Influence of Variety and Aging on Foaming Properties of Cava (Sparkling Wine). 2

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The chemical and physical parameters of 96 samples made of six kinds of cava were analyzed to evaluate the effect of variety and aging in contact with yeast on the foam properties. They came from the same harvest, and they were made in industrial scale by the same winemaker. Variety and aging affect foaming properties. Chardonnay cavas gave the best foam, and they were higher in total and neutral polysaccharides, soluble proteins, total polyphenols, absorbance at 280, 365, and 420 nm, titratable acidity, alcoholic content, conductivity, and malic acid. Eighteen months of aging seems to be the best for foamability and stability time apparently due to the release of compounds such as proteins and polysaccharides by yeast autolysis. However, after 18 months there was a decrease in foamability accompanied by an increase in monomeric compounds. Fructose increase could be due to the hydrolysis of plant components depending on the enzimes release from yeast during autolysis.

Keywords: *Sparkling wine; cava; foam; stability foam; variety; aging; autolysis*

INTRODUCTION

In complex mixtures such as wines or sparkling wines, foaming behavior results from interaction between the different foam active compounds or surfactants (Dussaud et al., 1994; Pueyo et al., 1995). This favors the possibility that synergistic effects may occur between foam active compounds, which could form part of more complex molecules, thus modifying their surface-active properties (Pueyo et al., 1995). According to Viaux et al. (1994), in wine there is a balance between constituents that act favoring or not the foam. Recently, Brissonnet and Maujean (1991) and Andrés-Lacueva et al. (1996a) reported that foaming is not only due to the presence or absence of certain compounds but also conditioned by the balance of a greater or lesser number of compounds of diverse chemical structures. Moreover, the chemical composition of each particular wine would be an additional factor which could have made results more difficult to interpret (Brissonnet and Maujean, 1993). Since foaming is affected by many variables, it should be checked with a large number of samples (Pueyo et al., 1995).

The foam results and chemical composition obtained in laboratory scale are different from those in industrial scale (Robillard et al., 1993; Viaux et al., 1994). A similar observation was made by Siebert et al. (1996a,b) when the stability or haze formation of beverages compared with model solutions was studied. Therefore, it is important to study the foam in wine production samples obtained in industrial scale. Robillard et al. (1993) performed foaming experiments with wine, model solutions, and aqueous alcoholic solutions without particles or macromolecules. They concluded that these samples had different foaming properties except for the Bikerman coefficient (Σ) (Bikerman, 1938), which was not particle dependent when considered under steady dynamic conditions. This is in contrast with foam formation and foam stability considered under *gravity drainage*, which are particle (colloids or surfactants) dependent.

The variety of grape, harvest, and winemaker affect wine composition, thus influencing foaming properties (Andrés-Lacueva et al., 1996a). In our study, since we aimed to evaluate the effect of white variety, the 96 samples of six kinds of cava analyzed came from the same harvest and they were made at the same winery, applying the same technology to avoid harvest and technology variables. In our previous paper (Andrés-Lacueva et al., 1996b), Chardonnay variety and blending of different varietal wines gave the cavas with the best foaming properties. Aging in the bottle with yeast increased the foam stability time (TS), although it decreased the foam height (HM), both determined with the Mosalux procedure (Maujean et al., 1990). We stress the importance of identifying the components of these cavas responsible for the foaming properties (Andrés-Lacueva et al., 1996b). The work described in this paper is focused on the chemical and physical parameters of the 96 samples previously described, relating them to the foaming properties.

MATERIALS AND METHODS

Samples. Six kinds of cava were made in industrial scale. Three of them came from three white varietal wines from *Vitis vinifera* grapes from Penedès region: Macabeo (M), Xarel.lo (X), and Parellada (P), another from Chardonnay (C), and two *coupages*: one of them a mixure of the three varieties (CP) (1:1:1), and the other the three plus Chardonnay (CPC) (3:3:3:1). The second vinification took place in bottles in contact with yeast (*Saccharomyces bayanus*) to produce sparkling wines. Samples were taken eight times in duplicate during 26 months of aging (3, 6, 9, 12, 15, 18, 23, and 26 months), following a factorial design ($6 \times 8 \times 2$), as described in Andrés-Lacueva et al. (1996b). The two bottles from each sampling time were analyzed separately.

