The use of cork as a production tool during the production of bottle-fermented sparkling wine

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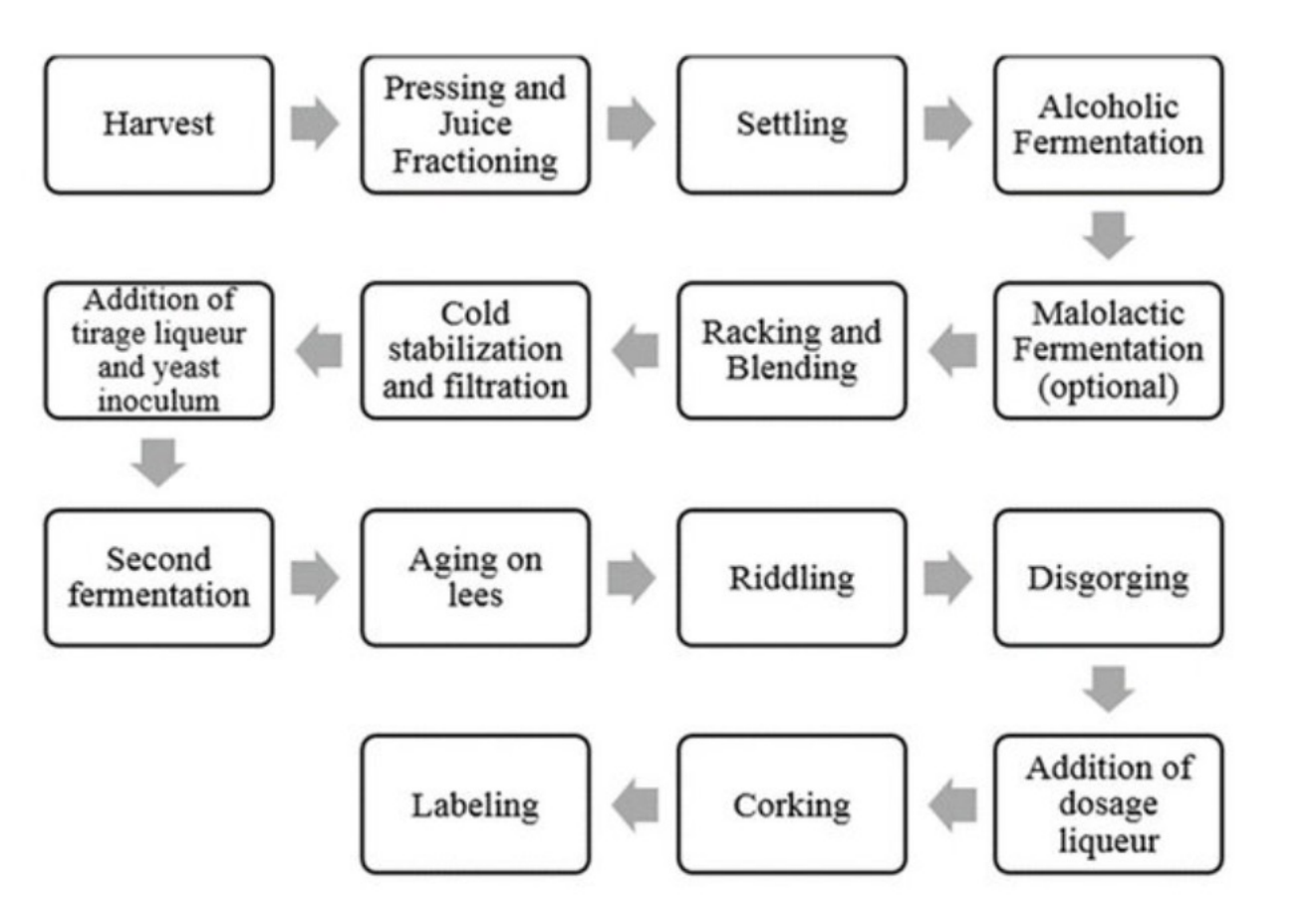
Introduction

Production of bottle fermented sparkling wine



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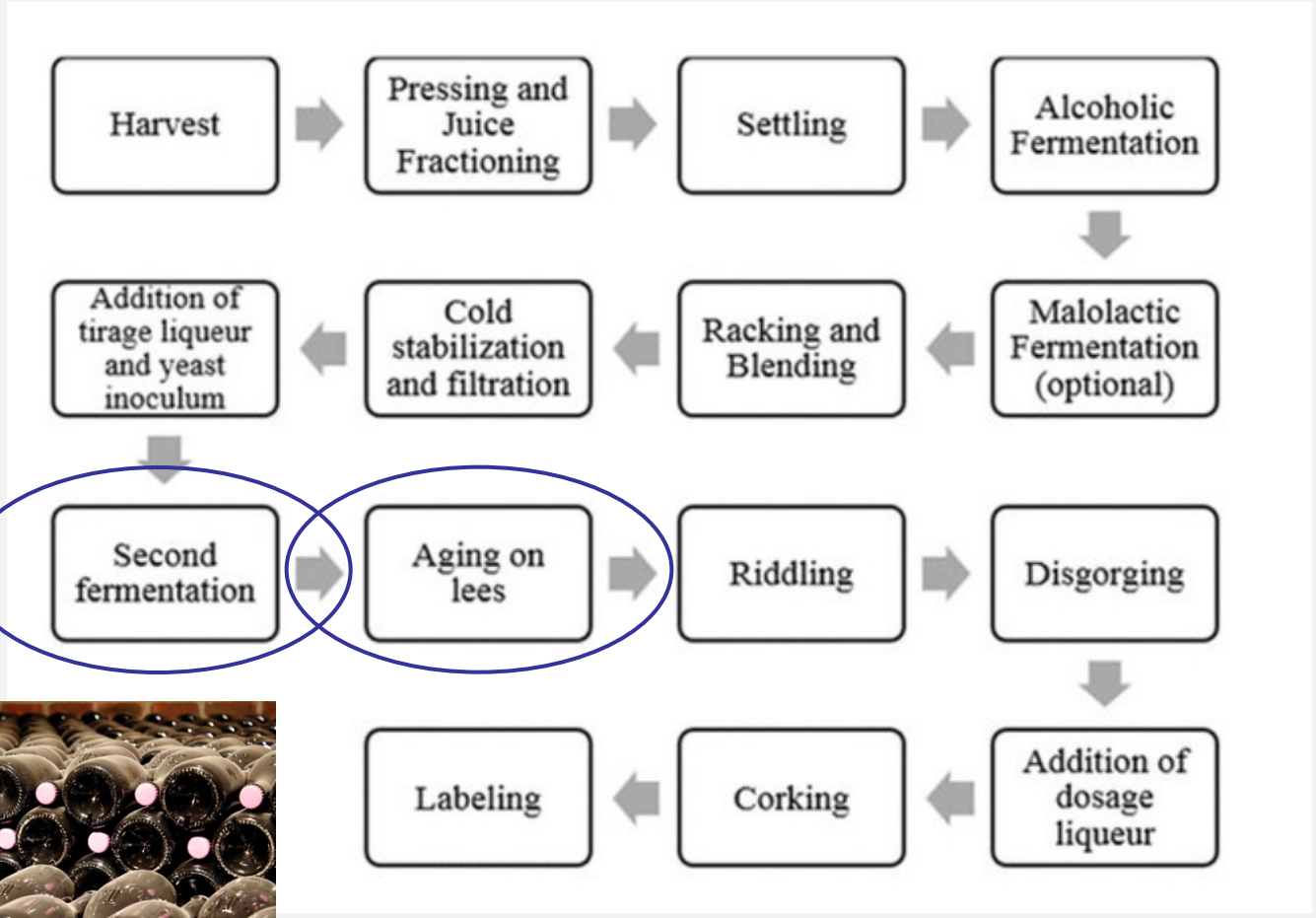
Production of bottle fermented sparkling wine



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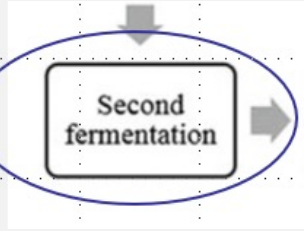
Introduction



- Second fermentation - standard practice is a crown cap.
- Ease of automation on bottling and disgorgement line.
- The first crown caps were used commercially in 1960.
- Previously bottles were closed with a cork held in place with a metal clip/staple (agrafe).
- Some producers, e.g. some Champagne Houses never switched for premium products – continued use of the traditional method (cork).
- Perceived favourable sensory outcome, despite the risk of cork-taint (2,4,6-trichloroanisole).
- Some Champagnes e.g. Dom Perignon Plénitude contact with cork for 15 years.
- Methode Cap Classique (MCC) industry is an important sector:
  - 1971: one producer; early 1990's: nine producers; current estimate: 250 producers.
  - Competitive market - increase quality and produce niche products.
  - One of the tools: cork closure instead of a crown cap during the second fermentation.

Cork?

