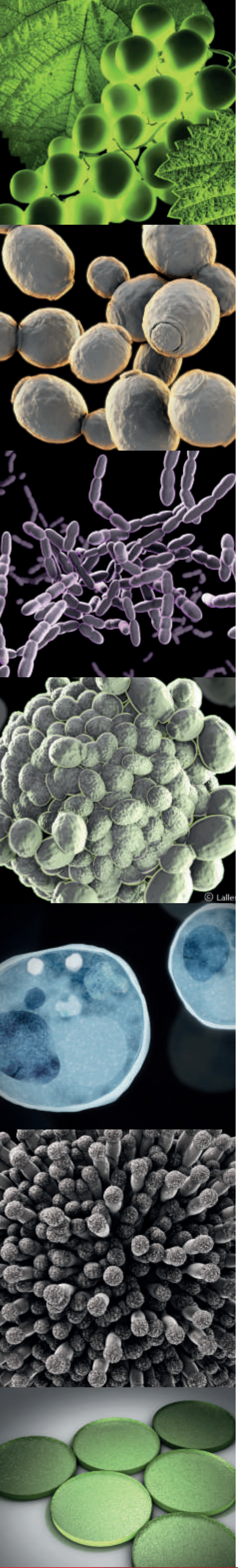

INVESTIGATING CONSUMER AND EXPERT PERCEPTIONS ON THE SENSORY EFFECTS OF LACTIC ACID BACTERIA IN WINE

STUDY DONE BY CHRISTINE MARSIGLIO, MW.

WINE YEASTS | WINE BACTERIA | NUTRIENTS /PROTECTORS | SPECIFIC INACTIVATED YEASTS | ENZYMES | CHITOSAN | VINEYARD SOLUTIONS

LALLEMAND
LALLEMAND OENOLOGY
Original by culture

ABSTRACT

Studies of microbiological impact on aroma profile in wine have recently shown that Lactic Acid Bacteria (LAB) can have just as profound a sensory impact as yeast (Silvano, 2019), yet little research has focussed on end-user perception of these differences, in white and red wines. In this study, engaged consumers and experts blind tasted wines which underwent malolactic fermentation (MLF) using different selected strains of *Oenococcus oeni* and *Lactobacillus plantarum* to compare the sensory and hedonic impacts. Three strains of LAB were tested in Chardonnay and two in Pinot Noir.

Flash Profiling (FP), a new and powerful Descriptive Analysis technique, was employed to differentiate and describe sensory effects caused by LAB in the wines. Descriptors created by experts during FP were compared to chemical analysis results, and to the usage of those descriptors by consumers. The different LAB also caused significant differences in tannin texture in the Pinot Noir, but also a noticeable difference in diacetyl and acid perception for both consumers and experts in the Chardonnay. These results illuminate the importance of choice of the selected LAB used in the vinification process when considering the impacts on final wine style in both red and white wines. Selected wine bacteria should be considered as an important contributor to match the desired style of wines winemakers wish to produce.

METHODOLOGY

WINES

Oenococcus oeni and *Lactobacillus plantarum* were used to complete MLF in Chardonnay from Tumbarumba, Australia and Pinot Noir from Carneros, California. The selected wine bacteria are freeze-dried bacteria produced according to the Lallemand production process named MBR™, which allows a direct inoculation of bacteria into wines.

Each of the wines underwent MLF by a different strain. The inoculation of bacteria was completed at the same time, at the end of the alcoholic fermentation for the both wines (sequential inoculation). For each of them, the wine was split after the end of alcoholic fermentation in different tanks and inoculated with the dose rate recommended on the commercial products.