Analytical Methods. All the experiments were performed in duplicate for each bottle except for the Mosalux parameters (HM, HS, and TS) which were analyzed in quadruplicate.

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Table 1. 95% Confidence Intervals for the Means for Which Significant Differences Were Found for Chardonnay According to Varietal or Coupage Cavas ($p < 0.0001$) ($n = 16$)

	Macabeo	Xarel.lo	Parellada	Chardonnay	CP[a]	CPC[b]
total polysaccharides (mg/L galactose)	237.13−244.66	239.84−247.37	239.61−247.14	268.47−276.00	246.60−254.13	251.53−259.06
neutral polysaccharides (mg/L galactose)	215.58−223.27	220.46−228.15	218.15−225.84	244.69−252.38	223.76−231.44	227.13−234.82
acid polysaccharides (mg/L galacturonic acid)	46.84−49.22	42.19−44.58	45.90−48.28	50.56−52.94	48.55−50.94	52.12−54.50
soluble proteins (mg/L)	4.80−5.31	5.33−5.84	5.26−5.78	6.92−7.43	5.30−5.81	5.34−5.86
total polyphenols (mg/L gallic acid)	146.1−150.0	145.1−149.0	143.5−147.5	166.8−170.7	148.2−152.1	147.7−151.7
absorbance 280 (nm × 1000)	482−495	459−472	472−491	614−627	490−503	491−504
absorbance 365 (nm × 1000)	67−70	57−60	59−61	72−74	65−68	61−64
absorbance 420 (nm × 1000)	71−72	79−81	81−82	106−107	79−81	81−82
titratable acidity (g/L tartaric acid)	4.27−4.34	4.09−4.15	4.14−4.21	4.38−4.45	4.12−4.19	4.15−4.21
alcoholic content (%, v/v)	11.91−12.01	12.38−12.48	11.77−11.87	12.68−12.77	12.05−12.14	12.15−12.24
conductivity (mS/cm)	1.319−1.322	1.276−1.279	1.287−1.290	1.381−1.384	1.274−1.277	1.308−1.311
malic acid (g/L)	1.65−1.93	1.60−1.88	1.46−1.74	1.90−2.18	1.61−1.89	1.42−1.70
surface tension (mN/m)	49.7−49.9	49.4−49.6	50.0−50.2	48.8−49.0	49.5−49.7	49.6−49.8

[a] CP blend with Macabeo, Xarel.lo, and Parellada (1:1:1). [b] CPC, blend with Macabeo, Xarel.lo, Parellada, and Chardonnay (3:3:3:1).

Measurement of Foaming Properties. All foam measurements were carried out using the Mosalux procedure (Maujean et al., 1990). Three parameters were measured: (1) HM (foam height), the maximum height reached by the foam after carbon dioxide injection through the glass frit (7 L/h), expressed in millimeters, which could represent foamability; (2) HS, foam stability height during carbon dioxide injection, expressed in millimeters, which could represent the persistence of foam collar or the wine's ability to produce a stable collar; (3) TS, foam stability time until all bubbles collapse, expressed in seconds; this could represent the foam stability time, once effervescence has decreased.

Conventional parameters such as alcohol content, pH, titratable acidity (g of tartaric acid/L), volatile acidity (g of acetic acid/L), density (g/L, 20 °C), conductivity (mS/cm, 20 °C), and free and total SO_2 (mg/L) were measured according to OIV methods.

Absorbance. Absorbances at 280, 320, and 365 were determined in a 1 mm cell for total phenols, hydroxycinnamic acids, and flavonols and at 420 in a 10 mm cell for browning, with a diode array spectrophotometer (Betés-Saura et al., 1996; Somers and Ziemelis, 1995).

Surface tension (σ, mN/m) was determined at room temperature (22 ± 1 °C) with a Krüss GMBH K6 tensiometer (Weser, 1980). A platinum ring, horizontally suspended, is dipped into the liquid and immediately removed afterward. The force K_{max} (maximum of force, nM) necessary to pull the wetted circumference L_b (wetted length, m) of the ring through the liquid was measured. A correction factor, F (ratio between theoretical, 72 mM/m, and experimental surface tension of double-distilled water), was used.

$$\sigma = K_{max}/L_b F$$

Soluble Proteins. According to the method of Bradford (1976), these were analyzed directly on the cavas.

