Effect of Olive Maturity at Harvest on Quality of Extra Virgin Olive Oil in New Zealand

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Te Kunenga ki Pūrehuroa

Presentation outline

- Background
  - NZ olive industry
- Objectives
- Pilot study methodology
- Results
  - Maturity indices
  - Composition
  - Sensory
- Conclusions to date
- Continuing research

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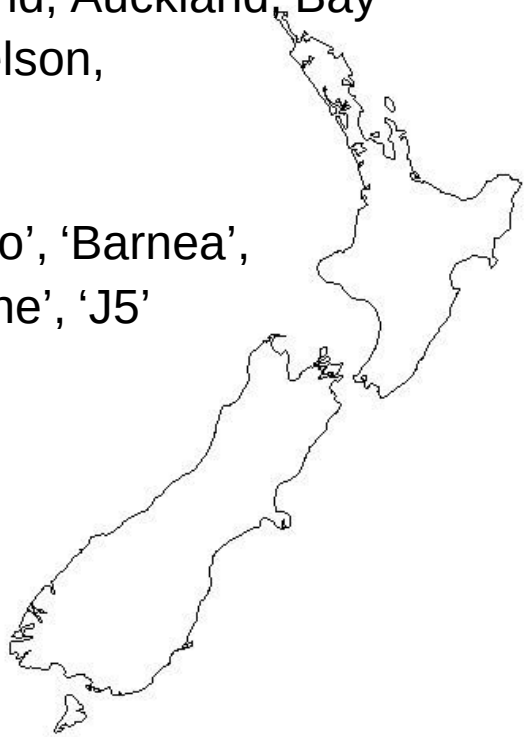
NZ olive and olive oil industry

- Area planted 2173 hectares
- 2010 estimated olive oil production - 350,000 L
- Growing regions – Northland, Waiheke Island, Auckland, Bay of Plenty/Waikato, Hawkes Bay, Wairarapa, Kapiti, Nelson, Marlbororough, North Canterbury, Central Otago.
- Main varieties grown – ‘Frantoio’, ‘Leccino’, ‘Barnea’, ‘Picual’, ‘Pendolino’, ‘Koroneiki’, ‘Manzanilla’, ‘Picholene’, ‘J5’



(Sources: Edwards, 2007; Plant & Food, 2008; ONZ 2009)

Background – when to harvest

- Harvest decision in the field up until now:
  - External colour
  - Squeezing an olive with fingers
  - Others are picking!
  - Send fruit for analysis → costly

- **No maturity index defined for NZ growing conditions**

→*Inconsistency in flavours, problems with balance and oil yields*

When is the best time to pick?

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Objectives

- To develop a maturity index for New Zealand, for harvesting olives for extra virgin olive oil.
- To determine the composition and sensory qualities of New Zealand extra virgin olive oil.

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Pilot study in Auckland Region

- > 8 – 10 years old
- ‘Frantoio’, ‘Leccino’, ‘Koroneiki’
- Early, mid and late harvest

Methodology – Year 1

- **Measures of maturity**
  - colour maturity index, dry matter, fruit weight, fruit colour, fruit firmness, oil content (solvent)
- **Cold pressed oil**
  - 10 kg batches
  - quality: % free fatty acids (FFA), Peroxide value (PV)
  - composition: phenolic content, fatty acids, sterols, tocopherols and pigments
- **Sensory analysis of cold pressed oil**

Harvesting

↓

Washing

↓

Grinding

↓

Malaxing

↓

Pressing

↓

Settling

↓

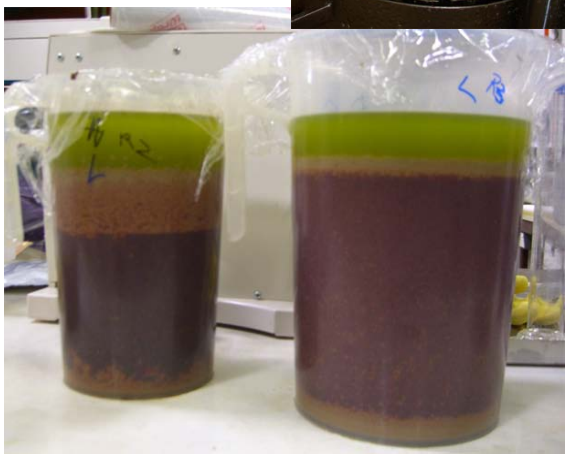
Centrifuging

↓

Bottling

↓

Re-bottling



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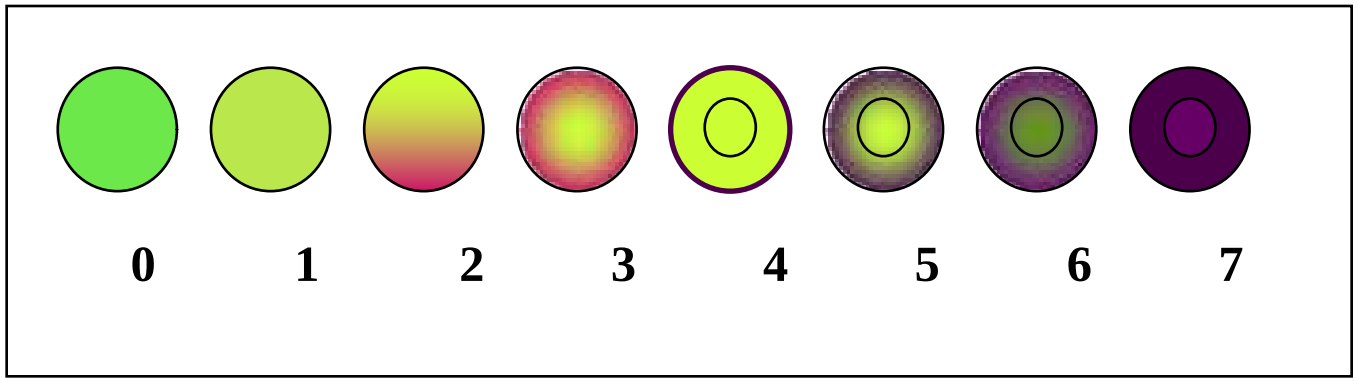
Colour Maturity Index



