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Foam Aptitude of Trepat and Monastrell Red Varieties in Cava Elaboration. 1. Base Wine Characteristics

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The foam properties of base wines made from red autochthonous varieties (Trepat and Monastrell) were studied. Four wines of each variety were elaborated (fermented off skins at industrial scale in two consecutive harvests) and blended at different proportions with the white traditional variety (Macabeo, Xarel.lo, and Parellada) wines to elaborate Cava (closed-bottle-fermented sparkling wine). When crescent amounts of Trepat were added to the traditional white blend, the foamability and the color intensity (CI) of the wine increased polinomically. The increase of the CI depended on the year of harvest. Thus, oenologists could decide the blend proportion most suitable to elaborate either a "blanc de noirs" sparkling wine or a new type of Cava.

KEYWORDS: **Trepat; Monastrell; foam; sparkling wine; Cava; red variety; color intensity**

INTRODUCTION

With the recent technological advances in the viticulture and winemaking field, and the introduction of foreign grape varieties culture, the wines obtained seem to be ever more homogeneous and with less identity. To support the Cava distinctive character, autochthonous red grape varieties have recently been proposed for elaborating Cava (closed-bottle-fermented sparkling wine, according to the European Union CEE 1993/1999 is a *vecprd*) (*1*). Penedès is a highly vocated area where the production of premium sparkling wines has been established for a long time. This area produces 190 million bottles of Cava annually, and more than 97 million are exported.

As the champagne winemakers use red grapes (*Pinot noir* and *Pinot meunier*), in the Penedès region (where 98% of Cava is produced) Cava is mainly made from white varieties (Macabeo, Xarel.lo, and Parellada being the most frequently used). Monastrell and Trepat are red varieties provided for Cava elaboration (Spanish Denominación de Origen Controlada (DOC)-Certified Brand of Origin). Occasionally, the Monastrell variety fermented off skins is used for blending, although it is not only autochthonous from the Penedès region. Since Trepat variety is exclusively autochthonous from this area, it could be considered the most interesting one to promote the idiosyncrasy of the Cava. At the present time, there are no published data about these red varieties to elaborate Cava. The aim of this work is to know the possibilities of the Trepat and Monastrell wines either to improve the traditional Cava with blending with a red variety (maintaining the characteristics of the Cava) or to elaborate a new type of Cava.

The quality of any wine is based on its flavor and color, but for sparkling wines foam is one of the most important quality parameters. The grape variety selected by winemakers is one of the important variables which affect the foam properties of the grape juices (*2*), the base wines (*3*, *4*), and the sparkling wines (*5*). This research was carried out on the white varieties (Macabeo, Xarel.lo, Parellada), but there are no studies on the foam properties of these autochthonous red varieties. The foam capacity of the monovarietal wines is of interest to winemakers since knowing their foam characteristics would be useful when blending (*4*). This paper is focused on the study of the foam aptitude of base wines made from Trepat and Monastrell varieties. The foam parameters [foamability (HM), Bikermann coefficient (Σ), and stability time (TS)] and their related chemical composition of wines made from Trepat and Monastrell were studied and compared with the wines made from the traditional white ones. Several *coupage*s of Trepat and Monastrell with the white wines were also included to study their effect on the foam quality and establish which proportion of the red variety could be the most suitable for elaborating white sparkling wine. All the wines were fermented off skins on an industrial scale by the same winery and for two consecutive vintages to consider the possible variability due to the harvest factors.

