Evaluation of proposed CODEX purity standards for avocado oil

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Outline

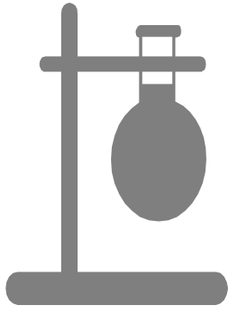
- Evaluations of quality and purity of avocado oil sold in the US market
- Standards are needed – CODEX? NOM?
- Natural variables influences fatty acids, sterols and tocopherols
- Take home messages

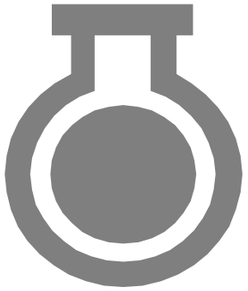
Sample information

- 22 samples, representative of avocado oils available in the US, were collected from in stores (14) and online (8)

- Samples were grouped according to their label: Extra virgin (EV), refined (R), and unspecified (U)

- Price varied from US $8.45-79.4/Liter





Quality

- Free fatty acidity
- Peroxide value
- UV absorbance

Purity

- Fatty acids
- Sterols
- Triacylglycerols

Minor Components

- Tocopherols
- Chlorophylls

ELSEVIER

Food Control

Volume 116, October 2020, 107328

First report on quality and purity evaluations of avocado oil sold in the US

Hilary S. Green [a], Selina C. Wang [a, b]

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Highlights

- Avocado oils on the market labeled extra virgin and refined are of poor quality.
- Adulteration of avocado oils on the market was confirmed.
- There is an urgent need to develop standards for avocado oil to protect consumers.
- Standard are also needed to protect genuine producers and the industry as a whole.

Key Findings

- 82% of the samples were of poor quality or adulterated.
- Adulteration with 100% soybean oil was confirmed in three samples (two labelled as EV).

Recommendations

- Standards are urgently needed.
- More research is needed to understand how chemical compositions change with climate, region.

Green, H. S.; Wang, S. C. *Food Control*, **2020,** *116*, 107328: "First report on quality and purity evaluations of avocado oil sold in the US"

Codex Alimentarius

- Central part of the Joint FAO/WHO Food Standards Program, established in 1963 to *protect consumer health and promote fair practices in food trade*.

- At CCFO26(2019), the Committee agreed to establish an EWG, chaired by Mexico and co-chaired by the United States, to review all available data on avocado oil and prepare a report for CCFO27(2021).

- At CCFO27(2021), the Committee agreed to re-establish an EWG, chaired by Mexico and co-chaired by the United States, to consider the values/texts and comments submitted, and to prepare a report for consideration at the next session and to continue progress on the avocado oil standard.

Some revisions and proposals from 2021

- Revise the Product Definition to *"avocado oil may be derived from either the mesocarp of avocado fruit (Persea americana) or obtained by processing the whole avocado fruit"* and ~~*"Extra virgin and Virgin oils are derived using the mesocarp only."*~~
  - The United States, Kenya, Egypt, Burundi, Uganda, Tanzania, Colombia, Jordan, and Saudi Arabia supported this definition. Chile expressed a reservation.
- Express fatty acid composition values to one decimal place and propose changes for some fatty acids and sterols.
  - Revise the value for C18:1 from 42.0 – 70.0 to 42.0 – **75.0**, as proposed by New Zealand and supported by the United States, Colombia and Peru.
  - Revise the delta-7-avenasterol range from ND – 1.0 to ND – **1.5** as proposed by Canada and agreed upon by CCFO. Mexico objected to this value and proposed that if the delta-7-avenasterol limit were set at 1.5, the delta-7-stigmastenol limit should also be set to 1.5. CCFO did not accept this.
- Place tocopherols and tocotrienols proposed at CCFO26 (2019) for further consideration.
  - Proposed by United States and supported by Canada.
  - No values for these parameters were proposed by the EWG.

Standards need to accommodate natural variables while also minimizing the likelihood of economically motivated adulteration.

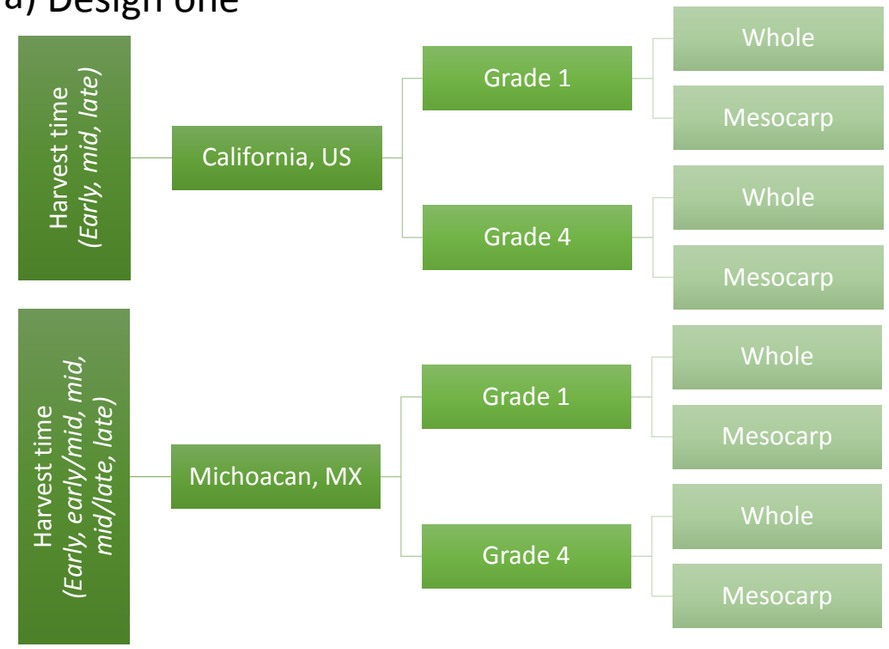
Variables included:

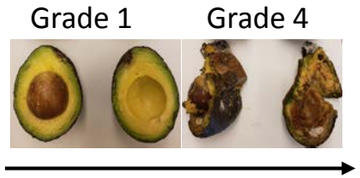
- Region
- Harvest time
- Cultivar
- Grade of fruit
- Using whole fruit oil vs. only mesocarp

Chemical parameters:

