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FINAL REPORT 2024

SA WINE number: WW JT 22-01

1. PROGRAMME & PROJECT LEADER INFORMATION

	Research Organisation leader	Project leader
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2. PROJECT INFORMATION

Project title	The role of phenolic levels in sparkling wines. Optimisation of juice yield extraction in sparkling wine production
Short title	Understanding sparkling wine phenolics to optimise juice yield extraction

Fruit kind(s)	grapes		
Start date (mm/yyyy)	2022-01	**End date** (mm/yyyy)	2023-12

Key words	white wine, sparkling wine, juice yield extraction, phenolics

	CFPA	RAISIN SA	HORTGRO	SATI	SA WINE	ARC	OTHER
TOTALS All years	R 0	R 0	R 0	R 0	R 739000	R 0	R 0

Total cost of entire project	R 739000

3. EXECUTIVE SUMMARY

Objectives and Rationale

The press fraction of white and sparkling wine juice is commonly kept separate as pressing time and pressing force are increased. However, the sensorial effects of the pressed juice fractions in the final wine are not well understood. This project aimed to understand the sensorial impact of different initial juice phenolic levels.

Methods

The total phenolic index (ABS 280 nm), the individual phenolic composition by ultra-performance liquid chromatography (UPLC) and the main oenological parameters of musts and wines were obtained. The ultraviolet-visible and MIR spectral properties were also measured. Triangular tests and mouthfeel descriptors were sensorially assessed in the finished wines.

Key Results

UPLC phenolics provide an accurate representation of phenolic fraction presence
pH is a good indicator of the pressing operation progression
Larger sensorial differences were observed in sparkling wines
Hydroxycinnamic acids and flavanols appeared as markers of free-run and press fractions, respectively
Spectroscopy calibrations can accurately predict phenolic content

Key Conclusion of Discussion

Phenolic measurements (hydroxycinnamic acids and flavanols) and pH should be considered when pressing still and sparkling wines. The sensory perception of sparkling wines was more severely affected by an increasing presence of press fraction. Spectroscopy-based calibrations can be used as a monitoring tool for pressing operations.

Take Home message for Industry

Monitoring the pressing operation with a combination of phenolics and acidity measurements can aid in maintaining wine quality while optimising the must extraction yield.

4. PROBLEM IDENTIFICATION AND MOTIVATION

Problem Identification

From our meetings with several winemakers, it was stated that juice recovery from grapes is of critical importance. In sparkling wine production, press juice fractions are generally kept separate as they are considered lower-quality fractions. This is mainly due to the excessive presence of phenolic compounds. However, phenolic levels can be of little meaning without a better understanding of the role of these compounds in the quality perception of sparkling wines. The sensory thresholds of phenolics in sparkling wines are not well established, and further research on this topic might improve overall wine quality. This study could also play a positive role in consistent wine production over time. Therefore, linking wine phenolic levels and quality will be beneficial for the wine industry. The aim of this study was to investigate the influence of phenolic levels on the overall perception of sparkling wine, based on the initial phenolic levels in juice. The phenolics measured in combination with a better understanding of the phenolic levels will hopefully assist in the optimisation of juice extraction yield and in the overall quality of sparkling wines.

Motivation

Industry partners mentioned that an increase in the pressed juice fraction did not have a significant effect on the sensory properties of finished wines. However, the press fraction is commonly kept separate as the pressing time and force increase. This is due to the release of phenolic compounds from the solid parts of the berries. However, the sensorial effects of the pressed juice fractions in the final wine are not well understood. The purpose of this project was to gain an understanding of the sensorial effects of different initial juice phenolic levels in sparkling wines. Higher juice yield recovery will potentially be obtained as more press juice fraction will be combined with free-run juice, leading to a higher recovery of A-quality grade juice. Optimisation of juice recovery and wine quality might be achieved by an increased understanding of the role of phenolics. Guidance and advice will be provided to winemakers in sparkling wine production.

5. ACCUMULATED PROGRESS TABLE

Objectives	Milestones (Significant event or stage in a project)	Date Achieved
Obtaining juice samples with different phenolic content for sparkling wine production	- Identification of a representative sample set with the inclusion of the relevant cultivars and phenolic profiles - Determination of blends of different proportions free/press juice fractions to create wines with varying phenolic content and profiles - Making the different sparkling wines	2023-12-31
Analyse the chemical and phenolic profile of the juices and wines used in the study	- Phenolic profiling of juices and wines using LC-MS - Analysis of total phenolic content and colour properties using UV-visible spectrophotometry - Analysis of additional oenological parameters.	2023-12-31
Sensorial evaluation of the wines produced	- Investigation of the best-suited sensory approach for the evaluation of the wines - Sensorial evaluation of the finished sparkling wines by expert winemakers	2023-12-31
Data analysis of the chemical and sensorial data sets	- Understanding of the phenolic profiles in juices and wines - Application of multivariate data analysis techniques to explore correlations between juice and wine phenolic profiles - Application of data fusion techniques to evaluate relationships between chemical and sensory results	2023-12-31
Investigation of simple and rapid methods for the assessment of final wine properties using juice data	- Spectral data acquisition of juices and wines - Evaluation of clustering techniques for decision-making	2023-12-31

6. WORKPLAN (MATERIALS AND METHODS)

Objective 1. To obtain juice samples with different phenolic content for sparkling wine production

- Chardonnay and Pinot Noir free-run and press juice fractions will be used in this project. Chardonnay and Pinot Noir grapes will be sourced from different producers. The idea is to include juices and base wines with varying phenolic profiles, and for this, lower- and higher-quality juices will be sourced with the help of the collaborating cellars.

- Five blends with varying free-run/press fractions will be made per cultivar. The wines will consist of (1) 100% free-run, (2) 75% free-run–25% press, (3) 50% free-run–50% press, (4) 25% free-run–75% press, and finally, 100% press fraction. Three 50/50 blends Chardonnay/Pinot Noir will also be included, and the same free-run/press fraction ratios as above created. This will give a total of 45 wines (3 Chardonnays x 5 blends + 3 Pinot Noirs x 5 blends + 3 50/50 Chardonnay/Pinot Noir x 5 blends)

- Wines will be made in the experimental cellar in smaller volumes following the specification of the MCC procedure

- Based on the results observed, a second experiment will be planned and executed during the second year. This experiment will take into account the possible need for more variability in the juices (collection of more juices if high variability in the results obtained is observed), refining the proportions free-run/press juice, consider aroma analysis or even optimise the sensory approach

Objective 2. To analyse the chemical and phenolic profile of the juices and wines used in the study

- The low levels of phenolics in juice samples require advanced analytical techniques. UPLC analysis will be used to obtain the phenolic profile of the juice blends as well as of the final sparkling wines

- Total phenol content will be measured as the absorption at 280 nm using a UV-visible spectrophotometer. The brown (440 nm) and yellow (420 nm) colour components will also be measured. The CIElab colour coordinates will also be obtained using the visible absorption spectra. Luminosity (L*), hue (H*), red/green (a*), blue/yellow (b*) and intensity of the colour (chroma*) will be measured

- Oenological parameters will also be obtained (TA(g/L), pH, malic acid, residual sugar, glucose, fructose, alcohol content etc.)

Objective 3. Sensorial evaluation of the wines produced

- The wines will be tasted using expert tasters.
- The following sensory approaches will be attempted during the first year of the experiment: preference/acceptance tests, triangular tests, check-all-that-apply and just-about-right techniques will be explored.

Objective 4. Data analysis of the chemical and sensorial data sets

- Multivariate data analysis techniques will be used to explore correlations between the chemical (phenolic and oenological) parameters in juices and wines.

- Data fusion techniques will be employed to analyse the chemical, colour and sensory data. Correlations, patterns, and trends will be explored to link chemical and colour data in the juice with the sensory perception of wine. The idea will be to gain an understanding of the phenolic levels in the juice that lead to the best-rated final wines.

- The same will be done with wine chemical and colour data with sensory perception. This will serve to better understand the phenolic and colour features of the best-rated wines and could be used as a tool to classify final sparkling wines.

Objective 5. Investigation of simple and rapid methods for the assessment of final wine properties using juice data

- Infrared spectral data acquisition of juice samples. Fluorescence, mid and near-infrared data will be explored

- Using the sensory data as a benchmark, multivariate data analysis techniques (clustering and classification) will be explored to develop a rapid tool to assess the juice quality. The juices of the different blends will be classified according to the sensory evaluation. Based on the spectral data of new juices, a quality assessment will be attempted using the clustering or classification models.

7. RESULTS AND DISCUSSIONS

OBJECTIVE 1. To obtain juice samples with different phenolic content for sparkling wine production.

Problem identification: *reproducing industry conditions at the experimental level is challenging. Harvest size, equipment and processing methods might influence the results obtained. Experimental conditions have the benefit of having a controlled approach and optimising resources but might not be representative of industry practices.*

During the first year of the study, three scenarios were considered: (1) conducting the experiment using a small volume basket hydraulic press, (2) obtaining the samples from experimental wineries during the winemaking process, and (3) using a larger size pneumatic press available at the experimental cellar. After careful consideration, it was decided to proceed with option 1. This decision contemplates the need for smaller amounts of grapes, the possibility of conducting an increasing number of experiments, the assurance of obtaining the samples and the benefit of using controlled conditions. Option 2 and 3 were temporarily discarded due to the difficulty of conducting an experimental project in a commercial winery during harvest time and the need for large amounts of grapes, respectively.

The first set of experiments conducted during the 2022 harvest included sparkling winemaking of Chardonnay and Pinot noir grapes from Simonsig (Stellenbosch) and Colmant (Franschhoek). Still white wines were also included in the study to understand the pressing operation mechanisms. For still white wines, Sauvignon Blanc, Chenin Blanc and Chardonnay were sourced from Kleine Zalze (Stellenbosch) and Perdeberg (Wellington).

Still-white wines were made following a standard protocol. The separate pressing fractions and blends were treated with the settling enzyme Rapidase® Clear to decrease the viscosity of the must, allowing more compact lees and, therefore, more juice yield optimisation. SO_2 was added to limit oxidation. The juice was left to settle overnight in the 4°C room. The following day, all the blends were racked into fermentation vessels and inoculated with Vin 13 yeast (Oenobrands). Simultaneously Nutristart® was added to ensure the completion of the fermentation. Balling measurements were taken every day for each fermentation vessel, and once the must dropped by 5° balling, Dynastart® was added to avoid stuck/sluggish fermentations. Samples of each cultivar were taken and blended before settling, after settling, and after alcoholic fermentation. Once alcoholic fermentation was completed, the wines were racked and treated with SO_2 and bentonite to remove proteins and other haze-causing particles, leaving the wine clear and stable. The wines were then put through cold stabilisation in the -4°C room for a minimum of a week. Once ready for bottling, the wines were racked again, making sure no tartaric crystals were present. The wines were analysed for SO_2 levels and adjusted accordingly before bottling. Bottles were sterilised, and wines were filtered manually with a pad filtration technique and capped. The sparkling wine juice was settled overnight, and the first fermentation was conducted. Protocol and conditions for the first fermentation were the same as the ones followed for still-white wines.

Two pressing methods were explored to assess the phenolic content. Fifty kg of grapes were processed for each wine.

- Method 1 (sparkling wines): 17.5 liters of free-run juice were collected and kept separate. Pressure was then applied, and press fractions 1, 2, and 3 were individually collected at increments of 3.5 liters. These volumes correspond to the protocol used by some of the sparkling wine producers, where out of 1000 kg of grapes, the first 350 L are considered free-run juice. Secondly, 200 L are obtained by applying minimal to moderate pressing. Finally, the last 50 L are obtained after intense pressing. While the free-run and the first

pressing fraction might or might not be combined, the second press fraction is often kept separate as it is considered the lowest-quality fraction.

- Method 2 (sparkling and still wines): Similar to method 1, 17.5 litres of free-run juice were collected. The press fractions were combined until the press ran dry. Five blends were made from the free-run and press juice collected. The blends included 100% free-run, 75% free-run & 25% press juice, 50% free-run & 50% press juice, 25% free-run & 75% press juice and lastly 100% press juice.

Still and sparkling wine samples were taken and analysed for total phenol content before and after settling and after the first fermentation. The conclusions extracted from the results obtained are summarised below.

- In sparkling wines, the total phenol content, as the absorbance (ABS) at 280 nm, reflects increasing pressing applied and blends with a larger presence of press fraction when analyses were conducted before settling. However, the differences in phenolic content were relatively small.
- These results were not observed after settling or after the first fermentation.
- For still wines, the total phenol content was unable to represent increasing pressing force and increasing pressing fraction in the wines across the different stages (before settling, after settling and after fermentation)

As an additional experiment, free-run wine and press wine were sourced to assess if the variability in phenolic content was more significant due to the use of larger commercial presses. Slightly larger differences were observed for Pinot Noir than for Chardonnay and Chenin blanc obtained from Graham Beck and Uitkyk. However, the values observed were very much in line with what was observed in the experimental wines.

Two main conclusions were extracted from these experiments: (1) the experimental conditions and the use of a small-scale basket press were not able to replicate the pressing operation at an industrial scale; (2) the ABS 280 nm seemed to not represent the theoretical phenolic content increase that should occur during the pressing operation of both still and sparkling wines. Interferences of other absorbing compounds could be influencing the accuracy of the total phenol assessment in samples with low levels of phenolics.

Based on the above-mentioned, a new strategy was adopted in the 2023 vintage. First, in this new set of experiments, the pressing was conducted using a commercial-size pneumatic press (SK pneumatic press, series M, model PST) to better replicate industrial conditions. Secondly, together with the absorption reading at 280 nm, phenolic compounds were quantified using ultra-pressure liquid chromatography (UPLC) to obtain a detailed characterisation of the phenolic content of the samples and a total phenol content after the individual phenolic compounds were added together. In addition to this, spectral data in the ultraviolet visible region and the mid-infrared spectral properties of the samples were used to explore the presence of key information in both regions of the electromagnetic spectrum. The use of spectral properties is also investigated as a means of implementing rapid methods for the monitoring of the process. These strategies were implemented in both still-white wines and sparkling wines. A sensorial evaluation of the wines was also performed to validate the results obtained from the chemical analysis.

These new sets of wines were again made at the Stellenbosch University experimental cellar. For still-white wines, Chenin blanc and Sauvignon blanc grapes were used. Grapes of both cultivars were purchased from farms in the Stellenbosch wine region. Once the grapes were collected, they were stored in a 4°C room to ensure grapes were at an appropriate temperature to proceed with the pressing the following day. After discussion with industry professionals, the grapes underwent two different pressing techniques for both cultivars, namely whole bunch (WB) pressing and cold maceration (CM) after crushing and destemming. The capacity of the press

allows a maximum of 1000 kg, but the press was filled with 500 kg of grapes. From a ton of grapes, half of them were whole bunch pressed (WB), and the remaining half were crushed and destemmed and placed in the press overnight to undergo cold maceration (CM). The grapes received SO_2, and the press was filled with CO_2 to ensure oxidation was limited. Once the grapes had been pressed, the juice was collected separately for each pressing phase to distinguish between free-run juice and press juice. The free-run juice was distinguished by the juice that was released while the press was in rotation without any pressure being applied for the CM wines and after applying moderate pressure (up to 0.5 bars) for the WB wines. Once the press released little to no free-run juice, the pressing cycles were executed. The juice collected from this point was considered press juice. Six blends were then made from the free-run and press juice collected. The blends included are specified below.

- 100% free-run
- 80% free-run & 20% press juice
- 60% free-run & 40% press juice
- 40% free-run & 60% press juice
- 20% free-run & 80%
- 100% press juice

Due to the soft pressing applied in the pressing operation of white wines, there were concerns regarding the ability of the pressing cycles to increase the phenolic content. Phenolics present in white wines are mostly located in the skins of the berries, and a moderate pressing might increase the juice release without promoting phenolic extractions from the skins. Blends were therefore included to ensure that increasing levels of phenolics were present in the wines with the aim of gaining an understanding of the role played by phenolic compounds. Wines were made following the protocol earlier described.

Chardonnay and Pinot noir grapes were purchased from a farm in the Stellenbosch area for the making of sparkling wines. In this case, grapes were only whole-bunch pressed in the pneumatic press. The pressing cycle consisted of 5 phases that gradually reached 1.5 bar. A softer pressing cycle was selected to mimic procedures used commercially in the wine industry and after the advice received by commercial partners. For each cultivar, half of the grapes were used to obtain the five pressing fractions, while the other half was used to produce the blends. Free-run juice for the purpose of the sparkling wine protocol was considered the first three pressing phases due to the extremely soft pressure applied following the automatic pressing schedule. The press juice was then considered as the remaining two cycles of the pressing schedule where the pressure increased to 1.5 bar. The blends consisted of:

- 100% free-run
- 80% free-run & 20% press juice
- 60% free-run & 40% press juice
- 40% free-run & 60% press juice
- 20% free-run & 80% press juice
- 100% press.

The separated musts were left to settle with the addition of Rapidase® Clear and SO_2 in the 4°C room. The following day, all the different pressing phases and blends were racked into fermentation vessels and inoculated with Zymaflore® Spark yeast (Laffort), specifically used for sparkling wines and simultaneously Nutristart® was added to ensure enough nutrients were available during fermentation. Degrees Balling were taken every day for each fermentation vessel and once the must dropped by 5° balling, Dynastart® was added, guaranteeing no stuck fermentations. Once the base wines finished alcoholic fermentation, they were racked for a second time and analysed for residual sugar. For each fermentation vessel volume, table-grade sugar (sucrose) was added. The wines were thoroughly mixed with an automatic mixer to ensure

all the sugar had been dissolved. Before the second fermentation could take place, the Zymaflore® Spark yeast was rehydrated to ensure yeast would acclimatise to the difficult fermentation conditions of the base wine. Gradually, over a week, additional base wine and sugar were added to the rehydrated yeast to make sure it had adapted to the increased alcohol content while increasing in biomass. In each 750 ml sterilised sparkling wine bottle, 23 ml of rehydrated yeast solution was added and topped up with the base wine. The bottles were then capped with a crown cap and left to ferment for a minimum of six weeks in a 15°C room. After the second fermentation in the bottles occurred, riddling was performed to loosen the sediment produced during the secondary fermentation. After riddling, disgorgement took place to eliminate the deposit that had collected at the neck of the bottle. This process was done manually with a bottle opener. Once the bottles had been disgorged, they were filled to the top with their respective sparkling wines to ensure there was no headspace in the bottle and then closed again with crown caps. Samples were taken of each cultivar and blended before settling, after settling, after primary fermentation, after secondary fermentation and at 12 months of bottle ageing as per the MCC protocol. These samples were treated with SO_2 and stored in the freezer until analysis.

Additionally, grapes were also processed during the 2024 harvest. In this case, Chenin and Sauvignon Blanc grapes were sourced for still wines and Chardonnay for sparkling wines. These grapes were obtained from a producer based in the Stellenbosch area. Cold maceration and whole bunch processing were again conducted for still whites, and both pressing fractions and blends were produced and analysed. These wines were made to increase the number of samples in the must dataset. One of the main goals of the project is to investigate the use of rapid methods to monitor the pressing operation, and for this, a larger dataset is needed.

Conclusions: *a pneumatic press was used to replicate industrial processing conditions. Still white wines were made following cold maceration and whole bunch pressing. A pressing protocol in line with commercial practices was used for sparkling wine production. Additional must data was generated during the 2024 harvest.*

OBJECTIVE 2. To analyse the chemical and phenolic profile of the juices and wines used in the study

Problem identification: *once the winemaking protocols have been defined, analysis to quantify the phenolic content, colour and oenological parameters of the musts and wines were performed to better understand the chemical changes taking place during the pressing and making of still and sparkling wines*

1. Still white wines

The total phenol content as the ABS at 280 nm was measured for the wines produced. Two winemaking approaches (whole bunch pressing (WB) and cold maceration (CM)) were used. Representative examples of the results obtained are presented in **Figures 1** and **2**.