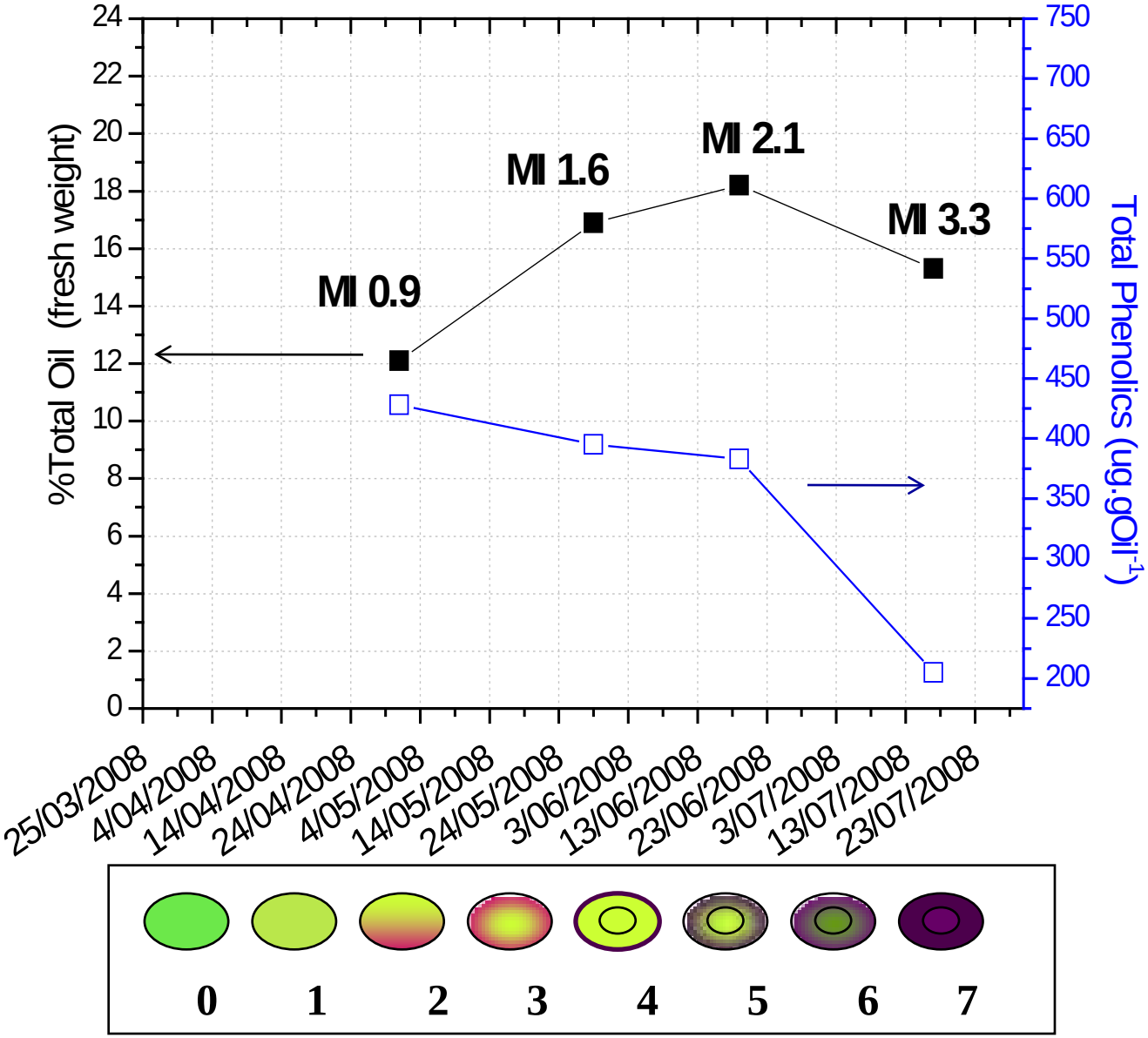
$$MI = \frac{Ax0 + Bx1 + Cx2 + Dx3 + Ex4 + Fx5 + Gx6 + Hx7}{100}$$