- Fatty acids
- Sterols
- Tocopherols

a) Design one

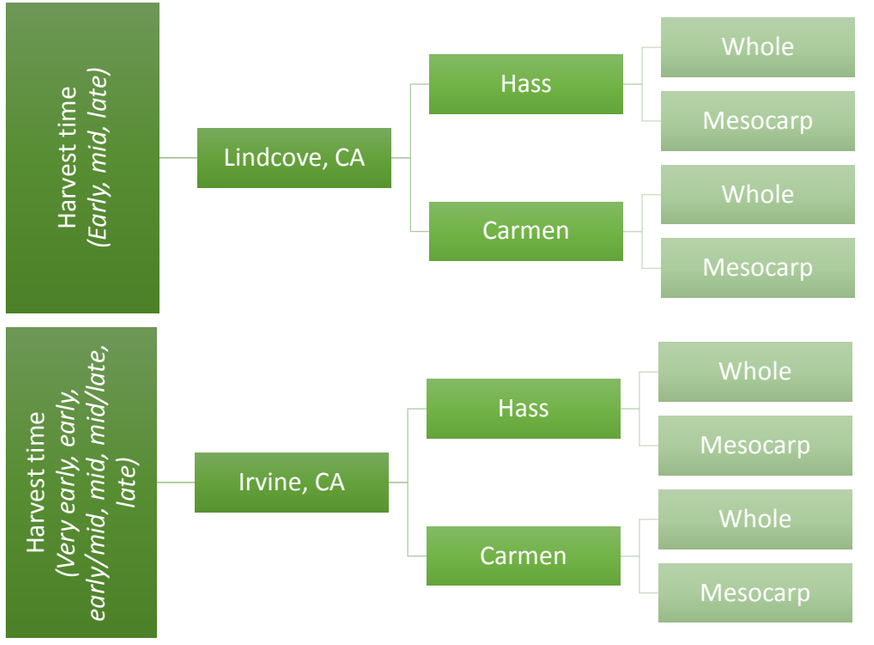




Lab-scale oil mill

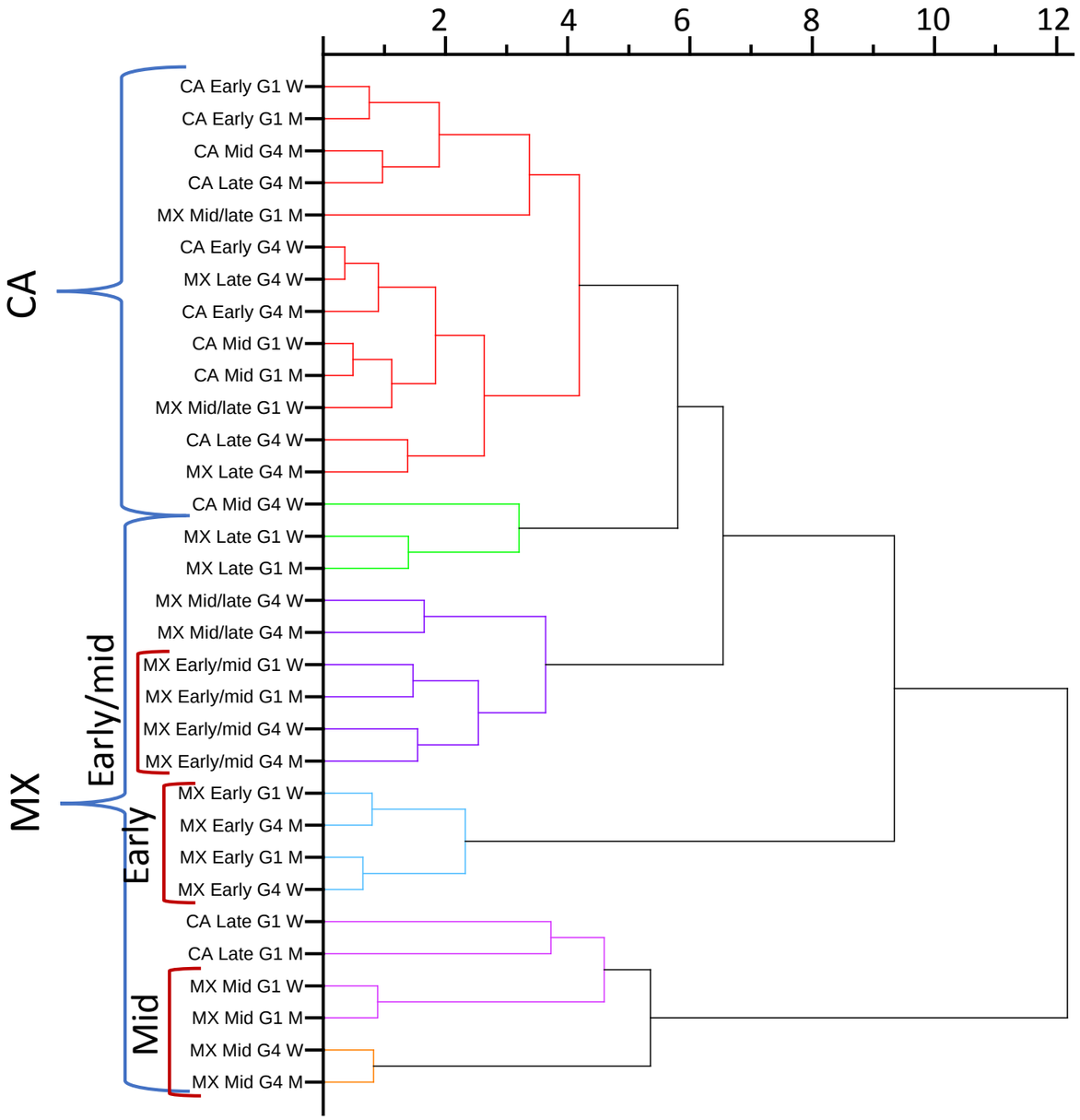
Purity analysis and comparison to standards