Strain Name[1]	Genus	Sensory Contribution[2]
A	*Oenococcus oeni*	High production of diacetyl in sequential inoculation
B	*Oenococcus oeni*	Low diacetyl production
C	*Lactobacillus plantarum*	No acetic acid production, no production of diacetyl
D	*Oenococcus oeni*	Very low production of diacetyl, increased red berry fruit aromas, and delicate tannin structure

Table 1: Bacterial sensory contribution as defined by Lallemand oenology

FLASH PROFILING

Descriptive Analysis (DA) of the wines was required to create descriptors that could be used during the hedonic tastings. Flash Profiling (FP) was chosen as it is a faster, more cost-effective form of DA that does not require the training of an expert panel and gives similar results to conventional DA but in a quarter of the time (Dairou & Siefferman, 2002). Additionally, FP can differentiate between samples in a significant way, like a duo-trio test (Taillet, 2018). These tastings were carried out by 10 experts[3], over two sessions, using the protocol derived from FP experiments of Mamede et al. (2016), Dairou and Siefferman (2002), and Montanuci et al. (2015).

[1] All of the LAB strains used are supplied by Lallemand Oenology.
[2] Information obtained from technical data sheets.
[3] Masters of Wine (MW), 7 MW Students, one WSET Diploma graduate, all regular blind tasters.

SESSION 1 (40 MINUTES) – ATTRIBUTE GENERATION

50 mL of each wine was poured into ISO glasses away from the assessors. The wines were served at room temperature (20-21˚C). Assessors were told that no communication between them was allowed during the trial, as to ensure no one was influenced by others' opinions.

All samples for the Chardonnay, including a duplicate of Strain B[4], were presented simultaneously and the assessors were asked to evaluate each sample and record all the attributes they could perceive (colour, aroma, mouthfeel, texture, aftertaste), and were asked to focus on the differences between the wines. Assessors could re-taste as many times as they wished.

Once all samples were evaluated, assessors were asked to create a list of all the descriptive terms (avoiding hedonic descriptors) they had generated and to group them by modality (aroma, flavour, colour, mouthfeel). Assessors were then given a 10-minute break to refresh their palates whilst the researcher reviewed their lists and created a questionnaire for each assessor using their unique list of descriptive terms. Each term was associated with a scale and anchors of "-" and "+" were used.

These descriptors, as they were quite universally understood and form part of most people's vocabulary, could also be used for consumer descriptive and hedonic tastings. Along with rating a wine based on hedonic preference, consumers can also use these descriptors, generated by experts, to help researchers understand the differences perceived by consumers between wines.

SESSION 2 (20 MINUTES) – SAMPLE RANKING

After the 10-minute break, assessors were presented with the wines again with their sample ranking questionnaire and asked to rank the wines from lowest to highest for each descriptor they generated. This protocol was repeated for the Pinot Noir, with the repeat sample of Strain D for statistical analysis purposes.

Data were analysed by the Generalized Procrustes Analysis (GPA), using XLSTAT 2019 statistical software (Addinsoft Long Island, NY). GPA is a powerful multivariate technique extensively used in sensory evaluation. The analysis uses translation, rotation, and isotropic scaling to minimise differences among panellists (Gower, 1975; Paulos et al. 2015), identifies agreement between them, and summarises the sets of 3-dimensional data (samples, characteristics, and assessors).

HEDONIC TASTING WITH CONSUMERS AND EXPERTS

87 educated consumers and 25 experts took part in the hedonic tastings.

Samples were served in Completely Randomised Design[5] to control for lurking variables. All samples were placed on tables along with corresponding coded paperwork before participants arrived.

Tasters were instructed to taste one wine at a time, evaluate it, spit the wine out, rinse with water, and then move onto the next wine.

The questionnaire asked participants to rate the wine on a 9-point hedonic scale (Lawless and Heymann, 2010). The 9-point scale, anchored at the end points with "dislike extremely" and "like extremely"

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[4] This was suggested by Eric Taillet at Sensostat (Dijon, France) as a way to have duplication of samples but without having to run duplicate or triplicate tastings, thereby saving resources.

[5] White wines were always tasted before red wines.

