BIO Web of Conferences **56**, 02022 (2023) https://doi.org/10.1051/bioconf/20235602022
43rd World Congress of Vine and Wine

Effect of ageing on lees on the quality of white and rosé wines from Iași vineyard

Maria Iulia Cerbu[1], Cintia Lucia Colibaba[1], Camelia Luchian[1], Cătălin-Ioan Zamfir[2], Bogdan Constantin Nechita[2], Ionel-Bogdan Cioroiu[2], Marius Niculaua[2], and Valeriu V. Cotea[1,*]

[1]University of Agricultural Sciences and Veterinary Medicine "Ion Ionescu de la Brad", 700490, 3 M. Sadoveanu Alley, Iași, Romania
[2]Romanian Academy of Sciences, Center of Oenological Researches, Iași Branch, 9 M. Sadoveanu Alley, 700490 Iași, Romania

Abstract. Ageing of wines on lees (autolysis) involves keeping wines in contact with dead yeast cells for several months/years to intensify the transfer of compounds between yeast cells and wine. During yeast autolysis, release of different compounds has been shown to have a positive influence on organoleptic characteristics of wine as these compounds, including lipids, mannoproteins, peptides, proteins, amino acids, and glucans, are breakdown products of yeasts and can impact on volatile profile of wine. The aim of this study was to evaluate the quality of white and rosé wines aged in contact with lees for 2 months, using 12 commercial maturation products. The studied wines were produced in Iasi vineyard, vintage 2020, from Sauvignon blanc and Busuioacă de Bohotin grapes variety. Thus, 26 samples were obtained (V1 SB-V13 SB; V1 BB – V13 BB). The effect of ageing on lees was assessed by analysing some main aroma compounds, performing an organoleptic analysis and quantifying color changes (CIEL ab parameters). The first impression that the consumer receives from wine is color and to some extent it can influence the taste. In terms of color parameters, an increase in color intensity was evident for all samples after the lees ageing period. Sensorial analysis coupled with statistical analysis tests showed a definite correlation between the maturation products used and their composition vs. certain sensorial indices. The treated wines boasted a smoother sensorial profile, with enhancement of mouth feel and persistence (V2, 3, 11 SB and V2, 3, 11 BB).

1 Introduction

The quality of wines has often been associated with their geographical area of production, as well as the grape variety used in their elaboration, but also with the technological process. Wine ageing on lees is a fundamental step in adding complexity and depth of flavour. In the final stage of wine-making process, namely bottle ageing, many chemical changes occur. During the period of ageing on lees, the wine matures; several processes take place and enhance its sensory attributes. Aromatic but also structural compositional complexity evolves as a consequence of important changes developing from differently reactions like esterification, redox, and hydrolysis, CO_2 removal, continuous and slow diffusion of oxygen, spontaneous clarification [1].

Sur lie wines are obtained by a traditional winemaking technique used in many countries, which involves the contact of wine with less for a certain period of time. Typical yeast-aged wines are Muscadet wines from the Loire Valley in France, wines from the Gulf of Lion region, Pays d'Oc wines and famous Burgundy wines, as well as wines from Italy, California, Australia, and South Africa [2]. Therefore, ageing on less is an oenological practice used to improve the quality of wine, which allows it to remain in contact with yeast residues. The method shows an increased interest than the traditional method (maturation in stainless steel tanks without yeast deposits).

Ageing on less technique is generally coupled with the use of oak barrels (*barriques*) that allow a slow oxygenation, but also for white and rosé wines meant to be aged [3]. Traditionally, the oenological practice of ageing wine on lees is accomplished with lees originated after the alcoholic fermentation process, after applying racking.

Yeast cells autolyse at the end of the alcoholic fermentation. Yeast autolysis is a slow process, carried out under the action of hydrolytic enzymes that are release from the cytoplasm (fatty acids, peptides, amino acids, nucleotides) but also cell walls (mannoproteins) into the wine. These lees are composed of dead microorganisms (mainly yeast and bacteria) with a low density matrix related to the winemaking industry [4].

During ageing, some particular wines are left in contact with their lees. In champagne and sparkling wines technology, these are aged on less after the second fermentation. Some still white wines obtained from Chardonnay mainly also use this step in their technology.

The purpose of *sur lie* is usually based on wine complexity, increasing the aromatic complexity and adding extra body, enhancing the mouth feel and structure of wine. Also, through the absorption of oxygen by the yeasts, a slow and controlled oxidation occurs. By periodically stirring the deposit, a larger amount of yeast compounds can be released. Lees stirring can enhance flavour complexity and result in a denser mouth feel and creamier notes. Reductive aromas can be reduced through stirring and oxygen addition [5].

Several studies have been performed regarding the influence of yeasts on wine aroma [6]. The quality of the final product is influenced by the development of specific wine volatile compounds. The most common variables studied in wines due to their importance in physical, chemical and sensory characteristics have been the aroma

* Corresponding author: vvcotea@yahoo.com

compounds. The origin of aroma compounds is four-fold: from grapes, must fermentation, maturation stage and ageing processes. All these stages affect the olfactory quality of wines regarding the herbaceous, floral, fruity and toasted notes [7]. In recent years, specific aromas obtained after ageing on lees have been studied, but also their connection to their precursors - polysaccharides, mannoproteins from the yeast cell walls [8].