Total, Neutral, and Acid Polysaccharide Contents. The phenol−sulfuric acid method of Segarra et al. (1995) was used.

Organic Acids, Glucose, Fructose, and Glycerol. Analysis was made according to the method of López-Tamames et al. (1996).

Total Polyphenols. The Folin−Cicalteu method was used (Singleton and Rossi, 1965).

Statistical Analysis. STATGRAPHICS 7.0 (Rockville, MD) program was used to carry out multiple analysis of variance, two-way (MANOVA), considering variety and time of aging as qualitative variables and the 30 analytical determinations as quantitative variables. To evaluate the interaction between variety and aging, Statistical Software Package version windows 6.0.1 (SPSS Inc., Chicago IL) was used: interpolation type of calculation used was according to the Lowess model. This produces the locally weighted regression scatter plot smoothing method (Cleveland, 1979). Lowess uses an interactive weighted least-squares method to fit a line to a set of points on a scatter plot. The percentage of data points to use for local weighted regression is 50%. This method was carried out to evaluate the interactions variety−aging considering the foaming parameters HM, HS, and TS (Andrés-Lacueva et al., 1996b).

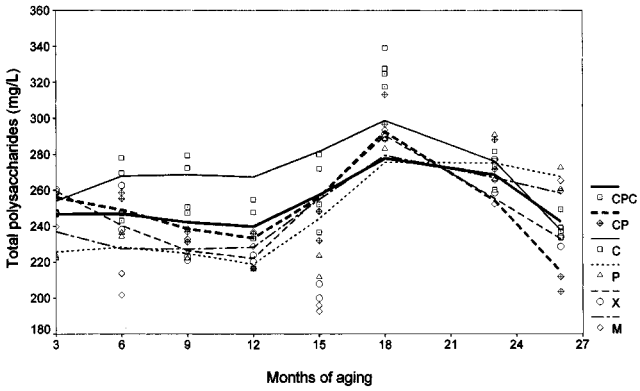

Figure 1. Levels of total polysaccharides (mg/L of galactose) during aging within varietal and blended cavas: M (Macabeo), X (Xarel.lo), P (Parellada), C (Chardonnay), blended CP (M:X:P) (1:1:1), and blended plus Chardonnay CPC (M:X:P:C) (3:3:3:1).

RESULTS AND DISCUSSION

Variety and blending are decisive for the foaming properties (Andrés-Lacueva et al., 1996b). The Chardonnay variety (C) had the highest foamability; and the blends containing this variety (CPC) had higher HM values than blends without it (CP). The three autochthonous varieties (M, X, P) had the same HM, although blending them (CP) slightly improved this property due to a synergistic effect. Cavas made from Chardonnay had the lowest TS. Aging, in general, increased TS values until a maximum at 18 months was reached, except for Chardonnay cavas, for which the increase in TS occurred later. HM decreased throughout aging, although an increase was observed at 18 months followed by a decrease after 21 months.

Variety. Chardonnay cavas were significantly higher than the other cavas ($p < 0.0001$) in most analytical measurement: total and neutral polysaccharides, soluble proteins, total polyphenols, absorbance values at 280, 365, and 420 nm, titratable acidity, alcoholic content, conductivity, and malic acid, and they showed the lowest surface tension values. Blended cavas (CP, CPC) were higher than autochthonous varieties (M, X, P) in total and acid polysaccharides, absorbance at 280 nm, and malic acid (Table 1).

