



Grape variety, aging on lees and aging in bottle after disgorging influence on volatile composition and foamability of sparkling wines



Silvia Pérez-Magariño ^{a,*}, Miriam Ortega-Heras ^{a,1}, Marta Bueno-Herrera ^a,
Leticia Martínez-Lapuente ^b, Zenaida Guadalupe ^b, Belén Ayestarán ^b

^a Instituto Tecnológico Agrario de Castilla y León, Consejería de Agricultura y Ganadería, Ctra Burgos Km 119, Finca Zamadueñas, 47071 Valladolid, Spain

^b Instituto de las Ciencias de la Vid y del Vino, Universidad de la Rioja, CSIC y Gobierno de la Rioja, C/ Madre de Dios 51, 26006 Logroño, Spain

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ABSTRACT

The aim of this work was focused on the study of the influence of grape variety and aging time in contact with lees and without lees, on volatile composition and foamability of white and rosé sparkling wines. Seven different grape varieties were used and the sparkling wines were studied until 30 months of aging on lees and after 12 months of aging in bottle after disgorging.

Sparkling wines from *Albarín*, *Verdejo*, *Godello* and *Prieto Picudo* grape varieties were the richest in most of the volatile compounds analyzed, especially those that contribute to the fruity aroma of wines, and maintained their varietal characteristics even after long aging time (30 months). *Verdejo* and *Prieto Picudo* sparkling wines presented the best foam characteristics, followed by *Albarín* and *Godello* wines.

Considering all the results, *Albarín*, *Verdejo*, *Godello* and *Prieto Picudo* were the most interesting grape varieties to elaborate sparkling wines, following the traditional or “champanoise” method.

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1. Introduction

Sparkling wines are obtained after a second fermentation of a base wine that can be carried out in closed bottles or in hermetically sealed tanks. High quality sparkling wines, such as Champagne wines in France, Cava wines in Spain or Talento in Italy, are fermented in closed bottles following the traditional or “champanoise” method, and they remain in contact with the yeast lees in a bottle for at least 9 months (EC Regulation N° 606/2009). The greatest differences among sparkling wines are mainly due to the grape varieties and the aging time on lees (Andrés-Lacueva, Gallart, López-Tamames, & Lamuela-Raventós, 1996; Pozo-Bayón, Martínez-Rodríguez, Pueyo, & Moreno-Arribas, 2009; Riu-Aumatell, Bosch-Fusté, López-Tamames, & Buxaderas, 2006; Torrens, Riu-Aumatell, Vichi, López-Tamames, & Buxaderas, 2010).

During the sparkling wine aging, yeast autolysis leads to significant changes in wine composition (Alexandre and Guilloux-Benatier, 2006), and especially in the volatile compounds that

could have a great effect on the final quality of these wines (Francioli, Torrens, Riu-Aumatell, López-Tamames, & Buxaderas, 2003; Pozo-Bayón, Pueyo, Martín-Alvarez, Martínez-Rodríguez, & Polo, 2003; Pozo-Bayón, Martín-Alvarez, Moreno-Arribas, Andujar-Ortiz, & Pueyo, 2010). During this process, different enzymatic and chemical reactions can lead to the formation or degradation of some volatile compounds, and others can be released into the wine (Del Barrio-Galán, Ortega-Heras, Sánchez-Iglesias, & Pérez-Magariño, 2012; Riu-Aumatell et al., 2006; Torrens et al., 2010), modifying the aroma profile of sparkling wines. On the other hand, some volatile compounds can be adsorbed on the yeast lees, reducing their concentration in sparkling aged wines, mainly the most hydrophobic ones (Gallardo-Chacón, Vichi, López-Tamames, & Buxaderas, 2009, 2010). Gallardo-Chacón et al. (2009) determined the volatile compounds retained by lees during the second fermentation of sparkling wines and found that esters, aldehydes and terpenes were retained by the lees surface. Sorption depends not only on the physicochemical characteristics of the volatile compounds but also on the structure of the yeast cell walls, hence the retention of volatile compounds by the lees surface can be reversible and the volatile composition of these wines can change over long aging time (Gallardo-Chacón et al., 2010). Therefore, the final aging time will determine the type and amount of the volatile compounds present in sparkling wines (Francioli et al., 2003;

* Corresponding author. Tel.: +34 983 415245.

E-mail address: permagsi@itacyl.es (S. Pérez-Magariño).