The current research studies the interaction between macromolecules and aromatic compounds in wines aged *sur lie*, using different commercial maturation products, applied in different doses. The aim of this work was to study the aromatic compounds of Sauvignon blanc and Busuioacă de Bohotin wines aged on lees, by sensorial and statistical analysis, with a time variable.

2. Material and methods

2.1 Samples and winemaking process

In order to conduct this study, grapes of Sauvignon blanc and Busuioaca de Bohotin varieties were harvested at the technological maturity from Iasi vineyard. 26 experimental samples were obtained by adding different doses from 12 commercial products used in wine aging on lees, as follows:

- V1S/V1B (4.02 g product/ 10L wine);
- V2S/V2B (4.02 g product/ 10L wine);
- V3S/V3B (4.02 g product/ 10L wine);
- V4S/V4B (6.01 g product/ 10L wine);
- V5S/V5B (4.02 g product/ 10L wine);
- V6S/V6B (2.01 g product/ 10L wine);
- V7S/V7B (2.01 g product/ 10L wine);
- V8S/V8B (8.02 g product/ 10L wine);
- V9S/V9B (3.01 g product/ 10L wine);
- V10S/V10B (4.02 g product/ 10L wine);
- V11S/V11B (3.01 g product/ 10L wine);
- V12S/V12B (4.02 g product/ 10L wine);
- V13S/V13B (no inactive addition).

Aging on lees lasted 2 months, after which the wines were filtered and bottled.

2.2 Study of physico-chemical and chromatic parameters

Basic wine parameters including reducing sugar, total and volatile acidity, alcohol strength, extracts and pH values of the given samples were determined according with the OIV methods (total acidity by use the method OIV-MA-AS313-01, reducing sugars – OIV-MA-AS311-01C, volatile acidity – OIV-MA-AS313-02,the ethanol content according OIV-MA-AS312-01 and pH values with OIV-MA-AS313-02 method).

The determination of the chromatic characteristics of the wines under study was performed five months after their obtaining and ageing on less in bottle, by the usual OIV spectrophotometric method. The chromatic parameters CIE-LAB 76 (luminosity L, chrome C, tone H, tint and intensity of wine color) obtained by calculation for each experimental variant [9].

2.3 Sensory evaluation

Wine aroma is composed of a wide variety of compounds with different organoleptic proprieties, which will slightly evolve during bottle ageing [10].

Sensory profile of wines is analysed through the tasting process and is considered very important for the final evaluation of wines quality. The organoleptic analyses were performed in the special tasting room of the Oenology Research Centre in Iasi by 10 authorised tasters according to the evaluation method proposed by International Union of Oenologists.

Olfactory evaluation is the only way in which the human senses are exposed to the volatile aromas of wine. The sense organ responsible for the perception of aromas is the nose and compared to the taste, it has a much higher sensitivity. In the organoleptic analysis of wine, the taste has a special importance because it completes the organoleptic analysis and offers the opportunity to identify quality through the intensity and duration of taste [11].

Wine tasters were asked to fill three different sheets: one with olfactory attributes of the wine (flavours like mineral, green, exotic, citrus, flowers, fruit aroma), the second with taste descriptors (sour, sweet, salty, bitter) and the last one with attributes conferred by lees autolysis (sensations like crisp, biscuits, bread crust, body and structure of wines) using marks from 1 to 9 for each sensory descriptor.

2.4 Statistical analyses

Data analysis - Statistical data analysis was performed using the analysis of variance (ANOVA) of Statistica V.7 software (Statsoft Inc.). All the mean values obtained during chemical analyse, as well assensory analysis are based on three replications. Fisher LSD test was used as comparison tests when samples were significantly different after ANOVA ($p < 0.05$) for sensory analysis. Principal Component Analysis (PCA) was used to examine any possible grouping of samples according to treatment dose applied and principal composition of products. Principal component analysis (PCA) was performed on the correlation matrix using the sensorial attributes that differed significantly by ANOVA. Pearson's correlation analysis was usedto investigate correlation between dose applied and sensory perception.

3 Results and Discussion

3.1 Physico-chemical and chromatic parameters of analysed wine samples

The technique ageing on lees is used to improve the sensory quality of wines through the autolysis process that leads to the release of various compounds like lipids, mannoproteins, polysaccharides, peptides, amino-acids and nucleic acids from yeasts. Autolysis literally means "self-destruction" and in that case represents self-degradation of the cellular constituents of a yeast's cell by its own enzymes. The process is slow and complex and it may involve some microbiological oenological transformations and organoleptic evolution [12].

Physical-chemical analyses were performed after the addition of different dosages of the above mentioned commercial products: ethanol content, volatile acidity, total acidity, density, pH, total sugars, malic and lactic acids.

Table 1 shows the physico-chemical parameters of wines obtained from Sauvignon blanc and Busuioaca de Bohotin produced at the Iasi-Copou vineyard, after ageing on less for two months in glass demijohns.

Table 1. Physico-chemical parameters of analysed wine samples.