Traditionally recommended to harvest time at colour grade 4 to 5

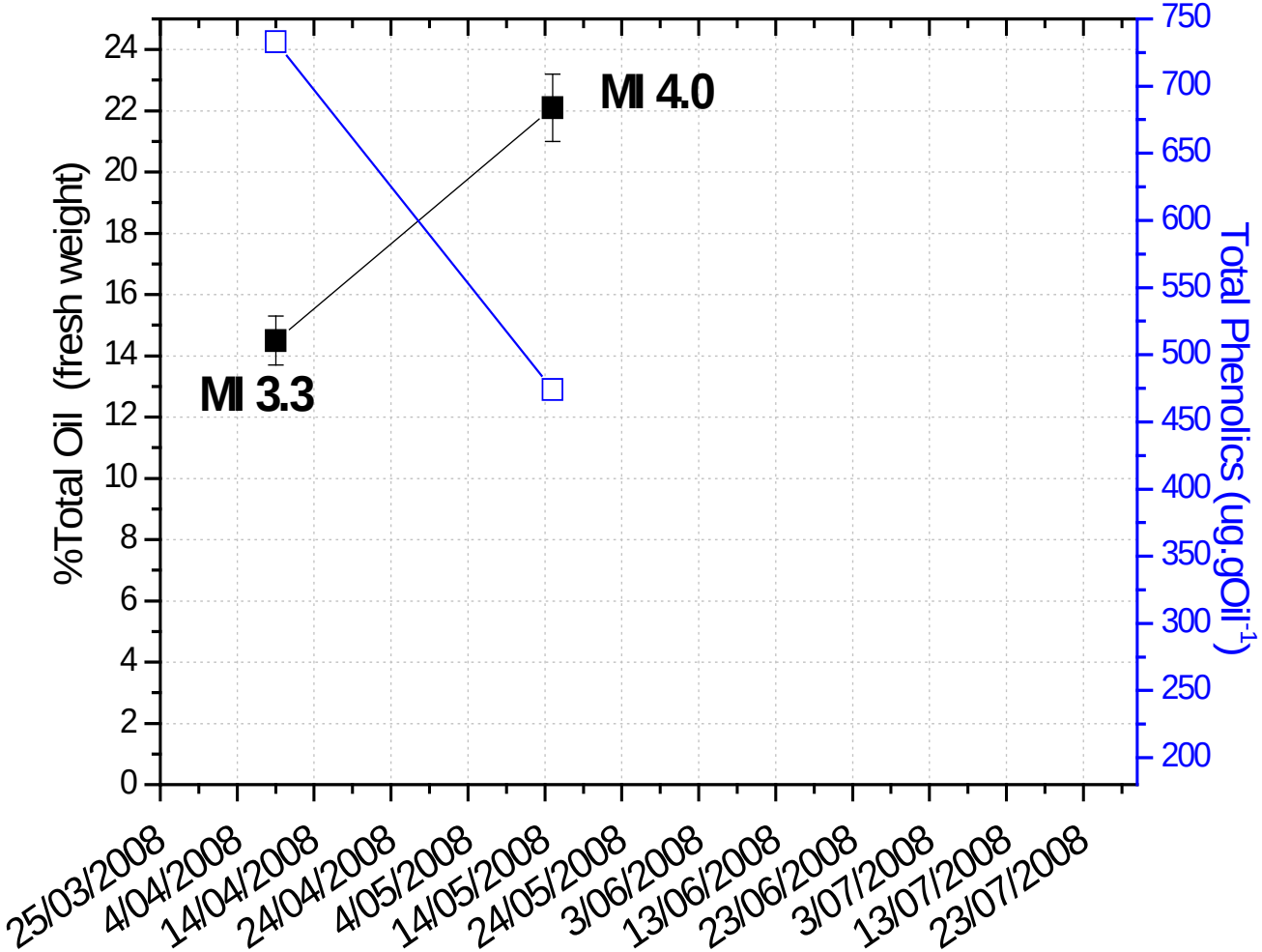
(Barranco et al., 2004)

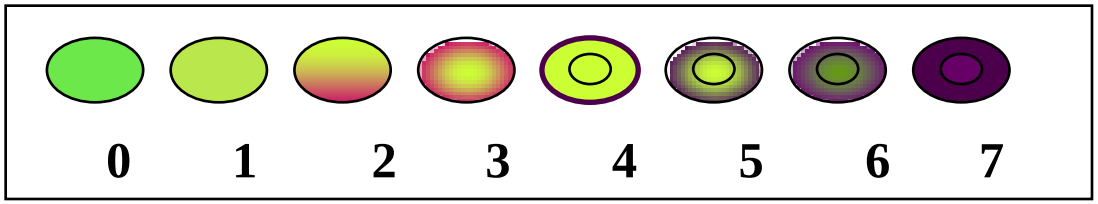
Is this the optimal maturity to harvest for New Zealand growing conditions?

Total oil and phenolic content related to harvest date – 'Frantoio' (Bombay)