MATERIALS AND METHODS

Samples. The samples were wines made from red grapes grown in the Penedès region: Trepat and Monastrell. These monovarietal wines samples were obtained from two lots of grape, which were pressed and fermented separately (a and b) and for two consecutive vintages, 1997 and 1998 (1 and 2), (T1a, T1b, T2a, T2b, M1a, M1b, M2a, M2b). Several *coupage*s between the monovarietal red wines and a white base wine blend made from Macabeo, Xarel.lo, and Parellada (CW) were

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Table 1. MANOVA Analysis Results

wine type[a,f]	HM[b] (mm) IC 95%[e] $n = 4$	Σ[c] (s) IC 95%[e] $n = 4$	TS[d] (s) IC 95%[e] n = 4
	Foaming Properties		
T1	187–197	12–23	0–131
T2	225–235	36–47	0–163
M1	41–51	19–30	49–248
M2	75–86	27–38	850–1050
CW1	95–109	7–22	0–223
CW2	162–177	9–25	35–317
CT150	175–186	9–20	0–114
CT250	210–220	14–24	0–185
CM1	52–62	8–19	46–245
CM2	125–135	13–24	0–170

Coefficients of Signification

variable	HM	Σ	TS
wine type ($n = 5$)	< 0.0001	< 0.0001	< 0.0001
harvest ($n = 2$)	< 0.0001	< 0.0001	< 0.0001
interaction	< 0.0001	< 0.01	< 0.0001

[a]T: Trepat base wine, M: Monastrell base wine, CW: blend of white variety wines, CT: coupage wine between CW and a 50% of Trepat, CM: coupage wine between CW and a 25% of Monastrell. 1 and 2: first and second year of harvest. [b] HM, foamability. [c] Σ, Bikermann coefficient. [d] TS, stability time. [e] IC95%, interval of confidence for mean. [f] No differents tanks (a,b) were considered ($n = 2$).

performed in the winery. In the first harvest, coupages with 25% of Monastrell (CM1a and CM1b), and coupages with 50% of Trepat (CT1a50 and CT1b50) were prepared. In the second harvest, the same blendings were performed, and coupages with 10 and 25% of Trepat (CT2a10, CT2b10, CT2a25, CT2b25) were also made.

When the grapes were technologically ripe, grape juice was obtained using a pneumatic press at 0.2 bar for 4 min (press capacity 33 000 kg). The juices were treated with SO_2 (ca 80 mg/L of juice) and were racked by settling for 24 h. Prior to fermentation, bentonite (10 g/100 L) and tartaric acid (for correction to 7.6−8.4 g/L) were added. The fermentation took place in tanks of 100 000 L at 16 to 18 °C, after the inoculation of selected winery yeast (*Saccharomyces cerevisiae*; 2 million cells/mL of grape juice). When the fermentation was finished, wines were racked and settled three times, filtered, and then put through a 0.45 μm (HA Millipore) to obtain the sparkling base wine. Monastrell wines (M1a, M1b, M2a, M2b) had been clarified with 75 g/100 L of carbon active just before the blendings were done due to their high color intensity. The foam properties of Monastrell before and after this clarification were measured and no significant differences were observed. For each year and each variety, samples were analyzed at three steps of the vinification: grape juices, cloudy, and base wines. The *coupage*s were made in this last step, using tanks of 1000 L.

Samples were centrifuged for 10 min, to 2500*g* at 10 °C. After this operation, samples were kept in a freezer (−18 °C) until analysis, except for the Mosalux analysis which was carried out with fresh sample.

Analytical Methods. *Foam measurements* were performed using the Mosalux method (*6*). According to Gallart et al., 1997 (*7*), the following parameters were chosen: *foamability* HM, maximum height (mm) reached by the foam after CO_2 injection through the glass frit; *Bikerman coefficient* Σ (*8*), bubble average lifetime (s) until all bubbles disappear, after CO_2 injection is stopped and *foam stability time* TS, time until all bubbles collapse (s), when CO_2 injection is interrupted.

Enological parameters were measured according to OIV methods (*9*) including pH, titratable acidity (g tartaric acid/L) and volatile acidity (g acetic acid/L), alcohol content (%, v/v), density (g/L, 20 °C), sugars (g of glucose/L), free, combined, and total sulfur dioxide concentrations (mg of SO_2/L), absorbances at 280 and at 420 and 520 nm (ua × 1000) determined in a 1- and 10-mm path length cells, respectively.

