Fermentation-derived aroma compounds and grape-derived monoterpenes

Leigh Francis

Flavours from yeast

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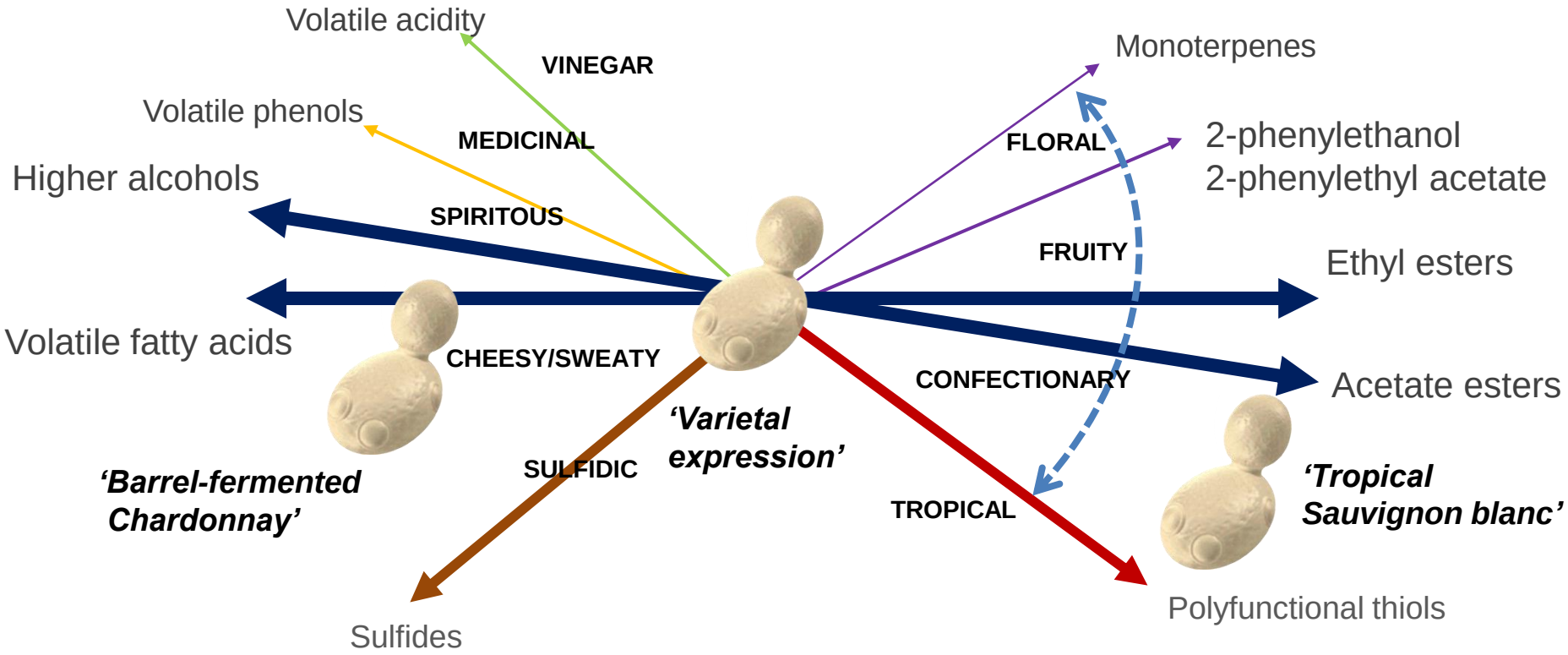

Adapted from Cordente et al Flavour-active yeasts
Appl. Microbiol. Biotechnol. (2012) 96: 601-618

Fermentation derived volatiles: fatty acids

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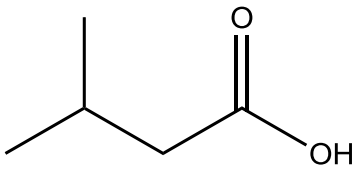
		aroma threshold (µg/L)
Isobutyric acid	rancid, cheese	2300
Isovaleric acid	sweat, rancid	33
Acetic acid	pungent, vinegar	200 000
Butyric acid	rancid, cheese, vomit	173
Hexanoic acid	sweat	420
Octanoic acid	sweat, cheese	500
Decanoic acid	rancid, fat	1000