Chardonnay cavas had the greatest values of total polysaccharides and neutral polysaccharides until 24 months (Figures 1 and 2, respectively). The blends with Chardonnay also had higher levels of acid polysaccharides (Table 1). Polysaccharides or macromolecules are reportedly responsible for the foam behavior. According

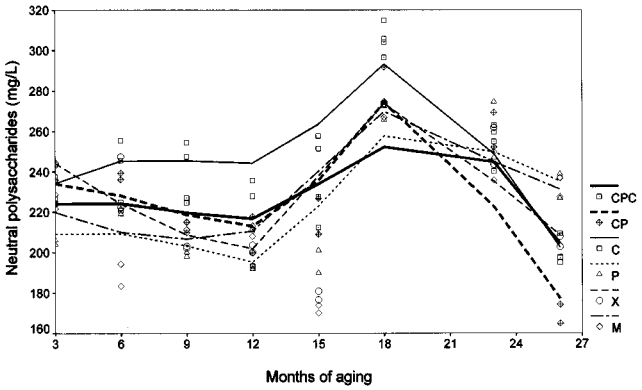

Figure 2. Levels of neutral polysaccharides (mg/L of galactose) during aging within varietal and blended cavas: M (Macabeo), X (Xarel.lo), P (Parellada), C (Chardonnay), blended CP (M:X:P) (1:1:1), and blended plus Chardonnay CPC (M:X:P:C) (3:3:3:1).

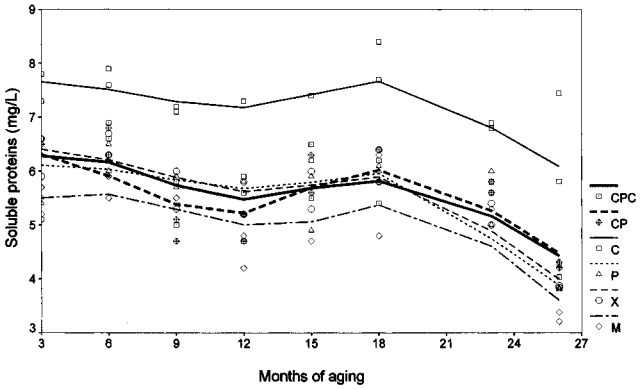

Figure 3. Levels of soluble proteins (mg/L of albumin) during aging within varietal and blended cavas: M (Macabeo), X (Xarel.lo), P (Parellada), C (Chardonnay), blended CP (M:X:P) (1:1:1), and blended plus Chardonnay CPC (M:X:P:C) (3:3:3:1).

to Pueyo et al. (1995), polysaccharides are directly correlated with foam stability in cavas. However, the literature gives several explanations: their influence on the viscosity of the bubble wall reduces the drainage of the liquid (Brissonnet and Maujean, 1991) or foaming may be due to their interactions with proteins (Marchal et al., 1996) and their surface properties and capacity to reorientate quickly at the liquid/gas interface in the bubble when the foam is formed (Robillard et al., 1993). With regard to the proteins, it is well-known that they affect the foamability (Maujean et al., 1990; Brissonnet and Maujean, 1991, 1993; Malvy et al., 1994; Robillard et al., 1993; Marchal et al., 1996). In this study, Chardonnay cavas showed the highest content of soluble proteins (Figure 3), determined by the Bradford method. However, their participation in the stabilization of the foam is controversial, since some authors have not observed any correlation (Maujean et al., 1990), others found a positive correlation (Pueyo et al., 1995), while Andrés-Lacueva et al. (1996a) observed an inverse correlation. The behavior of proteins in the foam depends on their hydrophobicity, solubility (dependent on the isoelectric point and the pH of the wine), and molecular weight (Brissonnet and Maujean, 1993; Marchal et al., 1996). Net charge of macromolecules depends on the pH (Vernhet et al., 1996). The isoelectric point of the wine proteins is between 3.5 and 4.5 according to Brissonnet and Maujean (1993) and between 4.6 and 5.0 according to Pueyo et al. (1993). At the wine pH, 2.9, its proteins would be positively charged and could migrate to the wall of the bubble,