The measure of the color intensity or density was determined by summation of absorbance at 420 and 520 nm (*10*).

Total phenolic content was measured as the absorbance at 280 nm (*11*).

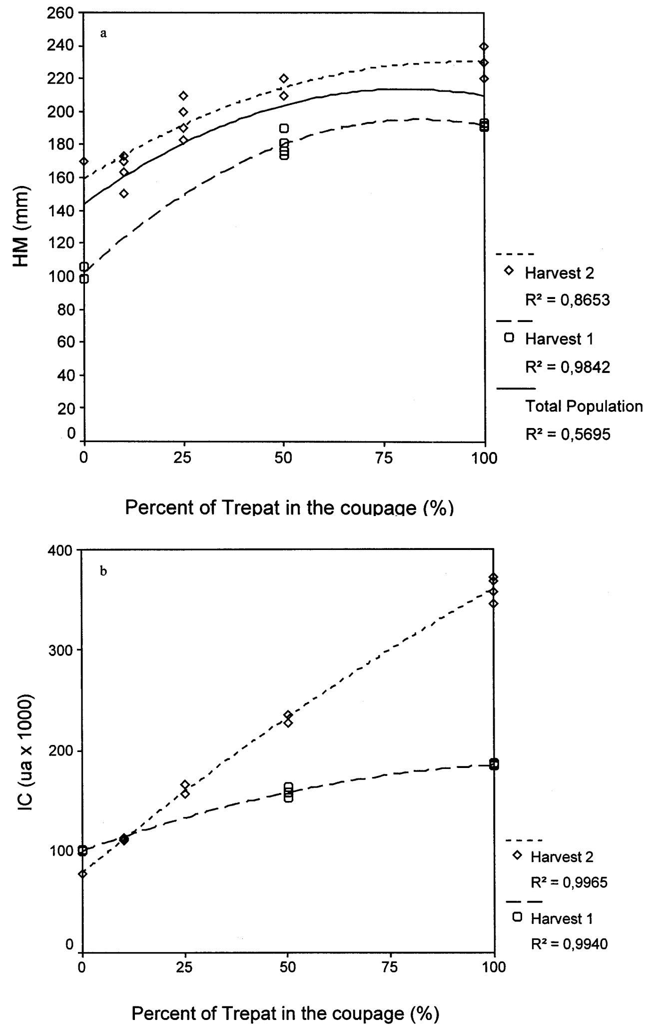

Figure 1. (a) Relation between the percent of Trepat in the coupage (%) and foamability (mm). (b) Relation between the percent of Trepat in the coupage (%) and the color intensity (ua × 1000).

The concentration of *soluble proteins* was determined following the Bradford method (*12*) after a decoloration with polyvinilpolypirrolidone (1 g of PVPP/20 mL wine) of the red variety wines.

Total, neutral, and acid polysaccharide contents were determined following the Segarra et al. (*13*) spectrophotometric procedure.

Concentrations of *organic acids, glucose, fructose*, and *glycerol* were determined according to the HPLC method of López-Tamames et al. (*14*).

All experiments were performed in duplicate.

Statistical Procedure. SPSS statistical Software Package version windows 10.0.6 (*15*) was used. To evaluate the foam parameters HM, Σ, and TS of the red varieties Trepat (T), Monastrell (M), and their respective coupages (CT50 and CM25) with the blend of white wines (CW), a multifactor analysis of variance, two-way (MANOVA) considering the type of wine ($n = 5$) and the harvest ($n = 2$) was carried out. To study the effect of the addition of the Trepat variety wine in the coupage on HM and the color intensity, a regression analysis was performed. The model fitting for the relation between the percent of Trepat wine in the coupage and HM, and the percent of Trepat in the coupage and the CI were found. To evaluate the contribution of the wine composition in the foamability, correlation analysis among foamability and the 23 analytical determinations were applied. Ninety-five percent confidence intervals for mean of wine characteristics was found.