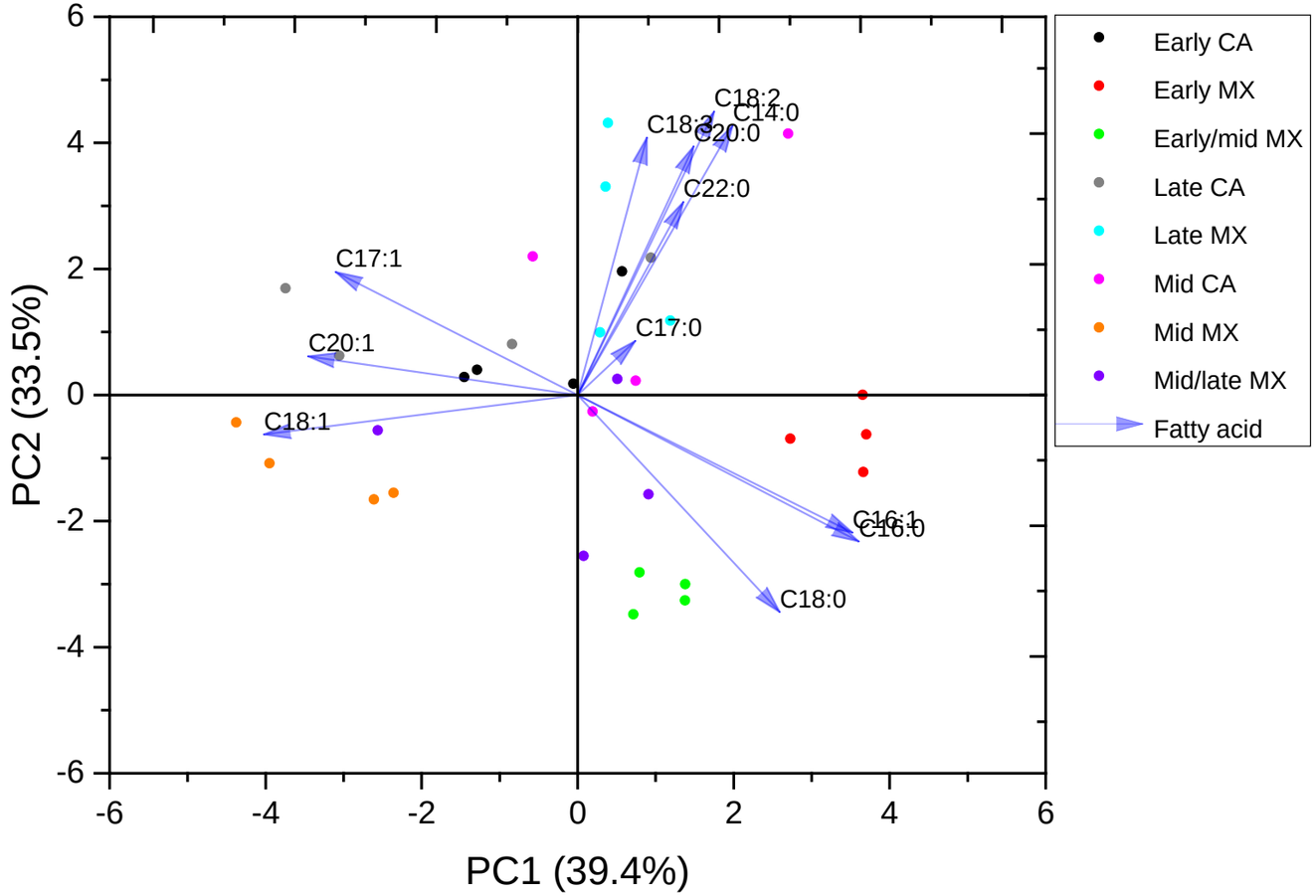
b) Design two



Solvent extraction

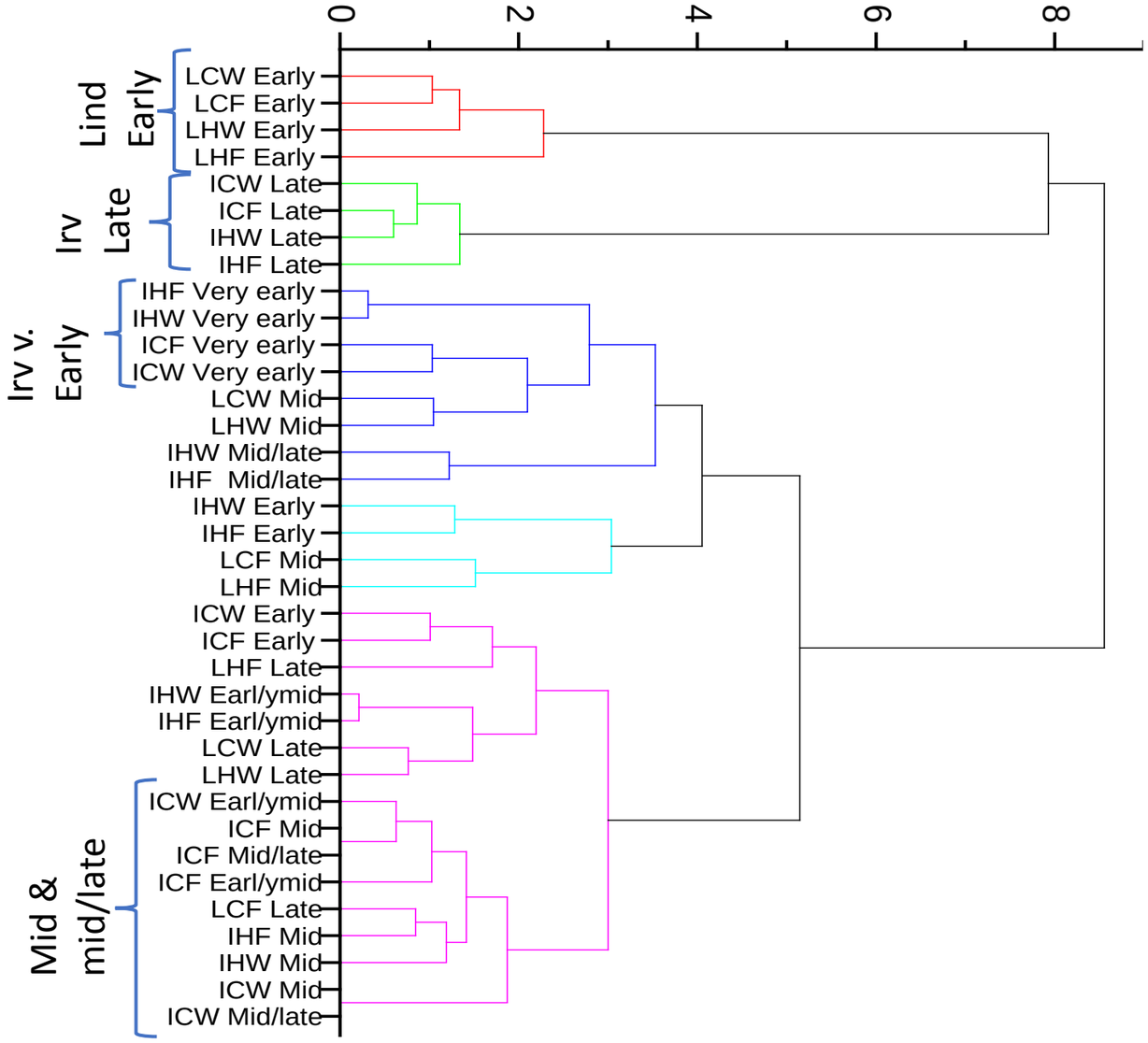
Hierarchal cluster analysis of fatty acids: Design one

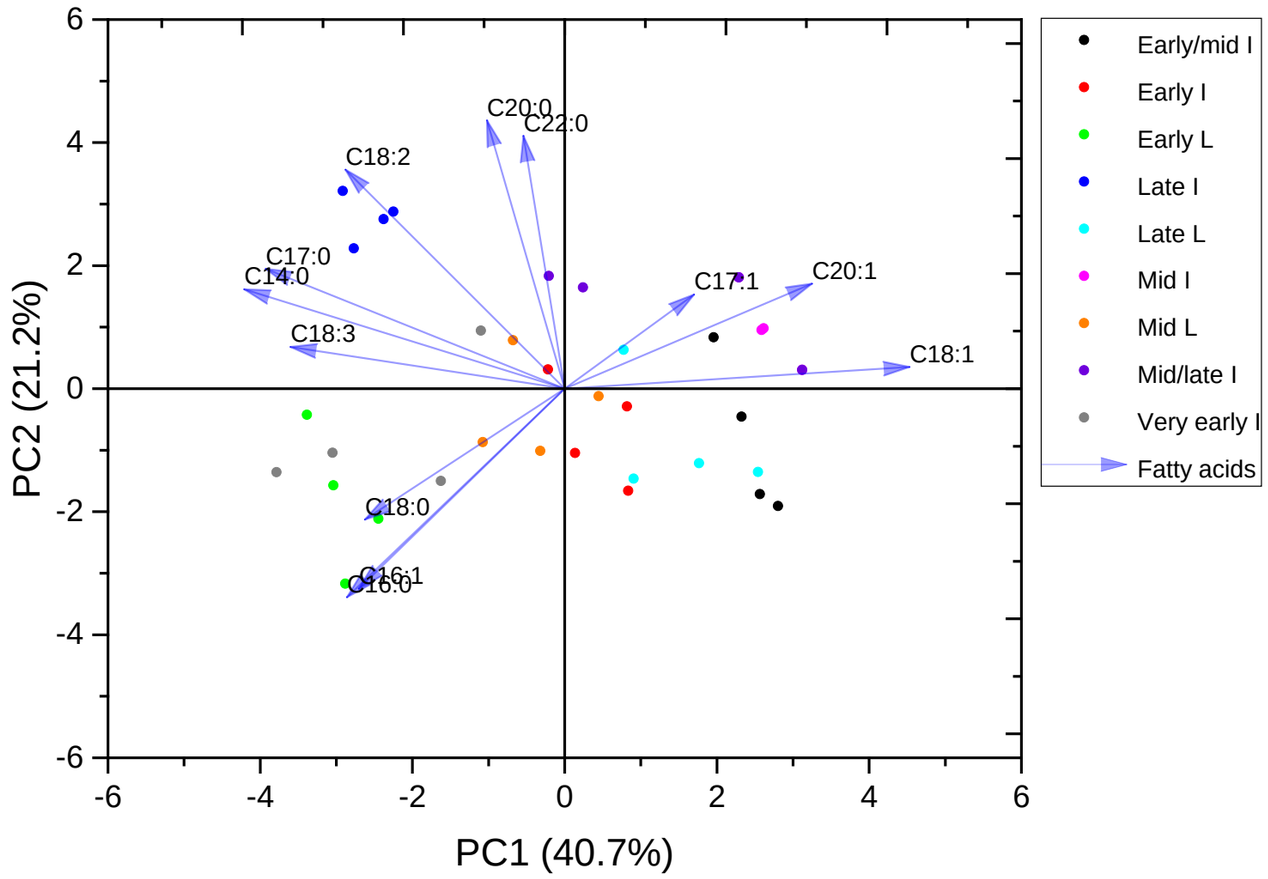




Green, H.G. and Wang, S.C. (2022). Evaluation of proposed CODEX purity standards for avocado oil. Food Control 143 (2023) 109277.

