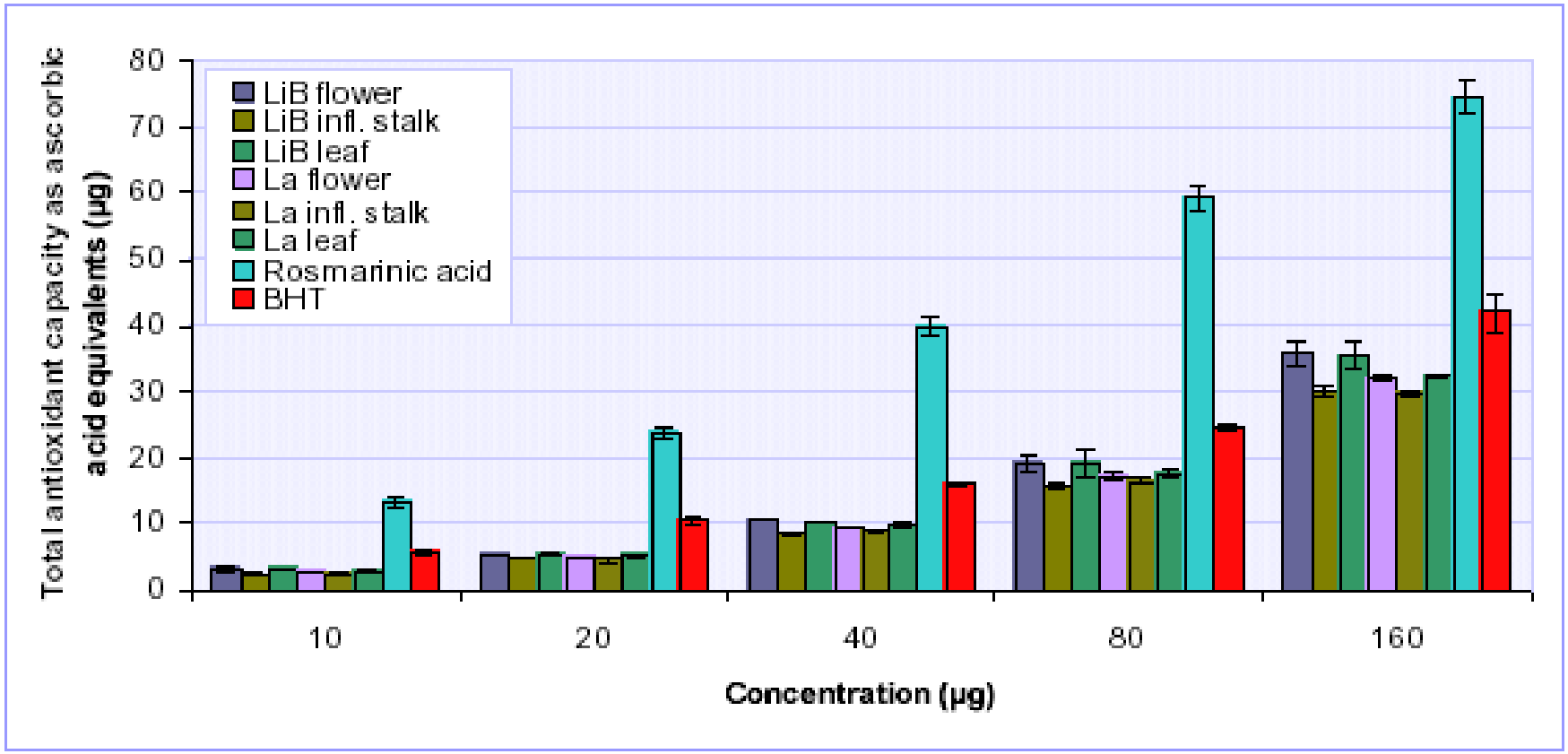
Lavender extracts antioxidant activity

Antioxidant activity of extracts from *L.angustifolia* and *L. x intermedia*



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Lavender - What is known

Biology and agronomy

Genetics and breeding, new molecular breeding science

Harvest and post-harvest crop management

Processing for essential oil and hydrosol production

EO quality assessment using GCFID and GCMS

Yield and chemistry of flower, stalk and leaf solvent extracts

Antioxidant activity of lavender extracts

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Lavender- Grow the Love

Grow the EO quality: Genetics, breeding, production, analysis, oil competitions

Grow in EO quantity: Bigger harvest, larger processors

Diversify lavender products:

EO *plus* hydrosols *plus* extracts

Medsafe permitted substance list?

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Questions ?