Sample	Ethanol %vol.alc.	Totalacidity g/ L	Volatileacidity g/ L	Totalsugar g/L	Total dry extract g/ L	Non-reducing dry extract	Density δ	pH
V1S	13.4	6.73	0.31	1.6	18.5	16.9	0.98965	2.93
V2S	13.3	6.73	0.3	1.9	18.8	16.9	0.98994	2.92
V3S	13.3	6.73	0.32	1.2	19.6	18.4	0.99021	2.98
V4S	13.4	6.89	0.3	1.6	18.8	17.2	0.98983	2.95
V5S	13.4	6.73	0.31	1.2	18.8	17.6	0.98978	2.95
V6S	13.4	6.73	0.3	0.9	18	17.1	0.98952	2.91
V7S	13.2	6.73	0.31	1.6	18	16.4	0.98977	2.93
V8S	13	6.43	0.3	1.6	17.2	15.6	0.98971	3
V9S	13.2	6.89	0.31	1.3	18.5	17.2	0.99003	2.95
V10S	13.2	6.73	0.32	1	17.7	16.7	0.9897	2.96
V11S	13.4	6.73	0.3	1.4	18.3	16.9	0.98958	2.93
V12S	13.3	6.89	1.4	1.4	18.8	17.4	0.98994	2.93
V13S	13.4	6.89	0.31	1.1	18	16.9	0.9895	2.93
V1B	13.9	6.43	0.3	1.6	21.6	20	0.99035	3.1
V2B	14	6.43	0.32	1.2	22.2	21	0.99041	3.13
V3B	14	6.56	0.29	1.7	21.6	19.9	0.99019	3.11
V4B	14	6.43	0.3	1.5	22.4	20.9	0.9905	3.14
V5B	14	6.43	0.34	0.6	22.2	21.6	0.99041	3.16
V6B	13.7	6.43	0.31	1.6	21.1	19.5	0.99039	3.11
V7B	14	6.56	0.31	1.5	21.6	20.1	0.99018	3.13
V8B	14	6.12	0.31	1.1	21.4	20.3	0.99005	3.18
V9B	13.9	6.43	0.31	1.6	21.9	20.3	0.99053	3.12
V10B	14.1	6.43	0.29	1.5	22.2	20.7	0.99029	3.1
V11B	14	6.43	0.31	1.3	21.9	20.6	0.9903	3.12
V12B	14	6.43	0.31	1.5	22.7	21.2	0.99058	3.11
V13B	14	6,43	0.3	1.4	22.4	21	0.99047	3.11

The maturation products for ageing on lees of white and rosé wines showed a low influence on the physico-chemical parameters, with an increase observed in non-reducing dry extract (V3S, V5S, V12S; V5B, V12B) compared to the control samples (V13S, V13B).

The ethanol content in wine samples represents the result of the conversion of monosaccharide from musts (glucose and fructose) into ethanol and carbon dioxide in the fermentation process stage of winemaking process [13]. The analysis showed an alcoholic strength ranging from 13% vol. (V8S) to 14.1% vol. (V10B), with no significant influence of the treatments used.

Regarding the values of density in wine samples treated with different doses of maturation products compared to the control samples (V13S, V13B), a small decrease was registered.

A slight decrease concerning total acidity was observed for all wine samples, fact mentioned by others studies as well [14].

The color of wines is one of the most important quality parameters and the winemaking steps have a defining role in its evolution [15]. Color plays a greater role in defining perceived odor than chemical constitution of wine and it is the most important sensory characteristics of white wine [16]. Hue and color intensity measurements give practical information about tendency for oxidation and phenolic concentration.

During ageing on lees, the color of wine undergoes changes, due to the influence of lees on wine anthocyanins, compounds being absorbed on the yeast cell walls [17]. Concerning the influence of the maturation products on the color of the experimental wine samples (Table 2), the highest values of luminosity (L*) are well correlated with the clarity of the wines (Table 2).

Table 2. Chromatic parameters of analysed wine samples.

Sample	Luminosity L(0-100)	Colorimetric coordinates		Chroma C	Tone H	Intensity	Tint
		A red(+) green (-)	b yellow(+) blue(-)				
V1S	99.26	2.68	2.65	3.77	44.66	0.22	1.35
V2S	99.32	4.19	3.03	5.17	35.83	0.31	1.14
V3S	99.36	3.89	3	4.92	37.71	0.29	1.18
V4S	99.3	3.73	3.42	5.06	42.48	0.31	1.26
V5S	99.34	4.06	3.16	5.14	37.9	0.31	1.18
V6S	99.63	4.13	2.97	5.08	35.76	0.31	1.14
V7S	99.3	4.46	3.03	5.4	34.15	0.32	1.11
V8S	99.56	3.46	2.81	4.46	39.13	0.27	1.19
V9S	99.59	3.87	3.05	4.93	38.31	0.3	1.19
V10S	99.65	3.83	2.98	4.85	37.85	0.29	1.18
V11S	99.43	4.08	3.07	5.11	36.93	0.3	1.16
V12S	99.16	4.68	3.09	5.61	33.48	0.33	1.09
V13S	99.51	4.93	3	5.77	31.37	0.33	1.05
V1B	97.64	-0.16	2.48	2.49	-86.25	0.11	3.75
V2B	96.54	-0.22	2.47	2.48	-88.94	0.1	4
V3B	96.71	-0.22	2.44	2.45	-84.73	0.1	4.11
V4B	96.6	-0.22	2.53	2.54	-88.06	0.1	3.97
V5B	96.55	-0.23	2.56	2.57	-84.87	0.1	4.15
V6B	96.53	-0.37	2.08	2.12	-79.86	0.07	6.03
V7B	96.37	-0.24	2.69	2.7	-84.92	0.11	4.14
V8B	97.01	-0.3	2.05	2.07	-81.92	0.08	5.03
V9B	96.67	-0.33	2.07	2.1	-81.02	0.07	5.43
V10B	96.76	-0.36	1.98	2.01	-79.67	0.07	6.14
V11B	96.57	-0.29	2.36	2.38	-82.88	0.09	4.52
V12B	96.27	-0.26	2.65	2.67	-84.47	0.12	3.74
V13B	96.15	-0.35	2.24	2.27	-81.07	0.09	5.05

The different dosage of the maturing product and the periodic agitation did not have a major influence on the intensity and tint of wine samples for both grape varieties used as raw matter.