Hierarchal cluster analysis of fatty acids: Design two





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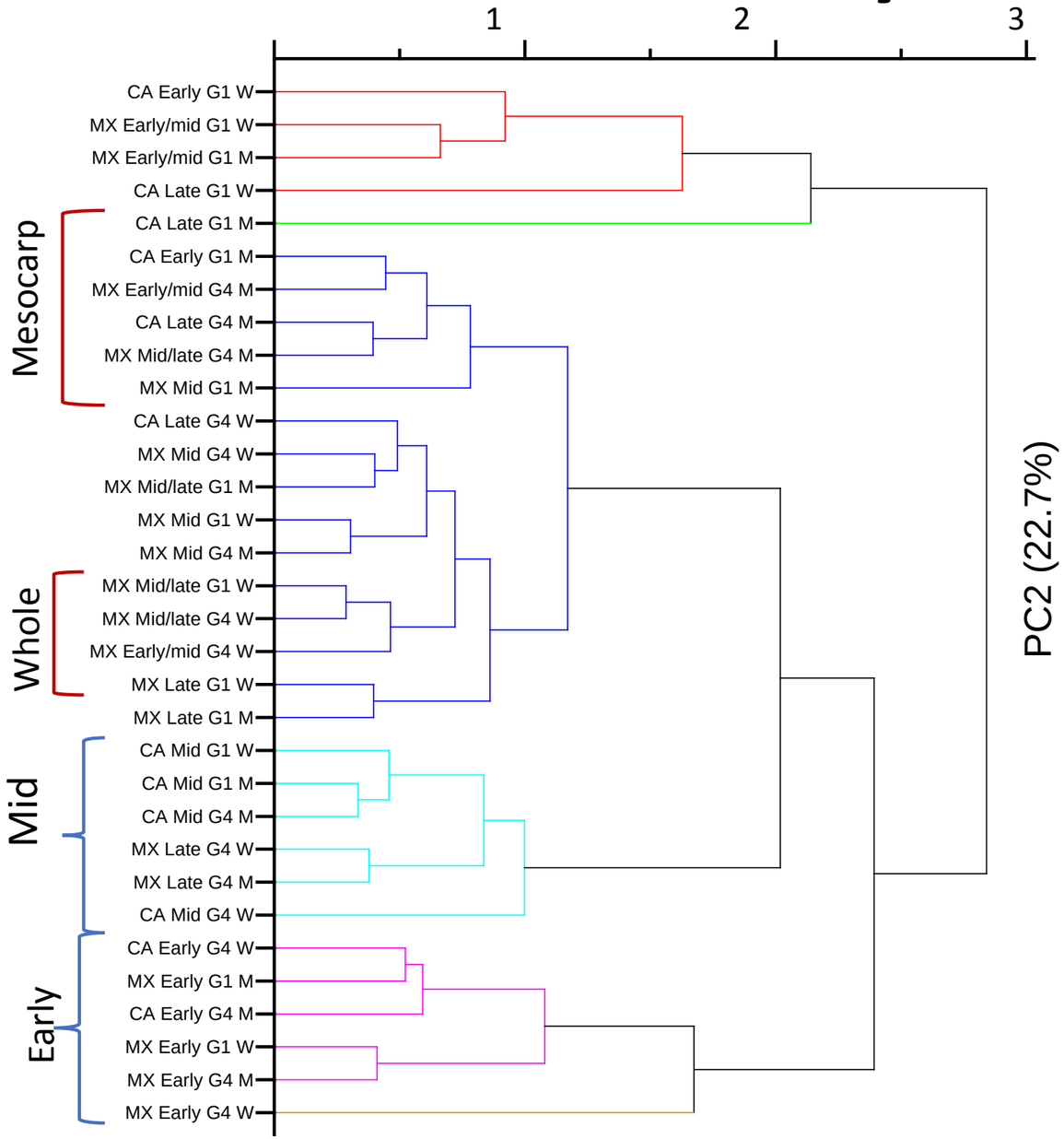
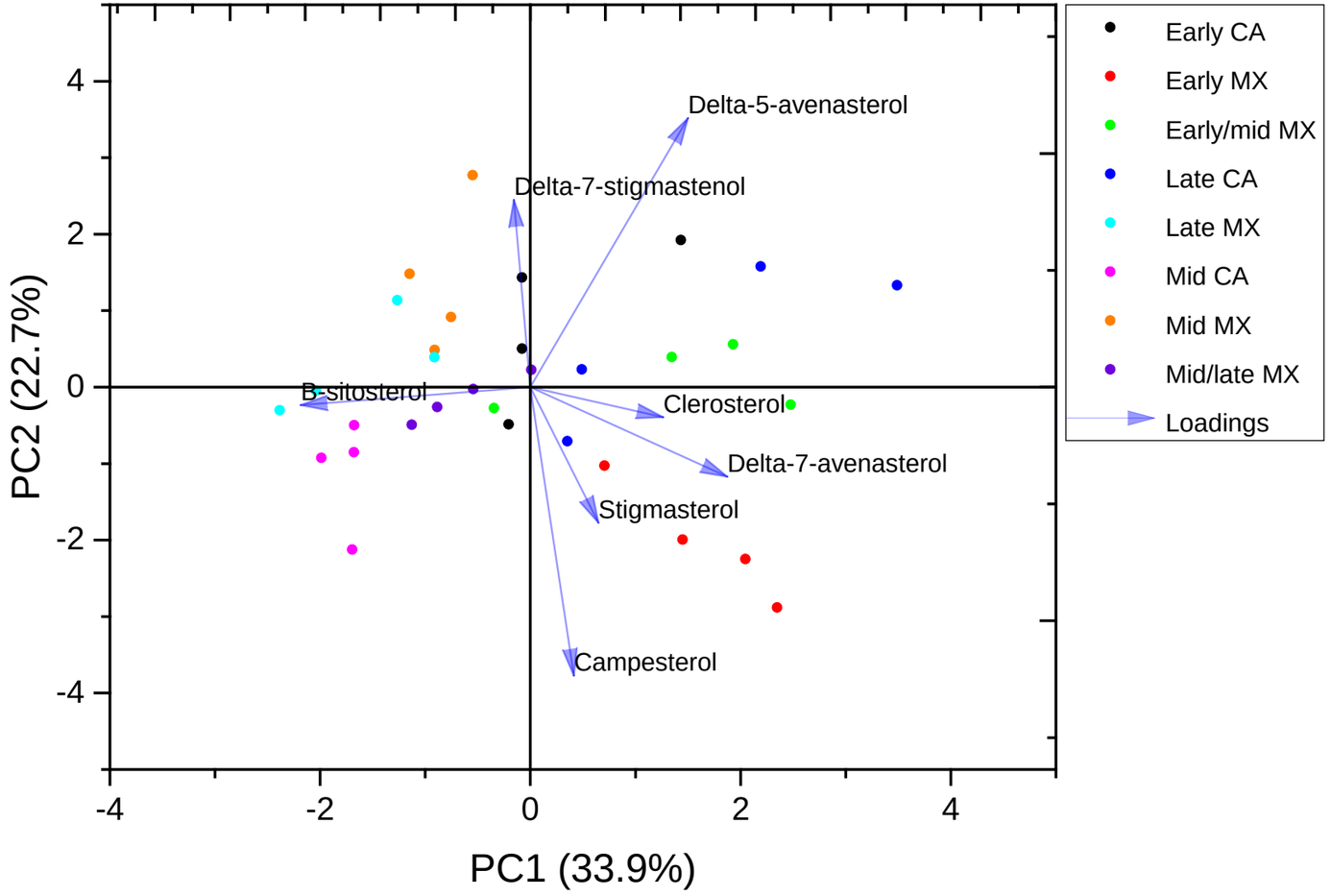
Hierarchal cluster analysis of sterols: Design one