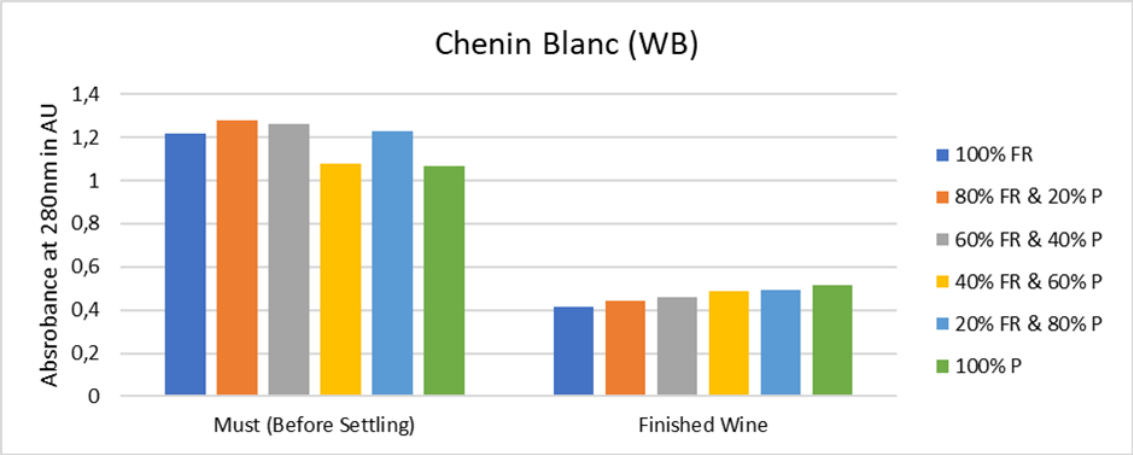

Figure 1. Total phenol content in absorbance units (AU) for whole bunch (WB) pressed 2023 Chenin Blanc musts and wines. FR: free-run; P: press

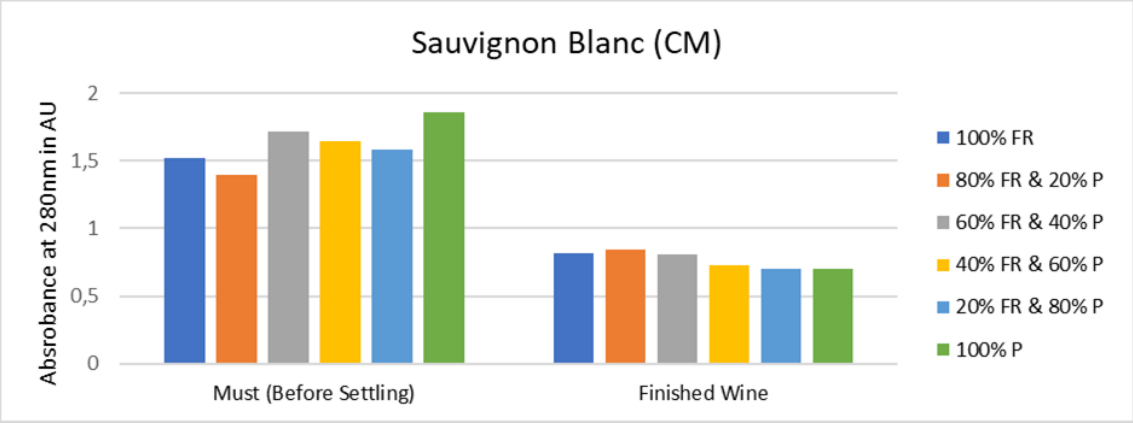

Figure 2. Total phenol content in absorbance units (AU) for cold macerated (CM) pressed 2023 Sauvignon Blanc musts and wines. FR: free-run; P: press

The ABS 280 nm, as a measurement of the total phenolic content, showed variable results dependent on cultivar and time during the winemaking process. Chenin Blanc does not show an increasing phenolic trend in musts as opposed to Sauvignon Blanc, which showed an increase in phenolics with increased presence of pressing fraction in the blends. No clear trend was observed in the finished wines for either variety (WB Chenin Blanc shown in Figure 1 being the only exception). Differences in phenolic extraction were also not observed in either processing technique, indicating that cold macerating white wines overnight do not have a drastic effect on the phenolic content of the wines produced. Wines made in 2024 showed the same trends supporting the above-mentioned.

The total phenol content was obtained using ultra-performance liquid chromatography (UPLC). This analytical technique quantifies individual phenolics, and the total phenol content is calculated by adding the individual phenolics identified. In addition, the data was also analysed per phenolic family. The flavanols, hydroxycinnamic acids and flavonols were investigated separately. A summary of the relevant results is presented in **Figures 3-6**.

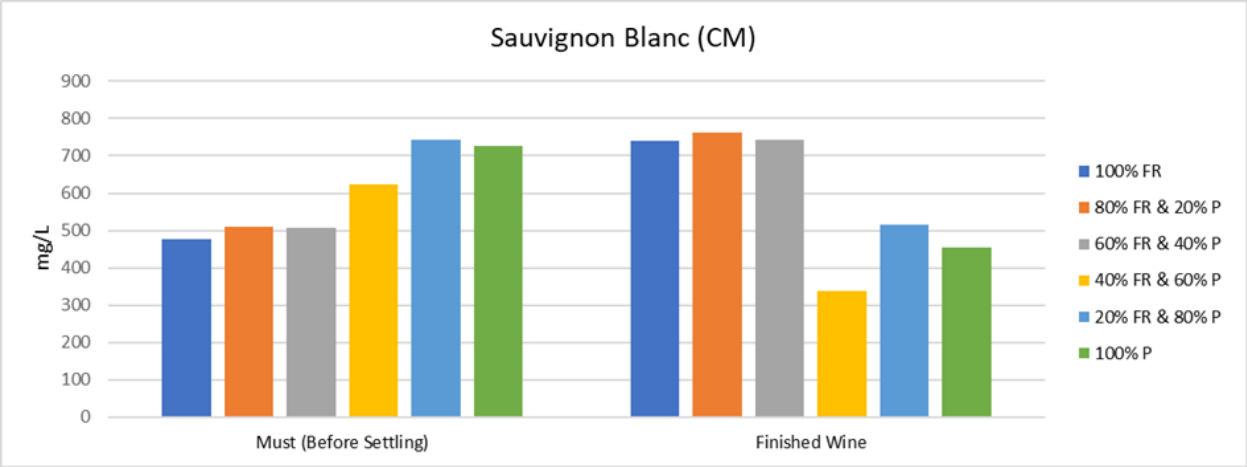

Figure 3. Total phenol content in mg/L obtained by UPLC for cold macerated (CM) pressed 2023 Sauvignon Blanc musts and wines. FR: free-run; P: press

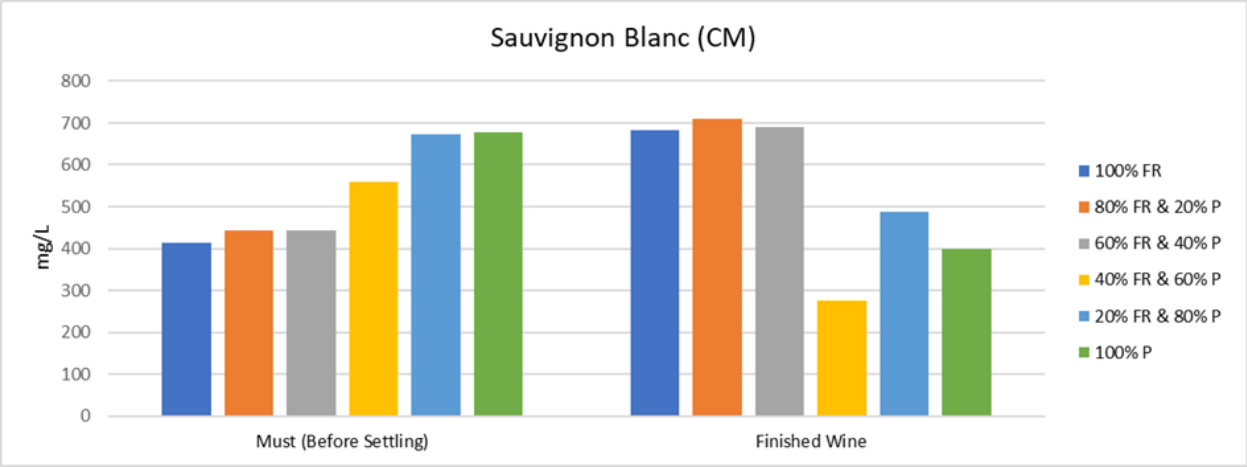

Figure 4. Total flavanol content in mg/L obtained by UPLC for cold macerated (CM) pressed 2023 Sauvignon Blanc musts and wines. FR: free-run; P: press

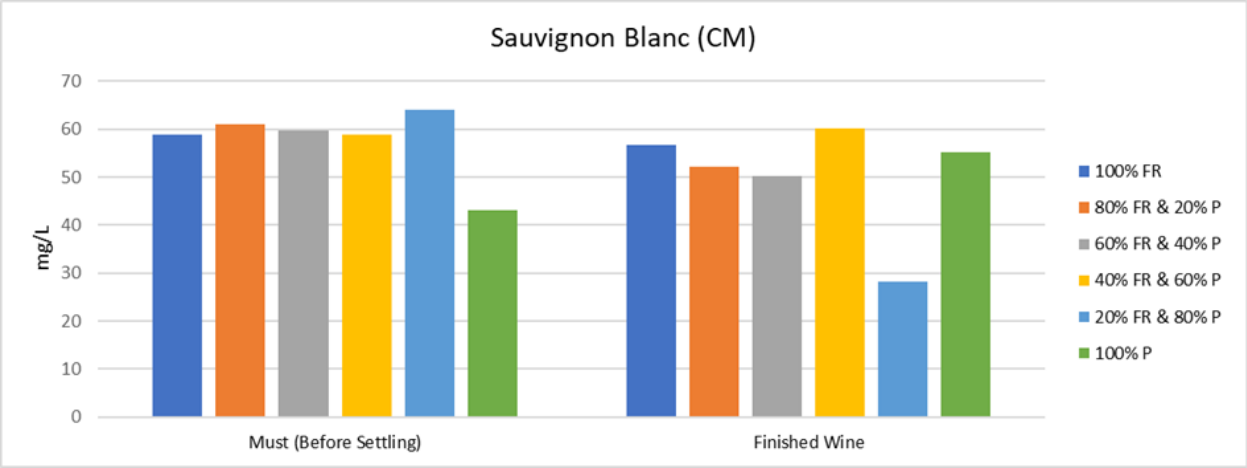

Figure 5. Total hydroxycinnamic content in mg/L obtained by UPLC for cold macerated (CM) pressed 2023 Sauvignon Blanc musts and wines. FR: free-run; P: press

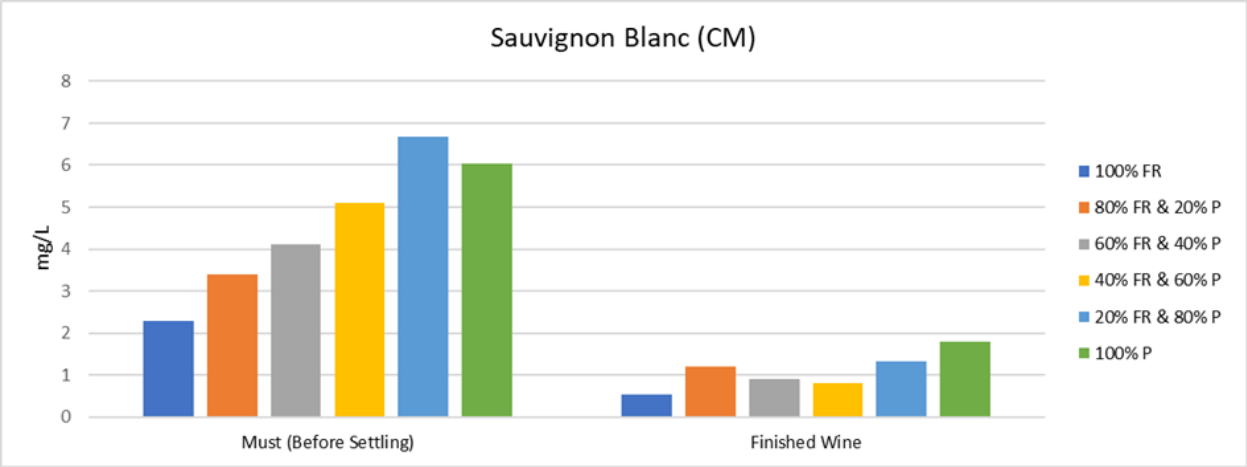

Figure 6. Total flavonol content in mg/L obtained by UPLC for cold macerated (CM) pressed 2023 Sauvignon Blanc musts and wines. FR: free-run; P: press

UPLC quantified total phenol content seems to better represent the presence of pressing fractions with higher levels of phenolics. Total flavanol content, which accounts for a big portion of the total phenol content, is also a good indicator of increasing pressing fraction presence. On the contrary, hydroxycinnamic acids do not show this trend, with higher levels observed in the free-run wine. Interestingly, flavonol content showed a clear increasing trend for both cultivars but only when cold maceration was applied. The trends observed in the must analysis are again not observed in the wines made thereof.

CieLAB colour coordinates were also used as an absolute measurement of colour. CieLAB coordinates represent colour using three coordinates: L, a* and b*, which represent the lightness of the colour, the colour between red and green and the colour between blue and yellow, respectively. The aim was to investigate if colour measurements could be used to differentiate between increasing levels of phenolics. It seems that the luminosity decreases as the presence of the pressing fraction increases in the samples. However, these results are not observed across the varietals and winemaking protocol or in the finished wines. The same was observed for the a* and b* coordinates indicating that colour properties are not always able to differentiate between pressing fraction presence. **Figures 7 and 8** below show the above-mentioned.

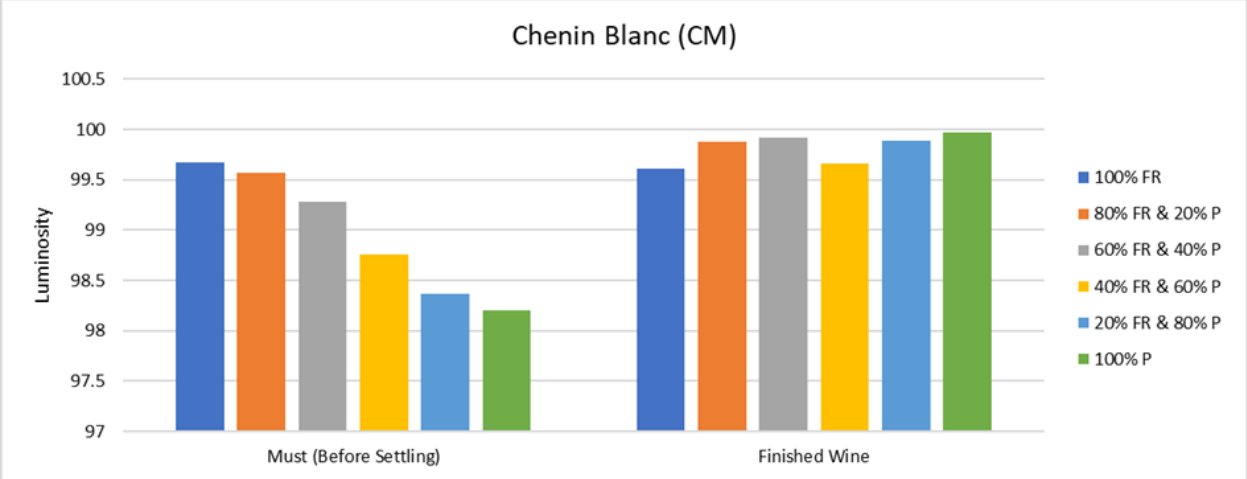

Figure 7. Luminosity (L) for cold macerated (CM) pressed 2023 Chenin Blanc musts and wines. FR: free-run; P: press

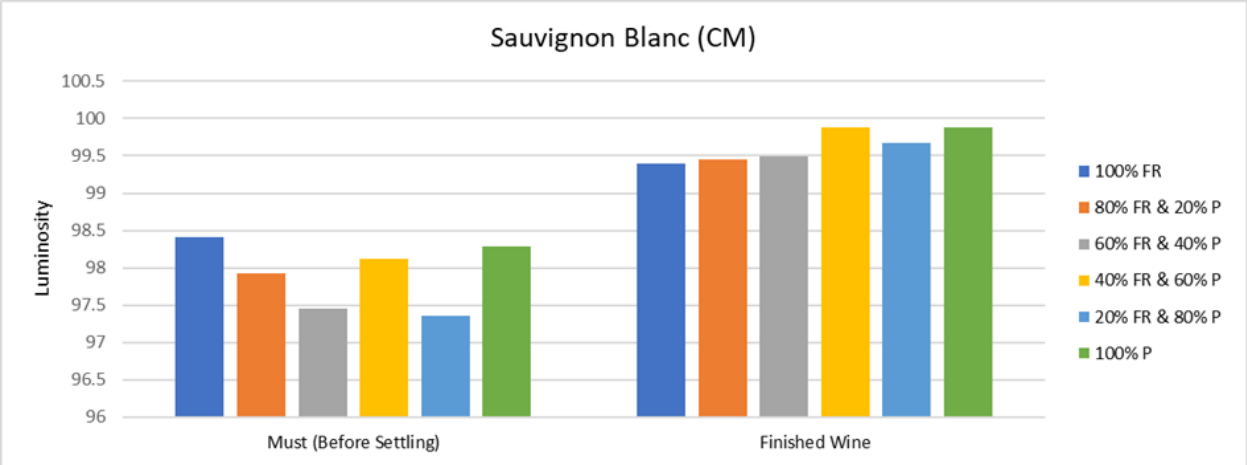

Figure 8. Luminosity (L) for cold macerated (CM) pressed 2023 Sauvignon Blanc musts and wines. FR: free-run; P: press

The oenological parameters of the musts and wines were also investigated to determine if they could be related to increasing phenolic presence in the wines produced. The following parameters were assessed in the musts: °Brix, density (g/cm3), malic acid (g/L), pH, probable alcohol (%), total acidity (g/L) and sugar content (g/L). pH was the parameter that showed a better representation of the increasing presence of pressing fractions in the blends (**Figure 9**).

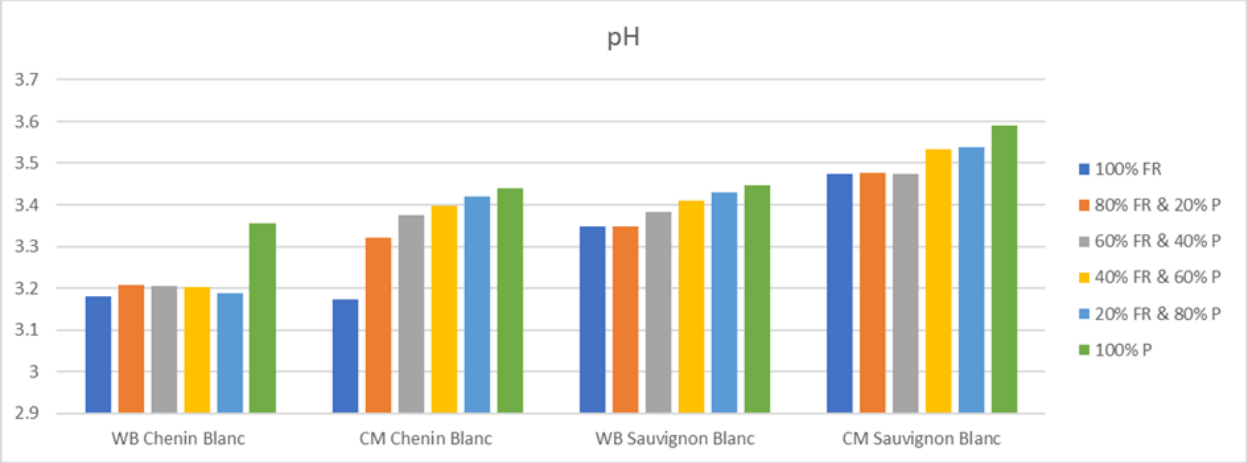

Figure 9. pH values for cold macerated (CM) and whole bunch (WB) pressed 2023 Chenin and Sauvignon Blanc musts obtained after the generation of artificial blends with Free-run (FR) and Press (P) must fractions.

Conclusions: *UPLC total phenol and flavanol content are the measurements that better represent increasing phenolic content from the increasing presence of press fraction in the blends. CieLAB colour properties and ABS 280 nm showed variable results. pH is the oenological parameter that best represents the pressing fraction presence.*

2. Sparkling wines

The ABS at 280 nm, the total phenolic content as the sum of the individual compounds quantified in the UPLC analysis, the CieLAB coordinates, and the oenological parameters were also assessed in the sparkling wines. Two methodologies to obtain increasing levels of phenolics were attempted. This consisted in the collection of samples following the pressing cycles applied during the grapes pressing and again by generating artificial blends. The ABS at 280 nm showed inconsistent results, with no clear trends observed in some wines (**Figures 10, 11, 12**). In agreement with the still wines, UPLC results showed a better representation of press fraction

presence, which was more consistent in the musts and wines obtained from the artificial blends (**Figures 13, 14**). It can be speculated that the pressing fractions generated during the pressing program applied might not always cause an increase in the phenolic content of the must. Limited pressures are applied during the pressing of grapes for sparkling wine production, and this might not be sufficient to cause a significant diffusion of phenolics from the solid parts into the must. Blends created artificially from the free-run and press fractions might provide a better gradual increase in phenolics than the phases collected.