3.2 Relation between olfactive and taste descriptors and the origin of maturation product

Ageing on leesis mainly used as it improves the aromatic balance of wine and adds complexity. Wines benefit from the release of many components and substances as polysaccharides, mannoproteins, vitamins, lipids, ribonucleic acids from the cell walls of autolyse cells. The process releases compounds which influence the final bouquet of wines and as some of them are considered to be precursors of wine aromas [18]. To develop and examine in detail the differences between olfactive and taste descriptors, the results of one-way ANOVA are presented in Table 3.

The classification was performed according to the main characteristic of the aging product composition, but also as function of the dose considered for every grape variety included in the study. In these conditions, the experimental wine samples were defined according to the composition of the used treatment. Because of their method of production all the products of aging are rich in peptides, amino acids and polysaccharides. As stated, for these products were identified specific sensorial characteristics imparted to wines, as function of the media which is developed during the activity in the wine environment. So, the characteristic is release of:mannoproteins (Batonage Plus® products) polysaccharides (Super-Mann®), vitamins (Sphere Blanc® and Sphere Express®), polyvinylpyrrolidone (Trap Metals®), gluthation (Fresh Arom®) with role in antioxidant reactions, peptydes (Oenoles®) and also enzymes (Powerless® Rouge). Also, the statistical analysis included the doses that were applied. Given the fact that a spectrum of different doses was not applied for every type of aging products, the analysis included the mean values obtained but was calculated indifferent to the type of product for every wine variety.

One of the main organoleptic characteristics of the aging products was reducing of the vegetable, green perception and increasing the sensation of ripe fruits. During evaluation, for wine samples obtained from Sauvignon blanc, green and mineral perception had significantly lower values than the control sample. In contrast, for wine samples obtained from Busuioacă de

Bohotin did not have the same behaviour, the green and mineral perception was similar. A decreased value in perception was in floral evaluation at the V6B and V7B samples (products with vitamins), with a clear difference in comparison to products that had mannoproteins and polysaccharides. Citrus perception had superior values for some type of products, as can be seen in samples V6S and V7S and V5B and V6 B. A lower perception of the same sensorial indices was in the case of products rich in vitamins and polysaccharides, namely samples V2B, V3B, and V2S, V8B. This has also been demonstrated by other studies [19]. In all these cases, the sensorial indices for white fruits, red fruits for wine samples obtained from Busuioacă de Bohotin were not significantly different in relation with control or with other parameters, the overall evaluation gave average bonification points of 3.01 ± 0.41 for white fruits, 5.7 ± 0.47 red fruits and 3.86 ± 0.38 spices. Bread crust was one of the most important descriptors, influenced by the presence of aging products in the wine matrix, the average values being considered as grouping variable principal compounds of the maturation products. Regardless of the grape variety, the exotic fruits perception was more intense. In the case of samples obtained fromBusuioacă de Bohotin, the highest bonification point was 6.2, while, in case of wines obtained from Sauvignon blanc, the values of the indicator were close to those from the control samples (4.8 vs 3.5 for the control).

The evaluation in relation with the dose applied was in some cases confirmed (Table 4). Taking inconsideration, that wines obtained from Busuioacă de Bohotin developed more intense bread crust aromas after use of maturation products, only some descriptor perceptions were found to be sufficient correlated with the dose. In the case of experimental samples from Busuioacă de Bohotingrape variety, bread crust descriptor was found to be linearly correlated with the dose, r=0.578 (p<0.05), as presented in Figure 1. The doses applied influenced the descriptors of wines since there were registered differences between the all samples.

Regardless to the type of maturation products, the dose applied produced significant differences only for some olfactive descriptors as spices for wines from BB, green and mineral indices in case of samples from SB. Mineral perception was lower than in case of control sample, up to -0.5 points in perception. The negative correlation was also found for floral, with r= –0.29. All the other descriptors had no or a weak variation as function to the dose applied.

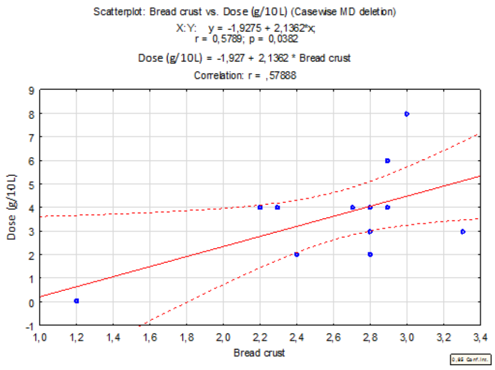

Figure 1a. Correlation of bread crust aroma perception as function of added dose (average values comprising all the variants) for wines obtained from Busuioacă de Bohotin.