- Cork's beneficial role in the maturation of still wines well-researched.
- Compounds such as phenolics migrate from the cork into the still wine.
- Phenolic compounds have the ability to bind with both proteins and peptides.
- The potential effect of the phenolic/protein interaction in the sparkling wine could theoretically impact the sensory attributes of the wine, but……

- Sparkling wine bottle: high pressure;
  thin layer of natural cork (one/two-disc cork) as a closure, as opposed to the traditional still wine cork.
- Will the result be the same?
- Anecdotal evidence noted by MCC producers using cork closure:
  - Stylistic changes in the wines.
  - Improved foam stability/bubble retention time (slower loss of CO_2 from the glass).
  - Improved bubble texture (smaller bubbles).
  - Increase in the wine complexity.
  - Beneficial 'cork effect' becomes more noticeable the longer the wine is in contact with the cork.

Aim

- Limited published literature available to guide South African producers.
- A selection of bottle fermented experimental and commercial sparkling wines closed with corks (two-disc) and crown caps were investigated for physical, chemical and sensory differences.

Experimental design

- Limited published literature available to guide South African producers
- A selection of bottle fermented experimental and commercial sparkling wines closed with corks (two-disc) and crown caps were investigated for physical, chemical and sensory differences.
- Six wine pairs, five vintages, three producers, different times on lees.

Vintage	Wine code	Closure	Number of months on lees	Producer
2012	LL12 Co	Cork	72	1
	LL12 Cr	Crown	72	1
2013	LL13 Co	Cork	60	1
	LL13 Cr	Crown	60	1
2014	LL14 Co	Cork	48	1
	LL14 Cr	Crown	48	1
2014	GB14 Co	Cork	43	2
	GB14 Cr	Crown	43	2
2015	LO15 Co	Cork	39	3
	LO15 Cr	Crown	39	3
2018	GB18 Co	Cork	4	2
	GB18 Cr	Crown	4	2



Jolly N, Gerber P, Minnaar P, Booyse M. 2021. Bottle Fermented Sparkling Wine: Cork or Crown Closures during the Second Fermentation? S Afr J Enol Vitic 42, 136-153.

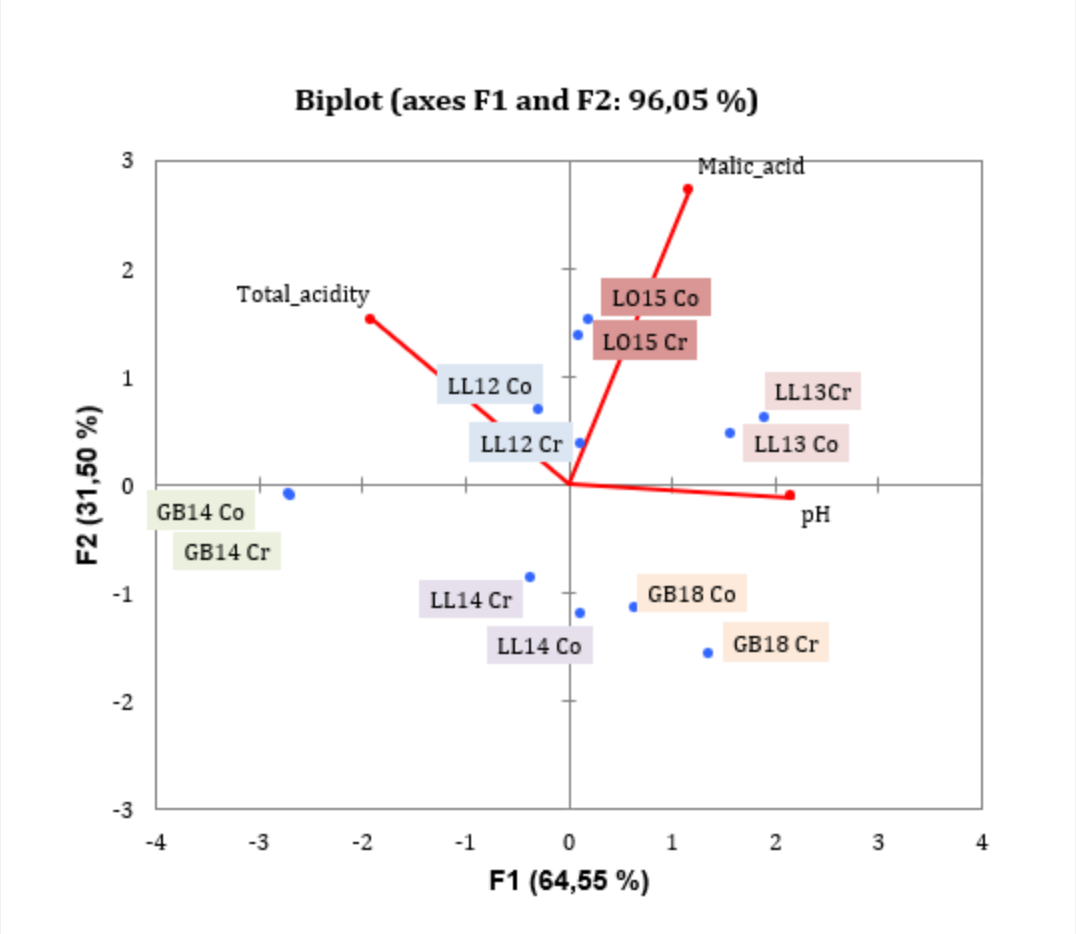
- Cork closures from three different cork suppliers.

Minnaar PP, Gerber P, Booyse M, Jolly N. 2021. Research Note: Phenolic Compounds in Cork-Closed Bottle-Fermented Sparkling Wines. S Afr J Enol Vitic 42, 19-24.

Cork and Crown wine analyses

- Pressure kPa at 20°C, Dissolved CO_2 (g/L), O_2 (mg/L).
- Wine clarified (remove lees) by centrifugation before chemical analyses.
- pH, malic acid, total acidity.
- Total yeast count (cells/mL), Sugar (°Balling), Alcohol (%), YAN (mg/L), Total extract (g/L).
- Phenolic classes: Phenolic acids; Flavonols; Flavanols.
- Phenolic acids: Gallic acid, Caftaric acid, Caffeic acid, p-Coumaric acid.
- Sensory analyses – Separate degorged wine. Not 2018 wines.
- Three to five bottles analysed.

pH, malic and total acidity



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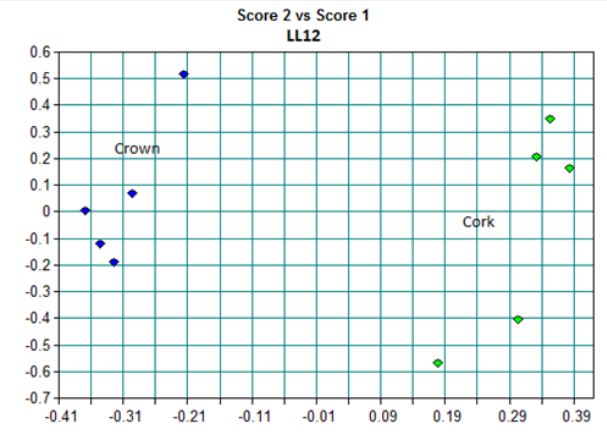
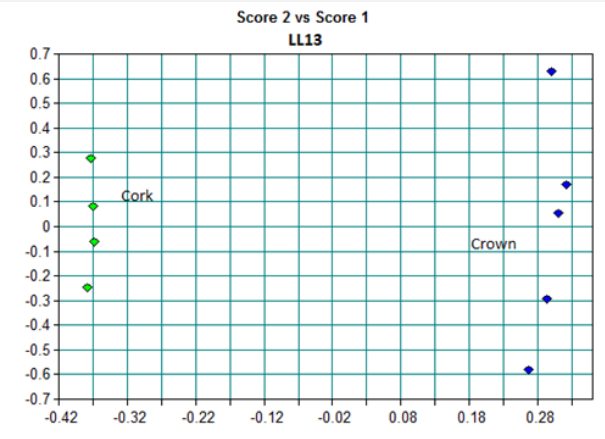
Pressure, CO_2, O_2