Finally, for each wine, participants had to circle up to three randomly ordered descriptors (Drew, 2018) that were previously created by the expert panel in Flash Profiling, that the participants felt fit best with that particular wine. Eight words each were selected for the white and the red wine (chosen by the frequency by which they occurred in the FP session[6] (Table 2)

Chardonnay Descriptors		Pinot Noir Descriptors	
Citrus	Green Fruit	Cherry	Grippy Tannins
Creamy	Mineral	Earthy	Herbal
Crisp	Rounded	Floral	Ripe Tannins
Floral	Stone Fruit	Full Bodied	Bitter

Table 2: Descriptors presented to tasters during hedonic tastings

CHEMICAL ANALYSES

Chemical analyses were completed in kind by Lallemand Oenology in Toulouse France (Table A & B, Appendix).

RESULTS & DISCUSSION

Question 1:

Can experts perceive the differences in sensory effects elicited by three different LAB strains in a selected white wine and two different LAB in a selected red wine?

Flash Profiling can be used to test for significant differences between products, and then can demonstrate where those differences lie within the product.

Using Discriminant Analysis in XLSTAT 2019, on the object co-ordinates taken from GPA, it is possible to see that the 10 expert assessors were able to differentiate the wines quite clearly using FP (Figures 1 & 2).

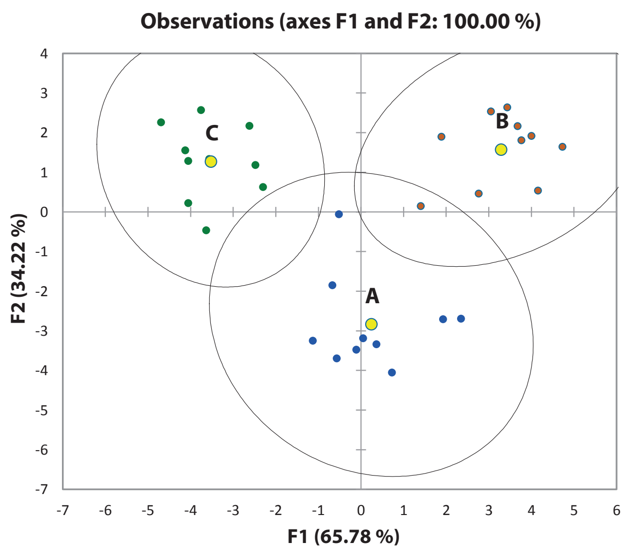

Figure 1: Discriminant Analysis with significance level of 5% of GPA coordinates of three different LAB Strains in Chardonnay.

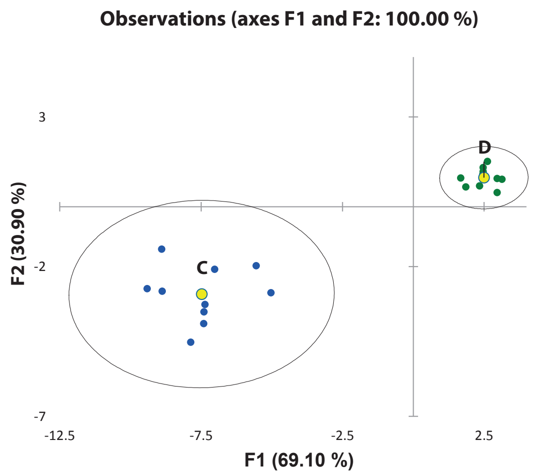

Figure 2: Discriminant Analysis with significance level of 5% on GPA coordinates of two different LAB Strains in Pinot Noir.

6 Bitterness was included as the educated consumers with less than Level 3 WSET knowledge may not have known how to describe tannins. Increased bitterness perception would then be linked with higher tannin perception.

Not only does FP show that the 10 expert assessors could differentiate between the various strains of LAB in Chardonnay and Pinot Noir to a 95% confidence level, it clearly illustrates the attributes on which the assessors differentiated the wines (Figures 3 & 4).