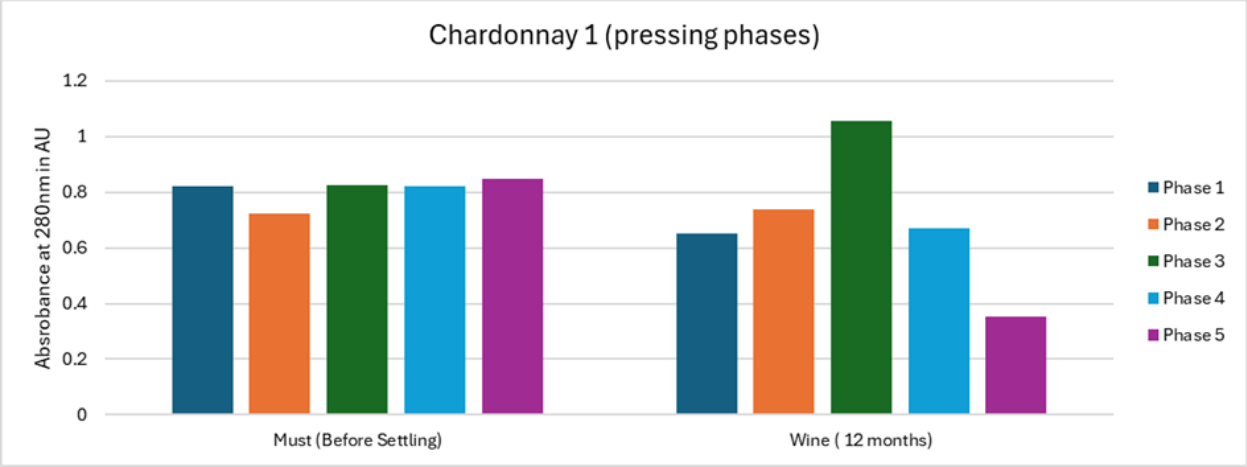

Figure 10. Total phenol content in absorbance units (AU) for the phases collected during the pressing operation of Chardonnay musts and wines made thereof.

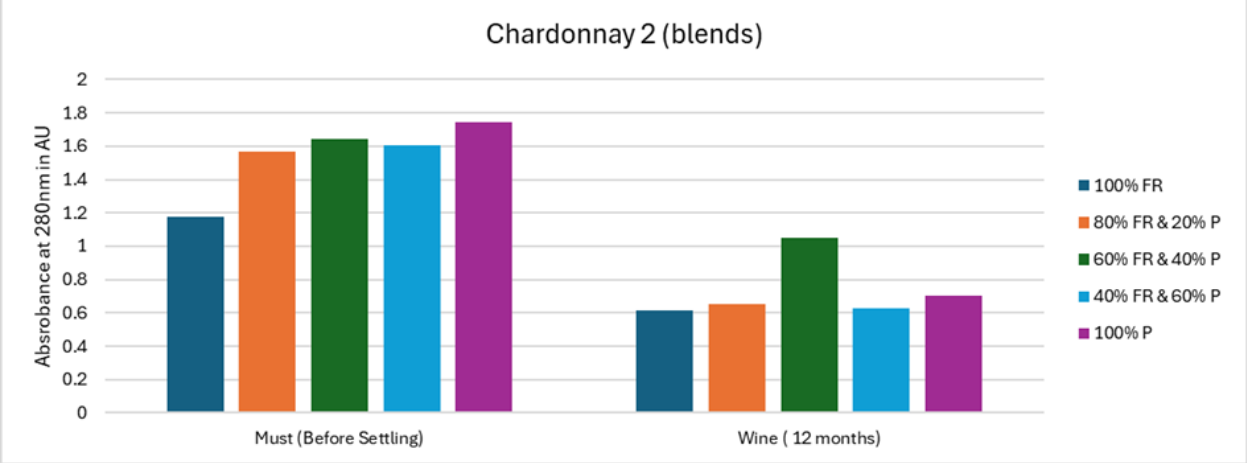

Figure 11. Total phenol content in absorbance units (AU) for the blends created of Chardonnay musts and the wines made thereof. FR: free-run; P: press

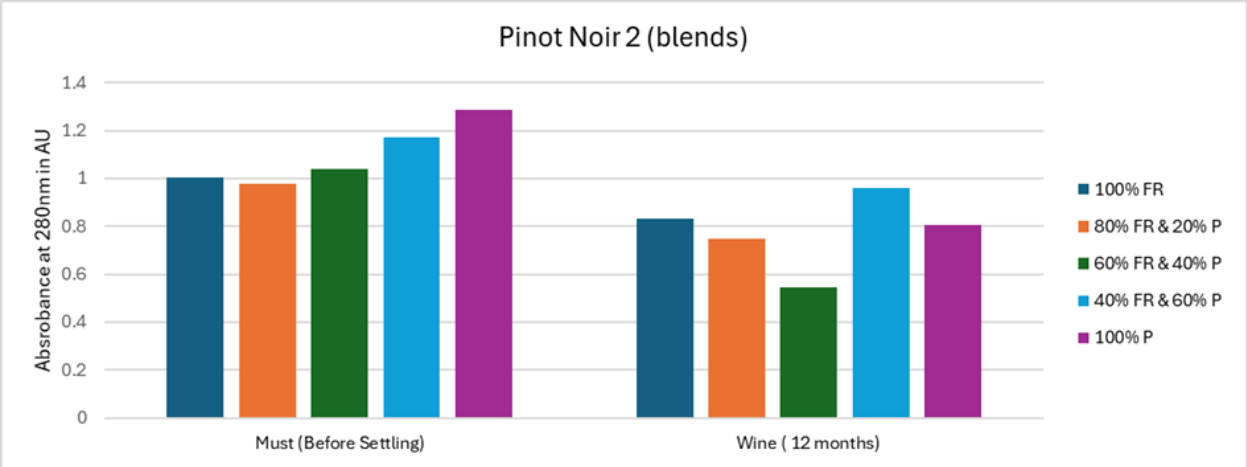

Figure 12. Total phenol content as ABS 280 nm in absorbance units (AU) for the blends created of Pinot Noir musts and the wines made thereof. FR: free-run; P: press

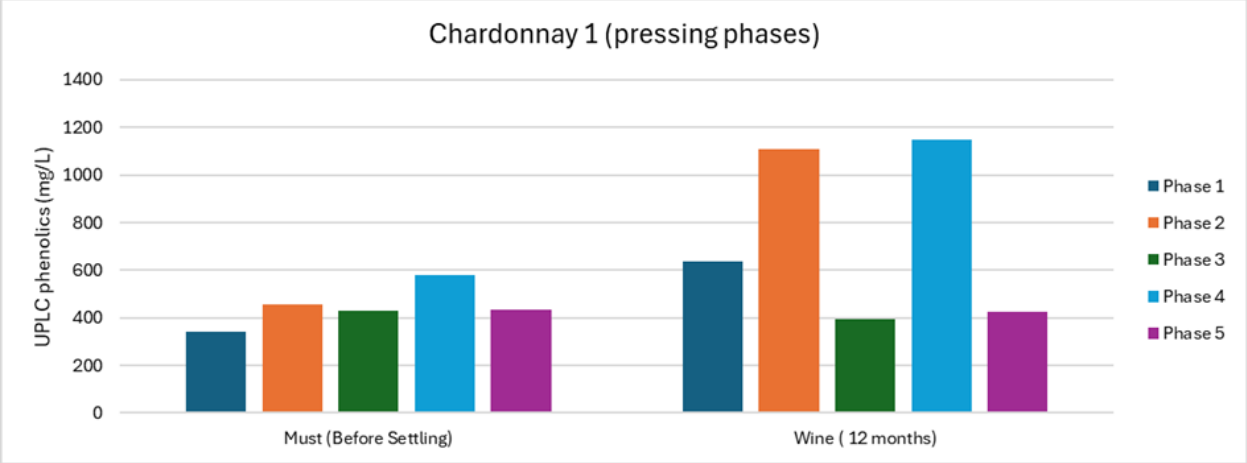

Figure 13. Total phenol content from the UPLC (m/L) for the phases collected during the pressing operation of Chardonnay musts and wines made thereof.

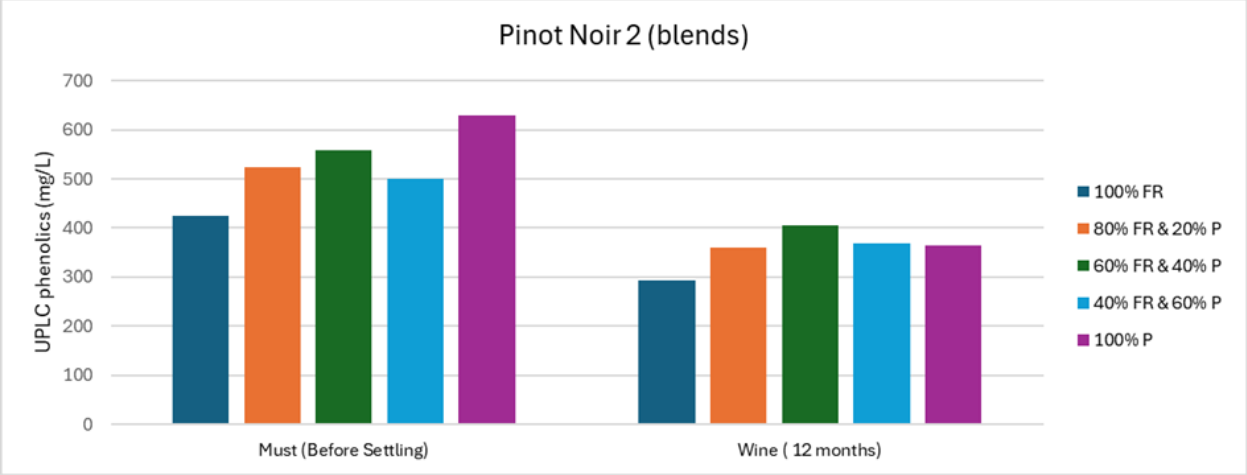

Figure 14. Total phenol content from the UPLC (mg/L) for the blends created of Pinot Noir musts and the wines made thereof. FR: free-run; P: press

CieLAB colour coordinates were also investigated, but similarly to the still wines, no trends explaining the increasing presence of pressing fraction were observed (data not shown). Finally, from the oenological parameters, the results of the pH values are reported in **Figures 15** and **16**. In agreement with the still wines, pH seems to be a good indicator of increasing pressing fraction.

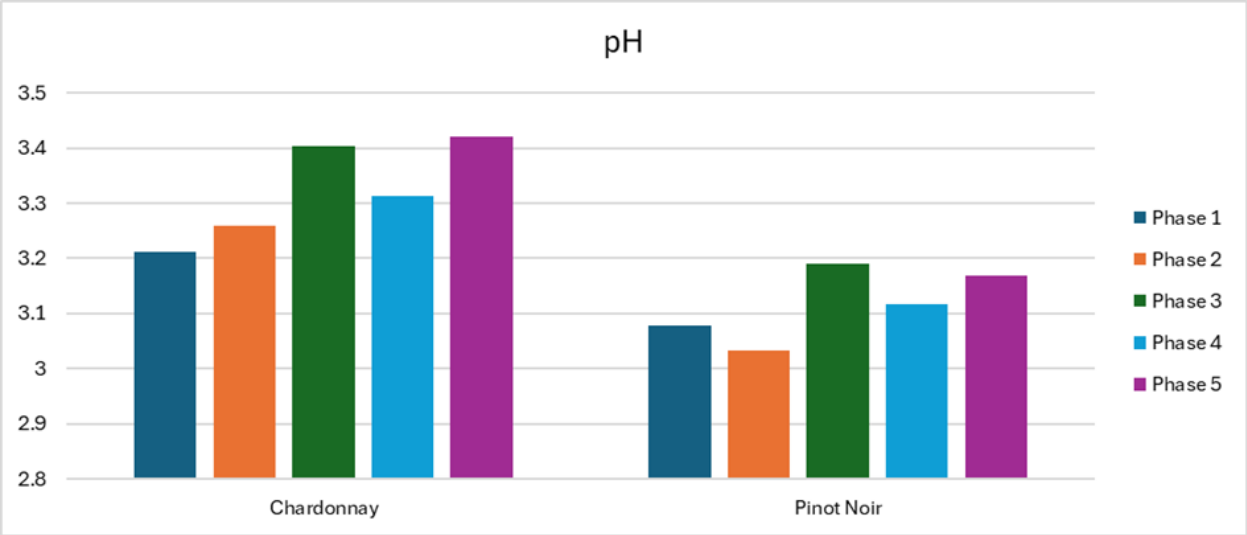

Figure 15. pH values for Chardonnay and Pinot Noir musts obtained during the pressing operation.

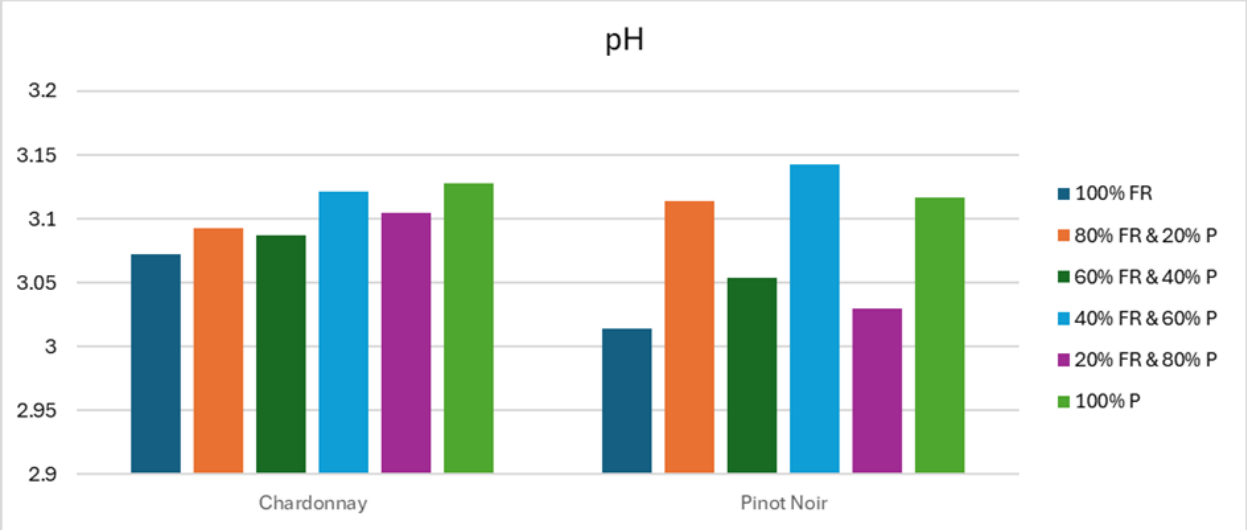

Figure 16. pH values for Chardonnay and Pinot Noir musts obtained after the generation of artificial blends with Free-run (FR) and Press (P) must fractions.

Conclusion: *UPLC seems to be a better indication of increasing pressing fraction presence. The phases collected during the pressing cycles applied in sparkling winemaking might be less consistent in representing increasing phenolic levels. pH appears again as a good indicator of increasing pressing fraction presence.*

OBJECTIVE 3. Sensorial evaluation of the wines produced

Problem identification: *It is important to find the appropriate sensory methodology to assess the panel's ability to identify sensorial differences between the wines produced. A discrimination method will indicate if samples are perceived differently. However, to better understand why the samples are perceived differently, attribute scoring should also be included.*

After careful consideration of the available methods, a sensory methodology to assess the still and sparkling wines produced was implemented. A trained panel consisting of 10 members, varying in age and experience from the sensory laboratory at the Department of Viticulture and Oenology (Stellenbosch University) took part in the sensory experiment. Before commencing with

the sensory analysis, the panel took part in two training sessions for both the still-white wines and the sparkling wines. The training sessions helped the panel familiarise themselves with mouthfeel attributes such as bitterness, sourness, astringency, and body in the wines of the study. For the first still white wine training session, a spiked standard base wine with different additives at varying increments was used. The panel was then asked to rank them from strongest to weakest. For the sourness test, the panel was presented with four random wines spiked with different levels of tartaric acid. Sample A was the control and consisted of the base wine, sample B was the base wine with 0,3 g/L of tartaric acid, sample C was the base wine with 0,1 g/L of tartaric acid, and lastly, sample D contained the base wine with 0,2 g/L of tartaric acid. The panel was then asked to rank them, and the results were discussed. The same procedure was repeated for astringency and bitterness. For astringency, the base wine was spiked with aluminium sulfate at concentrations of 0,25 g/L, 0,5 g/L and 1 g/L. For bitterness, grape tannins were added to the base wine from a 250 ml stock solution and a 125 ml stock solution. During these training sessions, the panel members were allowed to freely discuss answers among themselves, and the correct answers were given at the end for validation. In the second training session, the panel members were asked to taste the still-white wines that had been produced. They were asked to distinguish between the free-run juice and the blend consisting of 80% free-run and 20% press juice for both the Chenin Blanc and the Sauvignon Blanc. This was done to allow panel members to become acquainted with the wines they would be tasting for the rest of the sensory sessions.

For the sensory sessions, the panel members were seated in booths to ensure there was no discussion of answers between them. The room is a well-lit white room that is kept at a comfortable temperature, specifically for white wine tasting. The glasses used are opaque black to guarantee that members don't assess wines based on visual cues rather than mouthfeel attributes. Each glass had a randomised three-digit code, and the data was captured in the Compusense® database. The panel members were presented with triplicates of a triangle test; therefore, two of the wines were identical and one was odd. They were asked to perform the triangle test and select the odd sample and rate the intensity of sweetness, astringency, bitterness, sourness, and body on a 5-point scale. A comment bar was also provided if they felt the need to elaborate on a specific wine. Between flights, panel members were asked to leave the room for a ten-minute break to ensure their pallets did not become saturated. During this break, they are not allowed to eat, smoke, or drink anything besides water, ensuring their taste buds don't become tainted. During the sensory session, water is provided with spittoons and cream crackers to cleanse the pallet.

For the sparkling wine training sessions, the panel members were given a 100% Chardonnay MCC, a 100% Pinot noir MCC and an MCC blend. The training was focused on panel members getting acquainted with tasting sparkling wines with varying bubble sizes and bubble persistence. The same protocol was followed for the sparkling wines, and panel members were asked to do a triangle test in triplicate to indicate which sample was different. In a triangle test, two samples are the same and one is different. An equal number of tests were set up with random distribution of the sample that is presented twice in the test. Panelists were also required to rank the samples based on astringency, bitterness, sourness, and body. The only difference is that to make sure that the test was accurate and done uniformly, the sparkling wines had to be opened and poured within 10 minutes of the panel tasting to guarantee that the bubbles didn't differ between tasters and didn't become flat in the glass. Data was captured on the Compusense® software and evaluated using ANOVA.

1. Still white wines

Triangle tests were conducted on the wines produced during the 2023 harvest. A completely randomised approach was followed, and the most representative results are shown in the graphs below. Two tasks were initially conducted to better understand the perception of increasing pressing fraction presence in the wines produced. The first triangular test task involved the assessment of the pair 100% Free-run (FR) versus the wines that contained 80% Free-run

and 20% Press fraction (80%FR/20%P). Secondly, the panel was presented with the pair 100%Free-run (FR) versus 100%Press (P). This second task was included to avoid tasting the intermediate blends as in the case that no differences were obtained between the Free-run versus press it is accepted that no differences exist between the blends with a lower proportion of press fraction. In triangular discriminant tests, the results are statistically significant if half of the response plus 1 were correct in the identification of the wines that were different. **Figures 17** and **18** show representative examples of the results observed. Overall, the panel was unable to find differences in either cultivar (Chenin and Sauvignon blanc) or winemaking approach followed (i.e. WB or CM).

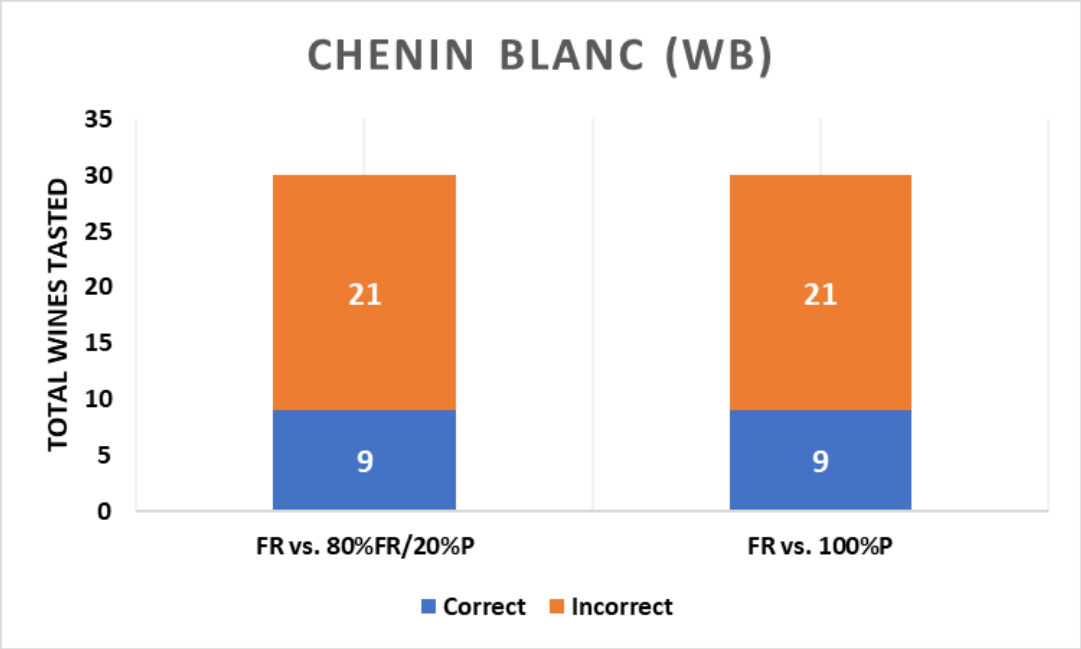

Figure 17. Triangular test between 100%Free-run versus 80% Free-run and 20% Press (FR vs. 80%FR/20%P) and between 100%Free-run versus 100%Press (FR vs. P) for whole bunch pressed Chenin Blanc.