$CH_3CH_2CH_2CH_2CH_2COOH$

Fermentation derived volatiles: alcohols

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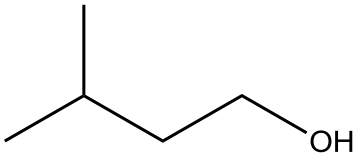
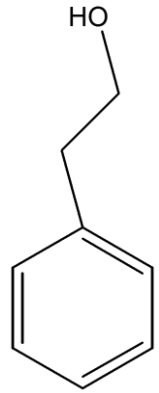
		aroma threshold (µg/L)
Isobutanol	Solvent, harsh	40000
Isoamyl alcohol	whiskey, malt, burnt	30000
2-Phenylethyl alcohol	rose, lilac	14000





Fatty acids and higher alcohols

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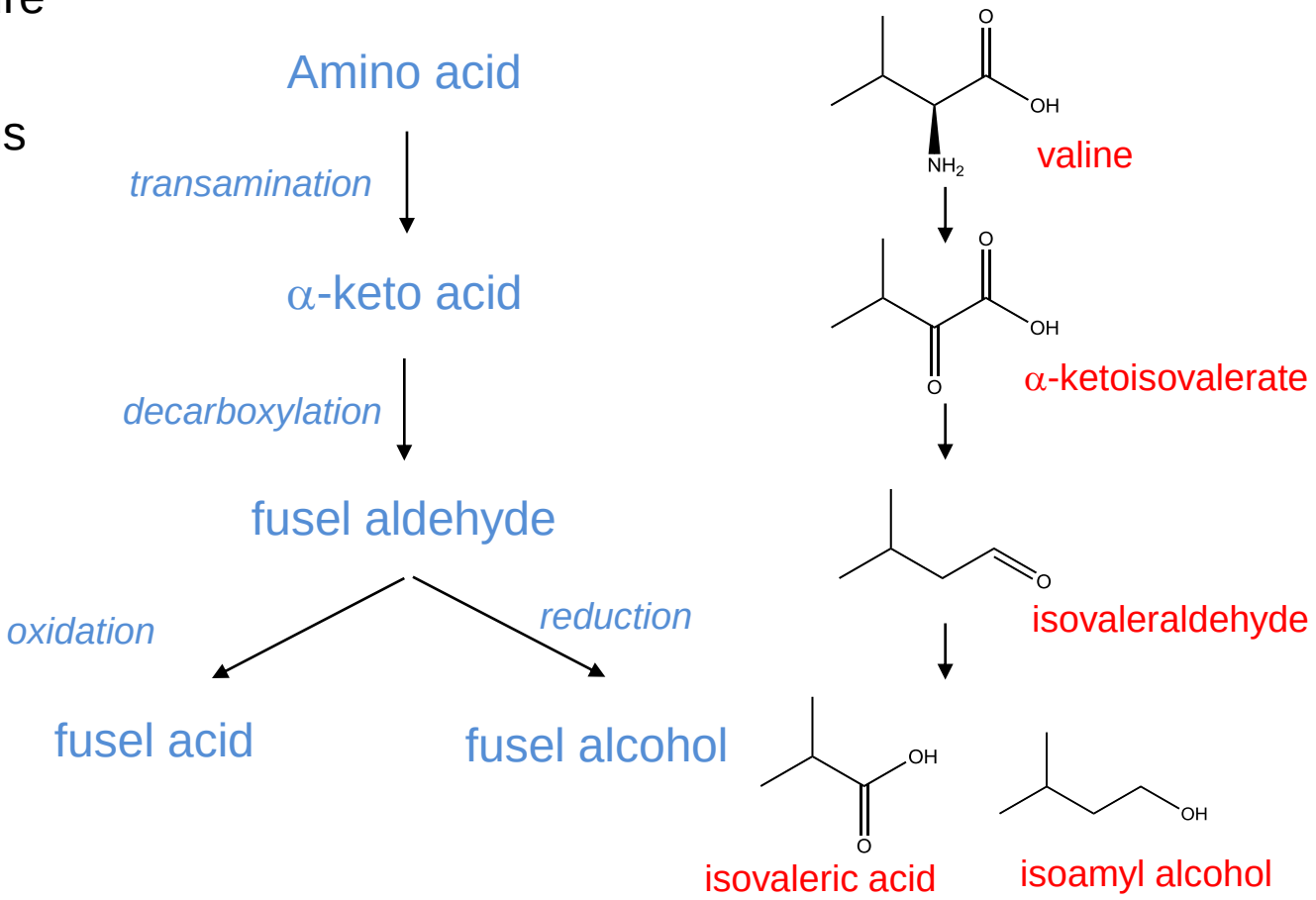
- Formation from amino acids, and glucose via pyruvate (BAT1 and BAT2 genes)
- Higher alcohols tend to be promoted with
  - higher temperature
  - higher nitrogen
  - aerobic conditions
  - higher Brix must