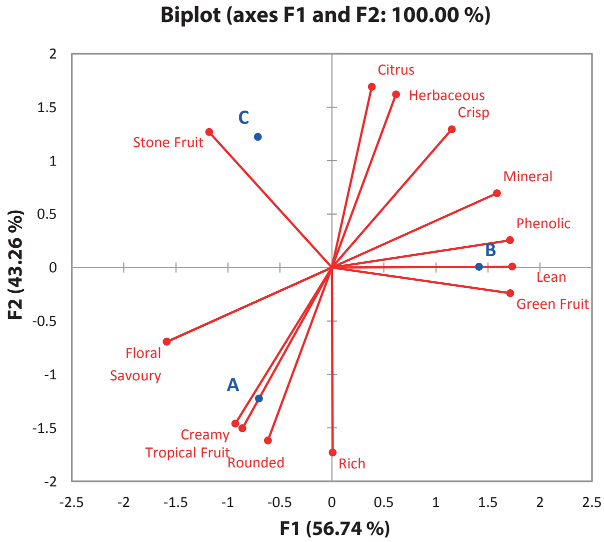

Figure 3: Consensus configuration: representation of the correlation between descriptors and their 1st and 2nd dimensions and groups of LAB strains in Chardonnay.

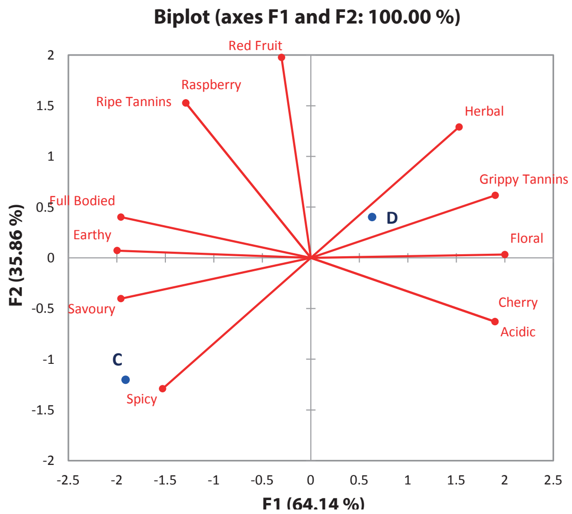

Figure 4: Consensus configuration: representation of the correlation between descriptors and their 1st and 2nd dimensions and two LAB strains Pinot Noir.

These sensory results are consistent with the chemical analyses, specifically with the Chardonnay. Strain A was found to have the highest level of diacetyl (0.8 mg/L) along with a low level of malic acid (210 mg/L), which are consistent with the descriptors of "Creamy" and "Rounded", respectively. Strain A was also found to be negatively correlated with descriptors of crisp, citrus, mineral, and lean, which may be explained by its lower level of malic acid. Strain A also had a high ethyl lactate level (122 mg/L), which has a buttery aroma, and can contribute to the body of a wine (Ribereau-Gayon et al., 2006). Additionally, Strain A had the highest level of isoamyl acetate, which correlates to the "Tropical Fruit" descriptor, and the highest level of ethyl octanoate, which correlates to the "Floral" descriptor.

Though the physical differences between the two Pinot Noirs is not great (see appendix), it is impressive that the experts were able to differentiate quite clearly between the two and could ascribe specific characteristics to each wine (Figure 4).

It can also be noted that the experts found a difference in tannin perception, rating one wine has having grippier tannins (Strain D), whilst the other was correlated with riper tannins (Strain C). Though the total polyphenol index of the two wines is almost identical, it has been shown that some LAB can increase tannin condensation, thereby reducing "grippy" tannins and reduce overall astringency (Vivas et al., 1997). This can be tested through molecular mass differentiation; however this test was no performed.

Question 2:

Can educated consumers perceive the differences in sensory effects elicited by three different LAB strains in a selected white wine and two different LAB in a selected red wine?

87 consumers tasted the three different Chardonnays and two different Pinot Noirs. After rating each wine, they circled descriptors, which were obtained through FP, which they felt best described each wine.