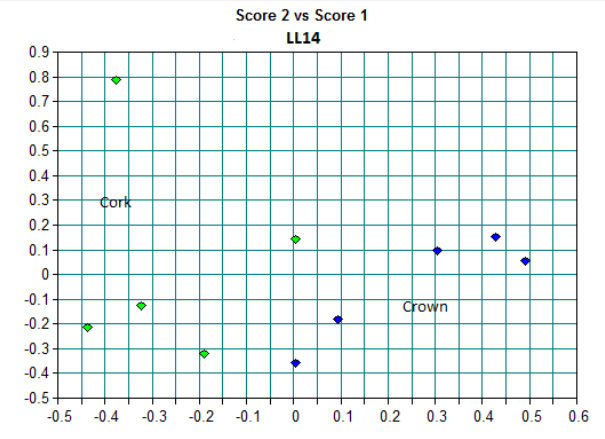
Parameter measured	Wine investigated n = 5 ± SD	
	LL12 Co	**LL12 Cr**
Pressure kPa at 20°C	264.60b ± 24.20	318.40a ± 10.00
Dissolved CO_2 (g/L)	7.71b ± 0.34	9.04a ± 0.25
O_2 (mg/L)	ND[2]	ND
	LL13 Co	**LL13 Cr**
Pressure kPa at 20°C	461.70b ± 32.80	543.10a ± 13.90
Dissolved CO_2 (g/L)	9.20b ± 0.72	11.25a ± 0.22
O_2 (mg/L)	0.020a ± 0.030	0.065a ± 0.052
	LL14 Co	**LL14 Cr[3]**
Pressure kPa at 20°C	521.30a ± 9.10	544.30a
Dissolved CO_2 (g/L)	11.15b ± 0.24	12.35a
O_2 (mg/L)	0.035a ± 0.032	0.008a
	GB14 Co	**GB14 Cr**
Pressure kPa at 20°C	480.10a ± 32.60	484.00a ± 37.90
Dissolved CO_2 (g/L)	8.95b ± 0.05	10.20a ± 0.16
O_2 (mg/L)	0.057a ± 0.029	0.171a ± 0.022
	LO15 Co	**LO15 Cr**
Pressure kPa at 20°C	621.20a ± 16.80	621.70a ± 57.9
Dissolved CO_2 (g/L)	10.94a ± 0.07	10.44b ± 0.29
O_2 (mg/L)	0.108a ± 0.095	0.154a ± 0.159
	GB18 Co	**GB18 Cr**
Pressure kPa at 20°C	450.80b ± 10.70	509.20a ± 21.80
Dissolved CO_2 (g/L)	9.55b ± 0.16	10.04a ± 0.03
O_2 (mg/L)	0.052a ± 0.009	0.140a ± 0.102

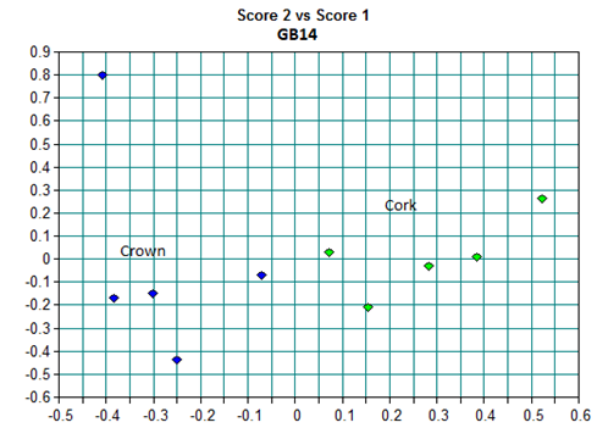
- Pressures within limit.
- Crown capped had higher pressure, but only significant for some.
- Crown cap a better barrier.
- No differences in oxygen.

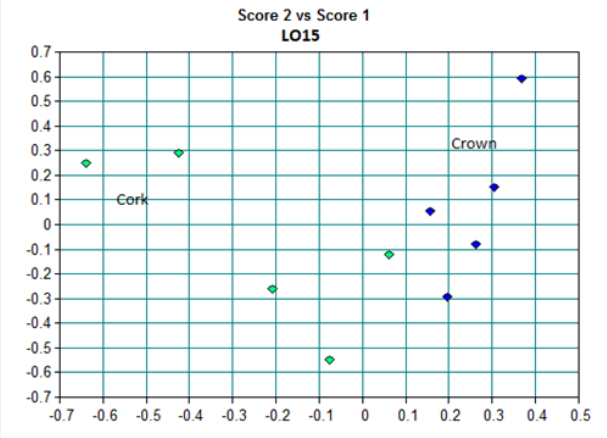
Mid infra-red spectroscopy – spectral fingerprints

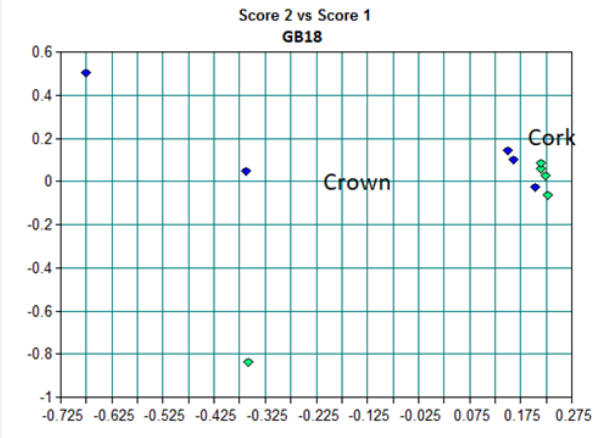


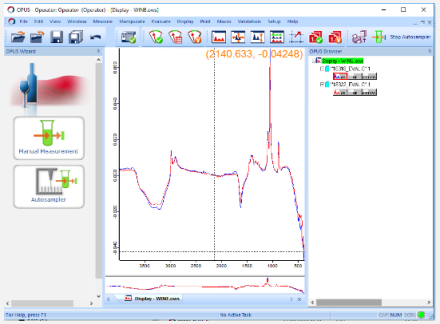












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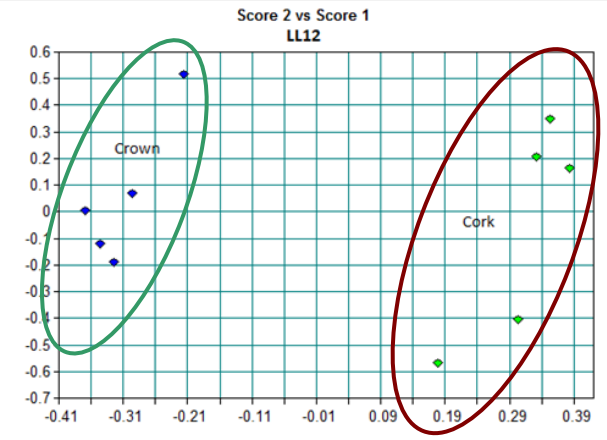
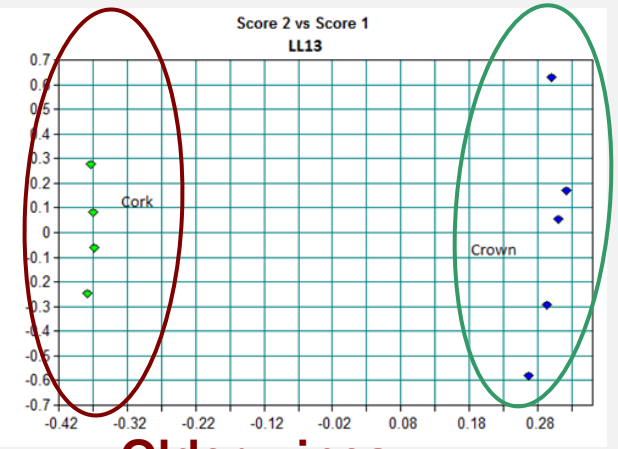
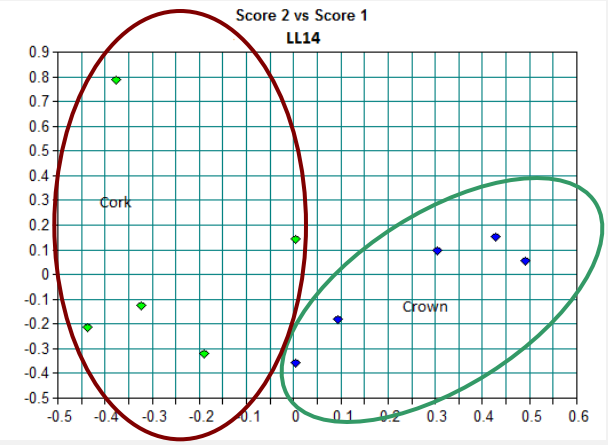
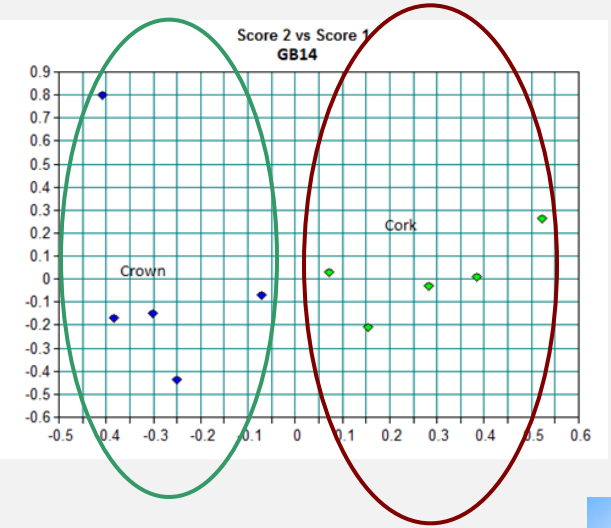
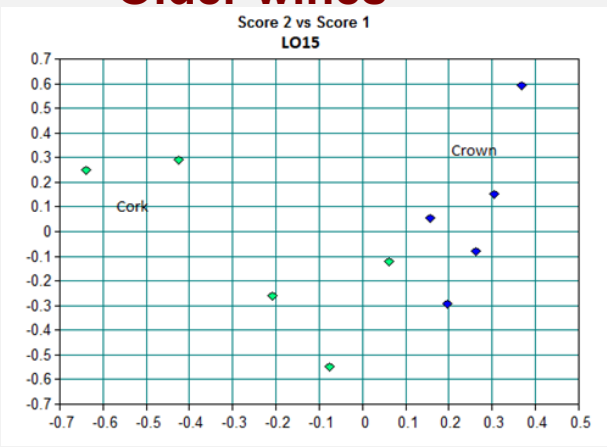