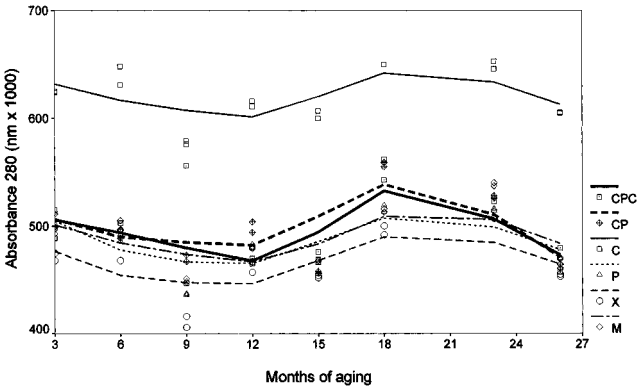

Figure 4. Levels of the absorbance at 280 (nm × 1000) during the aging within varietal and blended cavas: M (Macabeo), X (Xarel.lo), P (Parellada), C (Chardonnay), blended CP (M:X:P) (1:1:1), and blended plus Chardonnay CPC (M:X:P:C) (3:3:3:1).

helping foam formation (Robillard et al., 1993). Since Chardonnay cavas had higher protein levels (Figure 3), these cavas would have more positively charged proteins, which may favor this phenomenon.

Chardonnay cavas were significantly higher ($p < 0.0001$) in absorbance at 280 (Figure 4), 420, and 365 nm and in total polyphenol content (Table 1). *Coupages* (CP and CPC) also showed higher absorbance at 280 nm compared to the autochthonous monovarietal cavas. These results show the possibility that those parameters could be related to foam behavior. Marchal et al. (1993) reported the participation of the polyphenols in the foam. They can interact with proteins and polysaccharides (Marchal et al., 1996; Vernhet et al., 1996), mainly the low molecular weight polyphenols (Correa-Gorospe et al., 1991). According to Canals et al. (1996), the low molecular weight polyphenols participate in the hydration layer of the proteins.

Titratable acidity, alcoholic content, conductivity, and malic acid were significantly greater in the Chardonnay cavas ($p < 0.0001$) (Table 1). Chardonnay cavas had more titratable acidity than the other wines (Table 1), and this has been positively correlated with foamability (HM) by Andrés-Lacueva et al. (1996a) for 44 base wines from the Penedès region. When the alcohol content is low, other surfactants can be more active and thus more easily adsorbed at the interface, stabilizing the foam formed (Robillard et al., 1993; Dussaud et al., 1994). The Chardonnay cavas had higher alcohol content (Table 1), which could explain their low foam stability. Higher alcohol content was reported to decrease foamability (Maujean et al., 1990); however, this effect could be counteracted by other compounds produced in the second fermentation.

Malic acid was higher in Chardonnay and blended cavas ($p < 0.0001$) (Table 1), which have the highest values of foamability. It could indicate that malolactic fermentation is not recommended as a way to maximize HM in these cavas; the same fact was observed in base wines by Andrés-Lacueva et al. (1996a). However, these results were opposite to those obtained by Robillard et al. (1993) even though they considered the positive effect of the macromolecules that could be obtained from yeast or malolactic bacteria cell walls.

Surface tension, obviously, was lower in Chardonnay cavas (Table 1) because they had the highest alcohol content.

Aging. The increase in foamability and stability of foam at the 18 months of aging in the bottle with yeast

could be due to autolysis of the yeast. Maujean et al. (1990) observed an increase in TS at 15 months, which they correlated with yeast autolysis. Autolysis proceeds only if wine is aged for several months in contact with yeast. In these cavas, considerable changes were observed between 12 and 18 months. There was a significant maximum ($p < 0.005$) of total and neutral polysaccharides, soluble proteins, absorbances at 280, 320, and 365 nm, total polyphenols, titratable acidity, conductivity, and succinic acid and a significant decrease after 15 months in acid polysaccharides. On the other hand, there was an increase after 18 months in glucose, fructose, galacturonic acid, glycerol, lactic acid, and absorbance at 420 nm (Table 2).