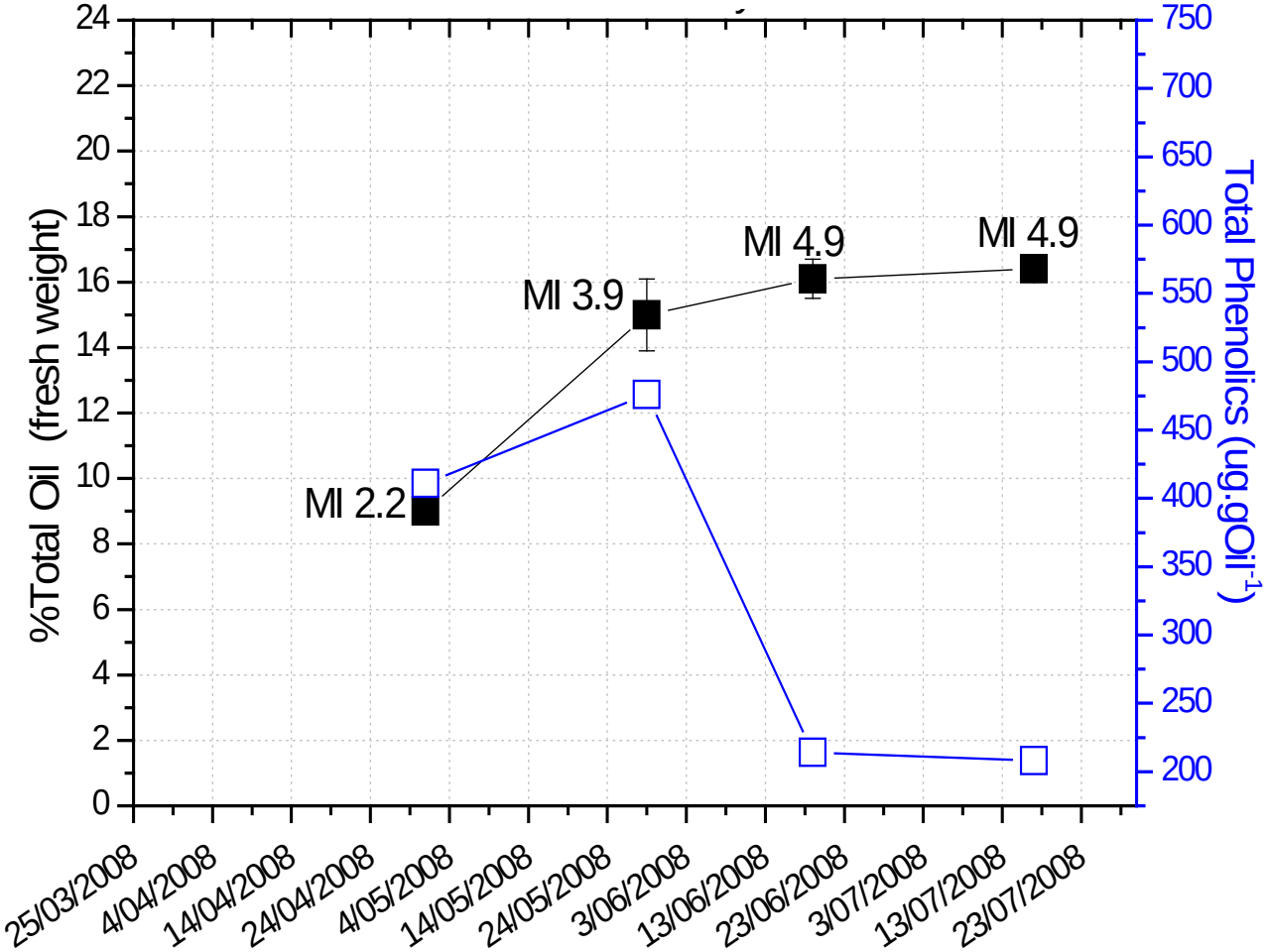


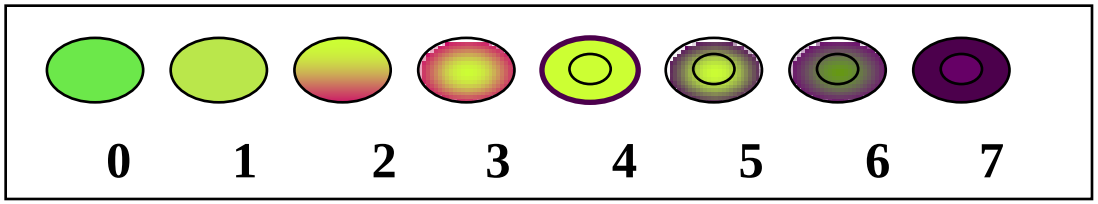
Total oil and phenolic content related to harvest date – 'Frantoio' (Waiheke)





Total oil and phenolic content related to harvest date – 'Leccino' (Bombay)