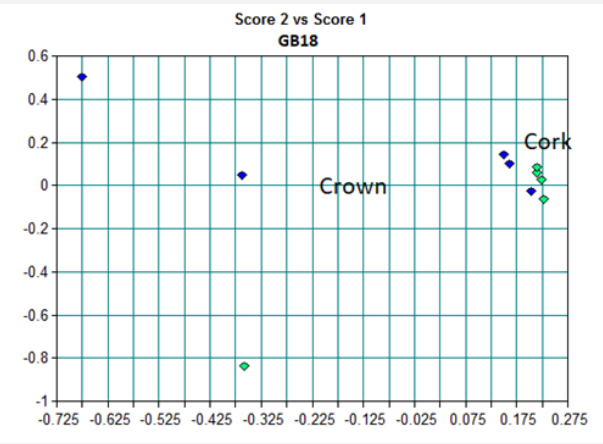


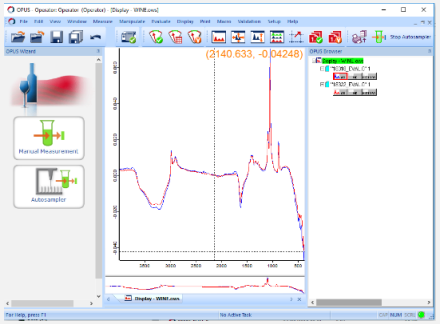


Older wines









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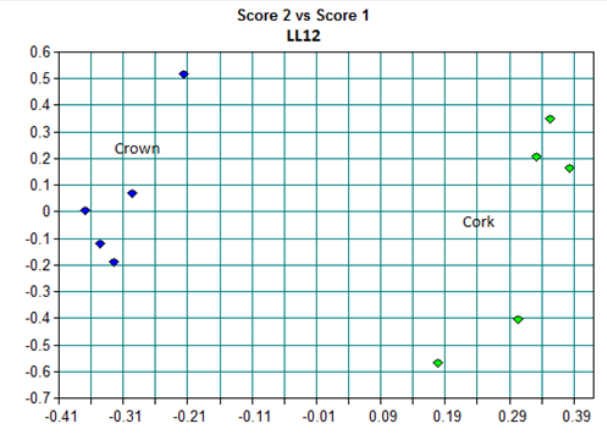
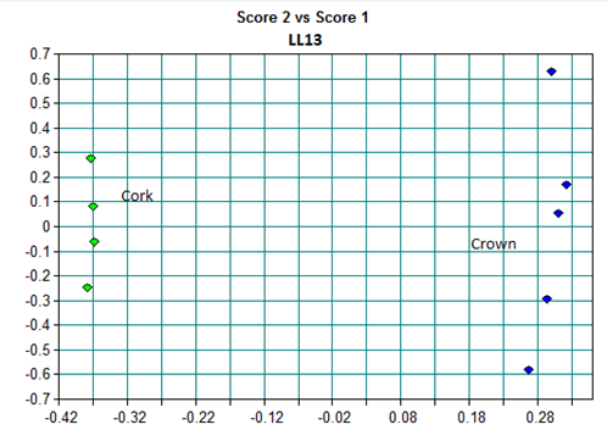
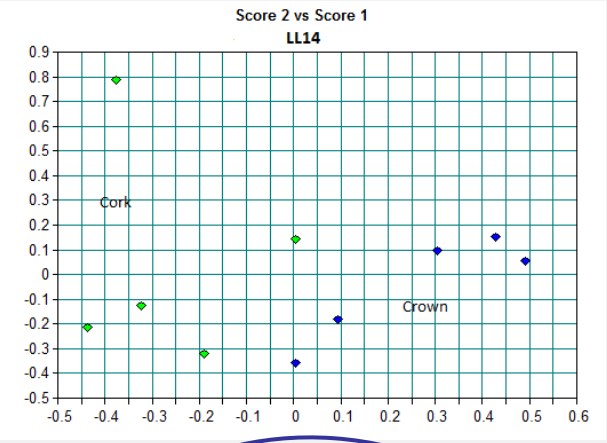
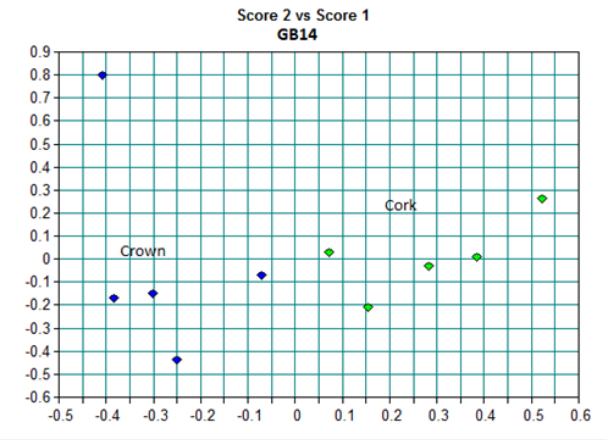
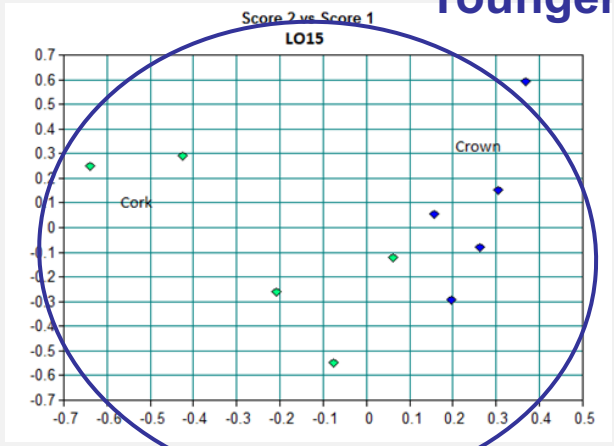


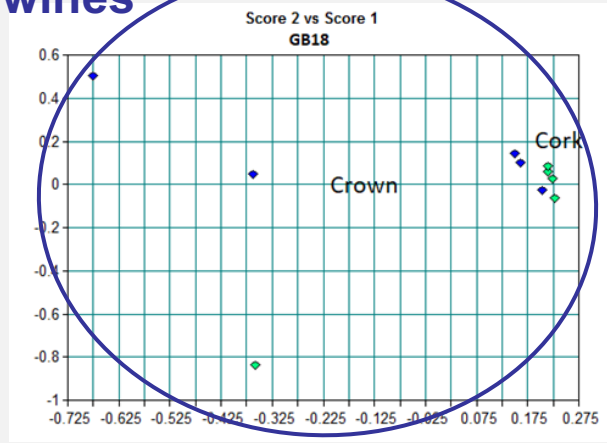


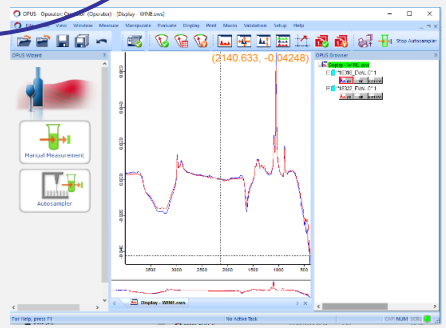






Younger wines





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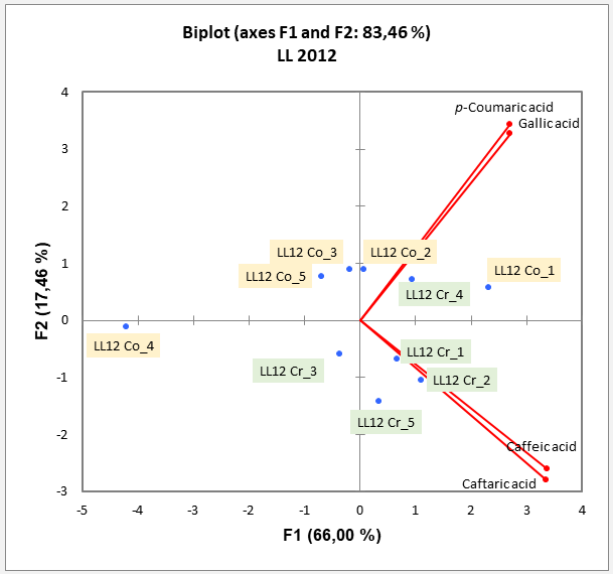
Total yeast cell count, alcohol, residual sugar, YAN, total extract

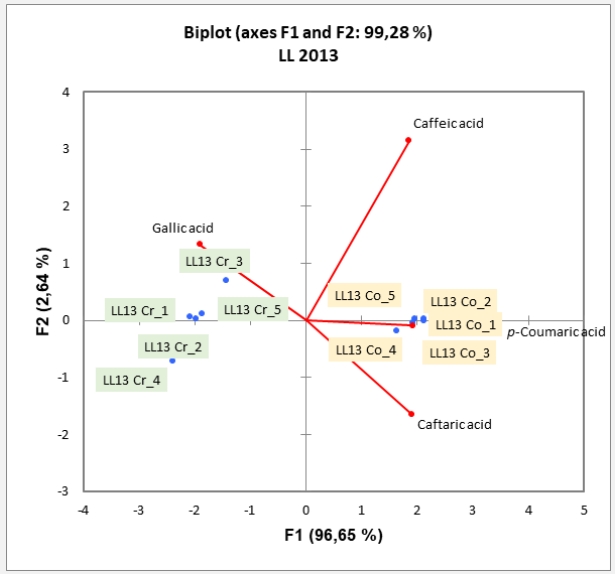
- Total cells, alcohol and residual sugar - some significant differences, but no pattern.
- Bottle variation?
- YAN and total extract – broad indication of degree of yeast autolyses.
- Overall:
  - Older crown capped wines (60-72 months on lees): yeast autolyses more advanced than cork counterparts.
  - 39 to 48 months on lees: yeast autolyses the same.
  - Younger wines (< 4 months): faster in the cork closed wines.