Fermentation derived volatiles: esters

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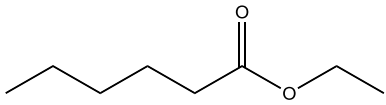
		aroma threshold (µg/L)
Ethyl isobutyrate	fruity	15
Ethyl 2-methylbutyrate	apple	18
Ethyl isovalerate	fruit	3
Ethyl butyrate	apple	20
Ethyl hexanoate	apple peel, fruit, pineapple	14
Ethyl octanoate	fruit, fat	5
Ethyl decanoate	grape	200
Isoamyl acetate	banana	30
Phenylethyl acetate	rose, honey	250
Ethyl acetate	fruity, solvent	12264



Fermentation derived volatiles: Esters

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fatty acid ethyl esters, acetate esters

EEB1, EHT1 + ATF1, ATF2 genes

- slower rate of fermentation, increase in esters
  - ie lower temp

- Higher acetate esters
  - higher Brix must
  - Higher nitrogen
  - 20 °C optima
- yeast strain
- juice composition: amino acid pattern
- undergo chemical hydrolysis/reaching chemical equilibrium with storage: rapid decrease in first year in bottle

$$R_1COOH + R_2OH \rightleftharpoons R_1COOR_2 + H_2O$$





Grape C6 levels contribute to acetate ester formation

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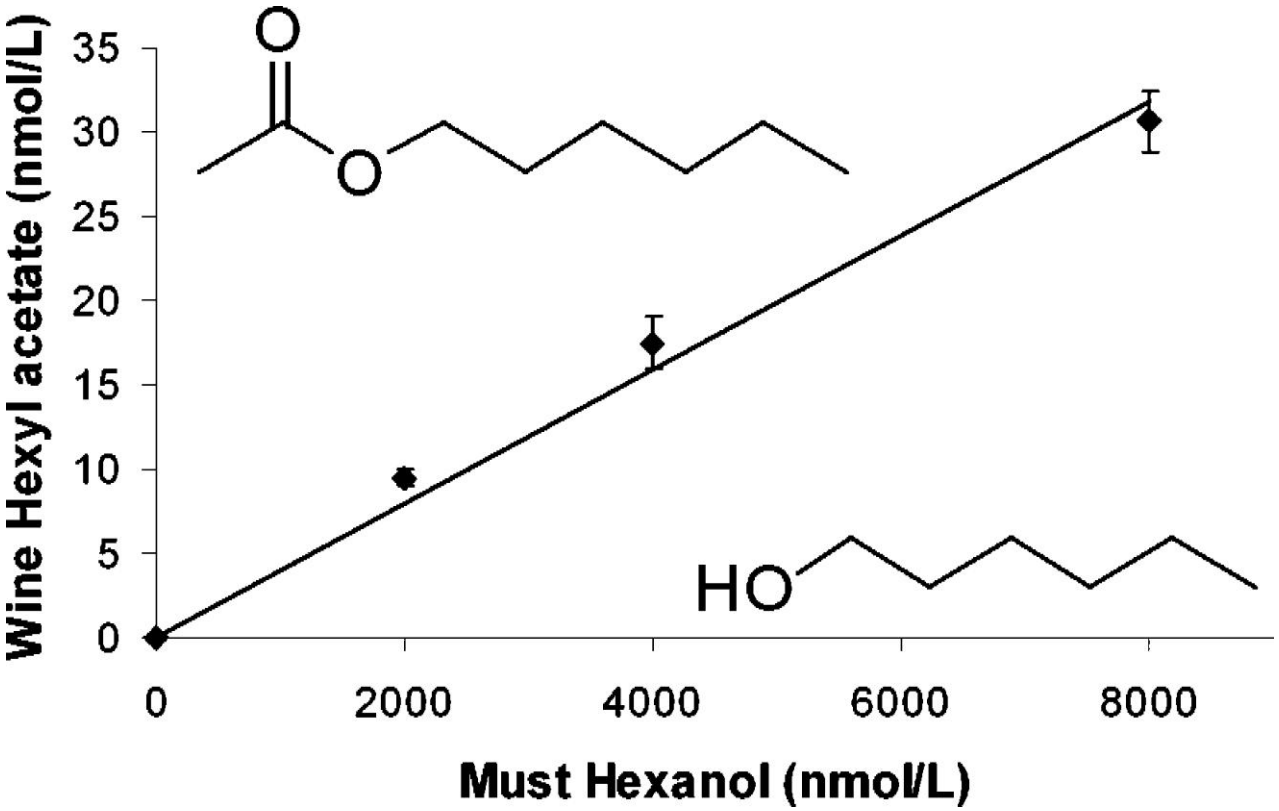