One of the two phases observed in macromolecule release (polysaccharides and especially mannoproteins) during yeast-less contact in white wine production occurs as a result of autolysis (Charpentier and Feuillat, 1992; Moreno-Arribas et al. 1996). The second production of macromolecules is by living cells, in proportion to the initial concentration of colloids in the medium (Guilloux-Benatier et al., 1995). Yeast is the basis of intracellular proteolytic activity (Feuillat and Charpentier, 1982), causing degradation of cytoplasmic constituents. Liberation of glucans from the cell wall occurred earlier than liberation of mannoproteins, and the loss of mannoproteins increased the porosity of the cell wall (Silva et al., 1990). According to Robillard et al. (1993), particles or colloids enhance foam properties, since they stabilize the gas/liquid interface. In our study there was a marked increase in neutral polysaccharides at 18 months (Figure 2), which, according to Charpentier et al. (1986), come from the yeast. This kind of polysaccharide forms the walls of the yeast and is comprised of mannose associated with low levels of glucose and proteins (Brillouet et al., 1989). The levels of monosaccharides, glucose and fructose, increased considerably after autolysis (Figures 5 and 6, respectively); the first one may be due to the hydrolytic activity on yeast polysaccharides (Feuillat, 1987). However, Saccharomyces has not been reported to make or store polymers of fructose. This data is most consistent with hydrolysis of plant components in a yeast-dependent manner (L. Bisson, personal comunication). After 18 months, there was an increase in galacturonic acid (Figure 7) accompanied by a decrease in acid polysaccharides (Figure 8), which could be due to pectic hydrolysis associated with autolysis. Polysaccharides favor foamability (Brissonet and Maujean, 1991; Robillard et al., 1993), so the hydrolysis of pectins could participate in the reduction in HM observed after 18 months (Andrés-Lacueva et al., 1996b).

Leroy et al. (1990) observed that the proteolytic activity of the biomass over time increased only slightly after 18 months, and total nitrogen reached a small maximum between months 15 and 20. The same evolution curve was observed in these cavas, in which the soluble proteins had a maximum at 18 months (Figure 3). The resulting cell death is proportional to yeast autolysis (Guilloux-Benatier et al., 1995).

Proteins and polysaccharides are well-known foam-positive compounds. Therefore, this increase in foam properties at 18 months observed by Andrés-Lacueva et al. (1996b) could be associated with the increase in their levels.

Table 2. 95% Confidence Intervals for the Means for Which Significant Differences Were Found between 12 and 18 Months of Aging According to Time of Aging ($n = 12$)

	3 months	6 months	9 months	12 months	15 months	18 months	23 months	26 months
titratable acidity (g tartaric acid/L)	4.23−4.31	4.25−4.33	4.17−4.25	4.17−4.24	4.20−4.28	4.26−4.34	4.15−4.22	4.07−4.15
conductivity (mS/cm)	1.300−1.304	1.300−1.304	1.293−1.297	1.396−1.400	1.272−1.276	1.325−1.329	1.264−1.280	1.295−1.299
glucose (g/L)	0.28−0.38	0.34−0.44	0.40−0.50	0.34−0.43	0.32−0.42	0.35−0.45	0.33−0.43	0.52−0.62
fructose (g/L)	1.29−1.66	1.48−1.81	1.63−2.00	1.47−1.84	1.43−1.80	1.50−1.87	2.19−2.56	2.43−2.80
galacturonic acid (g/L)	0.31−0.38	0.34−0.68	0.35−0.42	0.31−0.38	0.28−0.35	0.30−0.37	0.45−0.52	0.55−0.62
lactic acid (g/L)	0.06−0.16	0.08−1.77	0.09−0.19	0.11−0.21	0.20−0.30	0.37−0.47	0.62	0.71
succinic acid (g/L)	0.30−0.37	0.30−0.37	0.39−0.46	0.38−0.45	0.33−0.41	0.31−0.38	0.14−0.21	0.18−0.25
glycerol (g/L)	4.18−5.02	4.34−5.17	4.55−5.39	4.59−5.43	4.59−5.43	4.29−5.13	4.59−5.43	6.42−7.27
soluble proteins (mg/L albumin)	5.86−6.45	6.29−6.88	5.44−6.03	5.07−5.66	5.53−6.12	5.98−6.57	5.41−5.00	4.04−4.63
total polysaccharides (mg;L galactose)	242.08−250.77	240.62−249.31	235.76−244.46	224.64−233.34	225.12−233.81	300.16−308.86	267.53−276.22	237.01−245.70
neutral polysaccharides (mg/L galactose)	222.38−231.26	221.50−230.37	212.96−221.83	203.70−212.58	202.08−210.96	280.12−288.99	250.00−258.87	202.21−211.08
acid polysaccharides (mg/L galacturonic acid)	47.63−50.38	46.21−48.96	55.41−58.16	50.76−53.51	55.99−58.74	48.52−51.28	42.22−44.98	33.33−36.08
absorbance 280 (nm × 1000)	509−524	508−523	467−482	493−508	479−493	540−555	535−549	481−495
absorbance 320 (nm × 1000)	374−379	365−369	325−329	355−359	332−336	379−383	372−376	329−334
absorbance 365 (nm × 1000)	83−86	72.68−76	43−46	63−67	39−42	74−78	70−74	59−62
absorbance 420 (nm × 1000)	73−75	83−85	90−92	78−80	77−79	81−83	88−90	90−92
total polyphenols (mg/L gallic acid)	155.7−160.3	135.4−139.9	145.5−150.1	150.1−154.7	145.0−149.6	159.0−163.6	146.0−150.6	157.2−161.8