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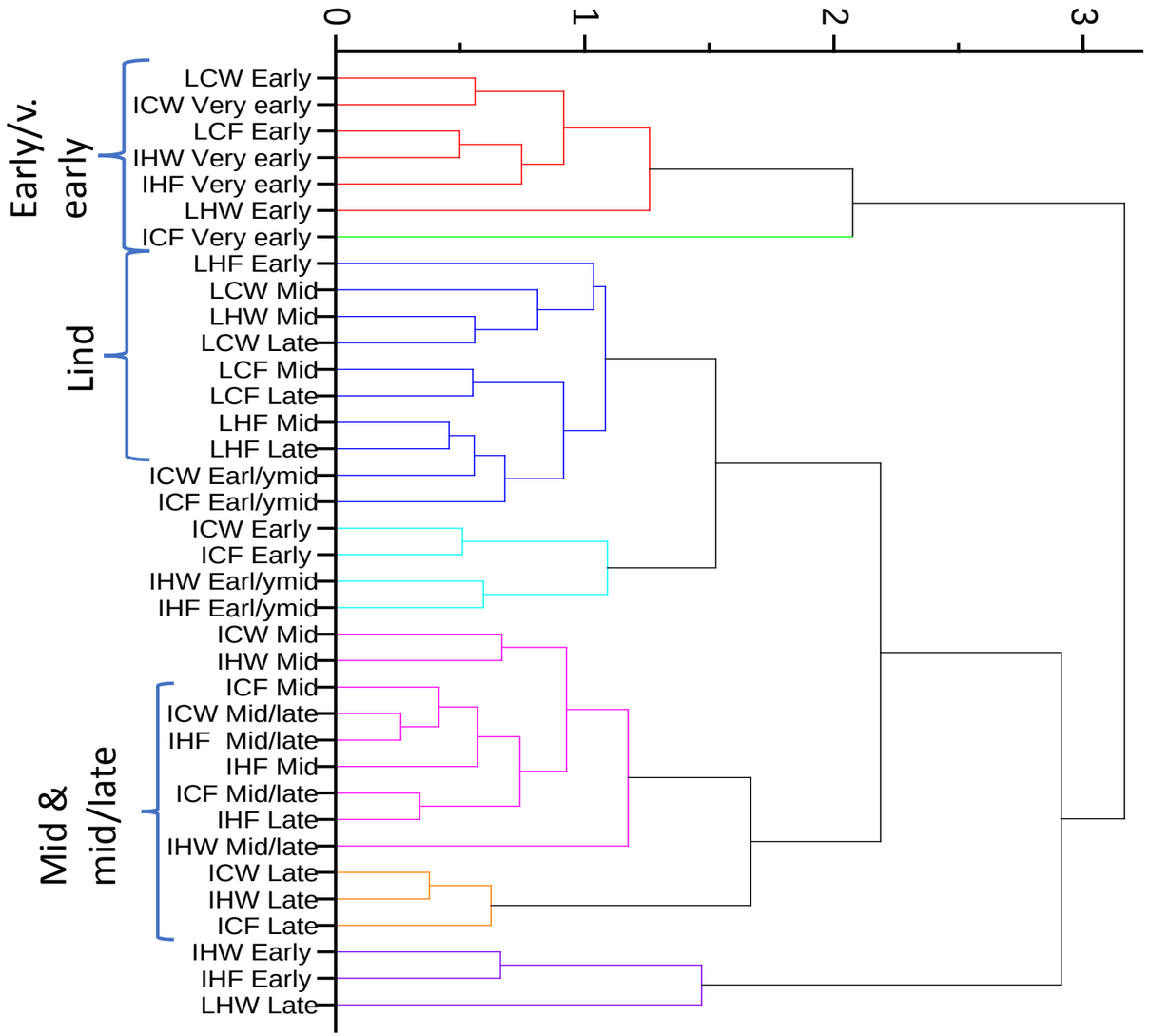
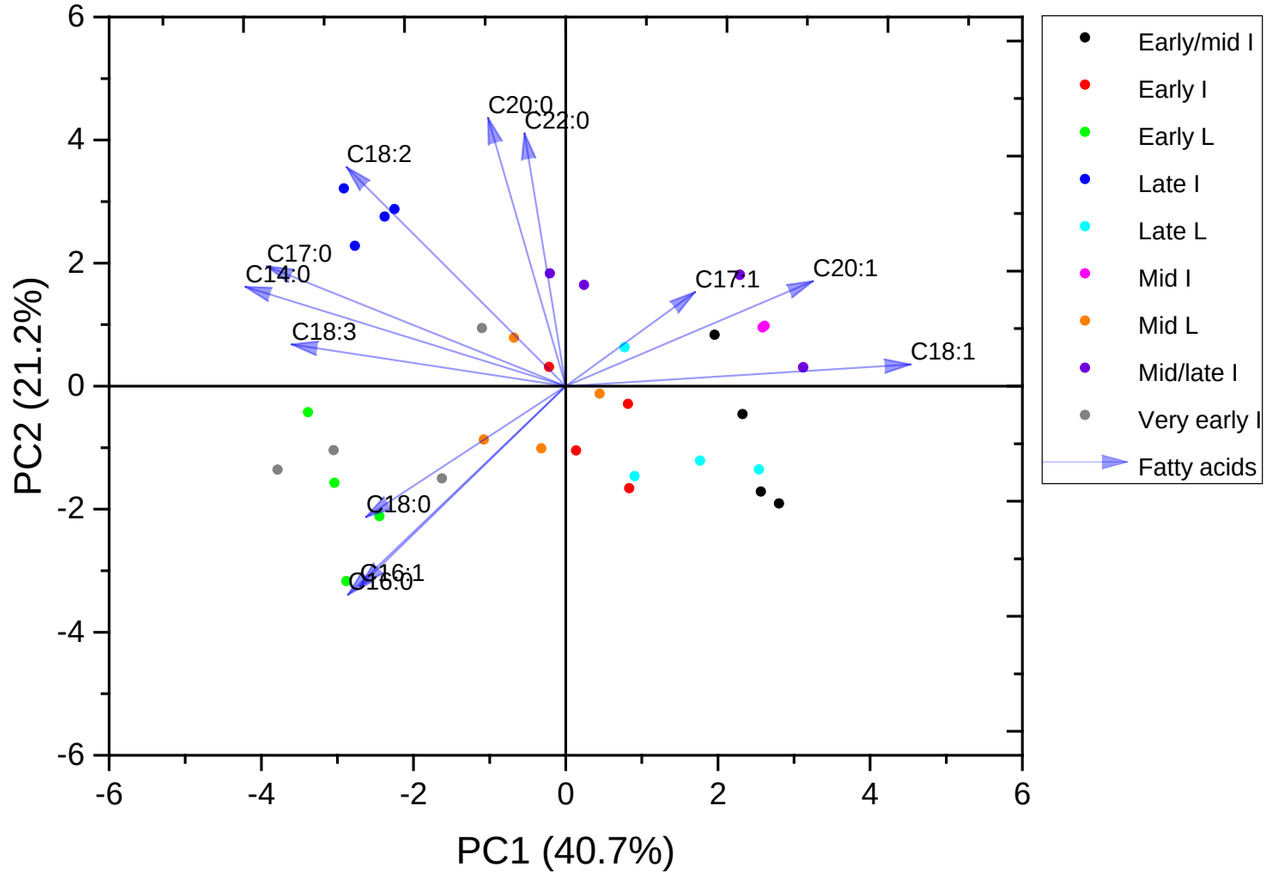




Green, H.G. and Wang, S.C. (2022). Evaluation of proposed CODEX purity standards for avocado oil. Food Control 143 (2023) 109277.