Published in: Eric G. Dennis; Robert A. Keyzers; Curtis M. Kalua; Suzanne M. Maffei; Emily L. Nicholson; Paul K. Boss; *J. Agric. Food Chem.* **2012,** 60, 2638-2646.
DOI: 10.1021/jf2042517

Grape derived monoterpenes

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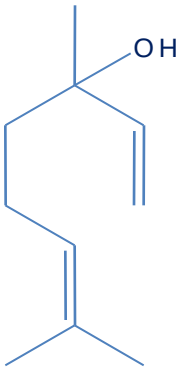
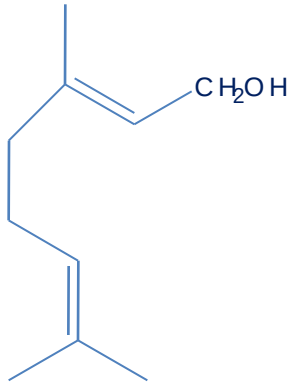
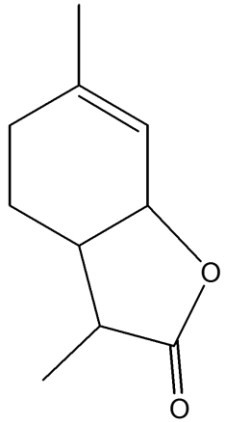


linalool



geraniol



wine lactone

Grape derived monoterpenes: unlocking flavour

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Formed in plant cells: geranyl pyrophosphate

- ~ 70 compounds identified, aromas may be additive

Three classes of monoterpenes

1. Free aroma compounds
   - low aroma thresholds eg linalool, geraniol, nerol
2. Polyhydroxylated forms
   - free odourless polyols
   - some are reactive and can break down easily to give other pleasant volatiles eg rose oxide
3. Glycoside conjugates
   - Attached to sugars
   - released by enzyme or acid hydrolysis

Glycoside precursors

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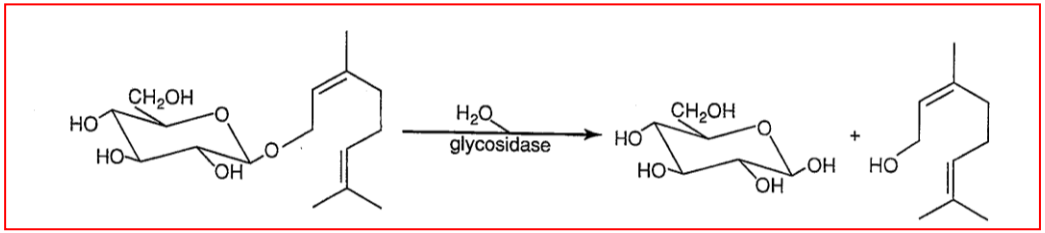
- enzyme hydrolysis
  - inhibited by glucose
  - Yeast/bacteria
  - Exogenous enzymes