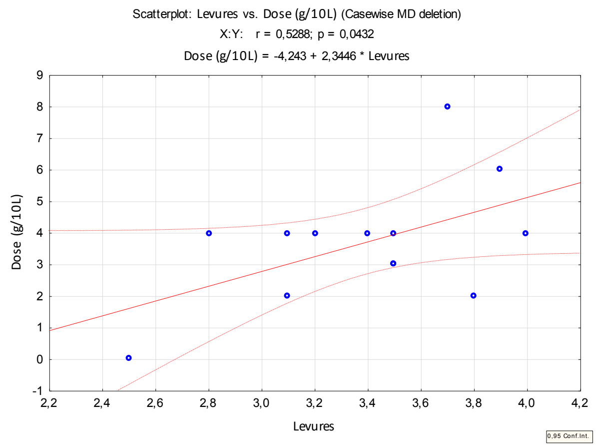

Figure 1b. Correlation of autolysis aroma perception as function of added dose (average values comprising all the variants) for Busuioacă de Bohotin.

Even if, regarding the r value, there was no sufficient linear variation, still, one can say that bread crust and biscuit were parameters to be considered and validated in the role of these maturation products, since the samples treated with several doses indifferent to the type of product created important modifications in the perception of the descriptors. The control samples were characterised with average points of 1.2 for samples from Busuioacă de Bohotinwhile samples from Sauvignon blanc had an average value of 0.9 respectively for bread crust. The treated samples were evaluated with points between 2.6 and 2.9 for experimental wines obtained from Busuioacă de Bohotin and 2.3, in case of samples from Sauvignon blanc.

The correlation coefficients for the olfactive and taste descriptors regarding the dose applied were 0.528 (Fig. 1b) for yeast taste descriptor and –0.44 for green descriptors. As in case samples obtained fromBusuioacă de Bohotin variety the negative values of green perception showed a clear activity of the maturation products towards reduction of astringent [20], acidic characteristics of fresh wines.

Table 3. Relationship between sensorial descriptors of wine samples and maturation products composition.

BB	G	M	F	C	WF	RF	EF	S	BC	BS	S	SW	BT	CR	LV	CRP	AP	ST
1	3,4	3,7^{3}	5,1^{3}	3,2^{3,4,7}	2,9	5,3	4,6^{2,5}	3,8	2,7^{8}	2,35^{8}	3,9^{6,7}	2,9^{8}	2,8^{2,5,6}	4,5^{8}	3,6^{2,3,5,8}	5,25^{5,8}	5,7^{2,5,8}	5,7^{5,8}
2	3,8	4,8	4,2^{3}	2,5$^{4-7}$	2,5	4,9	4,5^{1}	3,6	2,8^{8}	2,2^{8}	4,6	3,0^{8}	2,7$^{1,5-7}$	4,4^{8}	4,6^{1,8}	5,3^{8}	5,9^{1,7,8}	5,8^{5,8}
3	3,0	4,0^{1,8}	5,1^{1,2}	3,0$^{1,4-8}$	2,5	6,4	5,7^{5}	3,6	2,6^{8}	2,4	4,0	2,9^{8}	3,1^{5}	4,6	4,2^{1,7,8}	5,5^{5,8}	6,6^{8}	6,2^{5,8}
4	3,2	4,3	4,7	3,7^{2,3}	3,5	6,1	5,1	3,7	3,0^{8}	2,3	4,4	3,2^{8}	2,9^{5,6}	4,1	3,9^{8}	5,5^{8}	5,9^{8}	5,9^{5,8}
5	3,4	4,2	5,0	3,8^{1,2,3}	2,8	5,9	6,2^{1,3}	3,7	3,3^{8}	2,6^{8}	4,3	3,4^{8}	2,2$^{1-4,8}$	4,8^{8}	4,6^{1,7,8}	6,1^{1,3,7,8}	6,8^{1,7,8}	6,9$^{1-4,6-8}$
6	6,0	4,0	5,0	3,8^{2,3}	3,5	5,7	5,6	3,6	2,7^{8}	2,0	4,8^{1}	2,9^{8}	2,5^{1,2,4,8}	4,45	3,9^{8}	5^{8}	5,9^{8}	6,0^{5,8}
7	3,4	4,2	5,1	3,7$^{1-3,8}$	3,3	5,8	5,3	4,3	2,2^{8}	2,0	5,0^{1}	3,0^{8}	2,3^{2}	4,3	3,9^{3,5,8}	5,5^{5,8}	6,3^{2,5,8}	5,9^{5,8}
8	3,8	3,2^{3}	5,1	3,2^{3,7}	3,1	5,5	4,7	4,6	1,2$^{1-7}$	1,3^{1,2,5}	4,9	2,0$^{1-7}$	2,9^{5,6}	3,7^{1,2,5}	2,3$^{1-7}$	4,3$^{1-7}$	4,8$^{1-7}$	5,0$^{1-7}$
SB	G	M	F	C	WF		EF	S	BC	BS	S	SW	BT	CR	LV	CRP	AP	ST
1	3,3^{5}	4,0^{2,4}	3,1^{7}	3,6^{6,7}	2,8^{6}		3,8	3,0	4,0	2,9	4,7	2,05$^{4-7}$	2,1^{3}	3,9	3,7	4,85	5,3	5,55
2	3,6	4,5^{1}	2,9	3,3^{6}	2,5		3,5	3,0	2,9	2,5	4,6	2,3^{4,6,7}	2,7	3,2	3,1	4,7	5,3	5,1
3	3,8	5,2	3,6^{7}	3,6^{6,7}	2,8		3,7	3,1	3,6	2,9	4,8	2,25	2,0$^{1,5-7}$	4,3	3,45	5,3	5,8	5,9
4	3,6	5,4^{1}	3,9	4,1	3,4		3,7	3,3^{6}	3,6	2,3	4,5	3,6^{1,2,8}	2,1	4,2	3,7	5,8	6,3	5,6
5	4,0^{1}	4,7	3,2	3,8	2,9		4,1	3,0	2,6	2,3	4,8	2,9^{1,8}	1,8^{3}	4,3	3,5	5,6	5,8	5,1
6	3,8	4,8	4,1^{7}	4,2$^{1-3}$	3,1^{1}		4,6	2,7^{4,8}	3,7	2,9	5,0	3,35^{1,2,8}	1,8^{3}	4,2	3,4	5,4	5,7	5,6
7	3,5	4,2	3,0^{1,3,6,8}	4,4^{1,3}	3,9		4,8	2,4	3,9	3,0^{8}	4,6	3,5^{1,2,8}	1,8^{3}	4,7	4	5,8	6,1	5,7
8	3,8	4,5	2,9^{7}	3,5	2,7		3,5	3,3^{6}	0,9	0,9^{7}	4,0	1,1$^{4-7}$	2,1	2,7	2,5	3,9	4,5	3,9