As can be seen in **Figure 17** the panel was unable to distinguish between the free-run and the press wine, indicating that the presence of press fraction in the wines did not have a drastic effect on the sensorial properties of the wines produced. In addition, **Figure 18** shows again no statistical difference for the pair FR vs. P. However, a higher number of correct responses were obtained, which might be pointing to a different (although non-significant) sensory perception of the press fraction.

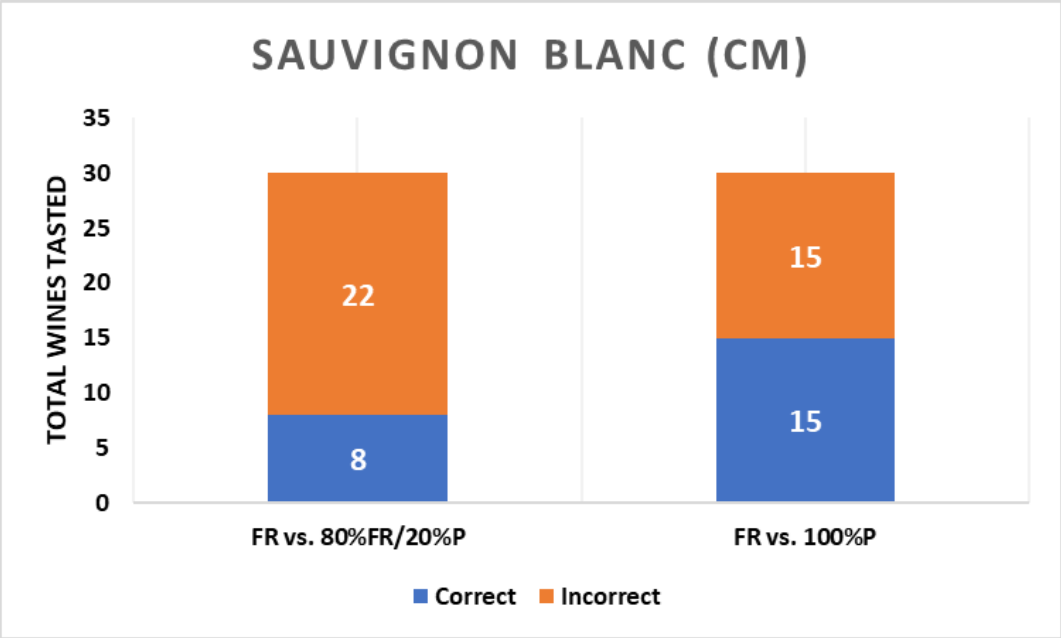

Figure 18. Triangular test between 100%Free-run versus 80% Free-run and 20% Press (FR vs. 80%FR/20%P) and between 100%Free-run versus 100%Press (FR vs P) for the cold macerated Sauvignon Blanc wines.

To investigate the sensorial differences of the wines further, the mouthfeel attribute scores given by the panel were analysed. In this case, box plots and analysis of variance were conducted. Only the scores provided by the panel's correct responses were used. From the four attributes' provided by the panel, only the body attribute showed statistical significance. **Figure 19** shows the box plots with the data distribution, the mean values and the significant letters for the body attribute. Interestingly, press wines were perceived with a lower body than free-run juice wines. The higher presence of phenolics in press wines might increase the perception of dryness with an overall perception of lower body.

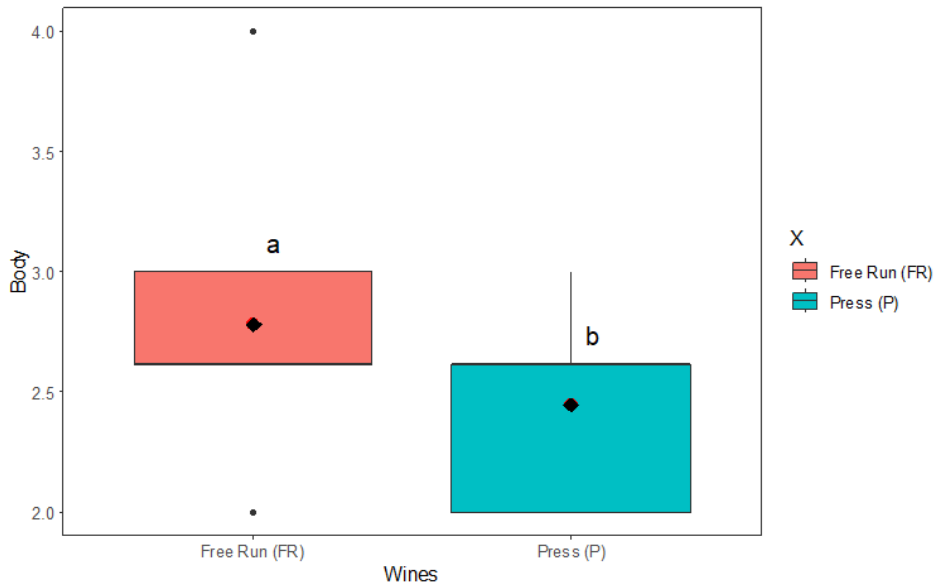

Figure 19. Box plot for the "body" attribute comparing free-run versus press Sauvignon Blanc wines made with cold maceration

Conclusion: *overall the addition of pressing fractions into the still white wines does not have*

a significant influence on the sensorial perception. The winemaking techniques (i.e. cold maceration and whole bunch) applied do not substantially influence the mouthfeel perception of increasing pressing fraction presence in the wines produced.

2. Sparkling wines

Similarly, sparkling wines with increasing presence of press fraction and phenolic content were assessed. In this case, two tastings (after the second fermentation and at 12 months in accordance with the MCC winemaking protocol) were undertaken. The results of the tastings after the second fermentation are discussed below. Varying pressing phases and blends were used to obtain wines with a higher presence of phenolics. The results of the tasting once the second fermentation was completed are shown in **Table 1**. Differently from what was observed for still white wines, sparkling wines seem to be more affected by the presence of pressing fractions. Four out of the five wines analysed showed statistical differences when the free-run was compared against the blend with a 20% press fraction. In two of the wines, there was an increasing number of correct responses in the comparison against the 100% press fraction, pointing towards increasing levels of phenolics causing larger sensorial differences.

Table 1. Summary results of the sensorial evaluation of the sparkling wines after second fermentation completion. Flight 1 corresponds to the comparison between the free-run and the 80% free-run 20% press blend. Flight 2 corresponds to the comparison between the free-run and the press wines.

Chardonnay (Pressing phases)				Pinot Noir (Pressing phases)			
Flight 1	Correct Answers			Flight 1	Correct Answers		
FR vs. Phase 2	Rep 1	Rep 2	Rep 3	FR vs. Phase 2	Rep1	Rep 2	Rep 3
2 x FR vs. 1xPhase 2	3	2	3	2xFR vs. 1xPhase 2	2	3	3
1 x FR vs. 2xPhase 2	3	3	2	1xFR vs. 2xPhase 2	4	2	3
Total	6	5	5	Total	6	5	6
16 out of 30 judges correct = significant				17 out of 30 judges correct = significant			
Flight 2	Correct Answers			Flight 2	Correct Answers		
FR vs.Phase 5	Rep 1	Rep 2	Rep 3	FR vs. Phase 5	Rep 1	Rep 2	Rep 3
2 x FR vs. Phase 5	5	1	2	2xFR vs. 1xPhase 5	5	5	4
1 xFR vs. 2 x Phase 5	2	2	3	1xFR vs. 2xPhase 5	4	4	4
Total	7	3	5	Total	9	9	8
15 out of 30 judges correct = significant				26 out of 30 judges correct = significant			

Chardonnay (Blends)				Pinot Noir (Blends)			
Flight 1	Correct Answers			Flight 1	Correct Answers		
FR vs. 80%	Rep 1	Rep 2	Rep 3	FR vs. 80%	Rep 1	Rep 2	Rep 3
2xFR vs. 1x80%	2	4	1	2 x FR vs. 1x80%	1	2	2
1xFR vs. 2x80%	1	2	2	1 x FR vs. 2x80%	5	4	2
Total	3	6	3	Total	6	6	4
12 out of 30 judges correct = not significant				16 out of 30 judges correct = significant			
Flight 2	Correct Answers			Flight 2	Correct Answers		
FR vs. P	Rep 1	Rep 2	Rep 3	FR vs.P	Rep 1	Rep 2	Rep 3
2xFR vs. 1xP	0	2	2	2 x FR vs. P	2	1	4
1xFR vs. 2xP	2	3	1	1 xFR vs. 2 x P	3	4	3
Total	2	5	3	Total	5	5	7
10 out of 30 judges correct = not significant				17 out of 30 judges correct = significant			

Chardonnay (Pressing phases)			
Flight 1	Correct Answers		
FR vs. Phase 2	Rep 1	Rep 2	Rep 3
2 x FR vs. 1xPhase 2	1	3	4
1 x FR vs. 2xPhase 2	2	4	2
Total	3	7	6
16 out of 30 judges correct = significant			
Flight 2	Correct Answers		
FR vs.Phase 5	Rep 1	Rep 2	Rep 3
2 x FR vs. Phase 5	3	2	4
1 xFR vs. 2 x Phase 5	4	4	4
Total	7	6	8
21 out of 30 judges correct = significant			

As mentioned, the sensorial evaluation of the wines was also conducted after 12 months of bottle ageing. **Figure 20** shows the correct and incorrect responses obtained from the sensory evaluation of the Chardonnay wines made with the pressing fractions collected. Although not linearly, an increasing number of correct responses was obtained from phase 2 to phase 5 of the pressing protocol. For instance, the initial comparison did not show statistical differences (10

correct responses), indicating that the panel was unable to perceive sensorial differences between the two wines. However, the following comparisons did show statistical significance (half of the responses + 1). Despite the observed differences, the analysis of the mouthfeel attributes did not reveal any significant differences.

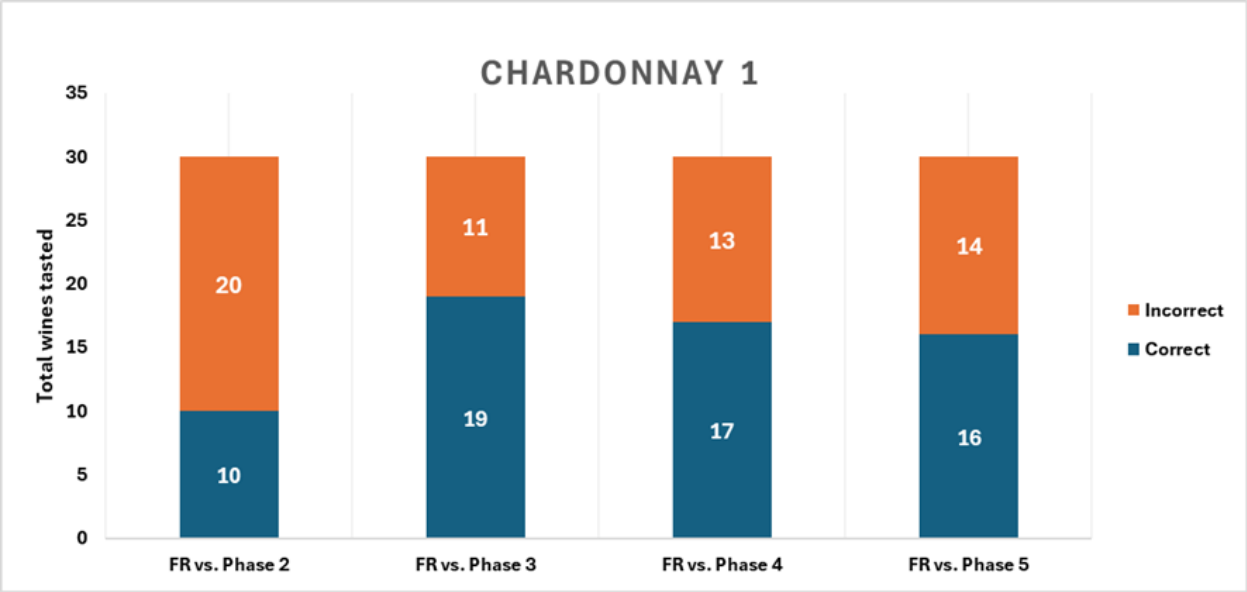

Figure 20. Pair-wise comparison between free-run and the different phases obtained from the pressing operation of Chardonnay grapes.

Figure 21 below shows the triangular test results for the Chardonnay blends obtained. In this case, artificial blends with increasing levels of phenolics were created. The results showed increasing levels of correct responses as press fraction presence increased in the blends. The differences are more intensively observed in the wines with 60% and 100% press fractions.

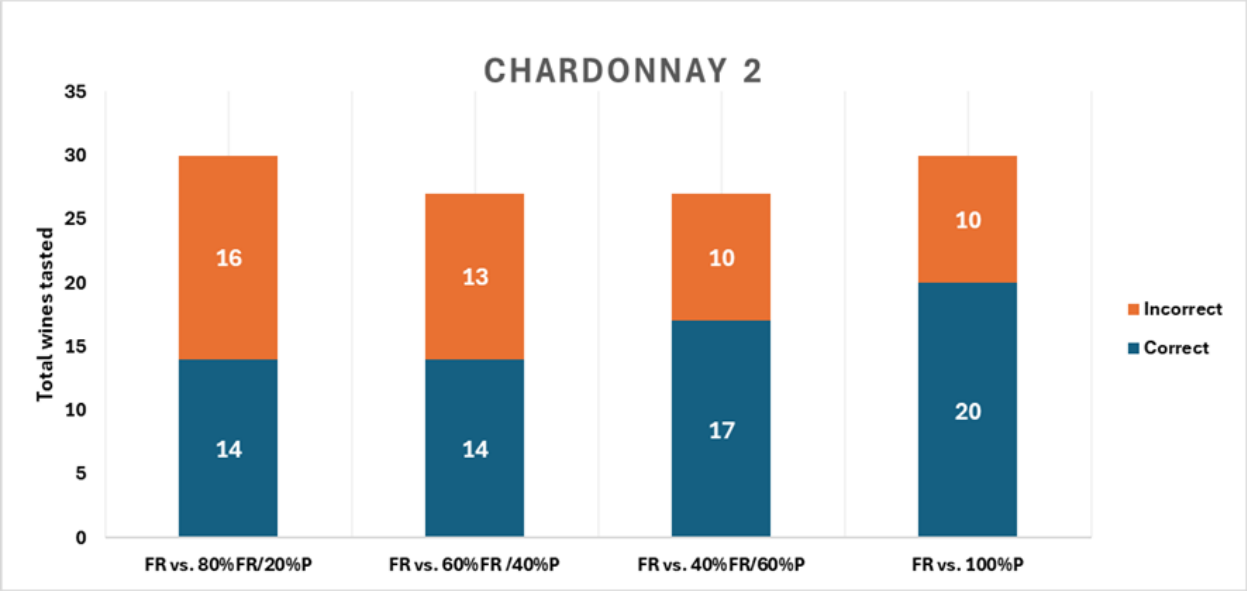

Figure 21. Pair-wise comparison between free-run and the different blends obtained from the pressing operation of Chardonnay grapes.

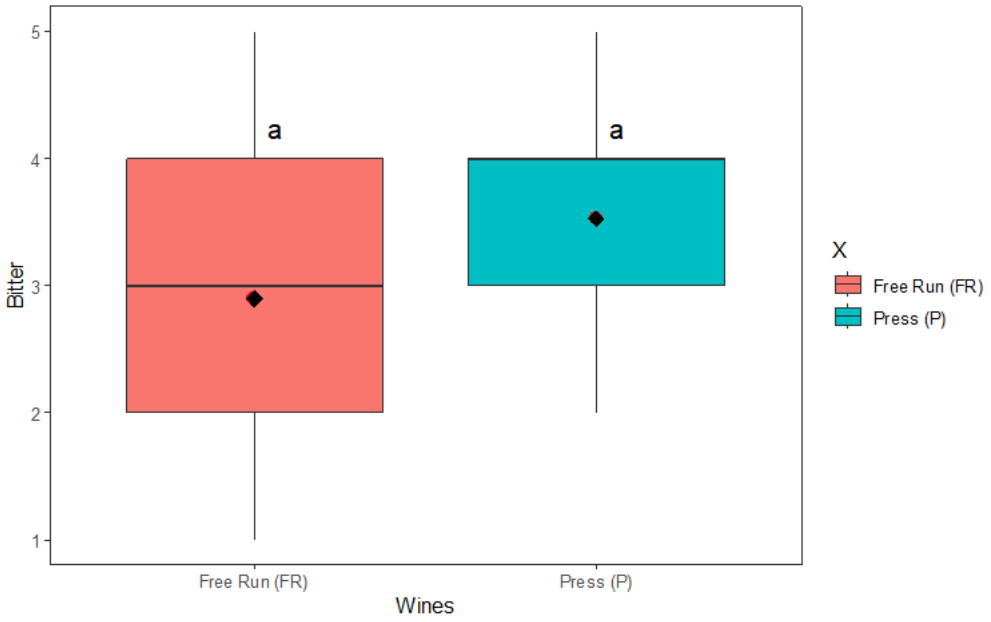

Figure 22. Box plot for the "bitter" attribute comparing free-run versus press Chardonnay sparkling wines at 12 months of bottle ageing. Average values are shown with a diamond symbol. The same letters (a, a) indicate no significant differences at a 95% confidence interval between the wines produced.

Figure 22 shows the box plot for the "bitter" attribute, comparing the free-run with the press Chardonnay 2 wines. Interestingly, the press wine was rated with increased bitterness. Although the statistical significance was only at 90% (and not at the standard 95% confidence interval), this can be an indication of the role played by increased phenolic extraction during the pressing operation. The other assessed attributes (i.e. sweetness, astringency, sourness and body) did not show statistical significance for these wines.

In addition, Chardonnay musts during the pressing operation were obtained from a commercial cellar. The pressing protocol used in the cellar was the same as the one followed in the wine of the study. After the collection of the musts, the wines were made at the experimental cellar following the protocol described above. **Figure 23** shows a high number of correct responses when the free-run and the press wines were compared. The scores provided by the panel for the mouthfeel attributes were again assessed to investigate which are the attributes causing the different sensorial perceptions. Surprisingly, despite the ability of the panel to discriminate between wines, no statistical differences were found. In other words, the wines were perceived differently, but the astringency and bitterness, as the main attributes that should be influenced by increasing phenolic levels, were not scored statistically differently.

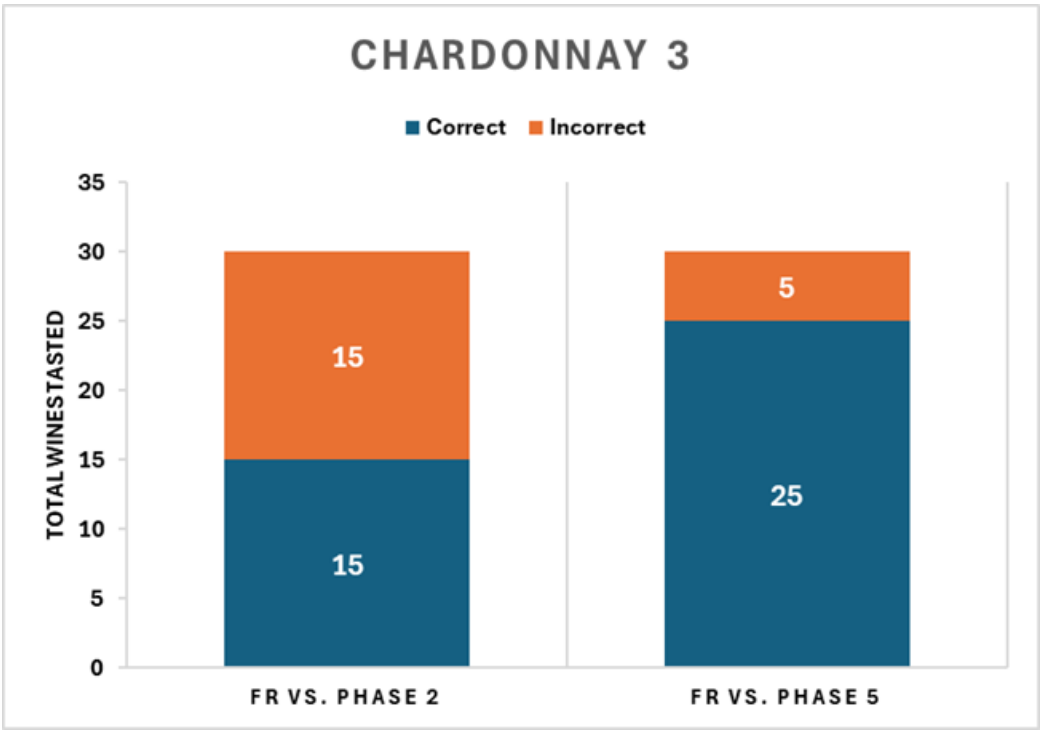

Figure 23. Pair-wise comparison between Free-run (FR) and Phase 2 and Free-run (FR) and Phase 5 of Chardonnay wines obtained from a commercial cellar.