¹ Present address: Dpto Biotecnología y Ciencia de los Alimentos, Universidad de Burgos, Burgos, Spain.

Table 1
Volatile compounds of the sparkling wines at the different aging times: T9, T18, T30: nine, eighteen, thirty months of aging on lees; 12 MB: twelve months in bottle after disgorging. Data in mg/L except those marked with an asterisk that are expressed in µg/L.

	Albarín					Verdejo				
	T9	T18	T30	T9+12 MB	T18 + 12 MB	T9	T18	T30	T9+12 MB	T18 + 12 MB
Ethyl butyrate	0.187	0.182	0.154	0.173	0.180	0.175	0.134	0.147	0.179	0.150
Ethyl 2-methylbutyrate	0.029	0.057	0.057	0.050	0.046	0.024	0.049	0.047	0.039	0.043
Ethyl isovalerate	0.051	0.070	0.084	0.097	0.074	0.041	0.059	0.070	0.068	0.066
Ethyl hexanoate	0.579	0.548	0.513	0.558	0.423	0.518	0.555	0.460	0.525	0.413
Ethyl lactate	19.7	23.7	22.8	18.3	20.9	17.4	22.4	20.1	14.7	19.1
Ethyl octanoate	0.592	0.501	0.480	0.557	0.380	0.558	0.566	0.443	0.563	0.402
Ethyl decanoate	0.068	0.052	0.036	0.084	0.027	0.059	0.058	0.040	0.077	0.035
Isoamyl acetate	0.273	0.226	0.150	0.175	0.117	0.434	0.367	0.156	0.180	0.127
2-Phenylethyl acetate	0.062	0.026	0.023	0.042	0.022	0.063	0.040	0.022	0.040	0.021
Isovaleric acid	1.247	1.100	1.078	1.468	0.990	1.141	1.186	1.101	1.177	1.059
Hexanoic acid	4.052	4.335	4.313	3.658	3.766	4.124	4.268	4.428	3.346	4.201
Octanoic acid	6.281	6.793	5.469	5.858	5.229	6.757	7.396	5.072	6.396	5.083
Decanoic acid	0.547	0.616	0.508	0.428	0.471	0.571	0.680	0.588	0.478	0.519
1-Hexanol	0.849	1.455	0.969	0.709	0.843	0.852	1.178	0.956	0.604	0.821
<i>trans</i> -3-hexen-1-ol	0.115	0.202	0.141	0.091	0.124	0.080	0.132	0.085	0.052	0.078
<i>cis</i> -3-hexen-1-ol	0.163	0.153	0.128	0.104	0.115	0.130	0.148	0.106	0.082	0.099
Benzyl alcohol	0.106	0.114	0.104	0.120	0.102	0.119	0.136	0.103	0.106	0.106
Linalool*	5.418	1.739	0.808	1.854	0.693	2.746	1.664	0.614	1.414	0.582
α -Terpineol*	9.828	9.303	8.336	10.835	8.133	3.960	4.678	3.108	4.501	3.396
Citronellol*	1.446	1.103	0.577	0.812	0.493	1.577	1.419	0.647	0.821	0.592
γ -Butyrolactone	10.30	13.58	9.45	9.57	9.72	14.25	12.29	10.27	11.54	11.03
γ -Nonalactone*	2.705	2.111	2.502	3.299	2.626	2.021	1.777	1.907	2.438	2.082
Vanillin*	2.799	nd	nd	9.260	17.24	1.949	nd	3.159	18.77	16.14
Methyl vanillate*	14.45	8.10	11.03	12.65	11.62	11.12	5.61	5.33	11.74	7.40
Ethyl vanillate*	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Acetovanillone*	15.5	10.4	12.8	11.0	14.1	11.7	7.3	9.9	14.4	11.7
2-Phenylethanol	37.7	66.6	49.7	43.9	45.3	32.3	58.2	37.3	29.8	35.5
1-propanol	28.3	23.8	21.0	25.2	26.1	34.4	27.6	25.9	34.5	31.1
Isobutanol	22.3	19.7	19.0	19.8	19.5	24.0	24.0	21.7	26.8	23.4
Isoamyl alcohols	179	175	182	166	187	188	186	193	202	196
4-vinylguaiaicol	0.155	0.120	0.178	0.213	0.197	0.433	0.166	0.125	0.219	0.121