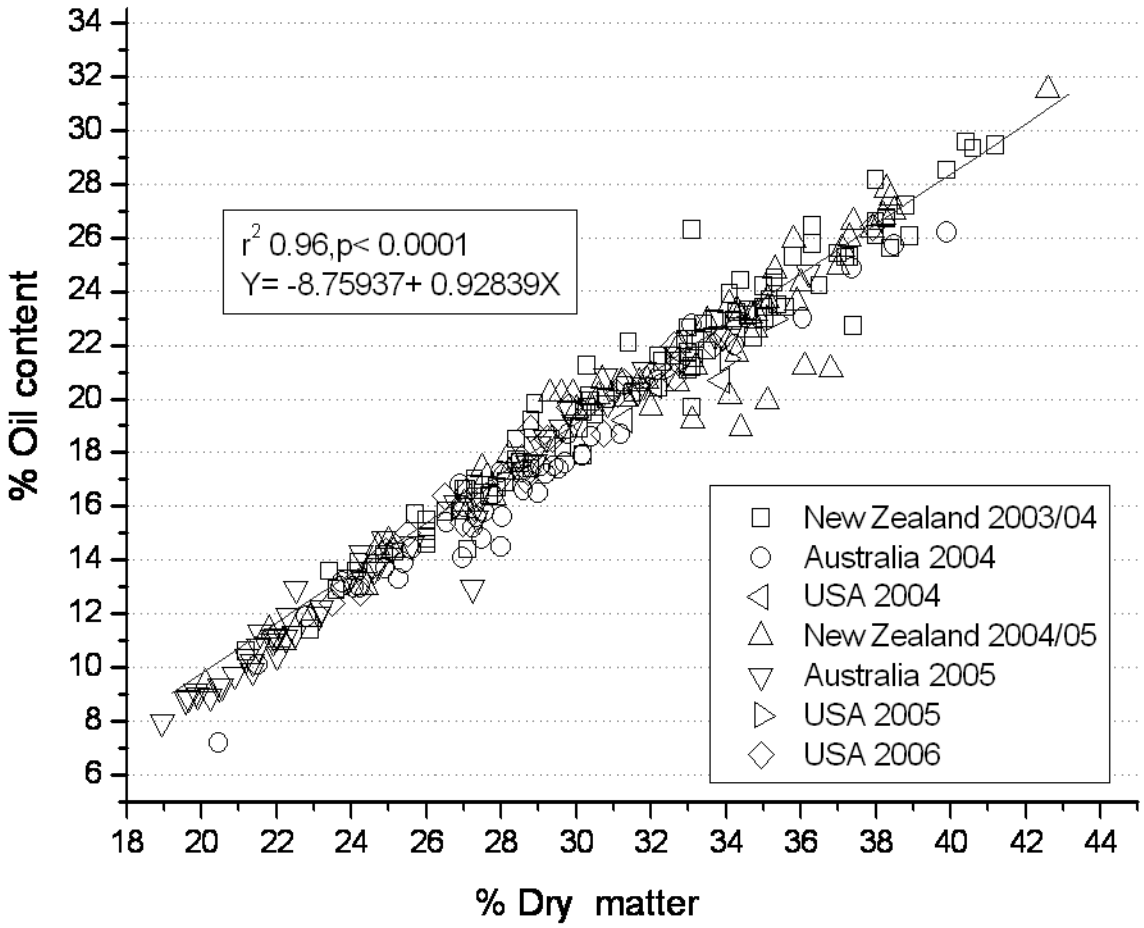




Colour maturity index - summary

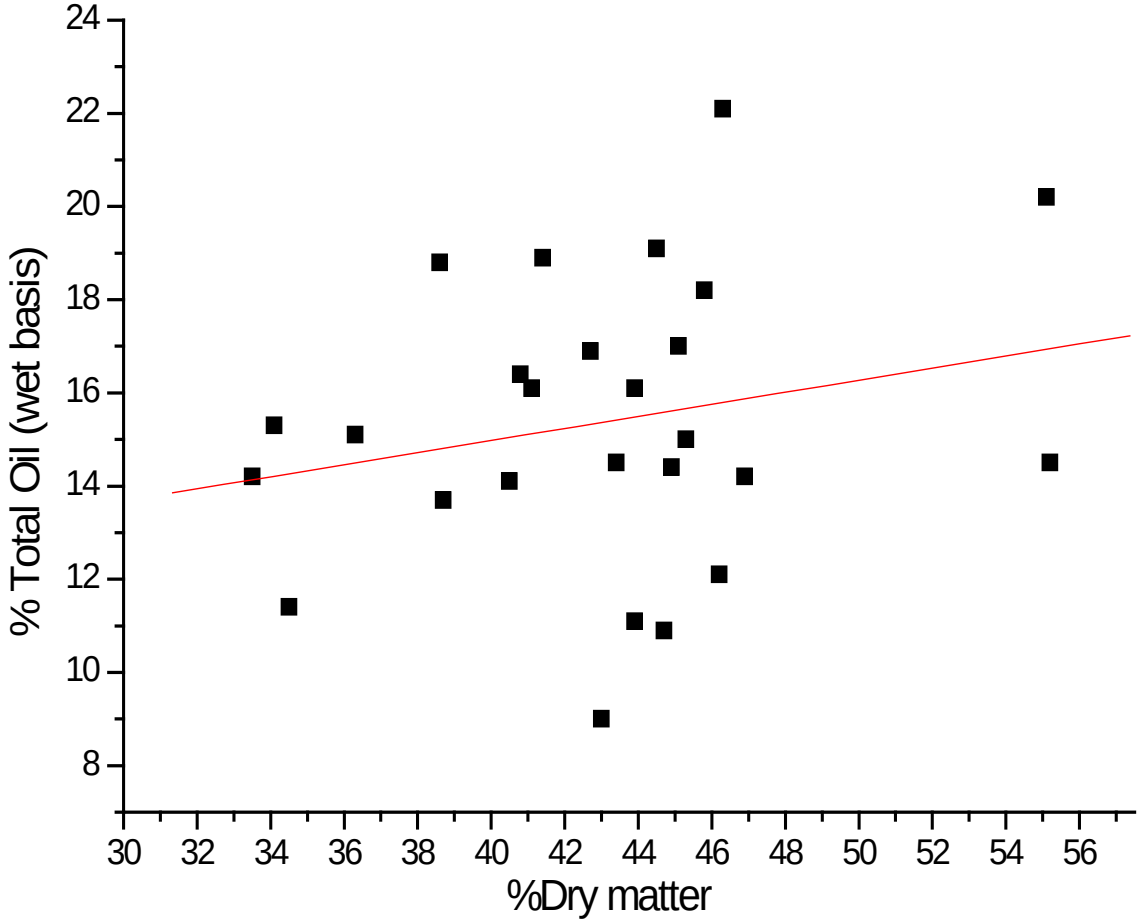
- Not a good predictor for total oil content or phenolic content
- Varied with cultivar and orchard location
- Using the colour maturity index may result in harvesting at the wrong time

Dry matter vs total oil content for Avocados



(Source: Woolf et al., 2009)

Dry matter vs total oil content for Olives, Year 1 data



Quality of cold pressed oils

	Pooled SE	'Frantoio'	'Koroneiki'	'Leccino'	Extra virgin limits (IOC)
PV (meq/kg oil)	± 0.02 (n = 89)	2.22 – 5.71	3.69 – 5.13	2.44 – 4.95	≤ 20
% FFA ($^{w}/_{w}$ as oleic acid)	± 0.01 (n = 66)	0.10 – 0.19	0.12 – 0.36	0.08 – 0.14	≤ 0.8
K_{232}	± 0.03 (n = 29)	1.54 – 2.04	1.49 – 1.56	1.40 – 1.98	≤ 2.5
K_{270}	± 0.01 (n = 29)	0.13 – 0.19	0.11 – 0.16	0.11 – 0.16	≤ 0.25