A pair-wise comparison between free-run and the different phases obtained from the pressing operation of Pinot Noir grapes is shown in **Figure 24**. In this case, a significant number of correct responses were observed even for the comparison with the wine obtained at the end of the second phase of the pressing cycle. When analysing the scoring data of the mouthfeel attributes, no significant differences were found. The astringency attribute showed higher scores in the press wine than in the free-run (**Figure 25**). However, as previously mentioned, these differences were not statistically significant.

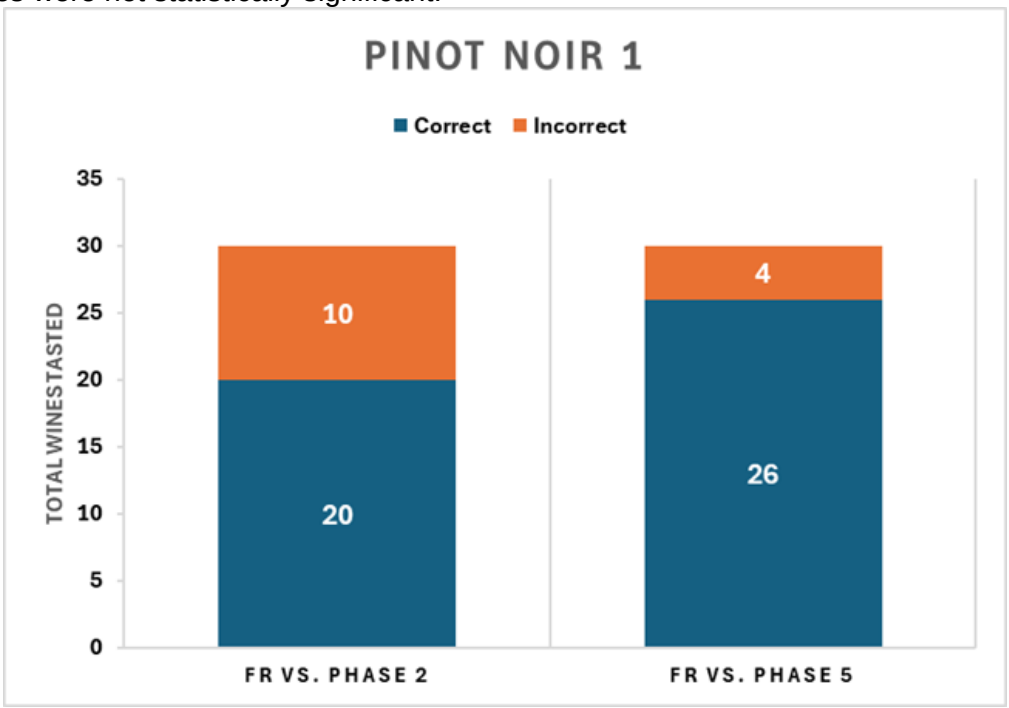

Figure 24. Pair-wise comparison between Free-run (FR) and Phase 2 and Free-run (FR) and Phase 5 of Pinot Noir wines.

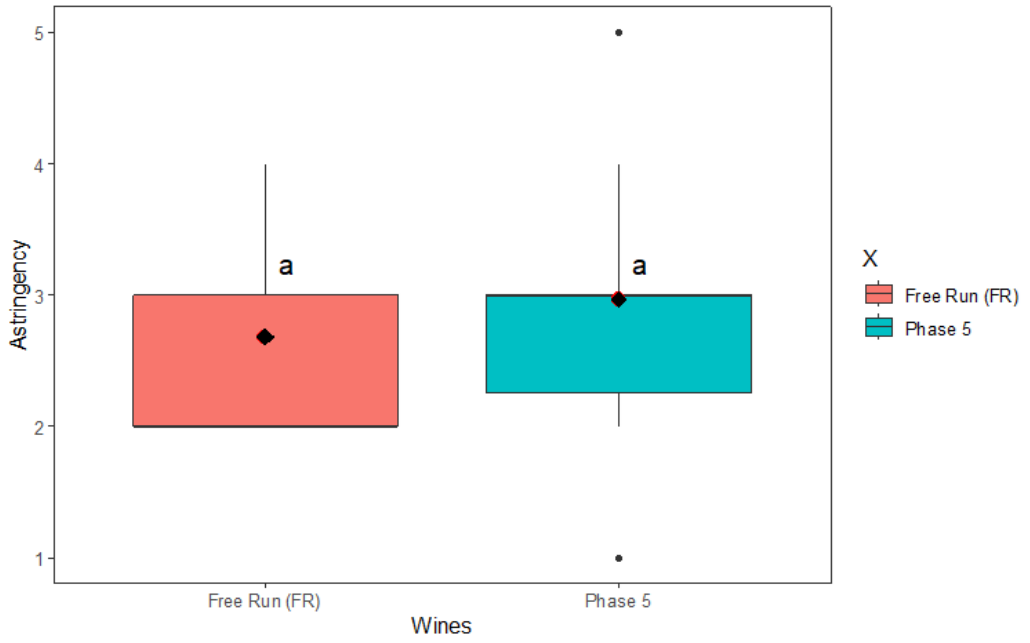

Figure 25. Box plot for the "Astringency" attribute comparing Free-run (FR) versus Phase 5 Pinot Noir sparkling wines at 12 months of bottle ageing. Average values are shown with a diamond symbol. The same letters (a, a) indicate no significant differences at a 95% confidence interval between the wines produced

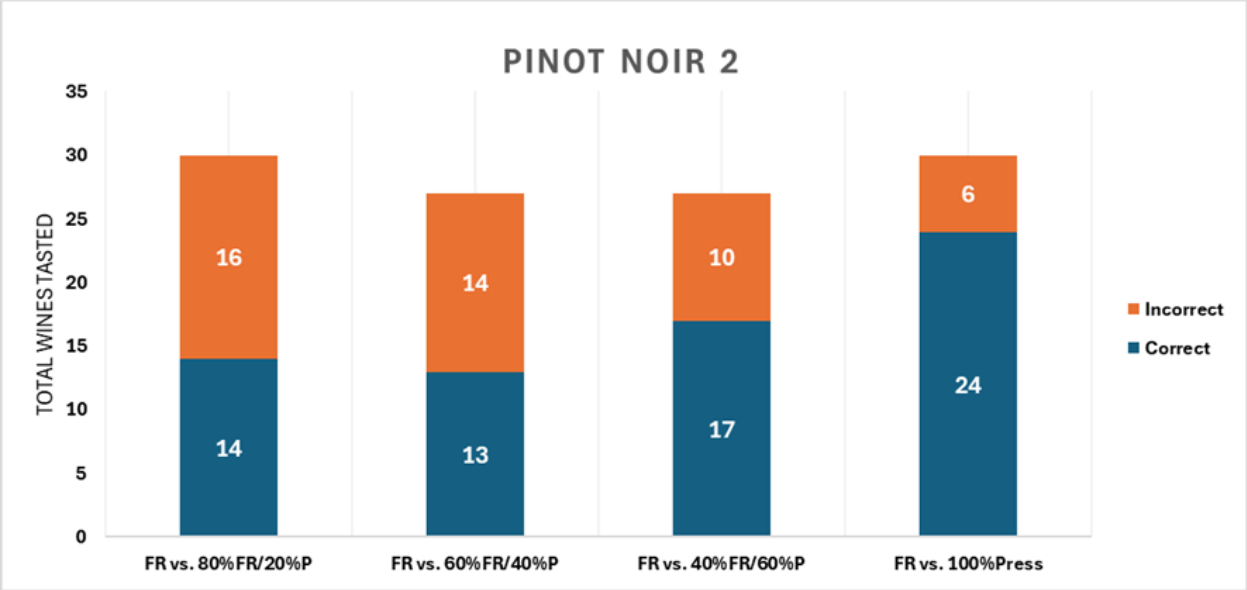

Figure 26. Pair-wise comparison between free-run and the different blends obtained from the pressing operation of Pinot Noir grapes.

Figure 26 below shows the triangular test results for the Pinot Noir blends obtained. Artificial blends with increasing levels of phenolics were created. The results showed increasing levels of correct responses as press fraction presence increased in the blends. The differences are more intensively observed in the wines with 60% and 100% press fractions. **Figure 27** shows the results of the attribute body where a lower body was perceived in the press wine. This, again, could be explained by the drying effect caused by phenolics interacting with salivary proteins, which subsequently contribute to a lower perception of the wine's body. In addition, the attributes of astringency and bitterness showed higher scores for the press wines, however neither of them was statistically significant.

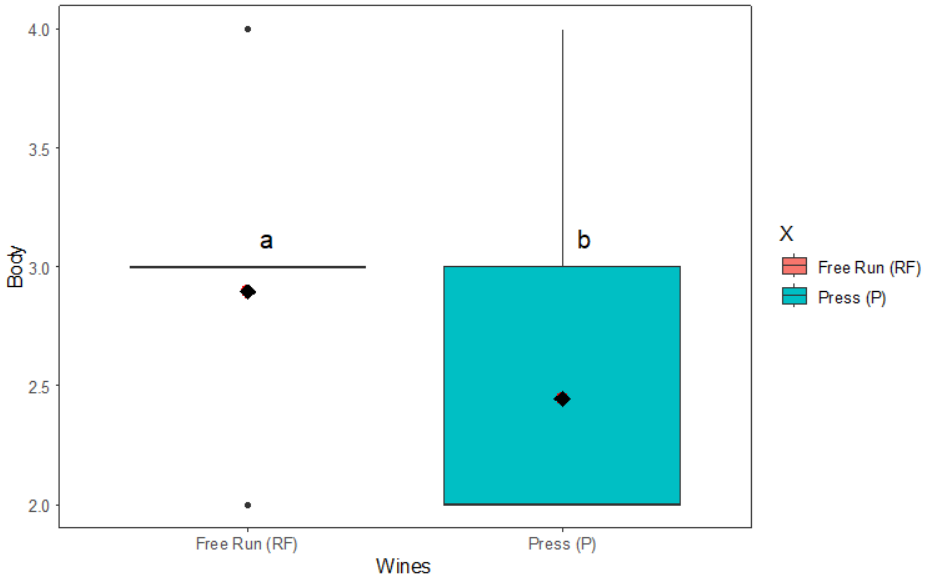

Figure 27. Box plot for the "Body" attribute comparing Free-run (FR) versus Press (P) Pinot Noir sparkling wines at 12 months of bottle ageing. Average values are shown with a diamond symbol. Different letters (a, b) indicate significant differences at 95% confidence interval between the wines produced.

Conclusion: *the panel was able to discriminate between wines with a larger presence of press fraction after 12 months of bottle ageing (differences that were larger than for still wines). However, the scoring of the mouthfeel attributes did not show large differences overall. The presence of press fraction seems to affect the perception of sparkling wine more intensively.*

OBJECTIVE 4. Data analysis of the chemical and sensorial data sets

Problem identification: *univariate data analysis is useful for gaining an understanding of the underlying phenomena. However, in complex and large datasets, multivariate data analysis techniques can provide useful information. These techniques can be applied to the chemical, spectral and sensory datasets to better understand the role played by phenolic compounds on still and sparkling wine production.*

The multivariate approach presented aims at obtaining information that could be generally applied to any wine. As shown in previous sections, variable results were often observed. For example, ABS 280 nm seems suitable for monitoring phenolic content in some wines, but inconsistencies were observed across wines. The same can be said for the colour properties, where the colour of some wines seemed to represent pressing fraction presence, but again, this was not consistent across wines. To overcome this, the results presented here are obtained after averaging the data corresponding to the wines included in the study. By doing this, it is intended to provide information that applies to the wines produced and not only to a specific wine.

1. Identification of spectral markers explaining the increasing presence of pressing fraction

    a. Still wines

The ultraviolet visible spectral properties were used to identify alternative regions containing explanatory information on the pressing fraction's presence. Due to the inability of the ABS 280 nm to represent the presence of press fraction in the musts and wines, alternative regions within the UV-Vis spectra were investigated. When the totality of the UV-VIS spectra is used, the musts and wines do not separate according to pressing fraction presence. This is

probably explained by interferences caused by other absorbing compounds. However, after attempting specific regions (i.e. the UV region, the VIS region and some combinations), it was found that the spectral regions combining a reduced part of the UV spectrum and a small part of the visible spectrum were the most accurate to differentiate musts with varying pressing fraction presence. **Figure 28** shows the PCA biplot of the still white musts obtained after preparing the different blends. The spectral data included the region from 250 nm to 340 nm.

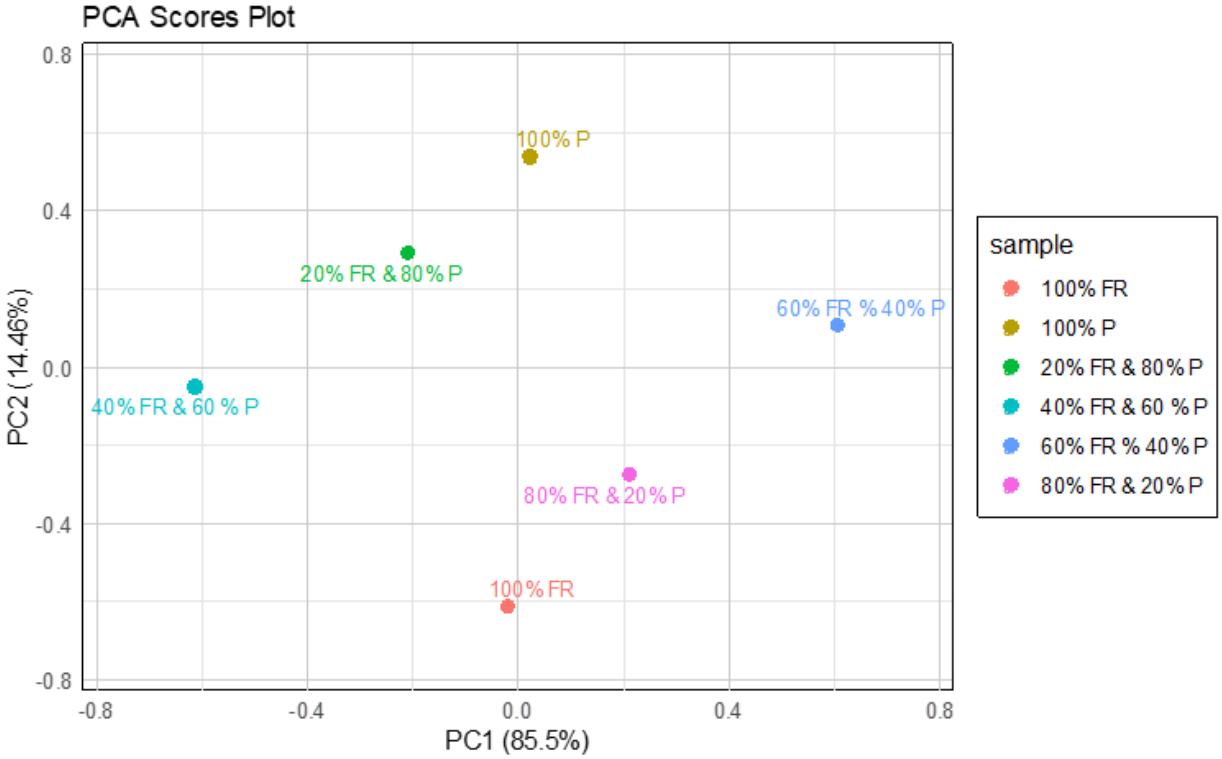

Figure 28. Scores plot of the average UV-VIS spectra of the still white musts made after preparing the different blends.

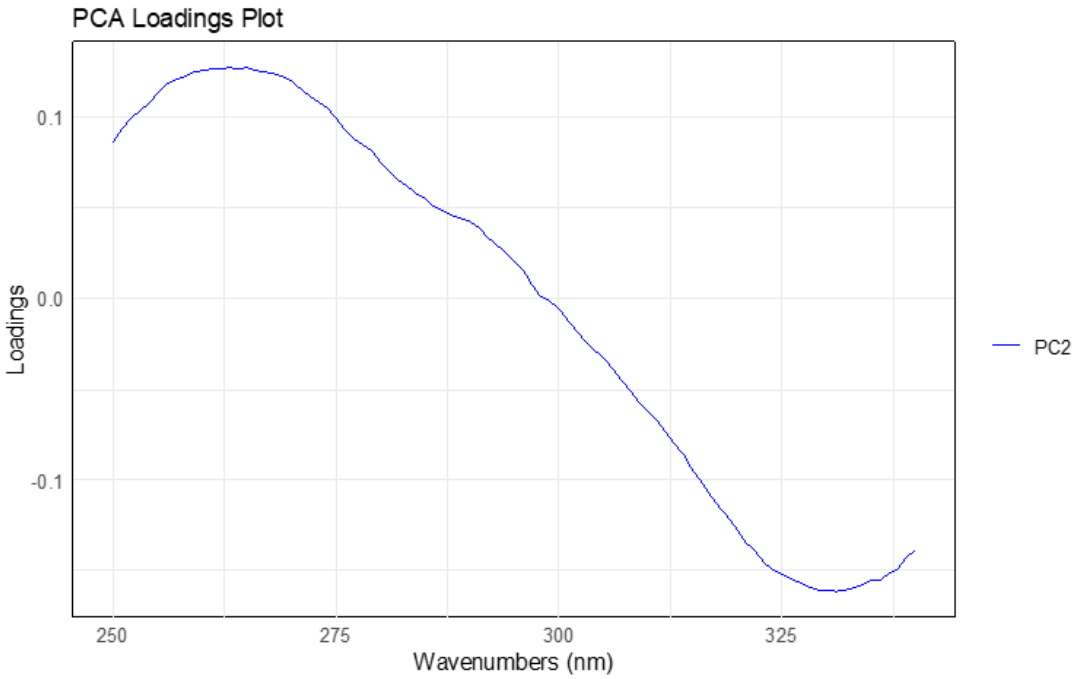

Figure 29. Loadings plot of principal component 2 (PC2) of the average UV-VIS spectra of the

still white musts made after preparing the different blends

Figure 28 shows the distribution of the blends in the scores space. The musts are separated along principal component 2 (PC2) with the Free-run (FR) must located in the negative part of PC2 while the Press (P) must is placed in the negative part. **Figure 29** shows the loadings plot explaining the regions in the spectra that are more strongly correlated with the musts. A very positive loading value linked with the Press (P) must is observed in the region around 262 nm. On the contrary, a strongly negative loading associated with the Free-run (FR) must is observed in the 328 nm wavelength. Interestingly, the results seem to indicate that initially free-run musts are characterised by a higher presence of hydroxycinnamic acids, compounds that absorb strongly in this region of the visible spectrum, whereas press musts are more related with compounds such as flavanols with strong absorptions in the ultraviolet region (around 262 nm). These results are also related to the presence of hydroxycinnamic acids in the flesh of the berry, leading to an early release into the wines as opposed to the flavanols location in the skins needing the pressing force and time to be released in the must. In addition, it is also understood that the hydroxycinnamic acids are the main compounds participating in oxidation reactions in must, whereas flavanols are the main phenolics participating in the oxidations taking place in wines. This might explain the less intense presence of hydroxycinnamic acids in press musts due to oxidation taking place during the duration of the pressing operation.

To further evaluate the ability of these newly proposed wavelengths, the Free-run (FR) UV-VIS absorption spectra in the 220-380 nm region were subtracted from the Press (P) UV-VIS spectra. The results are represented in **Figure 30**. Interestingly, and in accordance with what was reported previously, press musts are characterised by more intense absorbance in the UV region, with a maximum absorption of around 262 nm. On the contrary, Free-run (FR) musts are characterised by a more intense absorption in the VIS region with a maximum of around 328 nm.

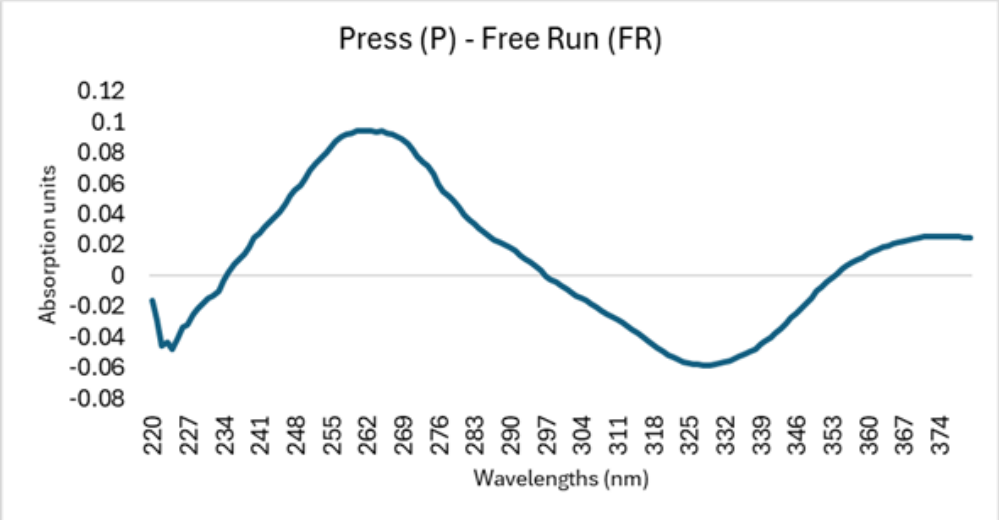

Figure 30. Press (P) minus Free-run (FR) UV-VIS spectra

The appearance of the two explanatory wavelengths is proposed here in the form of a ratio to monitor the increasing presence of pressing fractions in the musts. **Figure 31** shows the ratios 262/328 and 328/262 in the average blend obtained for the still-white wines, where consistent decreasing and increasing trends are observed. Overall, and based on the results observed in objective 2, the differences in phenolic content observed in some musts before settling were not observed in the wines later produced for both still and sparkling wines and regardless of the analytical technique employed to quantify the phenolic content of the wines. The newly proposed ratios were also investigated in finished wines, and in this case, increasing and decreasing consistent trends were also observed.