[a] CP blend with Macabeo, Xarel.lo, and Parellada (1:1:1). [b] CPC, blend with Macabeo, Xarel.lo, Parellada, and Chardonnay (3:3:3:1).

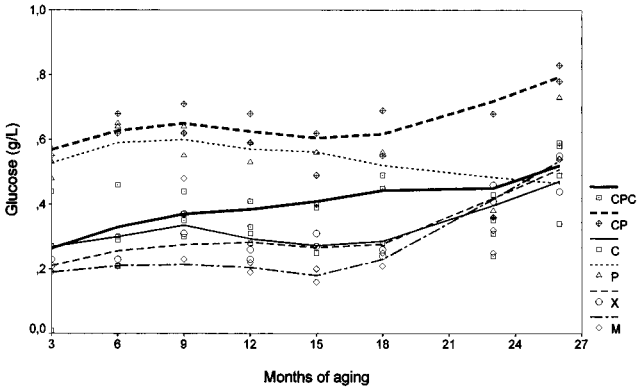

Figure 5. Levels of glucose (g/L) during aging within varietal and blended cavas: M (Macabeo), X (Xarel.lo), P (Parellada), C (Chardonnay), blended CP (M:X:P) (1:1:1), and blended plus Chardonnay CPC (M:X:P:C) (3:3:3:1).

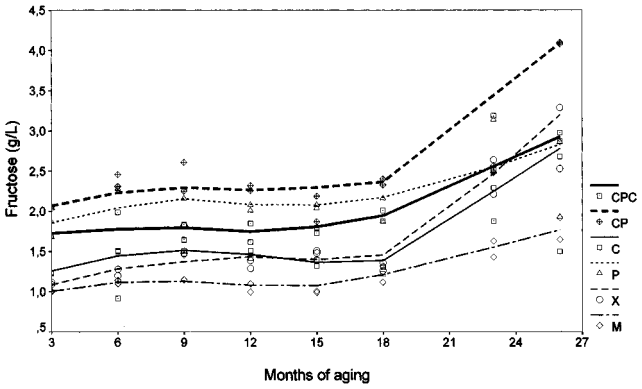

Figure 6. Levels of fructose (g/L) during aging within varietal and blended cavas: M (Macabeo), X (Xarel.lo), P (Parellada), C (Chardonnay), blended CP (M:X:P) (1:1:1), and blended plus Chardonnay CPC (M:X:P:C) (3:3:3:1).

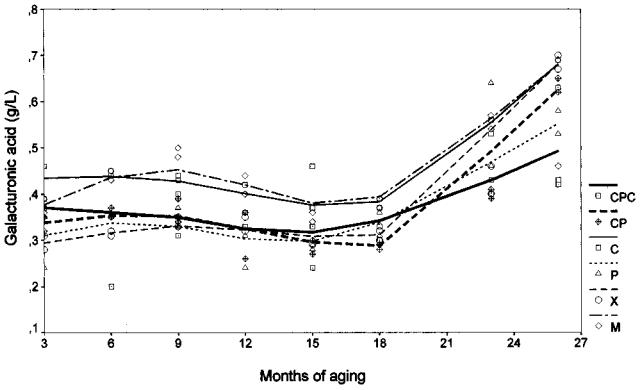

Figure 7. Levels of galacturonic acid (g/L) during aging within varietal and blended cavas: M (Macabeo), X (Xarel.lo), P (Parellada), C (Chardonnay), blended CP (M:X:P) (1:1:1), and blended plus Chardonnay CPC (M:X:P:C) (3:3:3:1).