The similarity of terms used to describe the different strains and genera of LAB fits quite closely to the descriptors used by the experts in FP, especially with the Chardonnays (Figure 5). This shows that "Creamy" and "Stone Fruit" are positively correlated to Strain A, whilst "Crisp" is negatively correlated to Strain A, as was seen through FP with the 10 experts.

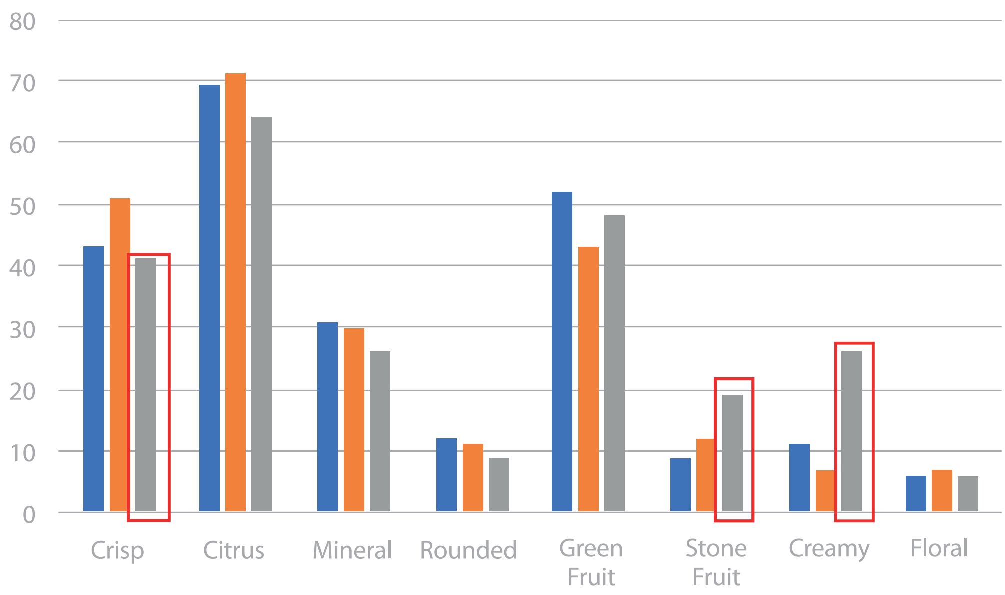

Figure 5: Frequency of descriptors used by consumers in hedonic tastings for three different LAB strains in Chardonnay. Blue-B, Orange-C, Grey-A. Selected differences in terms relating to the Strain A, are highlighted with red rectangles.

For the two Pinot Noir strains compared during FP, the expert panel used the words "Herbal", "Grippy Tannins", and "Floral" to describe Strain D. When observing the use of descriptors by consumers (Chart 2), the frequency is similar for each strain, supporting the conclusion that the consumers had difficulty differentiating between the two LAB in Pinot Noir. However, it should be noted that there is an increased perception of bitterness with Strain D, which could be connected to the experts' description of grippy tannins for that strain (Figure 6). Higher levels of ethyl esters found in Strain C, however, could also explain the decrease in perception of bitterness, and can help explain the increase in perception of "Cherry" descriptor, used by the consumers.