	Godello					Viura				
	T9	T18	T30	T9+12 MB	T18 + 12 MB	T9	T18	T30	T9+12 MB	T18 + 12 MB
Ethyl butyrate	0.143	0.159	0.180	0.127	0.200	0.160	0.154	0.154	0.178	0.161
Ethyl 2-methylbutyrate	0.046	0.073	0.084	0.063	0.081	0.031	0.048	0.063	0.049	0.076
Ethyl isovalerate	0.066	0.080	0.109	0.098	0.109	0.048	0.056	0.085	0.083	0.104
Ethyl hexanoate	0.536	0.492	0.462	0.487	0.431	0.358	0.389	0.353	0.379	0.374
Ethyl lactate	16.9	21.1	19.2	14.3	17.5	18.4	25.8	23.6	16.6	30.0
Ethyl octanoate	0.566	0.520	0.468	0.511	0.408	0.312	0.353	0.302	0.359	0.310
Ethyl decanoate	0.080	0.066	0.050	0.087	0.040	0.049	0.044	0.034	0.070	0.031
Isoamyl acetate	0.258	0.203	0.136	0.138	0.128	0.183	0.163	0.093	0.095	0.109
2-Phenylethyl acetate	0.048	0.018	0.017	0.027	0.017	0.043	0.027	0.016	0.026	0.016
Isovaleric acid	1.315	1.459	1.271	1.349	1.121	1.251	1.094	1.198	1.211	2.312
Hexanoic acid	3.712	5.694	3.952	3.059	3.378	2.716	3.123	3.470	2.268	3.014
Octanoic acid	6.290	6.111	5.629	4.837	4.676	4.485	4.259	3.958	4.721	4.015
Decanoic acid	0.657	0.466	0.577	0.474	0.530	0.478	0.538	0.524	0.428	0.597
1-Hexanol	0.778	1.126	0.866	0.575	0.730	0.518	0.722	0.673	0.401	0.642
<i>trans</i> -3-hexen-1-ol	0.113	0.187	0.127	0.078	0.114	0.028	0.059	0.033	0.019	0.043
<i>cis</i> -3-hexen-1-ol	0.089	0.102	0.062	0.049	0.058	0.187	0.275	0.174	0.129	0.257
Benzyl alcohol	0.079	0.104	0.077	0.077	0.072	0.069	0.091	0.065	0.075	0.111
Linalool*	3.329	1.040	0.000	0.886	0.327	4.923	1.965	0.617	1.379	0.829
α -Terpineol*	4.497	3.294	3.382	4.802	3.616	4.716	4.572	4.048	5.863	6.048
Citronellol*	1.368	0.696	0.625	0.522	0.402	1.772	1.343	0.678	0.878	1.272
γ -Butyrolactone	15.56	15.62	11.42	11.37	11.92	13.12	15.13	10.82	7.83	18.68
γ -Nonalactone*	1.659	1.336	1.544	1.865	1.672	1.847	1.644	1.798	2.193	1.996
Vanillin*	1.441	nd	3.953	23.41	14.95	1.630	nd	3.055	23.27	31.83
Methyl vanillate*	5.61	1.92	2.53	5.91	3.26	5.80	1.38	2.35	6.42	6.95
Ethyl vanillate*	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Acetovanillone*	5.1	3.2	3.9	4.6	4.7	14.4	9.6	12.3	16.9	18.3
2-Phenylethanol	36.4	65.0	44.8	32.0	41.5	30.8	52.1	41.0	27.9	52.1
1-propanol	20.5	18.3	13.9	19.5	17.8	24.3	20.6	19.8	23.3	22.9
Isobutanol	21.6	20.8	18.1	23.3	19.8	20.9	21.7	18.7	23.0	21.2
Isoamyl alcohols	203	205	202	218	211	170	174	183	182	187
4-vinylguaiaicol	0.190	0.053	0.075	0.119	0.076	0.287	0.097	0.100	0.166	0.170
	Malvasía					Garnacha-A				
	T9	T18	T30	T9+12 MB	T18 + 12 MB	T9	T18	T30	T9+12 MB	T18 + 12 MB
Ethyl butyrate	0.117	0.137	0.113	0.154	0.142	0.165	0.183	0.151	0.180	0.149
Ethyl 2-methylbutyrate	0.033	0.065	0.064	0.055	0.066	0.032	0.063	0.061	0.049	0.056
Ethyl isovalerate	0.040	0.056	0.067	0.071	0.071	0.046	0.064	0.073	0.073	0.076

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