Absorbance at 320 nm, mainly due to hydroxycinnamic esters, increased between 12 and 18 months (Figure 9). These compounds may be merely adsorbed by the yeast (Nagel and Wulf, 1979; Somers et al., 1987). For this reason, the maximum in 320 nm absorbance at 18 months (Figure 9) could be due to the release of this kind of polyphenol during the autolysis of the yeast cell walls. The same increase was also observed in absorbance at 280 nm (Figure 4) and, consequently, in total polyphenols owing to the adsorption phenomenon following the release from the yeast.

Yeast autolysis is a slow process which is a positive factor in the production of sparkling wine. Consequently there is a relationship between autolysis and improvement in the quality of the wine (Leroy et al., 1990). Therefore, aging for 18 months would give cavas with the best quality foam.

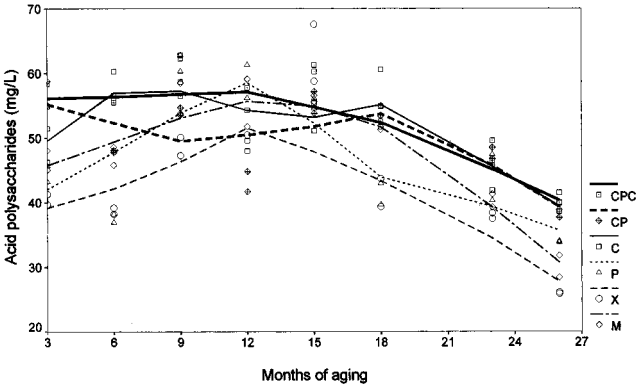

Figure 8. Levels of acid polysaccharides (mg/L of galacturonic acid) during aging within varietal and blended cavas: M (Macabeo), X (Xarel.lo), P (Parellada), C (Chardonnay), blended CP (M:X:P) (1:1:1), and blended plus Chardonnay CPC (M:X:P:C) (3:3:3:1).

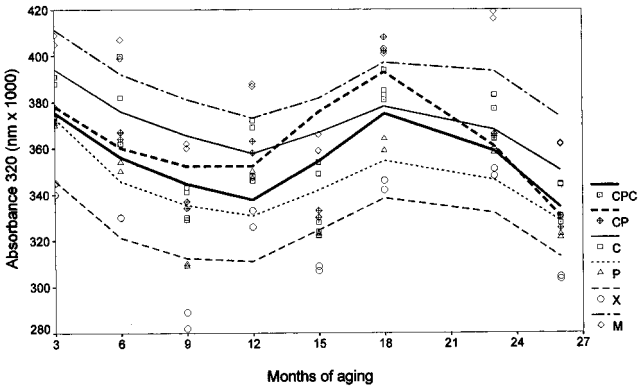

Figure 9. Levels of absorbance at 320 (nm × 1000) during aging within varietal and blended cavas: M (Macabeo), X (Xarel.lo), P (Parellada), C (Chardonnay), blended CP (M:X:P) (1:1:1), and blended plus ChardonnayCPC (M:X:P:C) (3:3:3:1).

CONCLUSIONS

Variety and aging affect foaming properties of cavas. Chardonnay cavas gave the best foam, and they are higher in total and neutral polysaccharides, soluble proteins, total polyphenols, absorbance at 280, 420, and 365 nm, titratable acidity, alcoholic content, conductivity, and malic acid. Eighteen months of aging seems to be the best for foamability and stability time thanks to the release of compounds, probably coming from yeast autolysis, such as proteins and polysaccharides. However, after 18 months there is a decrease in foamability accompanied by an increase in monomeric compounds. Fructose increase could be due to the hydrolysis of plant components depending on the enzymes released from yeast during autolysis. The participation of proteins and polysaccharides in foam is described. However, the effect of those compounds that can interact with them should also be considered.

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