Fatty acid compositions

		% fatty acids (as methyl esters)			
		'Frantoio'	'Koroneiki'	'Leccino'	IOC limits
Palmitic acid	C16:0	8.19 – 12.00	8.34 – 9.07	9.50 – 12.37	7.5 – 20.0
Palmitoleic acid	C16:1	0.54 – 1.29	0.65 – 0.78	0.76 – 1.48	0.3 – 3.5
Heptadecanoic acid	C17:0	0.04 – 0.06	0.04 – 0.05	0.03 – 0.06	≤ 0.3
cis-10Heptadecenoic acid	C17:1	0.08 – 0.12	0.07 – 0.09	0.09 – 0.13	≤ 0.3
Stearic acid	C18:0	1.23 – 2.08	1.69 – 2.25	1.17 – 1.37	0.5 – 5.0
Oleic acid	C18:1	75.81 – 82.94	81.32 – 82.94	76.91 – 82.37	55.0 – 83.0
Linoleic acid	C18:2	4.35 – 7.94	4.28 – 4.98	4.44 – 6.53	3.5 – 21.0
α-Linolenic acid	C18:3	0.47 – 0.81	0.66 – 0.99	0.56 – 0.79	≤ 1.0
Arachidic acid	C20:0	0.29 – 0.43	0.40 – 0.46	0.23 – 0.31	≤ 0.6
Gadoleic acid	C20:1	0.23 – 0.41	0.28 – 0.37	0.27 – 0.33	≤ 0.4
Behenic acid	C22:0	0.07 – 0.13	0.11 – 0.15	0.04 – 0.08	≤ 0.2

Sterol compositions

	%w/w of total sterols			
	'Frantoio'	'Koroneiki'	'Leccino'	IOC limits
Cholesterol	ND	ND	ND	≤ 0.5
Brassicasterol	ND	ND	ND	≤ 0.1
Campesterol	2.1 – 3.3	3.3 – 5.0	2.5 – 3.9	≤ 4.0
Stigmasterol	0.2 – 1.0	0.2 – 1.4	1.1 – 2.1	≤ campesterol
Δ-7-Stigmastenol	0.0 – 0.6	0.0	0.0 – 0.2	≤ 0.5
Betasitosterol	76.7 – 82.6	73.3 – 85.2	72.3 – 79.1	
Apparent Betasitosterol[a]	95.7 – 97.6	93.8 – 96.5	95.0 – 96.1	≥93.0
Total sterols	60.32 – 102.68	45.65 – 67.29	61.57 – 101.83	

[a]Apparent Betasitosterol = Betasitosterol+Δ-5-avenasterol+Δ-5,23-stigmastadienol+clerosterol+sitostanol+Δ-5,24-stigmastadienol