- Acid-catalysed hydrolysis and rearrangements during wine processing and ageing



From Hemingway et al (1999) Carbohyd. Polym. 38 283-286

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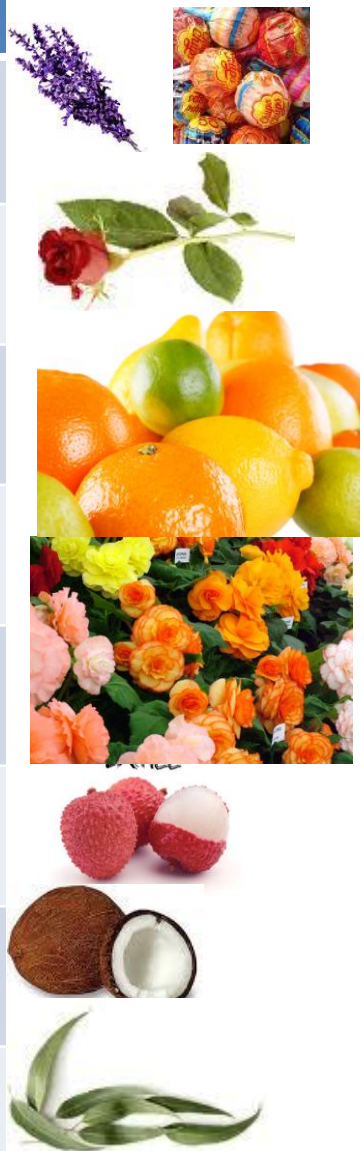
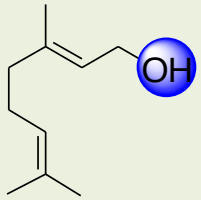
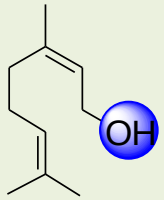
Compound	Odour Descriptor	Detection threshold
Linalool	Muscat, fresh, floral, lavender, sweet	25 µg/L
Nerol	Rose	300 µg/L
Geraniol	Spicy, flowery, citrus	30 µg/L
α-Terpineol	Floral, citrus, sweet	250 µg/L
Citronellol	Spicy, flowery	100 µg/L
cis-Rose Oxide	Lychee, rose	100 µg/L
Wine Lactone	Coconut, lime	0.01 µg/L
1,8-Cineole	Eucalyptus	3.2 µg/L

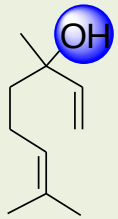




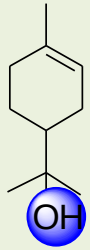
Geraniol
Rose, geranium
(30 μg/L)



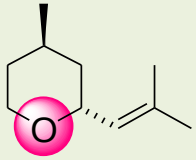
Nerol
Rose
(300 μg/L)



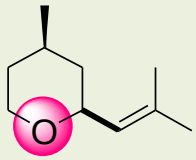
Linalool
Floral, lavender
(25 μg/L)



α-Terpineol
Floral, lilac
(250 μg/L)



trans-Rose oxide
Rose, floral
(80 μg/L)



cis-Rose oxide
Rose, lychee
(0.2 μg/L)

1,8-Cineole
Eucalyptus,
medicinal
(3 μg/L)

Monoterpenes

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- linalool floral, lemon
  - threshold ~25 µg/L, in Muscat wine up to 500 µg/L

- ‘wine lactone’
  - ‘coconut’, ‘lime’, ‘woody’ and ‘sweet’
  - very potent: threshold 0.01 µg/L, in wine ~0.1 µg/L, aged wines
  - First isolated in Koala urine (1975)