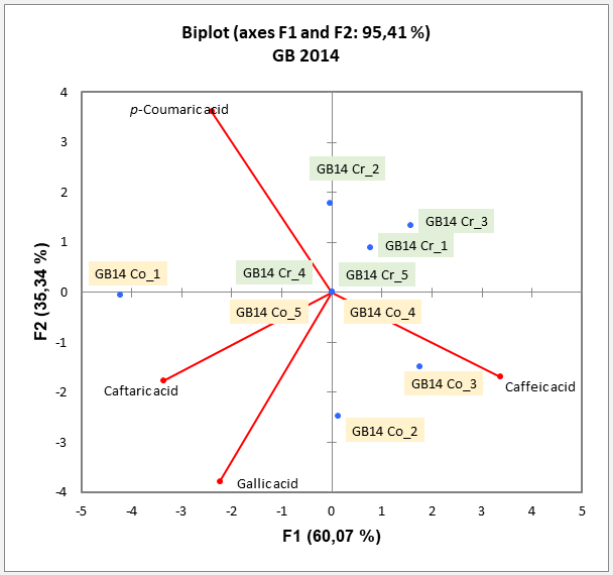
Phenolic content

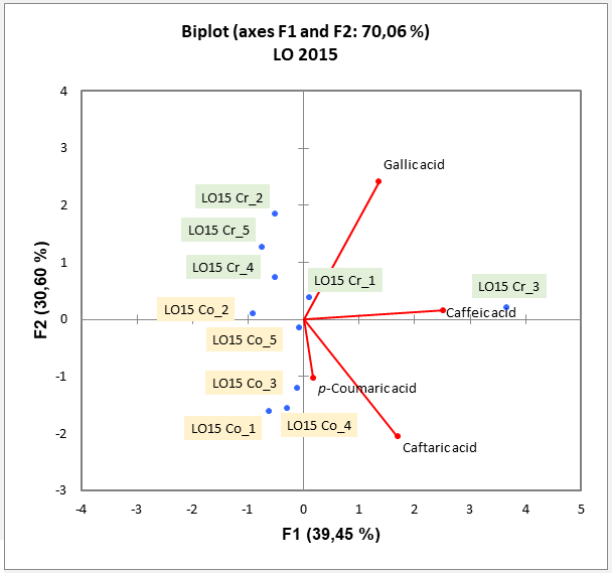
- Main source of phenolics – grapes.
- Corks – secondary source.
- Still wines – phenolic compounds migrate into wine.
- Measure phenolic classes (total phenolic acids, flavanols, flavonols).
- Phenolic acids (gallic, caffeic, caftaric and *p*-coumaric) - useful marker compounds.
- Results:
  - Phenolic classes – differences, sometime significant, no consistent pattern.
  - Phenolic acids…

Phenolic acids: gallic, caffeic, caftaric and p-coumaric









- Clear distinction, but no pattern linked to the individual marker compounds.
- Possibly due to polymerisation of monomeric phenolic compounds.

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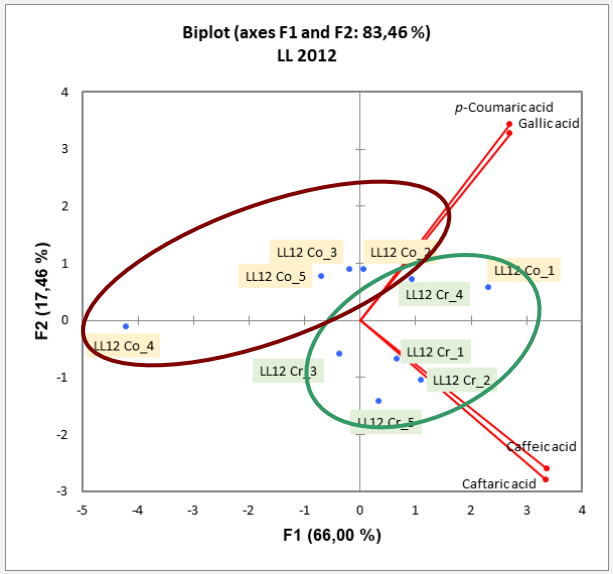
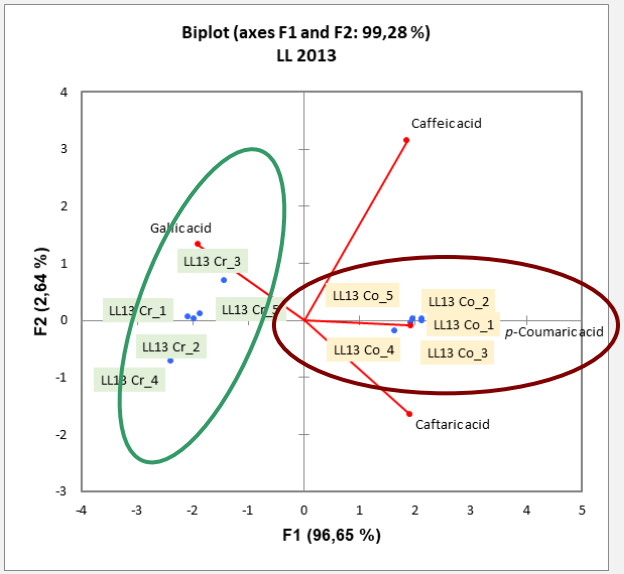
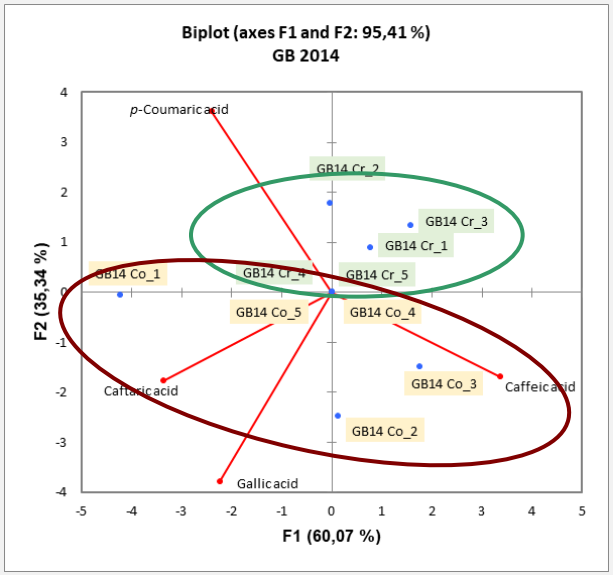
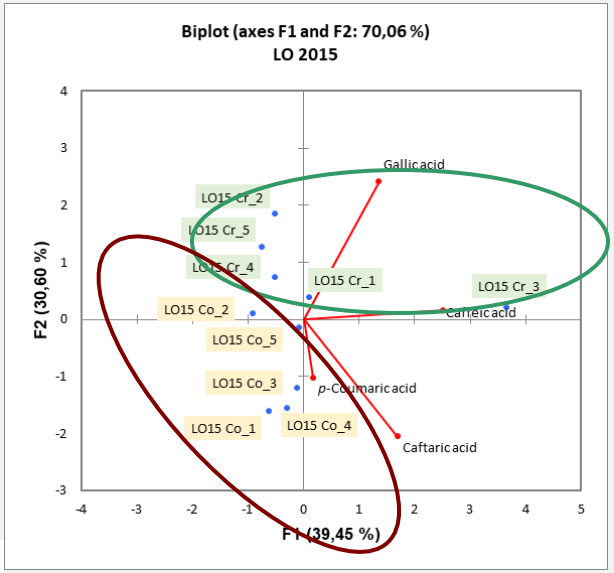
Phenolic acids: gallic, caffeic, caftaric and p-coumaric