Comparison to current FAP proposed standards

Fatty Acid	Range in samples (%)	Proposed CODEX Standards (%)	Number of samples that do not pass proposed standards (%)
C14:0	0.03-0.11	ND-0.3	0
C16:0	9.90-23.19	11.0-26.0	1.5
C16:1	3.32-10.03	4.0-17.1	2.9
C17:0	ND-0.09	ND-0.3	0
C17:1	0.08-0.11	ND-0.1	5.9
C18:0	0.29-0.68	0.1-1.3	0
C18:1	49.74-71.41	42.0-**75.0**	0
C18:2	9.25-22.46	7.8-19.0	5.9
C18:3	0.94-1.53	0.5-2.1	0
C20:0	0.08-0.17	ND-0.7	0
C20:1	0.17-0.23	ND-0.3	0
C22:0	ND-0.08	ND-0.5	0
C24:0	ND	ND-0.2	0

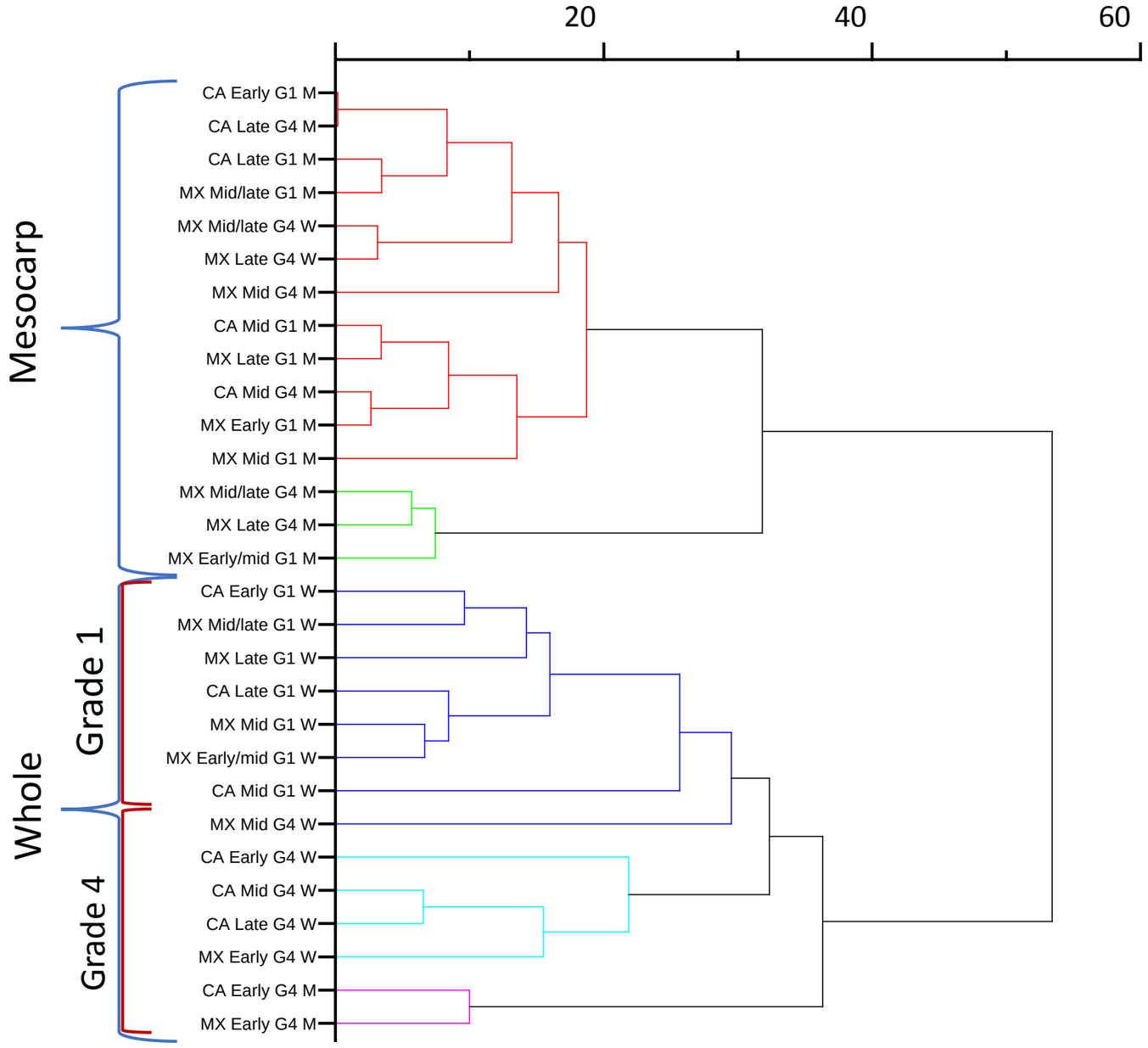
Green, H. S.; Wang, S. C. Food Control **2023**, *143*, 109277 "Evaluation of proposed CODEX purity standards for avocado oil"

Comparison to current sterols proposed standards

Sterol	Range in samples (%)	Proposed CODEX standards (%)	Number of samples that do not pass proposed standards (%)
Cholesterol	ND	ND-0.5	0
Brassicasterol	ND	ND-0.5	0
Campesterol	4.85-9.75	4.0-8.3	11.8
Stigmasterol	ND-1.36	0.3-2.0	33.8
Clerosterol	1.47-3.49	[0.6] [1.0]-2.0	39.7
Beta-sitosterol	81.71-85.87	[71.0] [79.0]-93.4	0
Delta-5-avenasterol	3.80-8.45	2.0-8.0	4.4
Delta-7-stigmastenol	ND-0.09	ND-[1.0] [3.5]	0
Delta-7-avenasterol	ND-0.27	ND-**1.5**	0

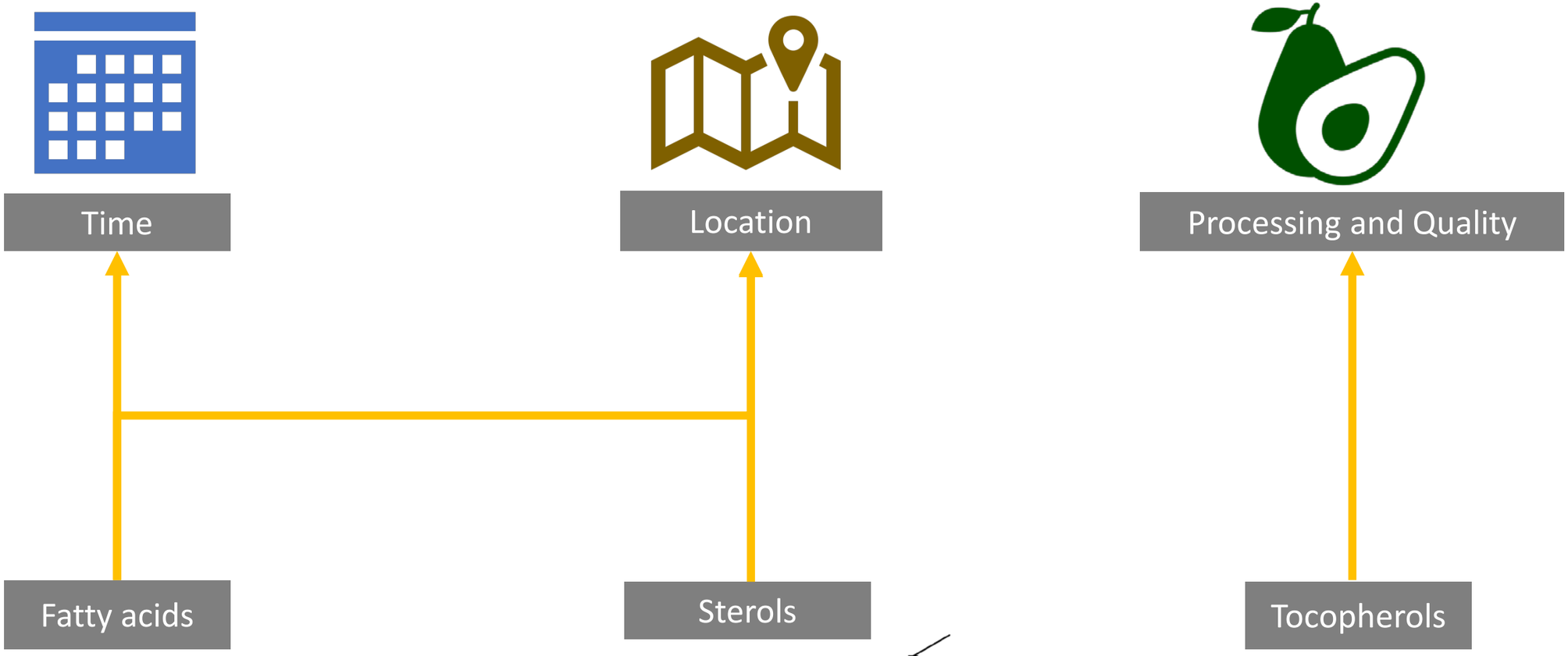
Green, H. S.; Wang, S. C. Food Control **2023**, *143*, 109277 "Evaluation of proposed CODEX purity standards for avocado oil"