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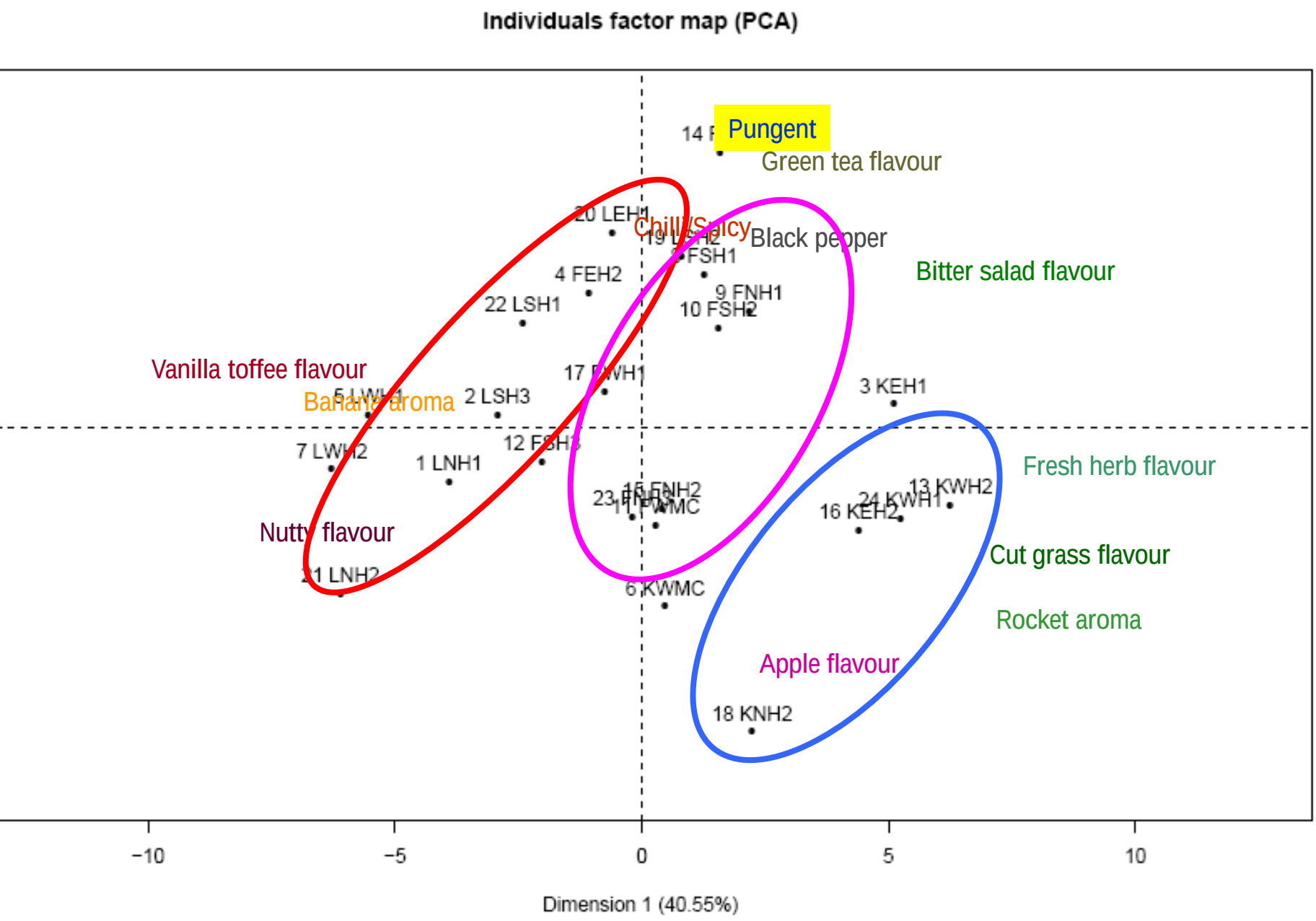
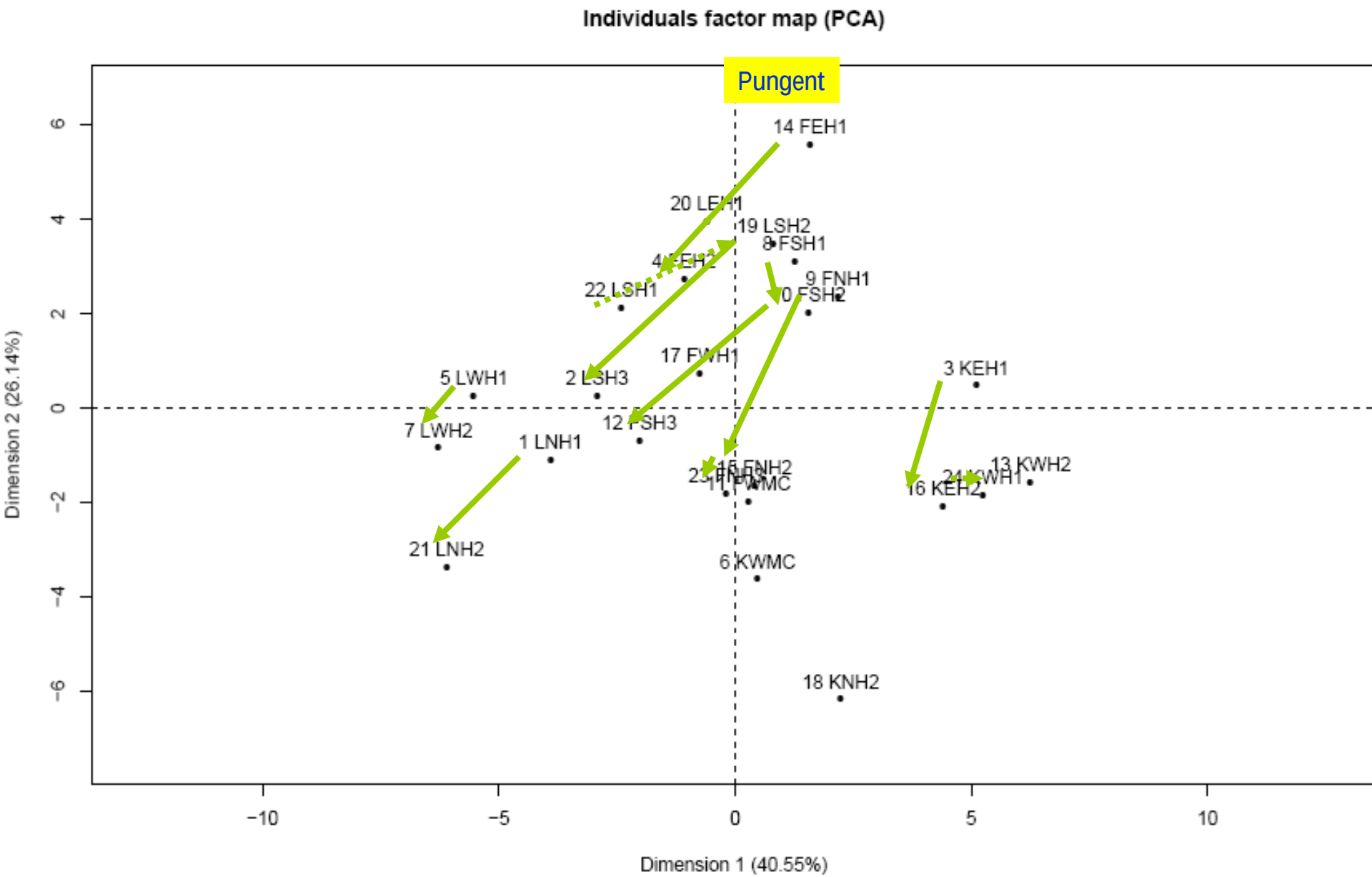
Tocopherol compositions

	mg/ 100g oil		
	‘Frantoio’	‘Koroneiki’	‘Leccino’
Alpha-tocopherol	11.6 – 19.1	18.6 – 44.7	23.4 – 33.7
Beta-tocopherol	0.0 – 0.4	0.2 – 1.0	0.1 – 0.6
Gamma-tocopherol	0.0 – 0.2	0.1 – 0.2	0.3 – 1.5
Delta-tocopherol	ND	ND	ND
Total tocopherols	11.8 – 19.3	19.4 – 45.1	23.8 – 34.8