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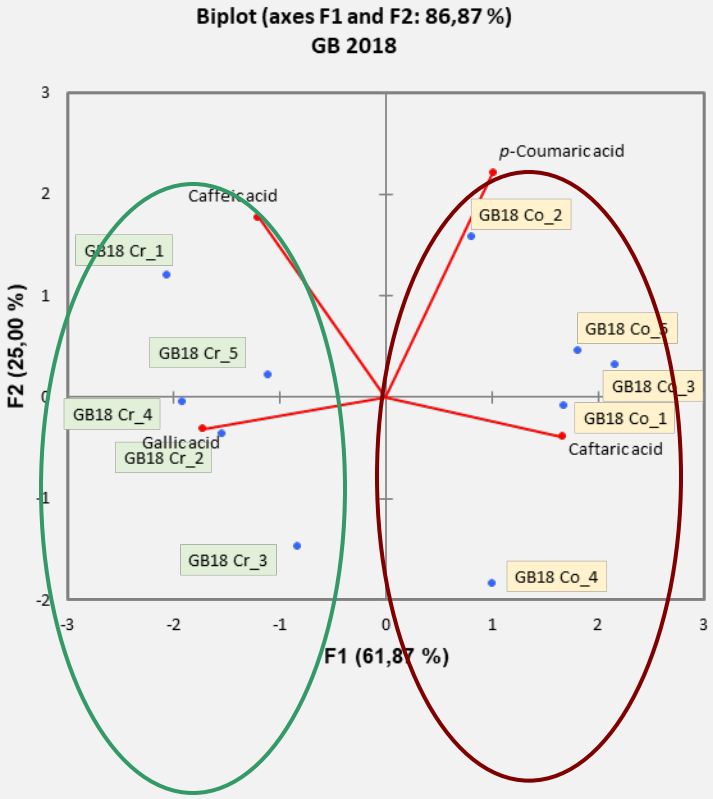
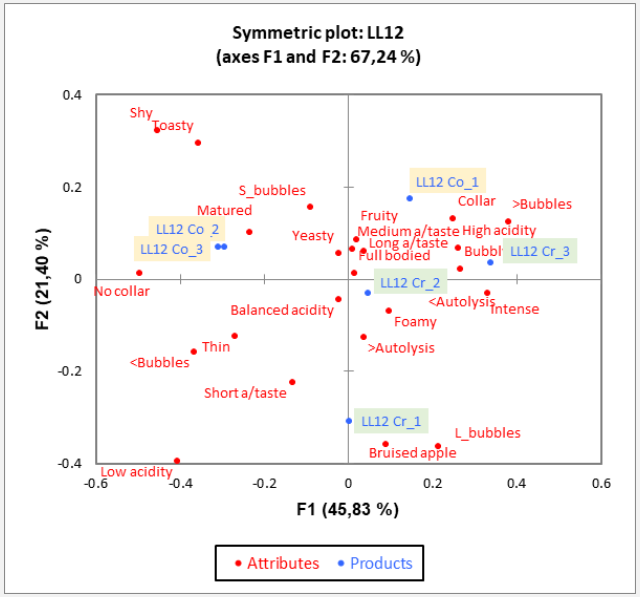
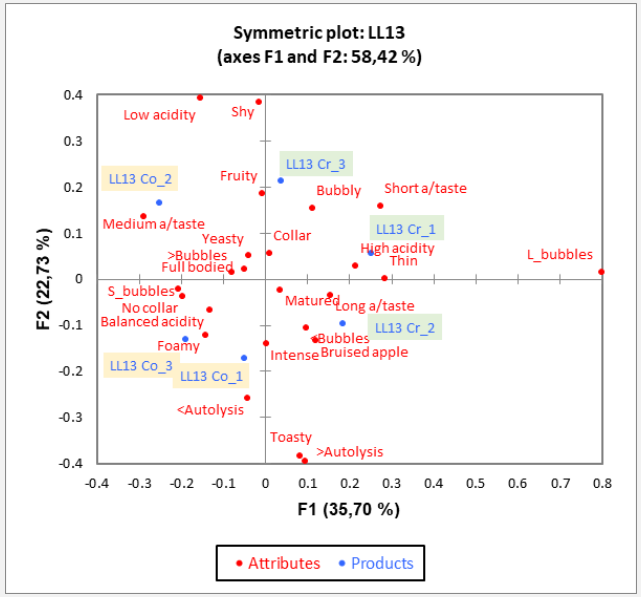
Phenolic acids: gallic, caffeic, caftaric and p-coumaric

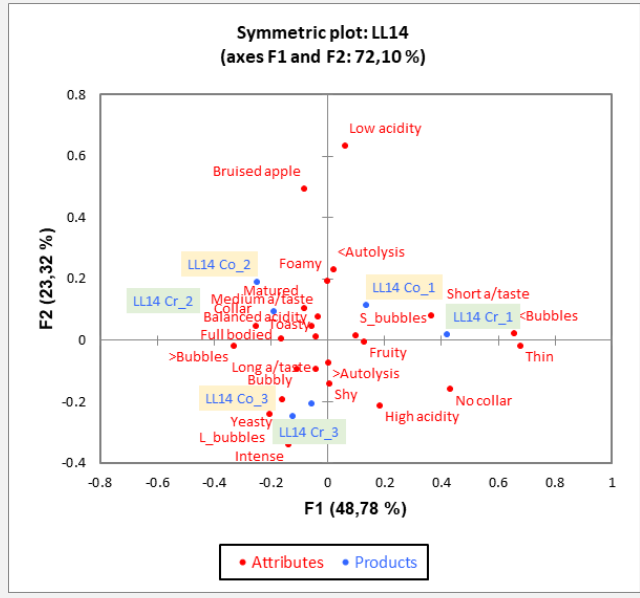
- 2018 wines - least time on lees (4 months).
  - Migration and polymerisation faster than originally surmised.
  - Area of cork related to cork roughness and porosity.

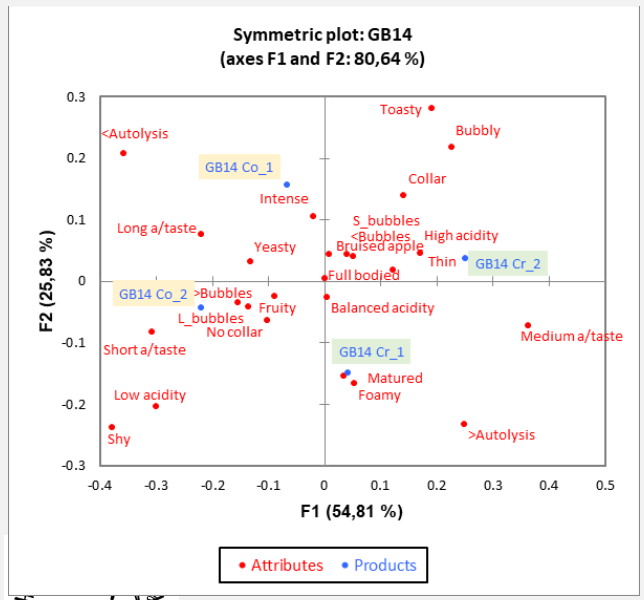


Sensory: CATA





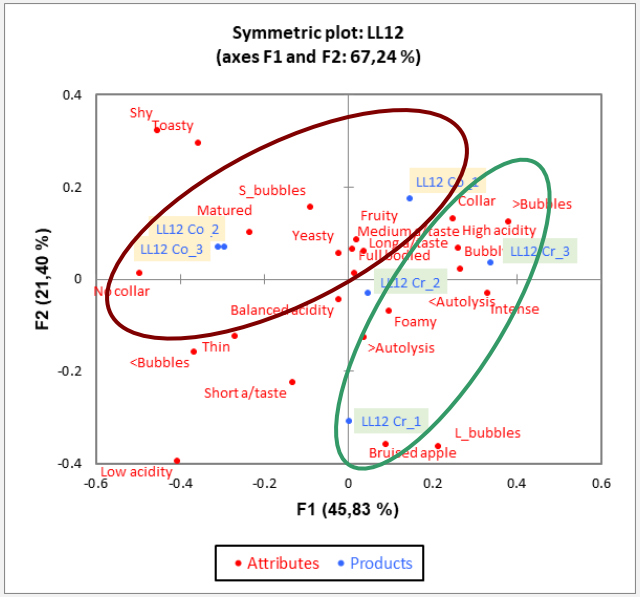


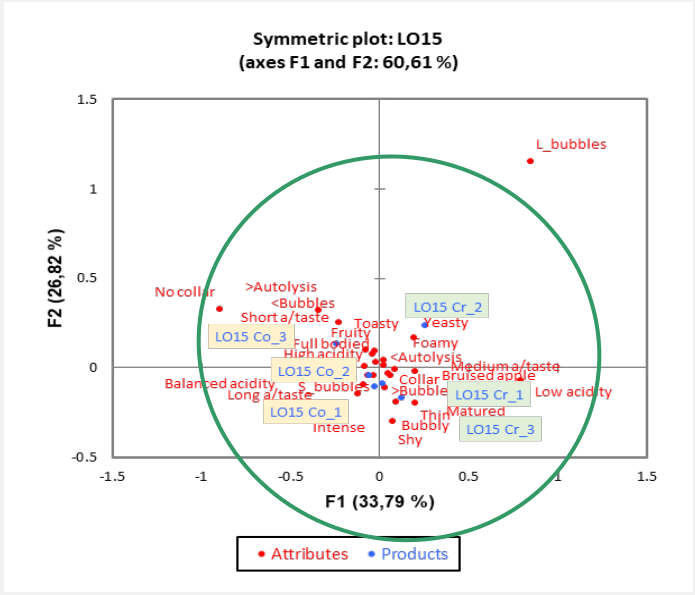


- 25 descriptors for CATA (Check All That Apply).
- No cork taint.
- Phenolic compounds contribute sensorially astringency, bitterness, mouthfeel/structure and flavour.
- Affected by pH, sweetness and alcohol.
- Different sensory profiles, but some overlaps.