Legend - Descriptors (G- green, M- mineral, F – floral, C-Citrus, WF-White Fruits, RF-red fruits, EF – exotic fruits, S – spices, BC -Bread Crust, BS – biscuit, S- sour, SW-sweet, BT-bitter, CR – crisp, LV-levures, CRP – corpulent, AP -Aftertaste persistence, ST – structure; Grouping variable: 1 – Manoproteins, 2 – Vitamins, 3 – Polysacharides, 4 – PVPP, 5- Gluthation, 6 – Enzymes, 7 – Peptides, 8 – Control.

https://doi.org/10.1051/bioconf/20235602022

Table 4. Relationship between sensorial descriptors of wine samples and dosages of maturation products.

BB	G	M	F	C	WF	RF	EF	S	BC	BS	S	SW	BT	CR	LV	CRP	AP	ST
1	3,8	3,2	5,1	3,2	3,1	5,5	4,7	$4,6^{2,4}$	$1,2^{2-6}$	$1,3^{2-6}$	4,9	$2,0^{2-4,6}$	2,9	$3,7^{2-4}$	$2,3^{2-4}$	$4,3^{2-4,6}$	$4,8^{2-4}$	$5^{2-4,6}$
2	3,0	4,0	5,2	3,0	2,6	6,4	5,7	$3,6^{1}$	$2,6^{1}$	$2,5^{1}$	4,1	$3,0^{1}$	$3,1^{3,4}$	$4,7^{1}$	$4,2^{1}$	$5,5^{1}$	$6,6^{1}$	$6,2^{1}$
3	6,2	4,3	4,9	3,8	3,0	5,5	$5,9^{3}$	3,9	$3,1^{1}$	$2,4^{1}$	4,6	$3,1^{1}$	$2,4^{2}$	$4,6^{1}$	$4,3^{1}$	$5,6^{1}$	$6,3^{1}$	$6,5^{1,4,5}$
4	3,5	4,0	5,1	3,3	3,1	5,5	$4,8^{4}$	$3,7^{1}$	$2,6^{1}$	$2,1^{1}$	4,4	3,0	$2,7^{2}$	$4,5^{1}$	$4,0^{1}$	$5,2^{1}$	$5,9^{1}$	$5,9^{1,3}$
5	3,4	3,7	4,8	3,2	2,8	6,0	5,4	4,2	$2,9^{1}$	$2,7^{1}$	3,9	2,7	2,8	4,2	3,3	$5,3^{1}$	5,7	$5,5^{3}$
6	3,2	4,3	4,7	3,7	3,5	6,1	5,1	3,7	$3,0^{1}$	$2,3^{1}$	4,4	$3,2^{1}$	2,9	4,1	3,9	$5,5^{1}$	5,9	$5,9^{1}$
SB	G	M	F	C	WF		EF	S	BC	BS	S	SW	BT	CR	LV	CRP	AP	ST
1	$3,8^{5}$	4,5	2,9	3,5	2,7		3,5	3,3	$0,9^{2-6}$	$0,9^{2-5}$	$4,0^{3,5}$	1,1	2,1	2,7	$2,5^{5}$	3,9	4,5	$3,9^{2,6}$
2	$3,7^{4,5}$	$5,1^{4,5}$	3,5	3,6	2,8		3,7	3,1	$3,5^{1}$	$2,8^{1}$	4,8	2,2	2,0	4,3	3,4	5,3	5,8	$5,9^{1}$
3	$4,0^{4,5}$	$5,0^{4,5}$	3,6	4,0	3,1		4,3	2,7	$3,4^{1}$	$2,9^{1}$	$5,0^{1}$	3,0	1,7	4,2	3,5	5,6	5,8	5,4
4	$3,3^{2,3}$	$4,2^{2,3,6}$	3,2	3,6	2,8		3,6	2,7	$2,9^{1}$	$2,4^{1}$	$4,4^{3,5}$	2,3	2,1	3,6	3,3	4,7	5,0	5,0
5	$3,4^{1-3}$	$4,0^{2,3,6}$	3,1	3,8	3		4,3	2,9	$4,3^{1}$	$3,5^{1}$	$5,2^{1,4}$	2,4	2,0	4,6	$3,9^{1}$	5,0	5,8	$6,1^{1}$
6	3,6	$5,4^{4,5}$	3,9	4,1	3,4		3,7	3,3	$3,6^{1}$	2,3	4,5	3,6	2,1	4,2	3,7	5,8	6,3	5,6

Legend - Descriptors (G- green, M- mineral, F – floral, C-Citrus, WF-White Fruits, RF-red fruits, EF – exotic fruits, S – spices, BC -Bread Crust, BS – biscuit, S- sour, SW-sweet, BT-bitter, CR – crisp, LV-levures, CRP – corpulent, AP -Aftertaste persistence, ST – structure; Grouping variable: dose : 1 – 0 g/10l, 2-2,0 g/10l, 3-3,0 g/10l, 4-4,0 g/10l, 5-6,0g/10L, 6 – 8,0 g/10l.