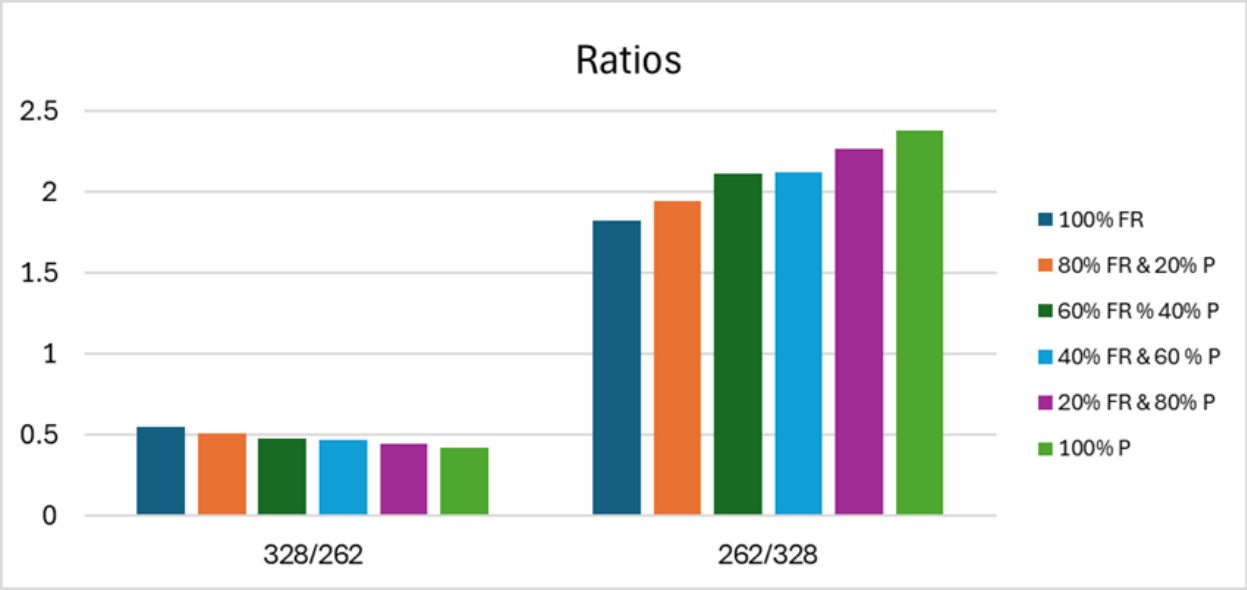

Figure 31. 262/328 and 328/262 ratios of the average blend wines obtained from Chenin and Sauvignon Blanc wines made with cold maceration and whole bunch pressing

A similar approach was followed, but the ability of the infrared spectral properties to explain the presence of pressing fraction in the wines produced was investigated. **Figures 32** and **33** show the scores and loadings plots of the average musts obtained. Separation alongside PC1 for the Press (P) and Free-run (FR) musts is observed in **Figure 32**. Multiple regions highly correlated with PC1 and PC2 can be observed in **Figure 33**. The complexity of the IR spectra where not only phenolics but also other organic compounds show absorption features might be affecting the separation of the blends. In addition, in this case, the separation takes place along PC1, which explains a larger part of the variability.

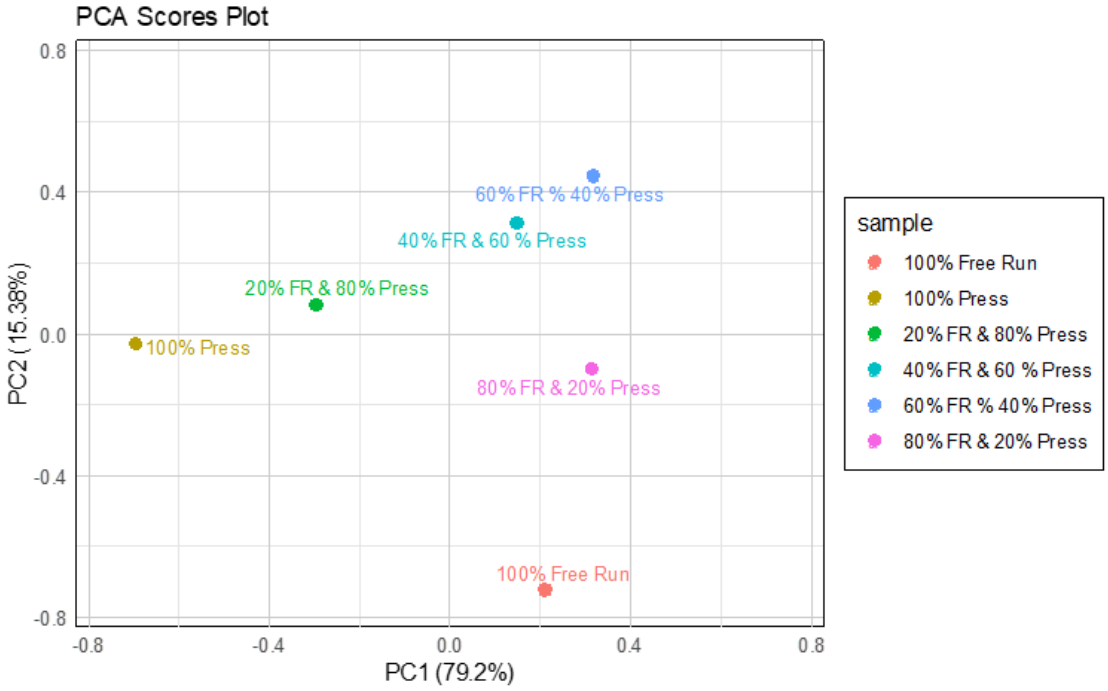

Figure 32. Scores plot of the average IR spectra of the still white wines made after preparing the different blends

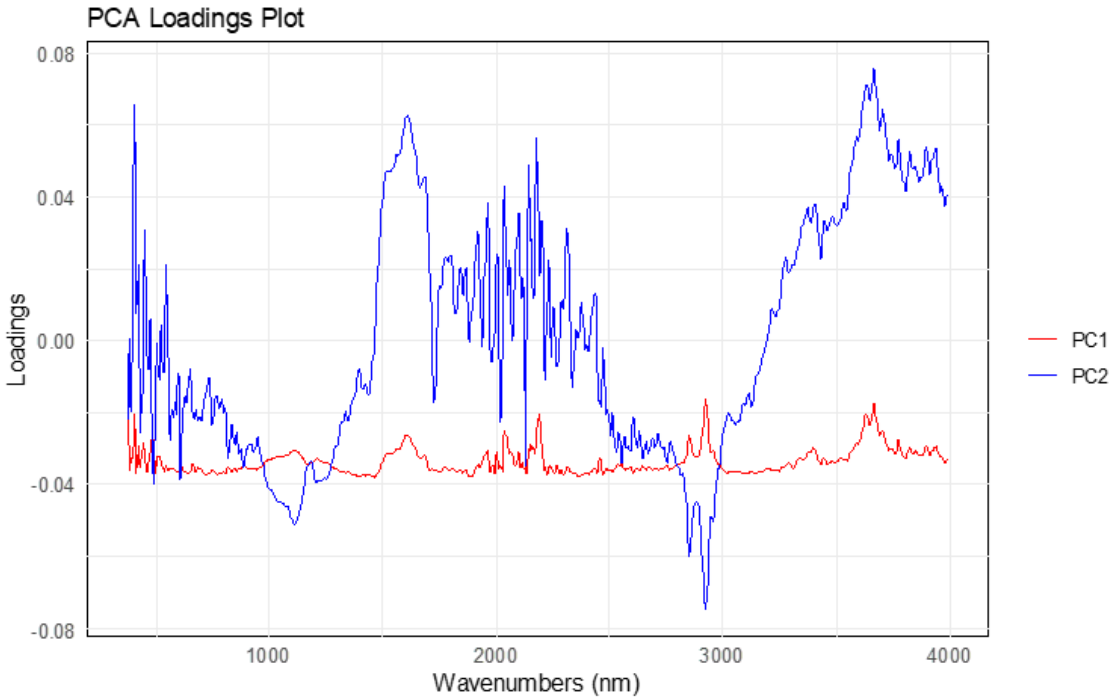

Figure 33. Loadings plot of principal components 1 (PC1) and 2 (PC2) of the average UV-VIS spectra of the still white wines made after preparing the different blends

b. Sparkling wine

In the case of sparkling wines, pressing phases and blends were obtained. However, as the number of phases was not constant across the wines produced, it was decided against extracting conclusions from the analysed data. Focussing on the blends, the preliminary analysis included the entire UV-VIS spectrum and showed strong loadings in the UV and early part of the visible spectrum. However, due to the presence of Pinot Noir a per cultivar analysis was considered as different phenolics present in red cultivars might be distorting the interpretation of the results. A separate analysis for Chardonnay and Pinot Noir was therefore conducted. Partial separation along PC1 was observed between Free-run (FR) and the Press (P) in Chardonnay musts. However, the blends appeared randomly positioned along PC1 indicating the inability of the UV-VIS spectra to completely explain pressing fraction presence. When assessing the loadings plot wavelengths at 232, 328 and 360 nm appeared positively correlated with press wines (results not shown).

Different results were obtained for Pinot Noir wines. In this case, partial separation was also observed alongside PC1 with the Press (P) wine positioned in the positive part of PC1. **Figures 34** and **35** show the scores and loadings plots for the Pinot Noir blends evaluated. Interestingly, the loading plot has its maxima in the region around 400 nm. This is pointing towards other phenolics playing a role in the separation between blends. In this case, flavonol phenolics, compounds with absorption maxima around 360 nm could be driving the differences between wines. It is also worth noting that high loading values are observed in the 500 nm region corresponding to the anthocyanins, red colour compounds of red varieties.

Although certain separation between the pure free-run and press wines is always observed, the inability of the UV-VIS spectra to completely discriminate between blends containing increasing pressing fraction could be explained with the fact that a significant increase in phenolic compounds might be only taking place during the last phases of the pressing operation. Based on the results observed, it can be speculated that the increasing pressing forces applied are only promoting a significant extraction of phenolics during the last pressing cycles.

The lower phenolic accumulation and extractability present in sparkling wine grapes might be also explaining the observed results (different from what was observed for still wines).

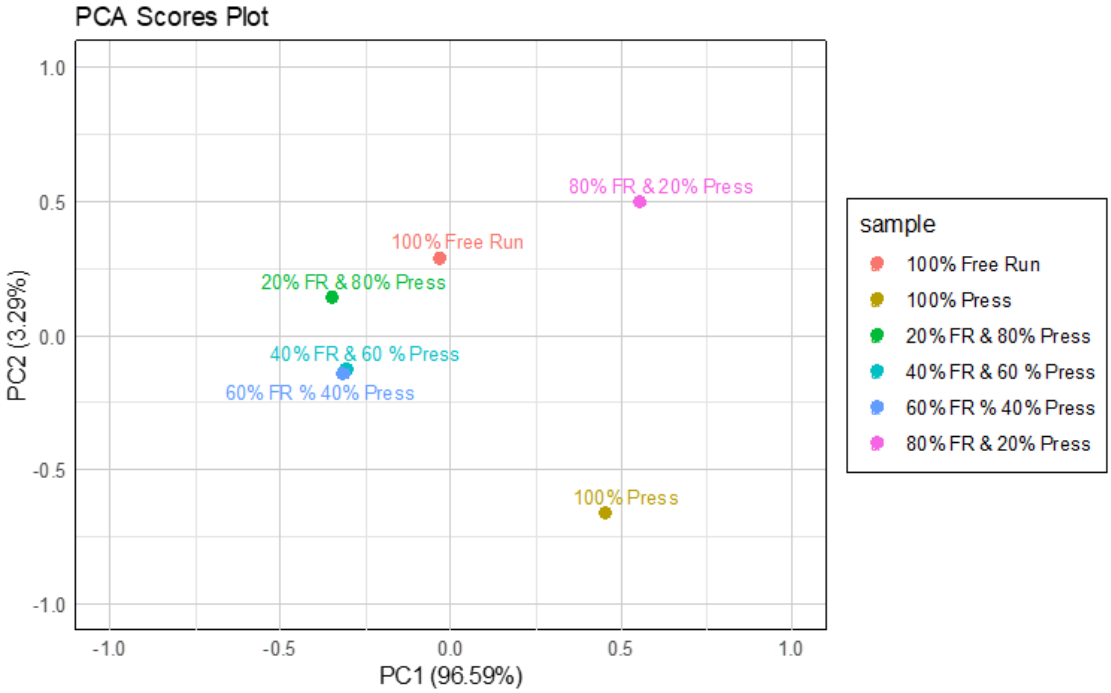

Figure 34. Scores plot of the average UV-VIS spectra (220-600 nm) of the sparkling wine blend with the Pinot Noir variety.

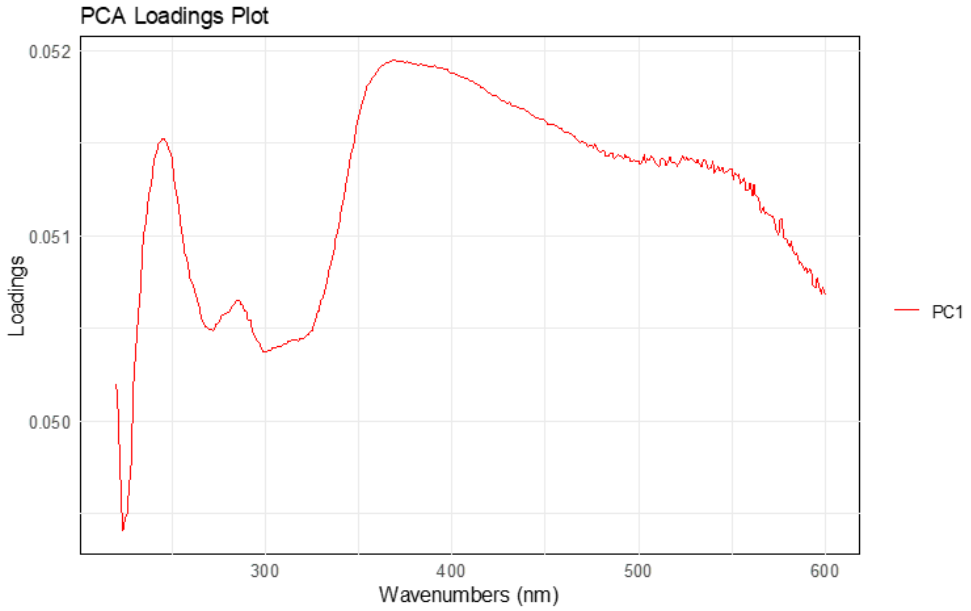

Figure 35. First principal components loadings plot of the average UV-VIS spectra (220-600 nm) of the sparkling wine blend with the Pinot Noir variety.

To gain a further understanding of the underlying information explaining pressing fraction presence the absorption derived from subtracting the Free-run (FR) UV-VIS spectra from the Press (P) spectra was explored. The first and the last phases collected were used in the case pressing phases that were obtained during the pressing process. For the blends, the Free-run (FR) fraction was subtracted from the Press (P). Chardonnay and Pinot Noir wines were again processed separately. Differently from what was observed for the still wine musts, no clear pattern

was observed for Chardonnay musts (**Figure 36**). The most significant difference in the spectra appears in the region around 232 nm, with another smaller region around 285 nm. However, for some wines, the Press (P) fraction seems to have higher absorption differences at 232 nm than for others, where absorbance values closer to 0 were observed. Both wavelengths and the absorption at 328 nm (as identified in the previous section) were individually investigated. The wavelength at 328 nm was the only one giving some consistent results, especially between the Free-run (FR) and the Press (P) musts, with some inconsistencies in the intermediate pressing fractions and blends.

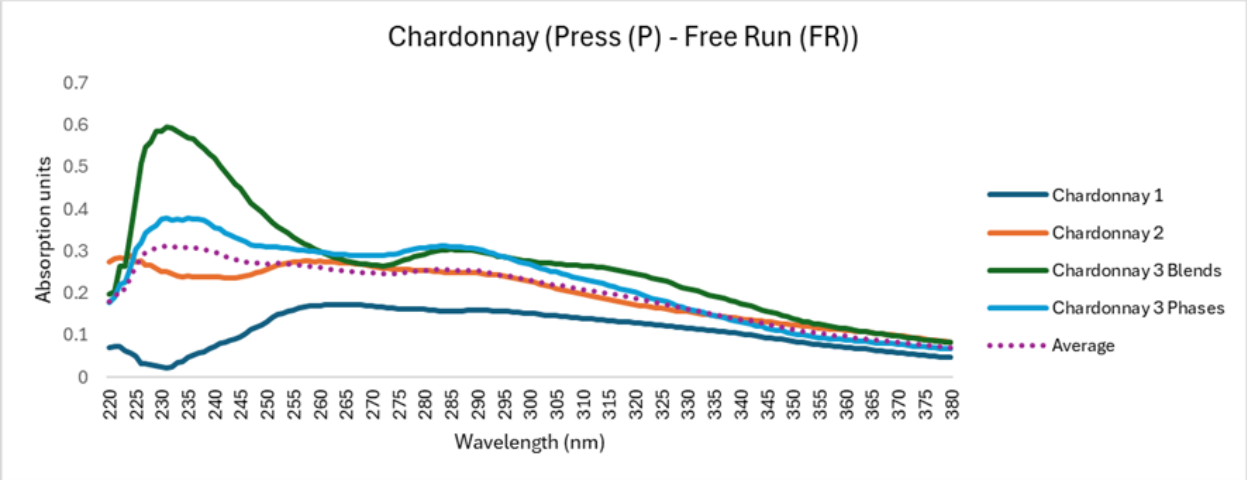

Figure 36. Press (P) minus Free-run (FR) spectra for the sparkling wine Chardonnay musts. The dashed line shows the average spectra.

Differences in spectral properties could be attributed to the use of grapes with different ripening statuses in the making of sparkling wines. Not only the phenolic accumulation but also the phenolic extractability might be at a different ripening point. Although hydroxycinnamic acids accumulate early during the phenological development of the grape berry, the lower extractability (firmer cell walls) present in less ripe grapes could explain the absence of a stronger signal in the region around 320 nm. On the contrary, flavanol compounds accumulate later during the season, which might explain the lack of a stronger signal in the region closer to 280 nm.

A similar analysis was conducted for Pinot Noir. The spectral difference between the Press (P) and the Free-run (FR) wines showed no clearly identifiable regions that could be used to distinguish between musts with increasing pressing fraction presence. In this case, absorption values of 235 and 300 nm and 360 and 400 nm from the multivariate analysis were investigated. None of these wavelengths was representative of increasing pressing fraction presence (data is not shown for the brevity of the report).

In a previous analysis, the ABS at 389 nm was identified as a potential estimator of phenolic fraction presence in sparkling wines. This wavelength was identified from the individual analysis of the different wines produced, including both varietals, Chardonnay and Pinot Noir. The results are very similar to those obtained for the 328 nm wavelength, where clear differences are observed between the free-run and the press wines but with some inconsistencies among the blends or phases.