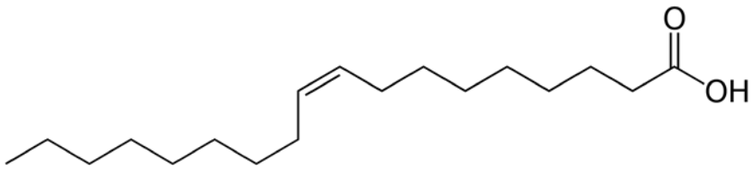
Hierarchal cluster analysis of tocopherols

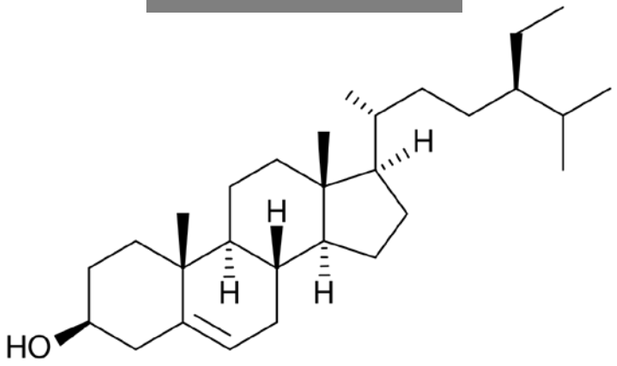


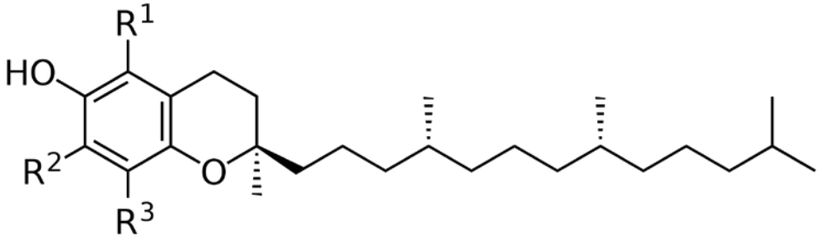
- Clustering driven by whole/mesocarp
- Within the whole cluster there is further separation between fruit grade
- Suggests this could be a way to differentiate whole fruit oils from mesocarp oils
- Due to differences based on fruit quality this may not be the best purity parameter

Summary of variables and primary influencers



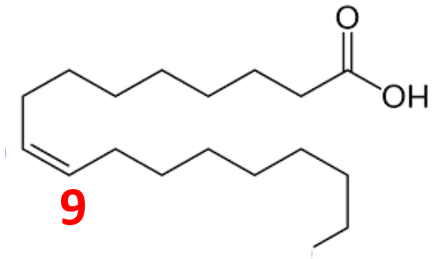






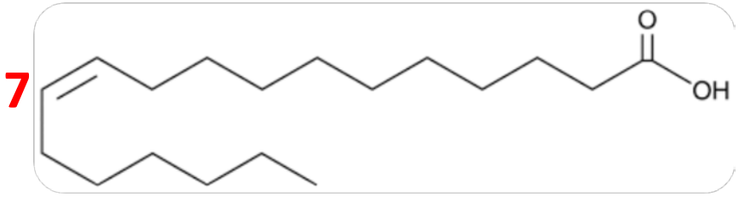
Cis-vaccenic acid in avocado oil vs seed oils

- Previous studies showed seed oils are difficult to detect



18:1 n-9 (cis-oleic)

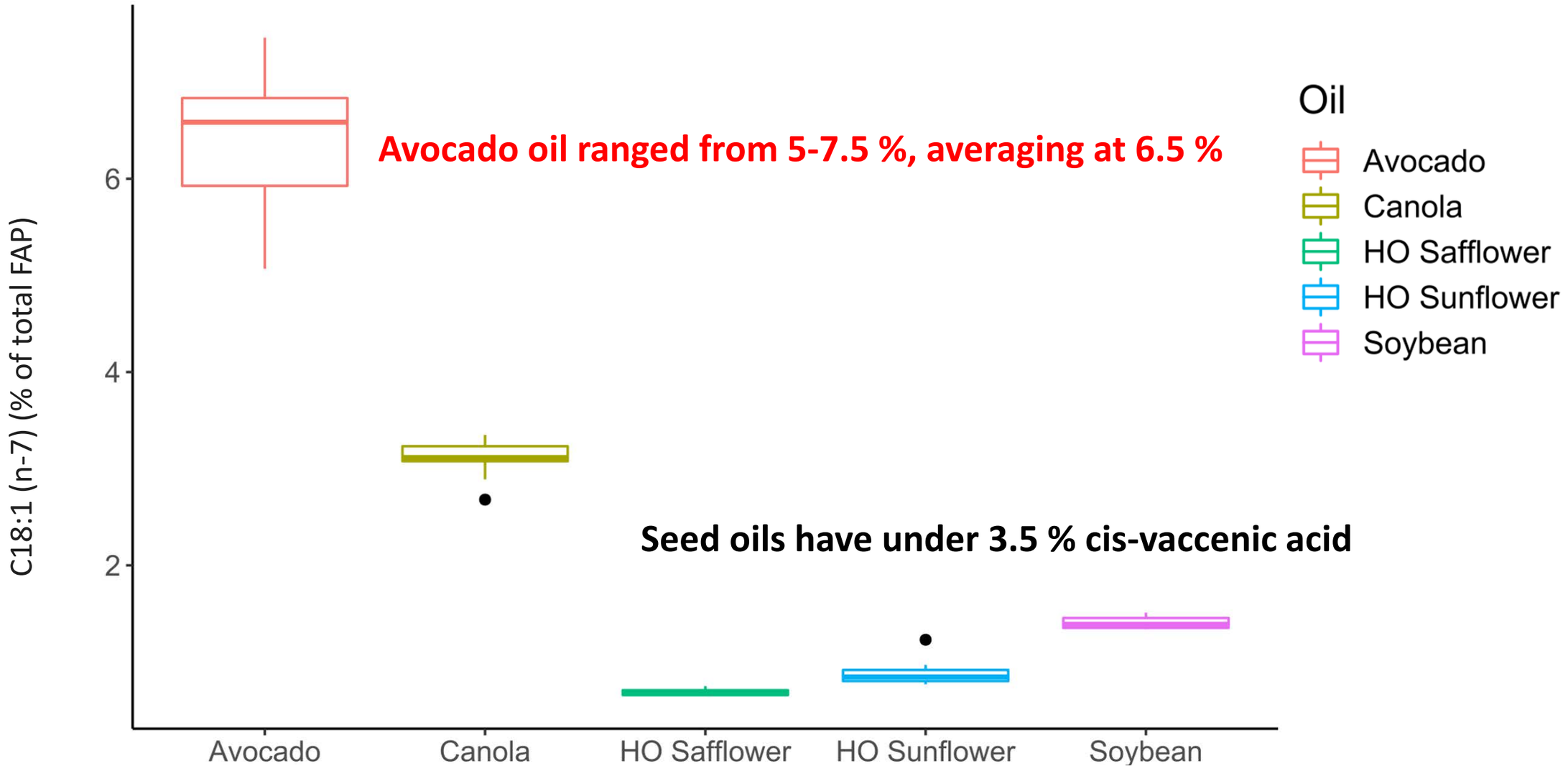
- We noticed changes in the cis-vaccenic content, particularly with seed oil adulterants