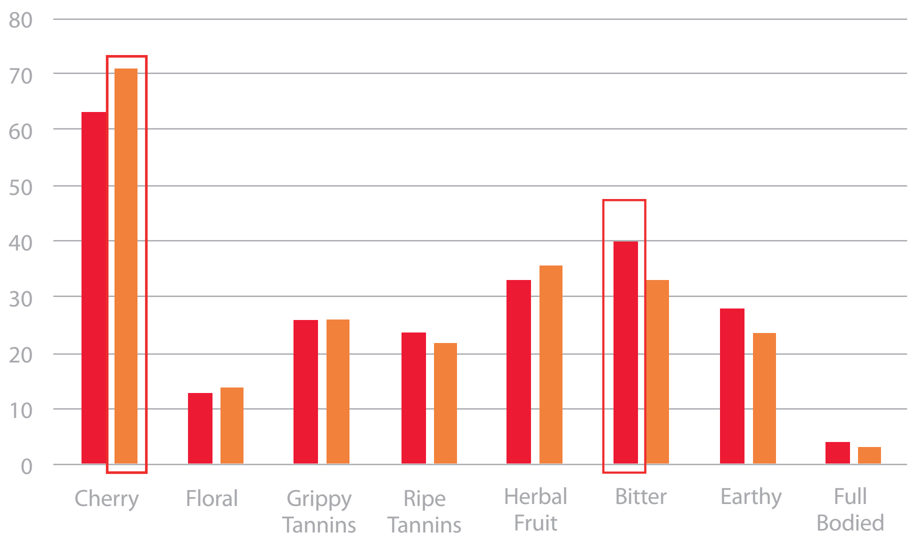

Figure 6.: Frequency of descriptors used by consumers in hedonic tastings for two different LAB strains in Pinot Noir. Red-D, Orange-C. Selected differences in terms highlighted with red rectangles.

CONCLUSIONS

This study has tried to determine the sensory effects of different LAB in Chardonnay and Pinot Noir. In summary: experts can detect differences between the different Lactic Acid Bacteria used for MLF. Certain descriptors, particularly diacetyl and acidity in Chardonnay, and tannin and cherry in Pinot Noir, are linked to chemical analysis, showing that physical differences in a wine can be manifested quite clearly in the sensory profile, even if these differences may seem minor.

The major differences for Chardonnay were shown to be in the aroma profile, which in another study (Marsiglio, 2019) influenced hedonic preference of these experts, notably increasing their preference when wines were creamier. As for Pinot Noir, the most differentiating feature, as noted by the experts, were the nature of the tannins which played a key role on the sensory impact, which again, influenced preference (Marsiglio, 2019).

Meanwhile, while the pattern of consumers' chosen descriptors mimicked those of the experts, also showing, that whilst consumers may not be as adept to differentiating aromas as experts particularly in red wines, they still do show a tendency toward understanding the minor differences between wines, which are created by different Lactic Acid Bacteria. This may prove to drive preference in future studies, and it is therefore essential for winemakers to evaluate which wine bacteria they are choosing during the winemaking process.

Whilst the focus of many studies in the past has been on how yeast can dramatically influence sensory perception of a wine, and influence preference (Belda et al., 2017; Swiegers et al., 2005), this study has shown that LAB can play just as an important role as yeast when it comes to the aroma profile of a wine, but also the tannic structure of a wine. These differences will have an impact on consumer and expert preference, and therefore the choice of wine bacteria should be as an important as the type of yeast for winemakers when deciding what style and quality of wine they hope to produce. This study demonstrates that certain LAB not only convert malic acid into lactic acid but have many other biological pathways that can modulate wine flavours and tannic structure.

APPENDIX

Test	Units	Pre-Inoculation	Strain B	Strain A	Strain C
Alcohol	% v/v	11.8	11.7	11.8	11.7
Residual Sugar (RS)	g/L		0.10	0.11	0.10
pH		3.09	3.29	3.29	3.22
Titratable Acidity (TA)	g/L	9.1	6.1	5.8	6.7
Volatile Acidity (VA)	g/L		0.26	0.23	0.14
Free SO_2	mg/L		29	30	29
Total SO_2	mg/L		83	90	92
Malic Acid	g/L	5.4	0.19	0.21	1.41
MLF duration	Days		70	59	32

Table A: Final chemical analysis of Chardonnay using three different LAB strains to complete MLF.

Test	Units	Strain D	Strain C
Alcohol	% v/v	13.6	13.6
Residual Sugar (RS)	g/L	<1	<1
pH		3.66	3.63
Titratable Acidity (TA)	g/L	6.7	7.0
Volatile Acidity (VA)	g/L	0.69	0.62
Free SO_2	mg/L	22	19
Malic Acid	g/L	0	0.25
MLF duration	Days	14	19
Diacetyl	mg/L	0	0

Table B: Final chemical analysis of Pinot Noir using two different LAB strains to complete MLF.

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