Conclusion: *for still white wines, a combined use of absorption measurements in the ultraviolet and visible regions (ratios 262 nm/328 nm) is a better indication of pressing fraction presence than just a single measurement. For sparkling wines, it was not possible to find a representative or combination of wavelengths able to completely explain pressing fraction presence. The ABS at 328 and 389 nm appeared as the best candidates to monitor phenolic extraction during pressing.*

2. Identification of phenolic markers explaining the increasing presence of pressing fraction

a. Still wines

Ultra Performance liquid chromatography (UPLC) was used to investigate the presence of markers that were able to discriminate between musts with varying pressing fraction presence. **Figure 37** below shows the distribution of the still wine's musts along the PCA scores space. A clear separation of the musts alongside the first principal component (PC1) can be observed with the Free-run (FR) musts placed on the negative part of PC1 and the Press (P) must be placed on the positive part of PC1. UPLC data was even able to position the blends with varying content of press fraction alongside PC1. In addition, **Figure 38** shows the loading plots of the PCA conducted. The loading plot shows which compounds are found at higher levels in certain musts. For example, wines positioned in the positive part of the PC1 scores plot are positively correlated with compounds showing positive loadings. As can be observed in **Figure 38**, the Press (P) must is characterised by higher levels of all the flavanol compounds (except flava-3-ol 3) and high levels also of some of the flavonol and hydroxycinnamic acids identified. On the contrary, Free-run (FR) musts are characterised by higher levels of some of the cinnamic acids (showing negative loadings)

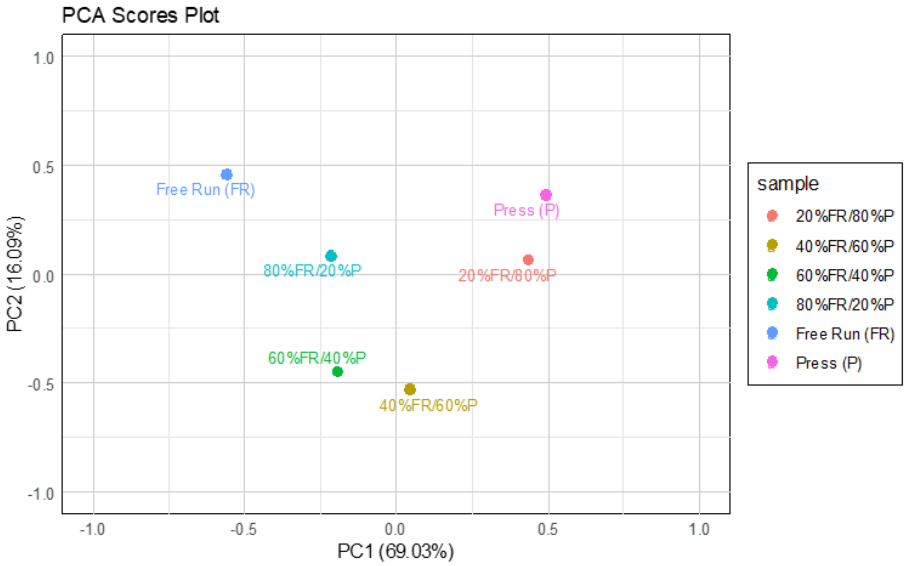

Figure 37. UPLC phenolics scores plot of the average blends obtained. The blends include the Chenin and Sauvignon Blanc varietals as well as cold maceration and whole bunch as processing techniques.

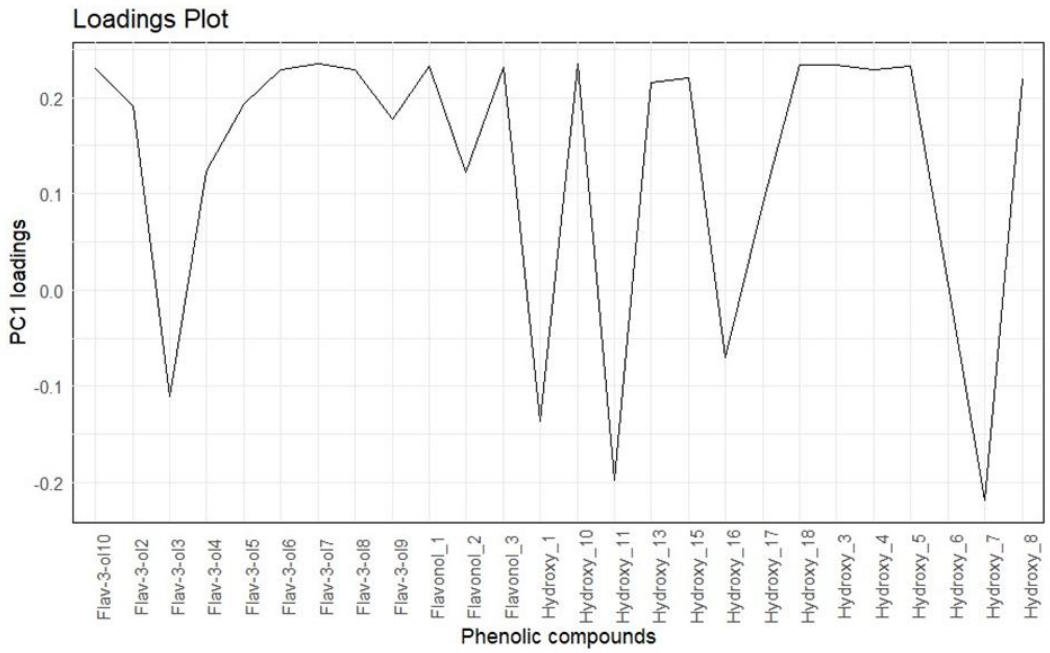

Figure 38. UPLC phenolics loading plot of the average blends obtained. The blends include the Chenin and Sauvignon Blanc varietals as well as cold maceration and whole bunch as processing techniques.

The results observed from the analysis above agree with what was observed and discussed in the previous section, where a positive correlation was found between press fraction presence and higher levels of flavanols and free-run presence with higher levels of hydroxycinnamic acids. To further confirm this hypothesis, an additional PCA was explored. In this case, the data was grouped per phenolic family, including a total phenol content measurement in addition to the compounds identified.

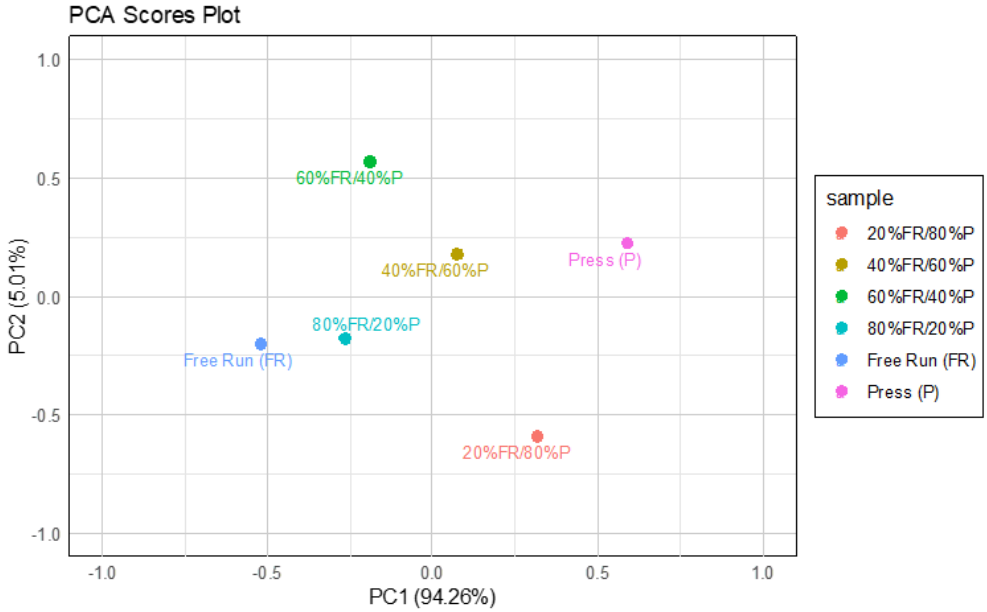

Figure 39. UPLC phenolics grouped per phenolic family scores plot of the average blends obtained. The blends include the Chenin and Sauvignon Blanc varietals as well as cold maceration and whole bunch as processing techniques.

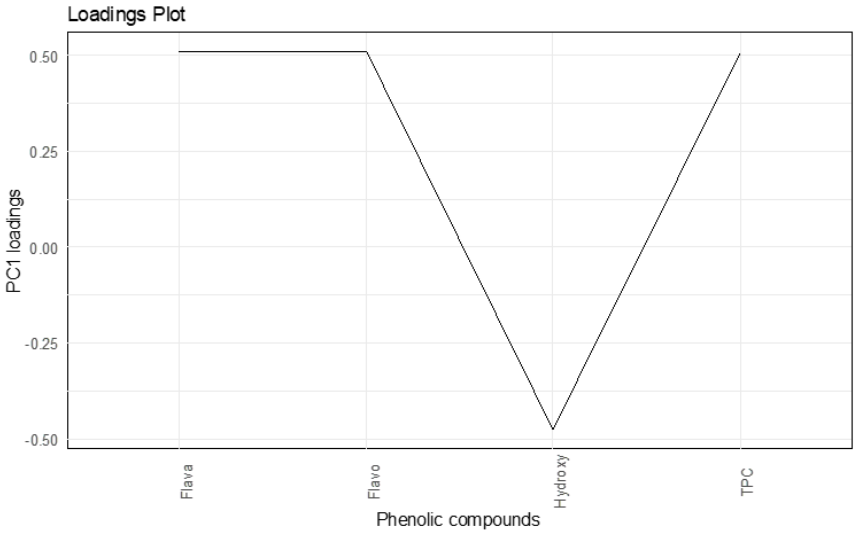

Figure 40. UPLC phenolics were grouped per phenolic family loading plot of the average blends obtained. The blends include the Chenin and Sauvignon Blanc varietals as well as cold maceration and whole bunch as processing techniques.

Interestingly, these results confirm the earlier observations with again the PCA plot (**Figure 39**) separating the musts alongside PC1 according to the increasing presence of pressing fraction. In addition, the loading plot (**Figure 40**) shows a positive correlation between the musts press fraction and the presence of flavanols, flavonols and total phenols. Compounds corresponding to these two phenolic families are in the skins of the berries, and, as opposed to the easily extractable hydroxycinnamic acids, they might require additional pressing forces to be released into the wines. These results are in agreement with the analysis of the musts spectral properties.

b. Sparkling wines

Despite some overlapping between phases 4 and 5, separation across PC1 can be observed in **Figure 41**. The loadings plot illustrated in **Figure 42** shows a more variable distribution of individual phenolic compounds in both the positive and negative parts of the first loading. Visually, a higher number of compounds with positive loadings that are positively correlated with press wines can be observed. This can be explained by the higher content of phenolics expected in musts obtained at later stages of pressing. Moreover, the PCA was repeated, but, in this case, the individual phenolics were grouped per phenolic family in hydroxycinnamic acids, flavanols and total phenol content as the addition of the individual phenolics identified. The results confirmed previous findings with a larger presence of hydroxycinnamic acids in free-run musts and a larger presence of flavanols in press wines. Again, the total phenol content was higher in press musts. UPLC data, therefore, confirms the initial results observed in still white wines when investigating the UV-visible spectral properties that could not be confirmed for the sparkling wines. In this case, the analysis of the individual phenolic compounds with chromatography confirmed an early release of hydroxycinnamic acids, followed by the later presence of flavanols as the pressing operation progresses.

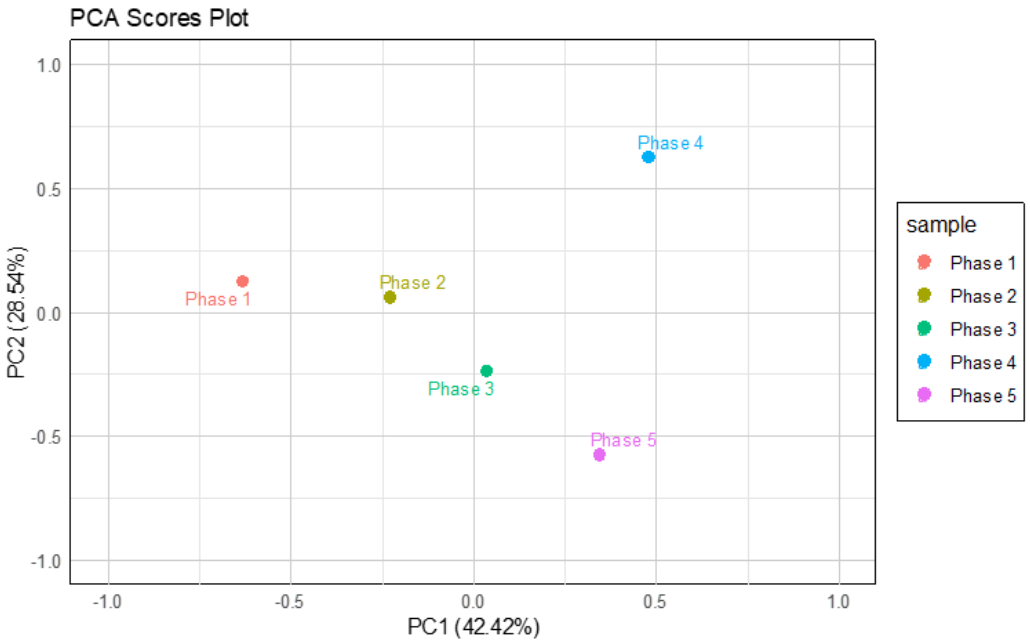

Figure 41. UPLC individual phenolics scores plot for the phases obtained during the pressing operation for the sparkling wines obtained. Chardonnay and Pinot Noir wines are included.

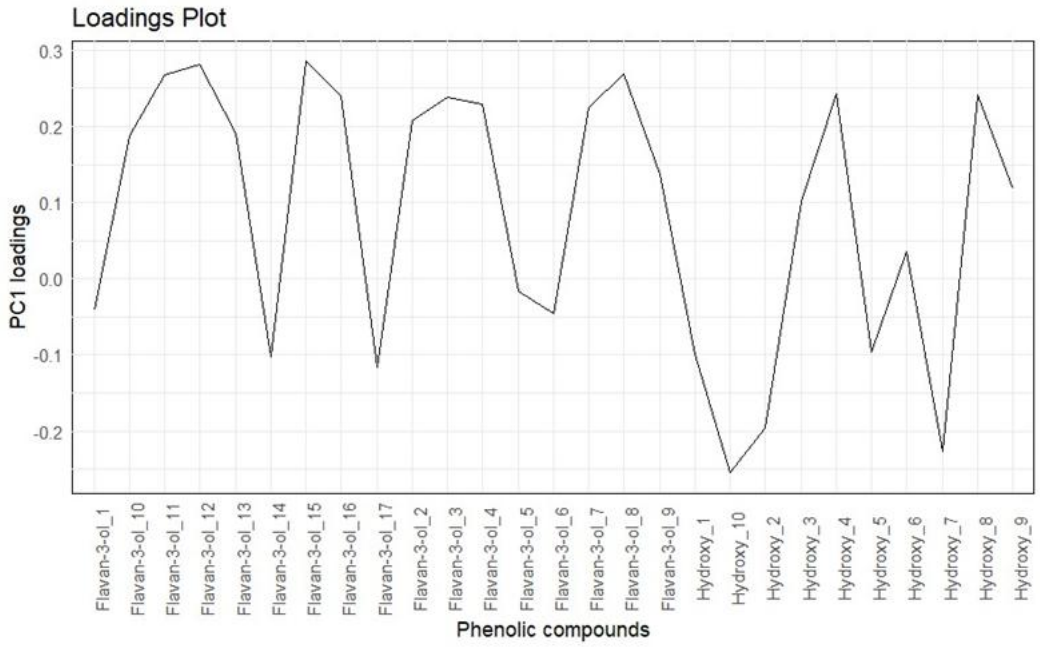

Figure 42. UPLC individual phenolics loading plot for the phases obtained during the pressing operation for the sparkling wines obtained. Chardonnay and Pinot Noir wines are included.

The same PCA analysis was conducted for the sparkling musts obtained after blending the different proportions of the free-run and the press fractions. The results that can be seen in **Figure 43** show a separation of the musts across PC1 and, interestingly, different positioning of the pure free-run and press musts (positive part of PC2) and the blends (negative part of PC2). The loading plots (data not shown) showed firstly an overall higher presence of individual phenolics in musts with the presence of press fraction and secondly the higher levels of specific phenolic compounds in the blends such as flavan-3-ol 13 and 14 and hydroxycinnamic acid 7. These results point towards the complex chemistry involving phenolics and the higher presence or even the formation of compounds in the blends. In addition, these findings could be related to

the often-observed abnormal behaviour of the blends not always presenting linear or gradual increases in the different measurements assessed in the project.

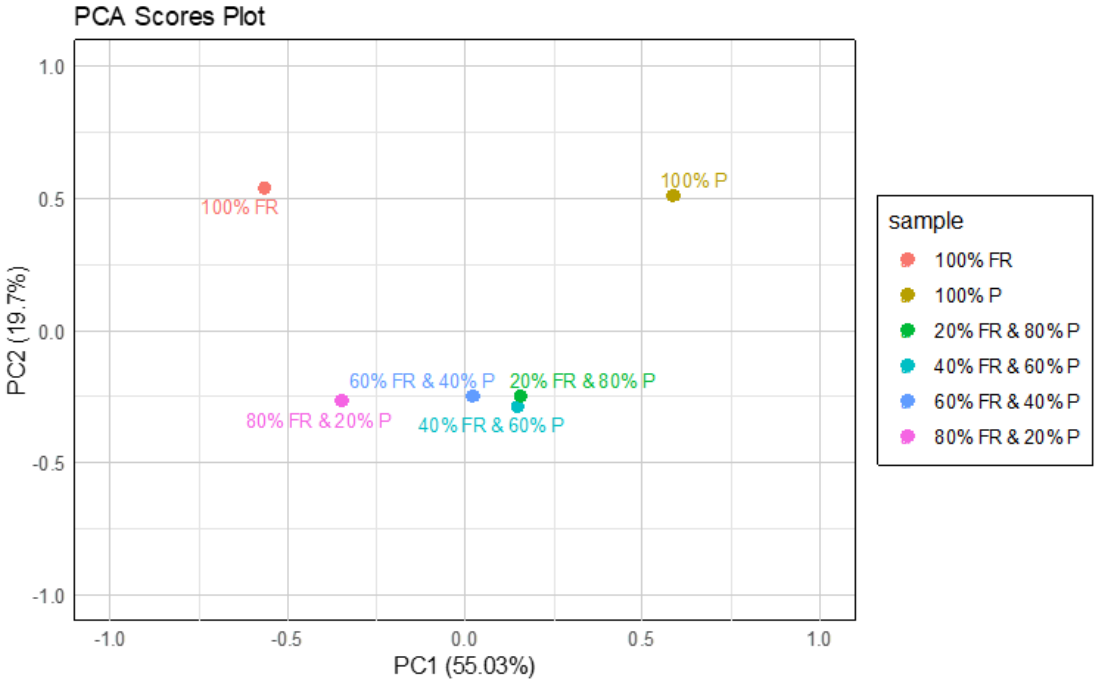

Figure 43. UPLC individual phenolics scores plot for the phases obtained during the pressing operation for the sparkling wines obtained. Chardonnay and Pinot Noir wines are included.

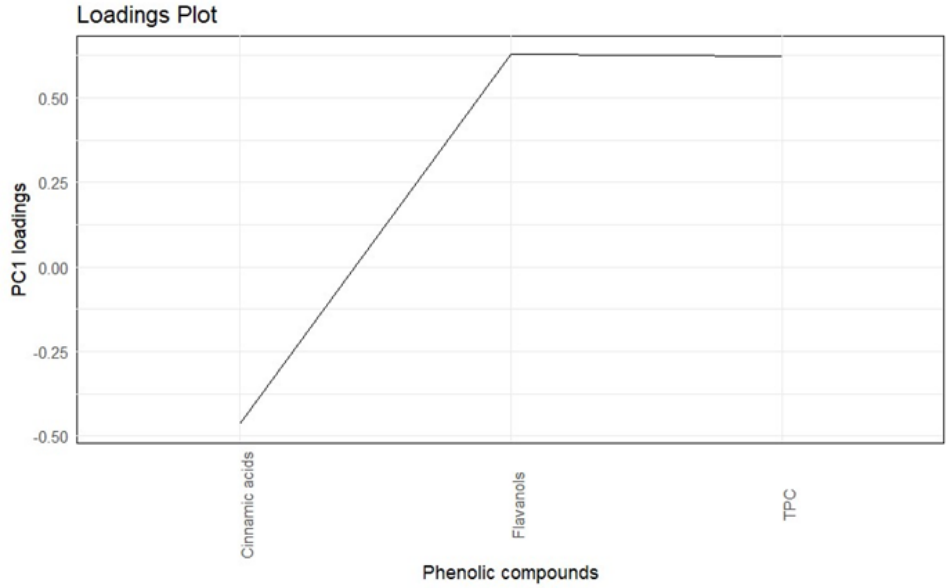

Figure 44. UPLC phenolic families' loadings plot for the blends obtained. Chardonnay and Pinot Noir wines are included.

PCA was again conducted, but in this case, the individual phenolic compounds were grouped according to phenolic families. A total phenol content (TPC) was also obtained after the addition of the identified compounds. Separation across PC1 in the scores plot was again observed between free-run and press wines. In addition, the loadings plot (**Figure 44**) confirmed the higher presence of flavanols in press wines and hydroxycinnamic acids in free-run wines.
Conclusions: *UPLC quantified phenolic compounds discriminate between increasing pressing fraction presence in the blends and phases produced during the pressing operation of still and sparkling wines. As postulated in previous sections, UPLC data confirmed the higher presence of*

hydroxycinnamic acids and flavanols in free-run and press musts, respectively.

3. Correlations between chemistry and sensory attributes

a. Still wines

To gain an understanding of the phenolic compounds potentially influencing the sensory attributes, a principal component analysis was conducted (**Figure 45**). The samples included in the PCA analysis correspond to the free-run and the press Chenin and Sauvignon Blanc wines. As expected, strong positive correlations are observed between the total phenol content (TPC) and the total flavanol content (compounds which account for the majority of the phenolics found in white wines) with the astringency attribute. A positive correlation can also be observed between the hydroxycinnamic acids (T_Hydoxy) and the attribute sourness which can be attributed to the acid nature of these phenolic compounds. A moderate positive correlation can also be observed for bitterness and body. Despite the correlations observed, it is important to mention that no differences were observed in the sensorial evaluation of the wines, as the panel was unable to discriminate between the different wines produced. In this case, it seems that the chemistry correlations are not significant enough to cause differences at a sensorial level.