The *n* values include the analytical duplicate, and results were considered significant when the significance level (p) was lower than 0.05.

Table 2. 95% Confidence Intervals for Mean of Wine Characteristics[a]

	variety		
	Trepat wines *n* = 12 95% CI	Monastrell wines *n* = 8 95% CI	CW *n* = 2 min-max
foamability HM (mm)	182–211	50–108	102–170
Bikerman coefficient (s)	14–28	16–29	15–17
stability time (s)	27–69	0–667	83–176
alcohol content (%, v/v)	10.16–10.58	10.57–11.49	10.29–10.68
pH	3.03–3.13	2.96–3.19	2.90–2.99
titratable acidity (g/L of sulfuric acid)	3.85–4.09	3.64–4.18	3.95–4.25
volatile acidity (g/L of acetic acid)	0.36–0.53	0.23–0.60	0.20–0.76
total SO_2 (mg/L)	52–73	55–169	57–83
free SO_2 (mg/L)	6–9	5–8	6–11
combinated SO_2 (mg/L)	46–65	48–163	51–73
absorbance at 280 nm (ua × 1000)	527–569	544–831	520–540
420 nm	103–130	84–109	60–80
520 nm	67–107	64–108	40–70
color intensity (ua × 1000)	168–236	148–213	100–150
citric acid (g/L)	0.07–0.13	0.05–0.24	0.06–0.32
tartaric acid (g/L)	2.87–3.30	2.31–3.68	2.97–3.63
galacturonic acid (g/L)	0.34–0.37	0.32–0.41	0.32–0.36
malic acid (g/L)	0.88–1.35	0.50–1.18	0.64–0.75
succinic acid (g/L)	0.60–0.67	0.59–0.92	0.45–1.06
lactic acid (g/L)	0.37–0.68	0.21–0.72	0.73–0.76
protein (mg of albumin/L)	5.80–13.95	5.00–8.40	6.50–6.90
total polysaccharides (mg of galactose/L)	261–285	228–344	164–304
acid polysaccharides (mg of galacturonic acid/L)	39–44	44–59	40–43
glucose (g/L)	0.65–0.92	0.49–0.69	0.65–0.77
fructose (g/L)	0.18–0.56	0.22–0.78	0.24–1.02
glycerol (g/L)	5.51–8.20	5.44–9.22	4.13–5.24

[a] CW: coupage of the traditional white variety wines. 95% CI: 95% confidence interval for mean.

RESULTS AND DISCUSSION

The foam properties were significantly different according to the type of wine and to the harvest (**Table 1**). The Trepat variety wines and their coupages had significantly higher foamability values than Monastrell variety wines, their coupages, and the blend of white varieties. The Monastrell wines of the second harvest showed significantly higher stability time values than all the other types of wines. The blendings with the red variety wines did not modify significantly the Σ and TS values in relation to the blend of the traditional white varieties. Only HM was affected by the addition of the red variety wine in the coupage.

As can be observed in **Figure 1a**, with the addition of a percent of Trepat in the coupage HM increased in both vintages (1 and 2). This increase fitted a polinomic model ($y = -0.0107x^2 + 1.7306x + 144.2$), so additions superior to a 50% of Trepat in the coupage would give no significant augments. As it was expected, the color intensity (CI) also increased with the addition of Trepat wine in the coupage (**Figure 1b**). A polynomial relation also fitted this increasement, but varied in relation to the harvest. The percent of the addition of red wine in the coupage depended on the color intensity of this monovarietal wine. The color intensity also increased polinomically ($y = -0.0037x^2 + 1.7675x + 89.5$) when the percent of Monastrell in the coupage augmented, but no differences between harvests were observed (data not shown). Probably because these monovarietal wines were decolorated in both vintages.