2018 not tasted due to not being on lees the required months.

Sensory: CATA

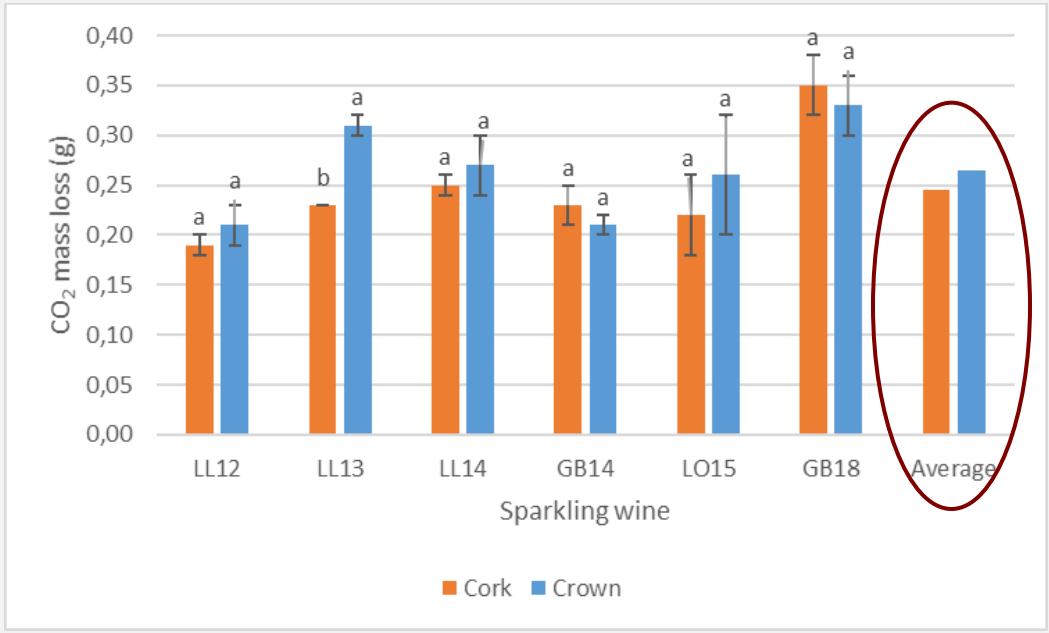




- Differences more pronounced in older wines (2012-2014) less in younger wine (2015).
- Overall cork associated with:
  - visually smaller bubbles, less autolytic character, longer aftertaste and for older wines yeasty/toasty.
- Crown capped associated with:
  - visually larger bubbles, more pronounced autolytic character shorter aftertaste.
  - Smaller bubbles and longer aftertaste; perception of more complexity.

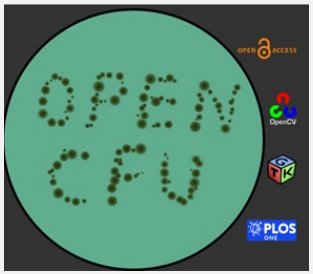
2018 not tasted due to not being on lees the required months.

CO_2 kinetics: loss from the glass (20 minutes)



- 10 to 20 minutes?
- Overall tendency for slower release from cork wines.
- Cork wines had lower pressures.

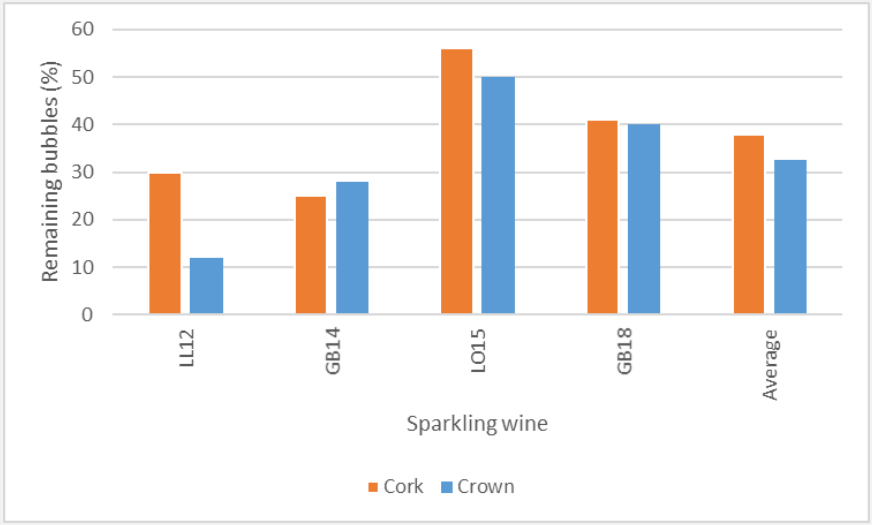
CO_2 kinetics: bubble count

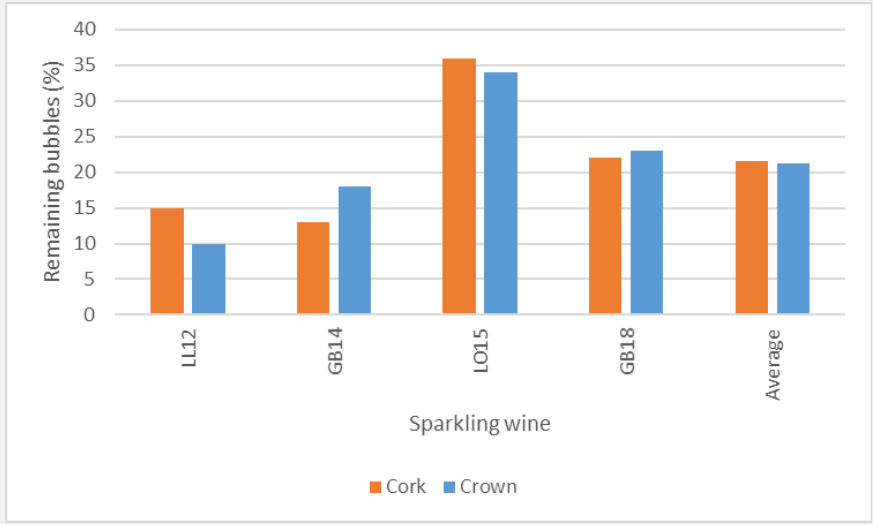


Geissmann Q. 2013. OpenCFU, a new free and open-source software to count cell colonies and other circular objects. PLoS ONE 8, e54072. https://doi.org/10.1371/journal.pone.0054072.