Considering the presence of maturation products, in the range considered between 2.0 g/10 L and 8 g/10 L, the presence of the doses influenced the quality of wines by changing the perception of the overall quality of wines. The spectrum of the descriptors that were not influenced during sensorial evaluation after 12 months of bottling for samples obtained from Busuioacă de Bohotin were green, mineral, floral, citrus, white fruits, red fruits. At the level of taste descriptors, the influence was totally different because all the variables were strongly influenced, except acid. In correlation of control sample, the descriptors crisp, yeasty, full-bodied, after taste and structure had significant differences (Table 4). Also, significant differences appearedbetween these descriptors as they were averaged taking in consideration several types of maturation products. Regarding the wine's structure, the mean values for samples with 8g/10 L, 6g/10 L and 4 g/10 L were significantly different, but the variation was towards decreasing of perception as the product dose increased. For the current experiment, the dose of 4.0g/10 L was optimum for the maturation process.

As was the case for wines obtained from Busuioacă de Bohotin grapes, in the case of Sauvignon blanc samples, the descriptors white fruits, exotic fruits spices did not undergo any significant change. In the same comparison, green and mineral perceptions had important variation in case of the doses for Sauvignon blanc samples, the variation was inverse proportional with the doses in relation with the control samples. Regarding other olfactive parameters, it can be seen from Table 4 that the bread crust and biscuit perception had superior levels than the control samples, for all the test samples. The difference was not also registered between the different doses applied.

3.3 Principal component analysis

After evaluation of the variables, descriptors that were significantly different, the correlation with the specific characteristics of the maturation products and the doses applied, a principal component analysis was performed for Sauvignon blanc and also Busuioacă de Bohotin wine samples. Figures 2 and 3 summarise this fact.

The interpretations of the principal components p1 and p2, whose total values explained in a minim 68% the model, were evaluated to be significant and correlated with the characteristics of maturation products (p1) and also for the doses included in the study (p2).

In case of wine samples from Busuioacă de Bohotin, p1 has 43.15% variance while p2 has 29.14% variance. As it was concluded in the chapter regarding the significant variation of the descriptors, samples from Busuioacă de Bohotin had a higher dynamic regarding

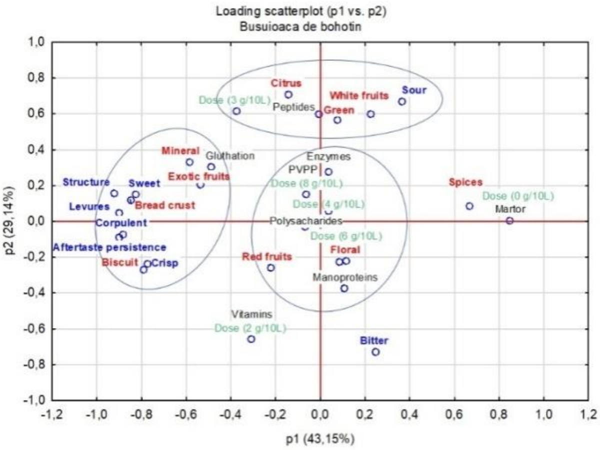

Figure 2. Principal component analysis for Busuioaca de Bohotin. Evaluation of principal component 1 (43.15%) and principal component 2 (29.14%) for aroma descriptors distribution according to dose and ageing products composition.

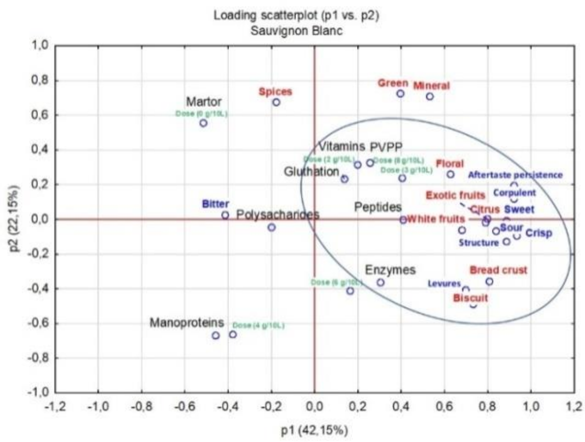

Figure 3. Principal component analysis for Sauvignon blanc. Evaluation of principal component 1 (42.15%) and principal component 2 (22.15%) for aroma descriptors distribution according to dose and ageing products characteristics.

the properties olfactive and taste of wines included in the study. So, PCA analysis clearly differentiated three groups according to the types of specific characteristics of the maturation products. Glutathione was one of the characteristics that influence more tasting perspectives [21]. Indeed, as can be seen in Table 3, the average values of perception for mineral (4.2), exotic fruits (6.2) bread crust (3.3) and biscuit (2.6) were among the highest in the series, so this made possible the correct association with glutathione having antioxidant properties. The same situation was considered for the tasting descriptors.