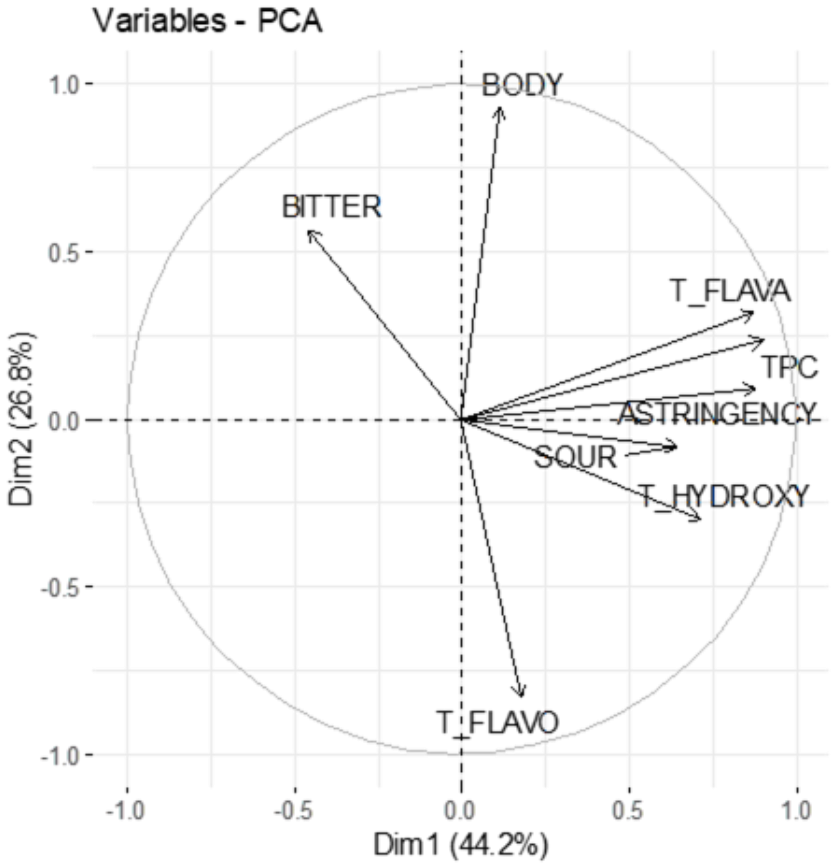

Figure 45. PCA loadings plot combining chemistry and sensory attributes of the still wines produced with Chenin and Sauvignon Blanc and following whole bunch and cold maceration winemaking processing techniques

a. Sparkling wines

A similar analysis was performed for the sparkling wines. In this case, free-run and press wines obtained after the collection of the pressing phases or the generation of the blends were

used. The first and last phases collected, as well as the free-run and press fractions, were used in the analysis. Astringency is again correlated with TPC and total flavanol content but only according to PC1, as a different position in the PC2 is observed (**Figure 46**). Bitterness and astringency appeared correlated, whereas a correlation between hydroxycinnamic acids and sourness was not found in this case. Finally, wines that were rated more astringent, bitter, sweet and with higher body were perceived as less sour. The nature of the sparkling wines and the presence of carbonic gas are possibly responsible for the differences with the still wines. The slight increase in pH (lower acidity) as pressing proceeds or pressing fraction presence increases correlates with the higher phenolic presence as the pressing operation progresses. In other words, it is understandable that wines with higher phenolics are perceived as less sour, explaining the negative correlation between attributes. In the case of sparkling wines, although minimal differences were observed in the mouthfeel rating exercise, the panel was able to discriminate the wines. Tasting mouthfeel attributes is a difficult endeavour, and the sensitivity of a tasting panel for this task might explain the minimal differences or almost no differences observed in the rating exercise. However, the positive discrimination and the correlations obtained from this analysis confirm that phenolics play a significant role in the perception of sparkling wines.

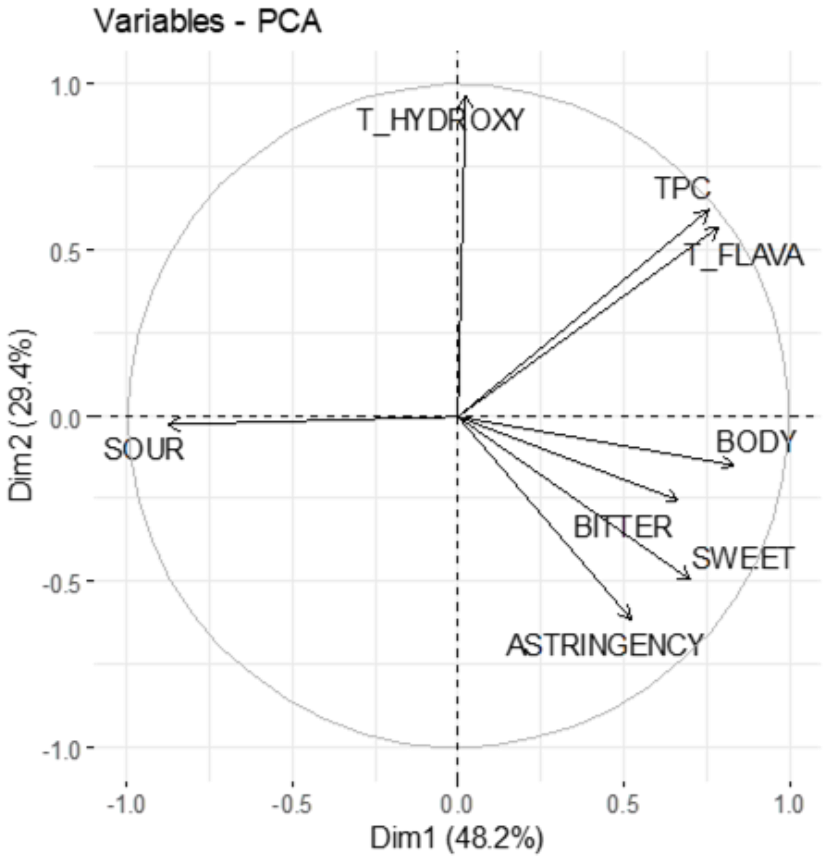

Figure 46. PCA loadings plot combining chemistry and sensory attributes of the sparkling wines produced with Chardonnay and Pinot Noir after collection of pressing phases or generation of artificial blends

Conclusions: *interesting correlations were observed between the chemical phenolic analysis and the mouthfeel sensory scores provided by the panel. Considering the results obtained from the sensory discrimination task and the winemaking protocols applied, still white wines perception seems to be less affected than sparkling wines by the presence of phenolics*.

OBJECTIVE 5. Investigation of simple and rapid methods for the assessment of final wine properties using juice data

Problem identification: *the implementation of rapid methods to monitor the pressing process of still and sparkling wines is required. Efficient quantification techniques avoid time-consuming methodologies and provide real-time data. Monitoring tools to assess the pressing operation leading to informed-based decisions are also required for the optimisation of the pressing process.*

To investigate the possibility of using rapid techniques to quantify the total phenol content of the musts and wines of the study (avoiding the need for advanced techniques such as liquid chromatography), partial least squares calibrations were attempted with the UV-visible and mid-infrared (MIR) spectral properties of the samples obtained. The ultraviolet-visible spectral properties were measured with the use of a UV-Vis spectrophotometer (Multiskan GO Microplate Spectrophotometer, Thermo Fisher Scientific, Inc., Waltham, MA, USA). Spectra was collected from 200 to 650 nm every 1 nm. Distilled water was used as a blank. MIR spectral data was obtained with an ATR-MIR instrument (Bruker Optics, Ettlingen, Germany) with the following specifications. The FT-MIR spectrometer was fitted with a 2 mm^2 single bounce diamond crystal sample plate in a closed configuration. When scanning the samples, 128 sample scans were taken with the sample plate set at 30^oC. The wavenumber range used was 4000-400 cm^{-1} with a 4 cm^{-1} resolution. A background spectrum, using distilled water, was obtained at the beginning of each scanning session and once every two hours. Model optimisation was performed with the OPUS software (OPUS v. 7.0 for Microsoft, Bruker Optics, Ettlingen, Germany). **Table 2** below shows a summary of the parameters used to assess the accuracy and robustness of the models, together with the interpretations of the model optimisation statistics.

Table 2. Summary statistics used to assess model accuracy and robustness

Parameter	**Ideal Value for Model Robustness**	**Abbreviation**
Coefficient of Determination	As close to 1 as possible	R^2_{cal} (calibration) and R^2_{CV} (cross-validation)
Root Mean Square Error	As close to 0 as possible	RMSEE (estimation) and RMSECV (cross-validation)
Residual Predicted Deviation	A high value is required	RPD_{cal} (calibration) and RPD_{cv} (cross-validation)

Mid-infrared spectra were used to attempt the quantification of the phenolic measurements that were found to be representative of increasing pressing fraction or increasing presence of phenolics. If accurate calibrations are obtained, a single spectral measurement is only needed to indirectly obtain the phenol levels or absorption values of interest. This included the total phenol, total flavanol and total hydroxycinnamic content obtained with UPLC, the ratio 262 nm/328 nm and the single absorption measurements at 328 and 389 nm. Calibrations were attempted including musts and wines of the still and sparkling wines produced during the 2023 and 2024 vintages. Specialised calibrations per winemaking stage (must or wine) and per wine type (still or sparkling) were explored. **Table 3** shows the models for still musts obtained from the Chenin and Sauvignon Blanc grapes over two vintages. UPLC phenolics, especially TPC (mg/L) and T_flava (mg/L) were accurately predicted with RPDcv values higher than 2.5. Interestingly, the ratio of 262 nm/328 nm was also accurately predicted in still wine musts. Lower model accuracy was observed for T_hydroxy (mg/L) and for the 328 nm and 389 nm absorbances. MIR spectra also struggled to accurately predict phenolics-related measurements in finished wines and sparkling wines. This seems to somehow confirm previous results where fewer clear trends in phenolic

levels were observed for sparkling wines. In addition, the lack of correlation commonly observed between the musts and wines might be linked with the inability of the MIR spectra to predict phenolic content in finished wines.

Table 3. Mid-infrared prediction calibrations for the phenolic parameters related to increasing pressing fraction presence in the still white musts produced. TPC: total phenol content in mg/L with UPLC; T_flava: total flavanol content from UPLC analysis in mg/L; T_hydroxy: total hydroxycinnamic on mg/L content from UPLC; AU: absorption units.

	Range	R2cal	RMSEE	RPDcal	R2cv	RMSECV	RPDcv
TPC (mg/L)	266.1-743.5	98.68	17.7	8.7	88.57	42.5	2.96
T_flava (mg/L)	254.4-677	98.43	17	7.98	85.04	42.8	2.59
T_hydroxy (mg/L)	10.46-63.97	99.38	2.04	12.7	79.02	8.71	2.24
262nm/328nm (AU)	1.284-2.641	99.04	0.0452	10.2	84.64	0.152	2.56
328nm (AU)	0.0344-0.177	75.4	0.0182	2.02	58.16	0.0221	1.55
389nm (AU)	0.0107-0.177	90.17	0.0135	3.19	77.75	0.0194	2.12

Similarly, the UV-VIS spectral properties were used to attempt prediction calibrations of phenolic-related parameters in the musts and wines of the project. In this case, only models for the UPLC obtained data were attempted as the absorption measurements (262, 328, 389 nm) are already contained in the UV-VIS spectral properties. Models were again attempted including both still and sparkling musts and wines, per winemaking stage (wine or must) and per wine type (still or sparkling). The most relevant results are included in **Table 4**. Overall, models including both musts and wines showed poorer accuracy, except for a model to predict the total hydroxycinnamic content. However, when models including only must data were attempted, higher prediction accuracy was obtained. The best models were observed when only still wine musts were included. Interestingly, TPC (mg/L) was not accurately predicted for sparkling wines (RPD = 1.6) or even in the model including both still and sparkling must data (RPD = 1.85). Fortunately, good prediction accuracy was obtained for the total flavanol content. In previous sections, the total flavanol content was seen to positively correlate with pressing fraction presence, whereas the hydroxycinnamic acids were seen to correlate with free-run wines. These results indicate that the levels of these two relevant phenolic families could be predicted with the use of UV-visible spectral properties.

Table 4. UV-VIS prediction calibration for the phenolic parameters related to increasing pressing fraction presence in the still and sparkling musts produced. TPC: total phenol content in mg/L with UPLC; T_flava: total flavanol content from UPLC analysis in mg/L; T_hydroxy: total hydroxycinnamic on mg/L content from UPLC; Still: still white wines; Spark: sparkling wines

	Range	R2cal	RMSEE	RPDcal	R2cv	RMSECV	RPDcv
TPC (still+spark)	5.504-802.5	96.38	34	5.26	70.82	86	1.85
TPC (still)	266.1-743.5	99.6	10.1	15.8	89.69	40.3	3.12
TPC (spark)	5.504-802.5	90.56	61.2	3.25	60.98	109	1.6

T_flava (still+spark)	254.4-745.3	92.17	42.2	3.57	83.51	54.5	2.46
T_flava (still)	245.5-677	99.55	9.33	15	86.87	40.1	2.77
T_flava (spark)	325.7-745.3	98.41	20.5	7.94	85.52	47.4	2.65
T_hydroxy (still+spark)	1.547-63.97	96.94	3.96	5.72	92.39	5.49	3.63
T_hydroxy (still)	10.46-63.97	99.94	0.633	39.3	98.72	2.15	8.86
T_hydroxy (spark)	1.547-57.19	96.37	4.01	5.25	94.71	4.52	4.35

Conclusions: *MIR spectroscopy was able to quantify relevant parameters related to the phenolic content and composition in musts to produce still white wines. On the contrary, MIR did not accurately predict phenolic levels in sparkling musts. UV-VIS spectroscopy showed a better ability to predict relevant phenolic parameters in both still and sparkling wine musts.*

Finally, a classification algorithm was implemented to assess the possibility of monitoring the pressing operation. The K-nearest neighbour algorithm is a supervised machine learning method widely used for classification tasks. The idea was to assign a low, medium or high-risk category to the must samples and investigate if it was possible to classify them under the correct categories during the pressing operation of the still and sparkling wines. The UV-VIS and MIR spectral properties were investigated in the still and sparkling musts. All of the UV-VIS and MIR spectra were initially used. In addition, based on the results previously observed, selected regions correlated with free-run and press wines were also attempted. This application aimed to explore the possible implementation of a control system that captures spectral properties and provides a risk assessment of press fraction or phenolic presence. Unfortunately, the results obtained indicated that neither spectroscopy technique was able to classify the must samples in the categories specified.

Conclusions: *the use of spectral properties as a tool to monitor the pressing presence in the musts did not yield successful results. Alternatively, spectroscopy calibrations to predict relevant phenolic parameters can be used to monitor increasing pressing fraction and phenolic levels during the pressing operation of still and sparkling wines.*

8. CONCLUSIONS AND RECOMMENDATIONS

The main conclusions of the project are listed below:

- The blends produced in the project with varying proportions of free-run and press fractions proved to be a better representation of increasing phenolic presence than the phases collected during the cycles of the pressing program. It is speculated that the pressure and time conditions of some of the cycles might not be able to increase phenolic content. The results are overall more consistent in the blends produced.
- The ABS at 280 nm, commonly used to quantify phenolic content in wines, does not appear to accurately represent increasing phenolic content in the blends or during the pressing operation of both still and sparkling wines.
- The total phenol content (TPC) obtained by ultraperformance liquid chromatography (UPLC) provides a better representation of pressing fraction presence or pressing phase in the wines produced.
- The increasing trends observed in must samples with some of the phenolic parameters were

not observed at later stages during the winemaking process of still and sparkling wines. This points towards complex chemistry and perception mechanisms involving phenolics taking place in white wine production
- pH appears to be an important oenological parameter highly correlated with increasing pressing fraction presence or pressing phase. A combined assessment of phenolic content and pH should be considered to optimise the pressing operation
- Chenin and Sauvignon Blanc still white wines' sensory properties were less affected by the increasing presence of pressing fraction. These results were observed for both winemaking techniques (i.e. crushed and destemmed followed by cold maceration and whole bunch pressing). A minimal effect on phenolic extraction seems to be taking place during an overnight cold maceration. The aromatic improvement expected with cold maceration should be considered
- On the contrary, larger differences were observed for sparkling wines. The panel was able to discriminate the wines as pressing fraction presence increased. However, the ratings of the mouthfeel attributes (sweetness, sourness, astringency, body and bitterness) failed to explain the different perceptions of the wines produced.
- Sparkling wine perception seems to be more affected by the increasing presence of press fraction (and increasing levels of phenolics) than still wines.
- The ratio ABS 262 nm/ABS 328 nm was identified as a good estimator of increasing pressing fraction presence in still wines' musts. This ratio was not representative of increasing pressing fraction or pressing phase in sparkling wines. Grape compositional differences (varying ripening status, content, composition, and extractability of phenolics) are proposed as the reason for explaining the inconsistencies observed in sparkling wine grapes.
- Interestingly, hydroxycinnamic acids were found to be representative of free-run wine, whereas flavanols were found at higher levels in press wines. The use of these two phenolic families as markers of increasing pressing fraction presence is proposed.
- Although non-significant sensorial differences were observed in the rating of the mouthfeel attributes, positive correlations between the chemistry (UPLC phenolics) and the ratings of the mouthfeel attributes were identified. Astringency in still wines and bitterness and astringency in sparkling wines were positively correlated with higher levels of phenolics, which confirms the role of phenolic compounds in mouthfeel perception.
- Mid-infrared spectroscopy calibrations could be used to quantify UPLC phenolic content and the ABS 262 nm/ABS328 nm ratio in still-white wine musts. On the contrary, UV-visible spectroscopy calibrations were able to accurately predict UPLC phenolics in both still and sparkling musts.
- The combined monitoring of the hydroxycinnamic and flavanol content together with the pH values of the musts with spectroscopy-based calibrations is recommended to optimise the pressing operation of still and sparkling wines. The ABS 262 nm/ABS328 nm ratio can also be used to monitor the pressing operation in still-white wines.

9. PLANNED OUTPUTS

a) TECHNOLOGY DEVELOPMENT, PRODUCTS AND PATENTS

The mid-infrared (MIR) and UV-VIS spectroscopy calibrations obtained to quantify UPLC phenolics could be IP-protected. The ABS 262 nm/ABS 328 nm ratio could also be IP protected in the form of a parameter estimator of the pressing fraction and, therefore, phenolic presence in still white wine musts.

b) SUGGESTIONS FOR TECHNOLOGY TRANSFER

No technology transfer activities have been planned for this work

c) HUMAN RESOURCES DEVELOPMENT / TRAINING (STUDENTS)

Student Name and Surname	Student Nationality	Degree (eg Hons, MSc)	Level of studies in final year of project	Total Bursary Cost for Industry for entire project
Honours				
Masters				
Bronwyn Boting	South African	MSc	BSc	R 250000
PhD				
Postdocs				

d) LIKELY PUBLICATIONS (POPULAR, PRESS RELEASES, SCIENTIFIC)

A scientific publication is intended to be produced and submitted to a relevant journal. One or two popular articles should be submitted to Winelands.

e) PRESENTATIONS/PAPERS THAT COULD BE DELIVERED

Bronwyn Boting, Jeane Brand, Wessel du Toit, Jose Aleixandre-Tudo. Evaluating Still White Wine Phenolics and the Optimisation of Juice Yield Extraction in Wine Production. 43rd South African Society of Enology and Viticulture (SASEV) Conference. 13-14 September 2023.

10. PROJECT OUTCOME AND IMPACT

New Knowledge	Benefits Supply Chain	Direct Grower Application	Direct Packhouse/Winery/ Cellar Application	Other
X	X		X	

Other is:

The Value of the project to industry

A better understanding of the parameters to assess during still and sparkling wine pressing. Pressing can be monitored with spectroscopy-based calibrations. The perception of sparkling wines is more intensively affected by increasing pressing fraction. The optimisation of the pressing can aid in maintaining wine quality while optimising the must extraction yield

11. PERSONS PARTICIPATING IN THE PROJECT:

INITIALS AND SURNAME	HIGHEST QUALIFICATION	RACE (B,C,I,W)	GENDER (M,F,X)	INSTITUTE DEPARTM	POSITION	TOTAL COST TO PROJECT
RESEARCH PERSONNEL						R 0
Jeanne Brand	PhD	W	F	DVO	Lecturer	R 0
Wesel du Toit	PhD	W	M	DVO	Professor	R 0
SUPPORT PERSONNEL						R 0

POSITION: Co = Co-worker (other researcher at your institution)
Coll = Collaborator (participating researcher that does not receive funding for this project from industry)
PF = Post-doctoral fellow
PL = Project leader
RA = Research assistant
TA = Technical assistant/ technician

12. TOTAL COST OF PROJECT

TOTAL ANNUAL COSTS (ALL YEARS)	CFPA	RAISINS SA	HORTGRO	SATI	SA WINE	ARC	OTHER	TOTAL
2019 and before	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
2020	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
2021	R 0	R 0	R 0	R 0	R 361500	R 0	R 0	R 361500
2022	R 0	R 0	R 0	R 0	R 377500	R 0	R 0	R 377500
2023	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
2024	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0

TOTAL	R 0	R 0	R 0	R 0	R 739000	R 0	R 0	R 739000