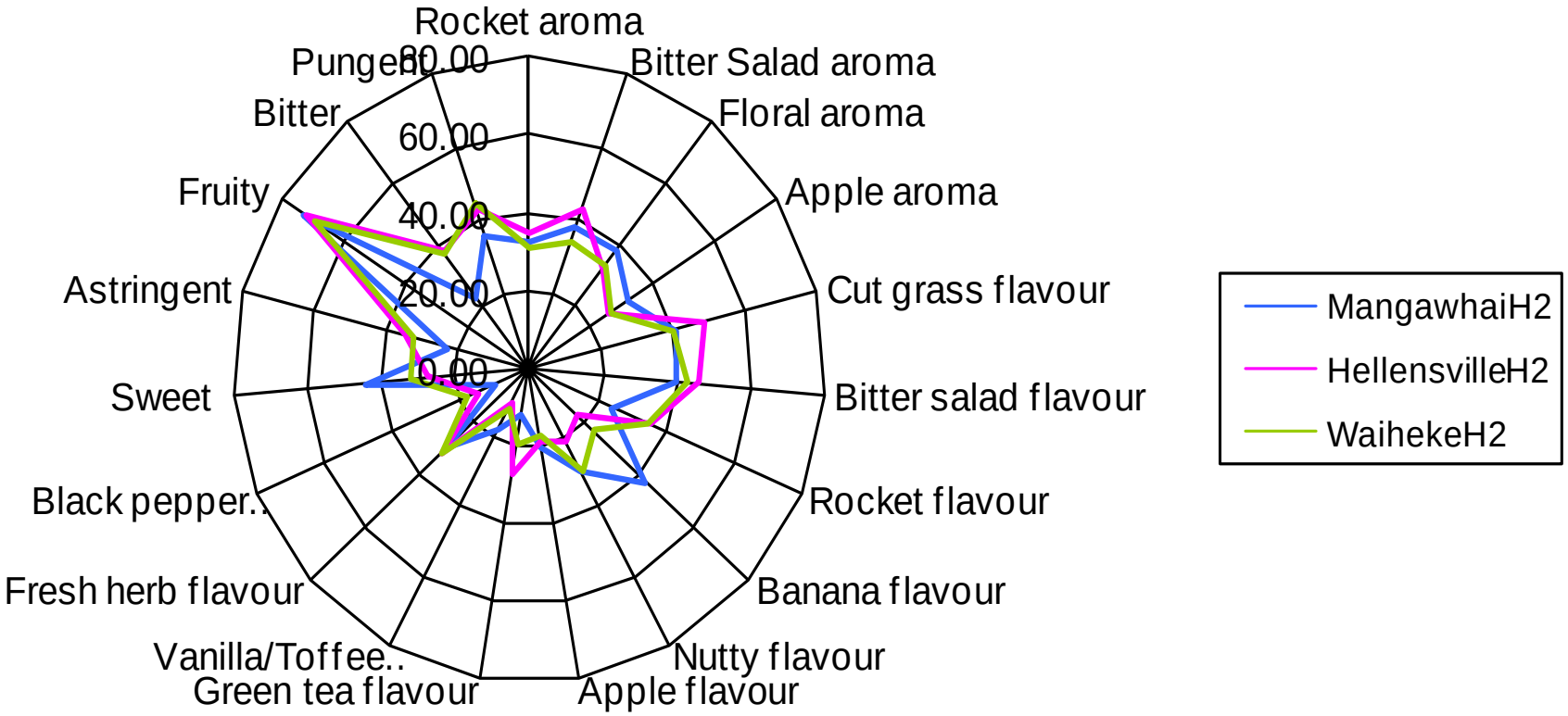
Sensory Analysis -Methodology

- Nine experienced panellists (36 to 53 years old)
- International Standard Descriptors (IOC)
- Screened a large range of flavours and aroma references
- Generated lexicon with 28 odour and flavour, and mouth feel attributes
- Assessed oils from 24 harvests in triplicate for their individual profiles


Individuals factor map (PCA)
Pungent
Green tea flavour
Chilli/Spicy
Black pepper
Bitter salad flavour
Vanilla toffee flavour
Banana aroma
Fresh herb flavour
Nutty flavour
Cut grass flavour
Rocket aroma
Apple flavour
20 LEH1
4 FEH2
22 LSH1
9 FNH1
10 FSH2
3 KEH1
2 LSH3
1 LNH1
13 KWH2
16 KEH2
6 KWMC
18 KNH2
−10
−5
0
5
10
Dimension 1 (40.55%)


Individuals factor map (PCA)
Pungent
14 FEH1
20 LEH1
19 LSH2
8 FSH1
4 KEH2
22 LSH1
9 FNH1
10 FSH2
17 FWH1
5 LWH1
2 LSH3
3 KEH1
7 LWH2
12 FSH3
1 LNH1
15 FNH2
23 FNH3
11 FWMC
13 KWH2
24 KWH1
16 KEH2
21 LNH2
6 KWMC
18 KNH2
Dimension 2 (26.14%)
Dimension 1 (40.55%)
6
4
2
0
−2
−4
−6
−10
−5
0
5
10

‘Koroneiki’ mid harvest



Summary of Sensory Results

- ‘Frantoio’, ‘Leccino’ and ‘Koroneiki’ olive oils have distinct sensory profiles
  - ‘Frantoio’ – ‘green tea’ and ‘black pepper’ moving to ‘nutty’
  - ‘Leccino’ – ‘pungent’ moving to ‘vanilla’ and ‘toffee’
  - ‘Koroneiki’ – ‘fresh herb’ and ‘rocket’ moving to ‘apple’ and ‘banana’

- Time of harvest and orchard location influences the sensory properties of the oils

Conclusions

- Colour maturity index not ideal for NZ growing conditions
- As oil content increases, phenolics decrease - as expected; varies with cultivar
- An alternative maturity index is needed
- Time of olive harvest important - influences oil yield, sensory qualities and stability.

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Continuing Research

Year 2

- More harvests
- Other regions in New Zealand
- One cultivar – ‘Frantoio’

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Acknowledgements

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Olives New Zealand

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