According to López-Barajas et al. (*16*), the HM of white wine blends can be calculated from the HM values of the monovarietal wines and the proportions which are added to the blend. On the basis of this work, the HM and the CI values of the blends between red and white variety wines were calculated. No significant differences between the calculated values and those obtained experimentally were observed in both cases. Before doing the industrial coupage, knowledge of the foamability and color intensity of the monovarietal base wines could be useful to determine the most suitable blend proportion. The color intensity range for base wines used to elaborate the "blanc de noirs" sparkling wine is 140−160 ua × 1000, according to data supplied by the winery.

The addition of Trepat wine in the coupage could increase the foamability of white wines made from the traditional varieties. As a first approach to evaluate the contribution of the wine composition of red varieties in HM, a simple regression between the wine characteristics (**Table 2**) and the foamability was performed ($n = 44$). The compounds that gave a significant positive correlation with HM were proteins ($r = 0.314$) and malic acid ($r = 0.403$), and compounds that gave a negative correlation were alcohol concentration ($r = -0.465$) and total SO_2 ($r = -0.677$). The positive effect of proteins on foamability in white wines was described in several studies (*3*, *6*, *17*, *18*). Some authors also observed a positive relationship between HM and malic acid (*3*, *19*), whereas a negative relationship with total SO_2 concentration (*3*) and the alcohol content. The negative effect of ethanol on foam depends on its content (*20*). According to Puff et al. (*21*), this could be explained by the ethanol modification of the solvent properties, the interactions between the protein and the solvent, and the structure of the adsorption layer. This is in line with Dussaud et al. (*22*−*24*), who described the negative effect of ethanol on the protein adsorption and protein secondary structure when the ethanol content was 12% v/v. Moreover, according to López-Barajas et al. (*19*), grape juice maturation index [ratio between soluble solids (°Brix) and titratable acidity (grams of tartaric acid per liter of juice)] ranging from 4 to 5.5 gives wines with the optimal foamability. The Monastrell grapes used in the current study had a maturation index of 6.9 ± 1.1 (mean ± SD) and led to wines with the

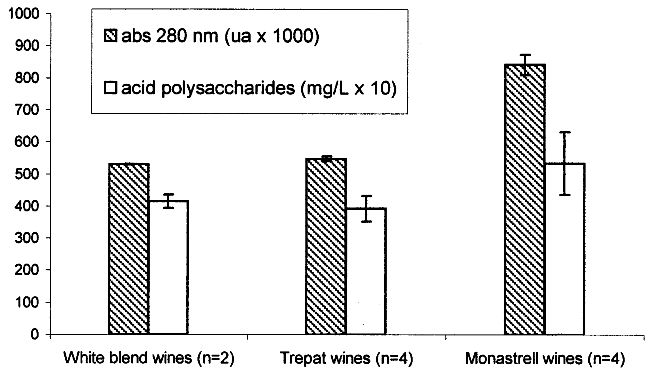

Figure 2. Histograms of polyphenols (absorbance at 280 nm, ua × 1000) and acid polysaccharides (mg/L × 10) contents of Trepat, Monastrell, and the white blend wines.

highest alcohol contents 11.4 ± 0.5 (mean ± SD). According to these results, high maturation indexes and ethanol contents seem to be unfavorable for wine foam.

A significant negative relation between polyphenols and HM ($r = -0.453$), and between acid polysaccharides and HM ($r = -0.762$) were also found. These relationships have not been described in previous studies. They could be due to the particular composition of the Monastrell variety wines, which had the highest polyphenols and acid polysaccharides levels (**Figure 2**). However, these relations should be extended in further studies.

To know all the possibilities of these red varieties to elaborate sparkling wine (Cava), data availability of the foam and other sensory properties of these wines throughout a second fermentation in bottle and aging with yeast should be also considered in the future.

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