CO_2 kinetics: bubble count

CO_2 kinetics – Number of bubbles

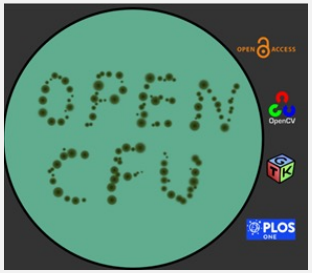




10 minutes after pouring

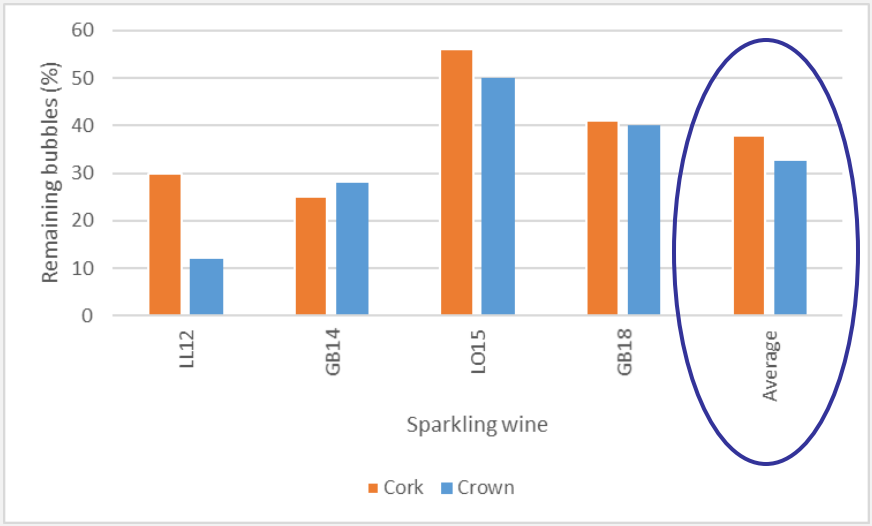
20 minutes after pouring

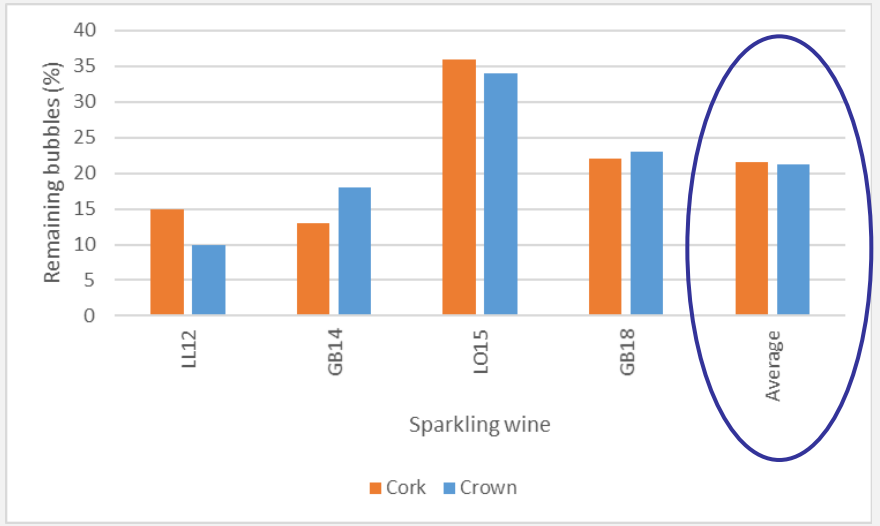
- Wines pairs differed.
- Average:
  - 10 min: Cork closed wines had more bubbles compared to crown.
  - 20 min: Number of bubbles the same for cork and crown.



Past research: Use of cork during ageing on lees - agrafe

CO_2 kinetics – Number of bubbles





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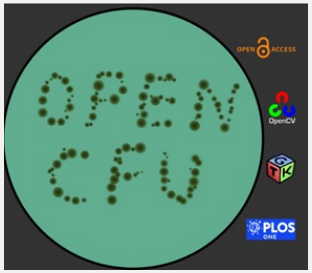
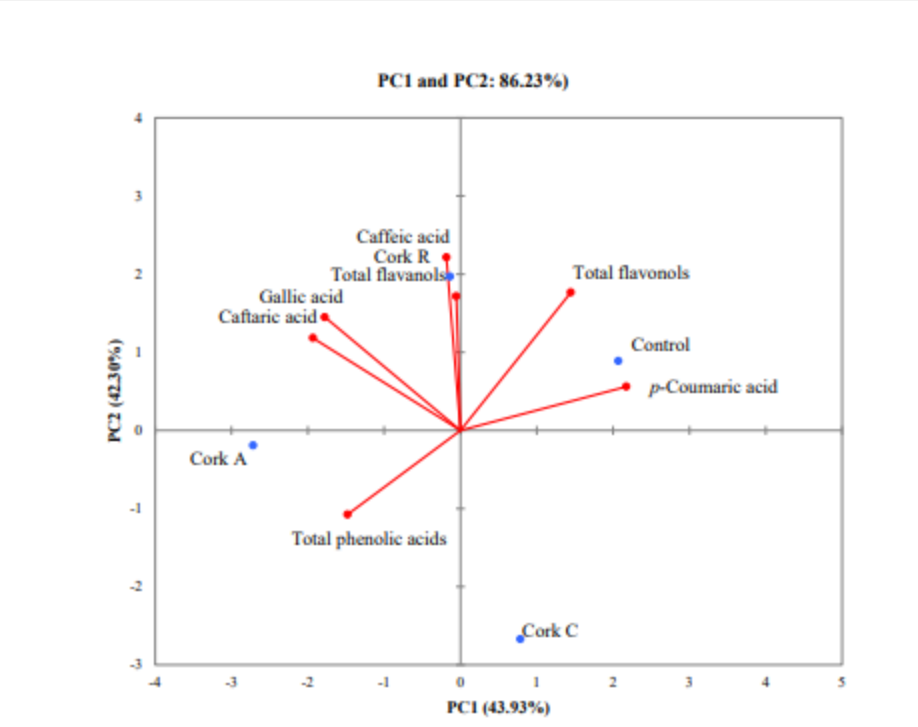


Different corks?

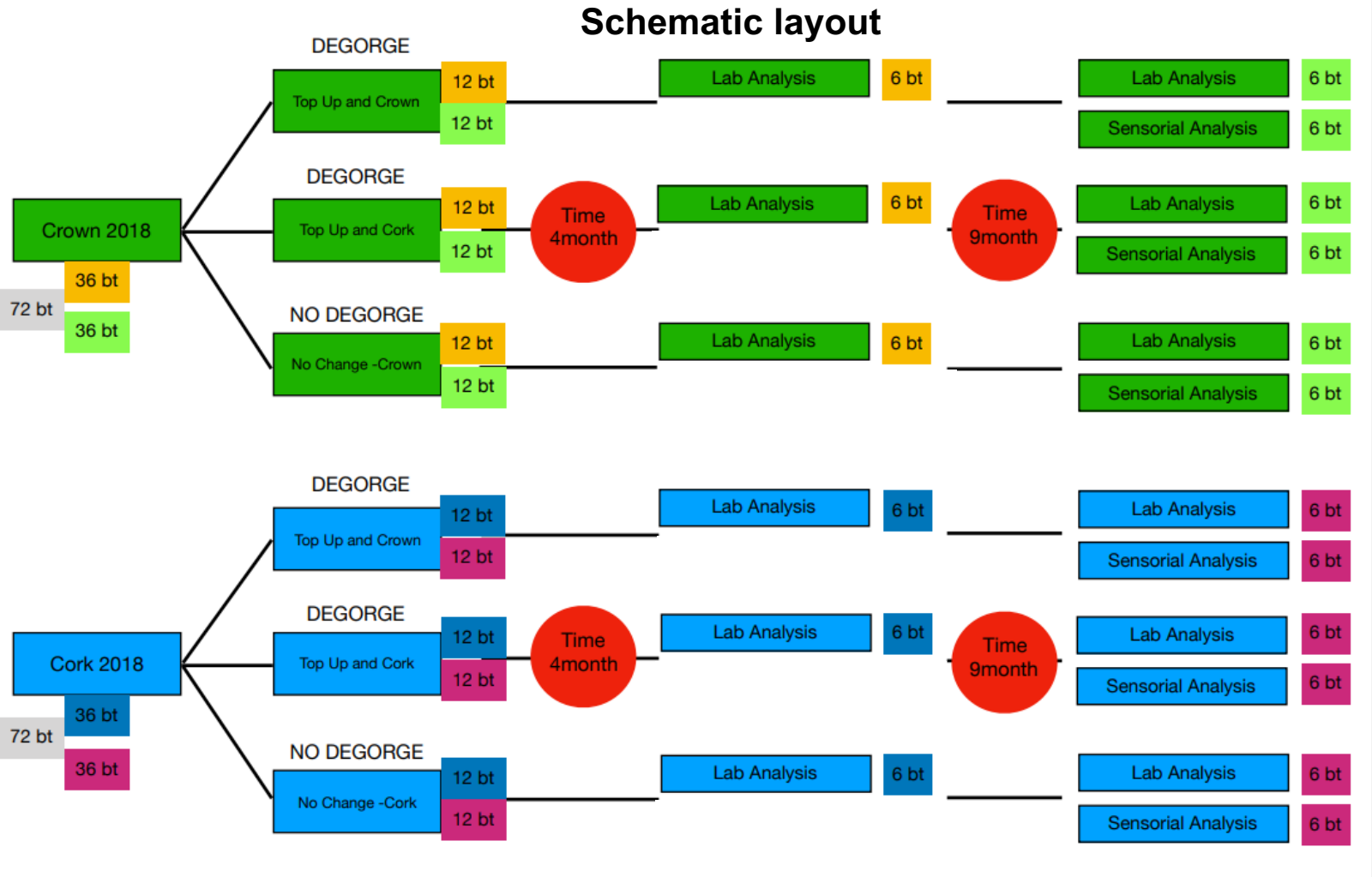


- N = 3 (cork A, R and C). Two–disc cork.
- Changes in the phenolic profile of the wine: phenolic classes and acids.
- Gallic acid was significantly highest in Cork A wines.
- Cork R wines were strongly associated with caffeic, gallic and caftaric acids and total flavanols.
- Cork origin (cork supplier) can bring about subtle differences.
- Cork is a natural product.

Conclusions - use of cork vs. crown cap during ageing on lees

- Infra-red spectroscopy a powerful and inexpensive tool to illustrate differences between the pairs of cork-crown wines.
- Cork-closed wines can have lower pressure (within legal requirements).
- Contact with the cork results in changes in the wine's phenolic acid profile. Gallic, caftaric, caffeic and *p*-coumaric acids can be used collectively as marker compounds to differentiate between cork and crown-capped wines.
- Sensorial changes to the wines. Cork-closed wines have less autolytic character but are more complex and have a longer aftertaste.
- An effect on the CO_2 kinetics can also occur. After pouring cork-closed wines lost CO_2 slower than the crown-capped wines with visually more and smaller bubbles. Lower pressure?
- Effect of cork on foam stability, bubble texture and stylistic changes in MCC wine is supported.

Future: Cork and crown post degorgement



2018 wines – one year on lees

2014 wines – five year on lees

Thank you / Dankie

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