The second plot includes the main characteristics of maturation products that can enrich wines in peptides, polysaccharides and mannoproteins. Also, the usage dose was included, so between these variables there is a correlation that may be associated with optimum doses. The plot confirmsthe capacity of products rich in peptide release (samples V10S, V11S, V10B, V11B), at a dose of 3 g/10 L, to increase the citrus, green and white fruits perception. Considering that in many cases, the green descriptor was perceived as lower for the samples that were treated in relation with control, one may conclude that all tested products reduced the green perception.

In Figure 3, Sauvignon blanc was evaluated in concordance with the same characteristics that defined the two principal components in the study p1 had a variance of 42.15% and p2 had 22.15%. Variables that had the most importance were structure, aftertaste persistence, crisp, bread crust, full-bodied. These were also highlighted by the Fisher test. Also, p1 can be associated with the specific composition of the maturation products and p2 can be associated with the doses applied.

Regarding the characteristics influenced by the maturation products, only one characterization zone was defined, in this situation most of the descriptors falls and are currently associated with most of the common characteristics, which are represented through capacity of releasing vitamins, PVPP; glutathione, peptides, and enzymes.

4 Conclusions

Aroma is an important quality factor of all foods, but in wines, it represents one of the most important aspects contributing to the final appreciation of the consumer. During winemaking process and ageing on lees stage, various interactions and reactions occur that can affect the perception of wine final aroma.

The products used for maturation stage showed a low influence on the physico-chemical parameters, being observed an increase in non-reducing dry extract (V3S, V5S, V12S, V5B, V12B) compared to the control samples (V13S, V13B).

Regarding the total acidity of the wine samples, one can observe a slight decrease after the addition of maturation products.

The different dosage of the oenological products used for maturation on lees, and the stirring period did not have asignificant influence on the chromatic parameters, intensity and tint of wine samples for both grape varieties used as raw material in winemaking process.

After statistical interpretations, the green and mineral perceptions had important variation in the case of wine samples obtained by Sauvignon blanc grape variety, the variation was inversely proportional with the used doses versus the control samples.

Between the correlations of autolysis aroma perception as function of added dose from maturation products, the statistical analysis confirms the capacity of products rich in peptides to increase the citrus, green and white fruits perception.

References

1. J.S. Câmara, M.A. Alves, J.C. Marques, Anal. Chim. Acta **563**, 188 (2006)
2. S.J. Connew, Aust.N.Z Wine Ind. J. **13**, 61 (1998)
3. T. Doco, P. Vuchot, V. Cheynier, M. Moutounet, Am. J. Enol. Vitic. **54**, 150 (2003)
4. M.A. Pozo-Bayon, A. Andujar-Ortiz, V.M. Moreno-Arribas, Food Res. Int. **42**, 754 (2009)
5. R.M. Parker Jr., Wine Buyer's Guide, 5th ed. (Dorling Kindersley Ltd., London, 2000)
6. D. Chassagne, M. Guilloux-Benatier, M. Alexandre, A. Voilley, Food Chem. **91**, 39 (2005)
7. M. José Gómez-Miguez, Manuela Gómez-Miguez, M. Isabel Vicario, F.J. Heredia, J. Food Eng. **79**, 758 (2007)
8. R. Del Barrio-Galán, S. Perez-Magariño, M. Ortega-Heras, P. Williams, T. Doco. J. Agric. Food. Chem. **59**, 12433 (2011)
9. G. Schwedt. The Essential Guide to Analytical Chemistry, (Wiley & Sons, Incorporated, John,Hoboken, 1997)
10. J. Ballester, H. Abdi, J. Langlois, D. Peyron, D. Valentin. Chem. Percept. **2**, 203 (2009)
11. C. Băduca-Cîmpeanu, Degustareavinului. Bazeleştiintifice ale degustării. Ed. Sitech, Craiova (2008)
12. D. Delteil, Working with lees: Key elements to wine maturation, 30th Annual Technical Issue of Aust. & NZ Grapegrower & Winemaker (2001)
13. J. Moreno, R. Peinado, Enological chemistry (Elsevier, Amsterdam, 2012)
14. W. Post, L. Adams, Mitt. Klistern. **37**, 54 (1987)
15. R.F. Simpson, Vitis. **21**, 233 (1982)
16. M. Guzmán Alfeo, Manual de espectrometria en enologia (2010)
17. J.A. Perez-Seradilla, Luque de Castro, Food Chem. **111**, 447 (2008)
18. M. Bertuccioli, S. Ferrari, Laboratory Experience on the influence of Yeast on Mouthfeel. Les Entretiens Scientifiques Lallemand, Montreal, CA (1999)
19. L.M. Bartoshuk, B. Rifkin, L.E. Marks, P. Bars, J. Gerontol. **41**, 51 (1986)
20. P.M. Wise, P.A.S. Breslin. Chem. Senses **36**, 581 (2011)
21. M. Medina-Carnicer, L. Zea-Calero, R. Peinado-Amores, I.J. Moreno-Vigara, L. Moyano-Cañete, J.E. Buenoo-González-Tejero, Viticultura Enologia Profesional **82**, 55 (2002)
22. R. Gawel, P.A. Smith, E.J. Waters, Aust. J. Grape Wine Res. **22**, 350 (2016)