- *cis*-rose oxide roses, lychee 0.2 µg/L, in wine up to 20 µg/L, esp. Gewürztraminer

Loss of monoterpenes over time

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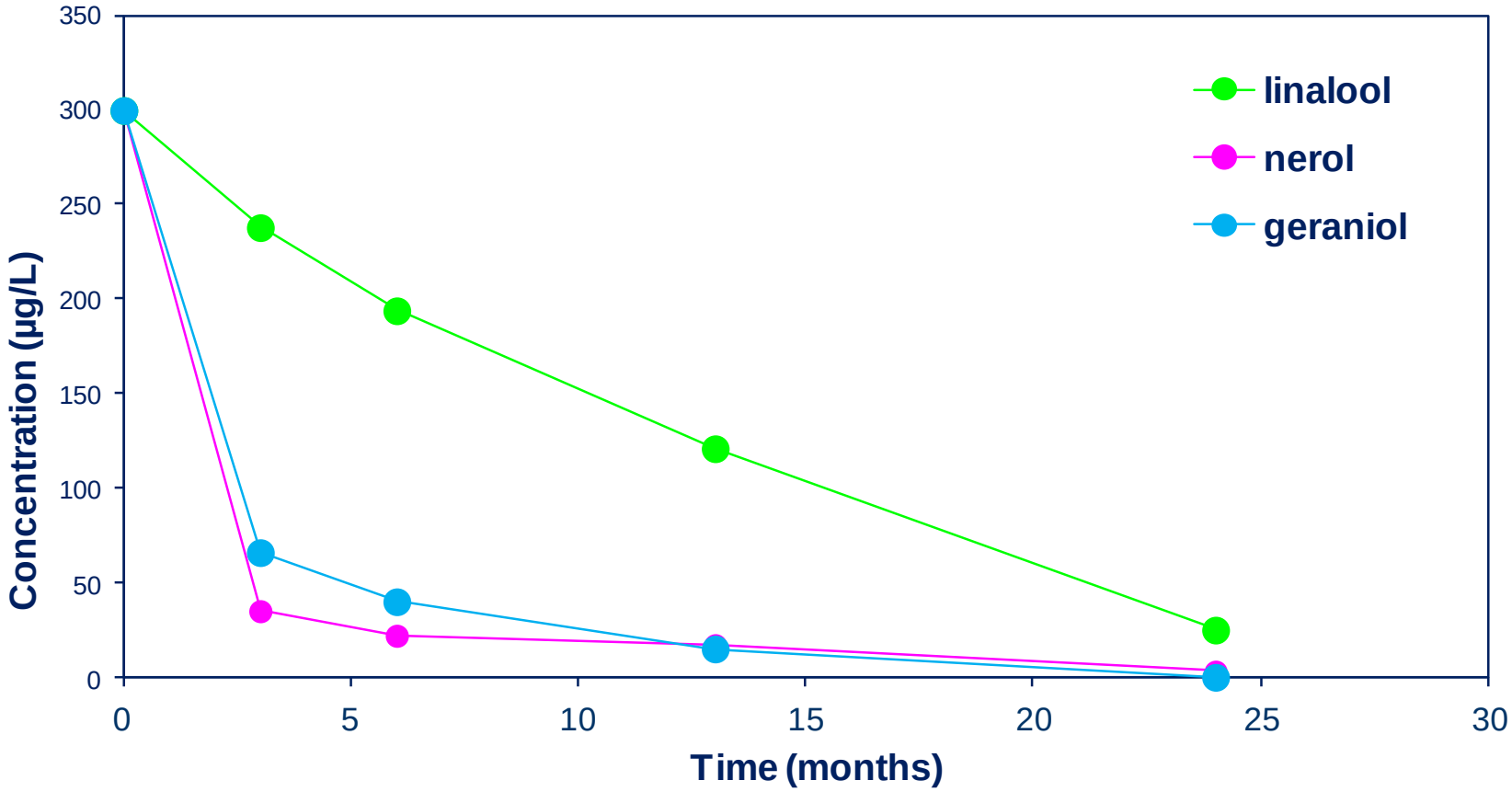

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