18:1 n-7 (cis-vaccenic)

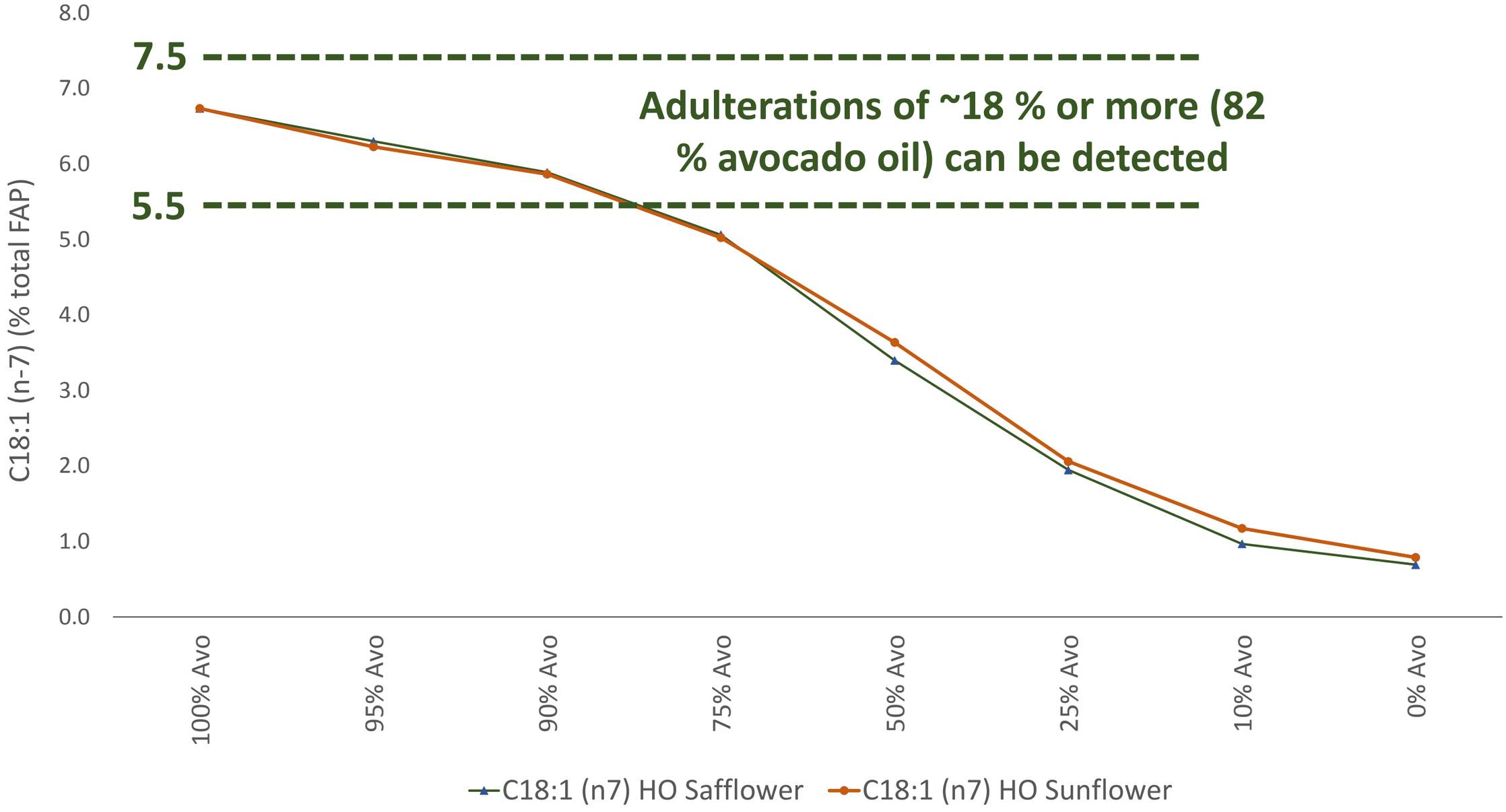
- So, we kept track of the concentration of cis-vaccenic acid in all samples

Cis-vaccenic acid in avocado oil vs seed oils



Box and whisker plot showing the percent cis-vaccenic acid (C18:1 n-7) in avocado oil compared to other potential adulterant oils.

Safflower and sunflower blended samples



Adulteration detection using cis-vaccenic acid

Fatty acid	Proposed CODEX limits (%)	% High oleic sunflower oil				% High oleic safflower oil			
		10	25	50	75	10	25	50	75
C14:0	ND-0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
C16:0	11.0-26.0	16.2	14.1	11.0	7.6	16.3	14.3	11.4	8.3
C16:1	4.0-17.1	7.4	6.1	4.2	2.1	7.4	6.2	4.0	2.1
C18:0	0.1-1.3	0.7	1.1	1.6	2.2	0.6	0.9	1.3	1.7
C18:1	42.0-75.0	63.7	67.3	72.8	79.0	62.9	65.6	69.8	74.0
C18:2	7.8-19.0	10.8	10.0	8.8	7.5	11.5	11.7	12.1	12.5
C18:3	0.5-2.1	0.9	0.7	0.5	0.3	0.9	0.8	0.6	0.4
C20:0	ND-0.7	0.0	0.2	0.2	0.2	0.1	0.2	0.3	0.4
C20:1	ND-0.3	0.2	0.2	0.3	0.3	0.2	0.3	0.3	0.3
C22:0	ND-0.5	0.1	0.3	0.5	0.8	0.0	0.1	0.2	0.2
Our proposed limits for C18:1 (n-7)									
C18:1 n-7	5.5-7.5	5.9	5.0	3.6	2.1	5.9	5.1	3.4	1.9

- Values in blue meet the current proposed CODEX standard for pure avocado oil. Values in red do not
- Cis vaccenic acid can detect 25 % of both oils; current proposed standards cannot (YIKES!)
- Uses the same approved IOC fatty acid extraction method

Green, H. S.; **Wang, S. C.** Food Chemistry Advances **2022**, *1*, 100107 "Cis-vaccenic acid: New marker to detect seed oil adulteration in avocado oil"

Take home messages

- **Fatty acids**
  - Samples overall fit the current proposed CODEX standards
  - Impacted by region and harvest time
- **Sterols**
  - Impacted by region and harvest time but to a lesser extent than fatty acids
- **Tocopherols**
  - Impacted significantly by oil made from whole fruit or mesocarp only

Purity parameters are affected by natural and processing variables. Limits set in the standards need to be carefully evaluated and more robust methods need to be developed.