Comparative study of the Diam cork closure with other low TCA content closures

Organoleptic qualities and defects

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TECHNICAL

Purpose of the study

This publication deals with two studies which were started in September 2005 and which were performed at the request of the Œneo Bouchage company by an independent laboratory (RIERE Laboratory, I sabelle Cutzach-Billard, Consulting Enologist and Ph.D. in Enology).
Study A compares different closures available on the market, including the Diam cork closure (cork powder treated with supercritical CO_2 in order to guarantee a TCA content < limit of quantification, i.e. 0.5 ng/L) and other cork closures characterized by low TCA contents ***(table 1)***.
Study B again compares the Diam closure, but this time with agglomerated, fine-grain closure prototypes produced internally and characterized by TCA contents that are also lower than the limit of quantification following double steam treatment of the cork powder. The goal on the enological level is to compare the effects of the steam treatment on the cork powder, with those of supercritical CO_2 treatment in the Diamant process.

Sample from study A *(table 1)*

Sample from study B *(table 2)*

Comment: prototype E corresponds to a formulation that is 10 times more permeable than prototype D. On the sensory level, in this second study, we compare different TCA-free closures (contents < 0.5 ng/l) treated either with a conventional steam process, or with the Diamant process.

Method

A panel of experienced blind tasters analyzed and ranked each sample after 0, 1, 3, 6, 9 and 12 months of bottle aging, per series of 6 bottles in the case of study A, and per series of 3 bottles for study B.
Each sample was also analyzed chemically. Lastly, the results underwent statistical treatment: preference tests and factorial correspondence analysis (FCA) were performed.

Study A deals with a dry white wine from the 2004 vintage, bottled on September 1, 2005.
Study B involves a dry white wine and a red wine from the 2004 vintage, bottled on September 1, 2005.
This article deals with one year of bottle aging, and it presents the sensory results obtained.
It intends to be as exhaustive as possible in order to determine in which cases cork taints or organoleptic defects are perceived.

Study A: preference test

At each tasting, i.e. at T 1 month, T 3 months, T 6 months, T 9 months and T 12 months, the seven samples were tasted. The results from each tasting are presented in the table below.
By looking at the year as a whole, we can observe that the tasting panel, *via* the five tastings conducted during this study, has a preference for the Diam process. For all of the tastings, this sample was preferred after 1 year of bottle aging, with an average ranking of 1.4 ***(table 3)***.

Table 1: Samples from study A: seven closure types were tested.

Closure ID	Closure type	Average TCA content
Closure 1	Natural cork (Premium grade)	1. 1 ng/l
Closure 2	Diam	< 0.5 ng/l
Closure 3	Fine-grain Agglomerate C	1.0 ng/l
Closure 4	Fine-grain Agglomerate A	0.7 ng/l
Closure 5	Fine-grain Agglomerate B	1.1 ng/l
Closure 6	Synthetic	0 ng/l
Closure 7	Cork 1+1	0.9 ng/l

Table 2: Samples from study B: three closure types were tested in white wine and red wine.

Diam (TCA < limit of quantification)
Steam-treated Agglomerate D prototype closure (TCA < limit of quantification)
Steam-treated Agglomerate E prototype closure (TCA < limit of quantification)

Table 3: Study A: ranking by preference (summary).

	Naturel	Diam	Agglo C	Agglo A	Agglo B	Synthetic	1+1
T 1 month	2	3	6	4	4	1	7
T 3 months	3	1	2	3	6	7	5
T 6 months	4	1	6	5	7	3	2
T 9 months	4	1	2	3	7	5	4
T 12 months	5	1	3	4	7	2	6
Σ rang	18	7	19	19	31	18	24
Av. rank	3.6	1.4	3.8	3.8	6.2	3.6	4.8

Study B: preference test

Starting at T+6 months of aging, the Diam sample is preferred by all of the tasters for both the white wine and red wine. This trend is confirmed after 12 months of bottle aging. The table below [sic: on previous page] shows the rankings of the different samples at T + 6, 9 and 12 months. Samples 3 and 4 from the two series are the most preferred, and in each case this is the Diam sample ***(table 4)***.

Study A: Descriptive sensory analyses

We used the statistical method of factorial correspondence analysis, taking into consideration the different wine/closure pairs as statistical individuals and the consensus descriptors as random variables. For each wine studied, we have noted the frequency of citation and the intensity of the different descriptors.
We thus obtain a contingency table showing the individuals and variables on which we have applied the techniques of factorial correspondence analysis (FCA). This analysis optimally summarizes the information by revealing the possible correlations between variables and individuals.

Factorial correspondence analyses:

Thanks to FCA, the information is summarized on a two- or three-dimensional space, while retaining the majority of the information. The results of this analysis are represented in the symmetrical figures (F1 and F2). Most of the information is represented in the first two axes F1 and F2 (70.71%).
These two figures represent the projection of the variables and individuals on the plane formed by the two main axes of interpretation. In general, at T+6 months of bottle aging, the individuals or wine/closure pairs were close to the origin and statistically not very different from each other. However, some trends seem to arise and are confirmed thereafter. After 12 months of the study, the FCA yields very interesting results: the asymmetrical and symmetrical results of the columns between the F1/F2 axes are characteristics of the different aroma descriptors encountered during the descriptive sensory analysis and of the different wine/closure pairs. FCA is used to differentiate the different closure types and to group some of them together.
Four groups were found, as shown in ***figure 1***:
– Natural and 1+1 cork closures seem to have the same organoleptic characteristics (negative y-coordinates),
– Agglomerate A and B cork closures also seem to form a group consisting of them alone (positive x-coordinates),

Table 4: Study B: ranking by preference (summary).

	White			Red		
	Mod. 1	Mod. 2	Mod. 3	Mod. 4	Mod. 5	Mod. 6
	Agglo D	Agglo E	Diam	Diam	Agglo E	Agglo D
T 3 month	nr	nr	nr	nr	nr	nr
T 6 months	2	3	1	1	3	2
T 9 months	2	3	1	1	3	2
T 12 months	2	2	1	1	2	3
Σ rang	6	8	3	3	8	7
Av. rank	2	2.7	1	1	2.7	2.3

nr: no ranking possible at T 3 months

Figure 1: Projection of the different closure types on the plane created by Factorial Correspondence Analysis (FCA).

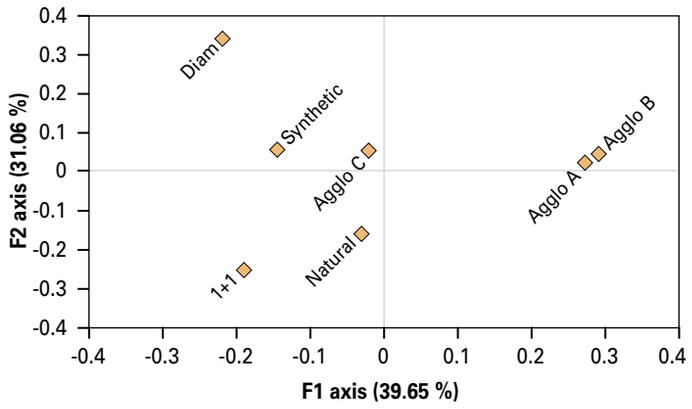
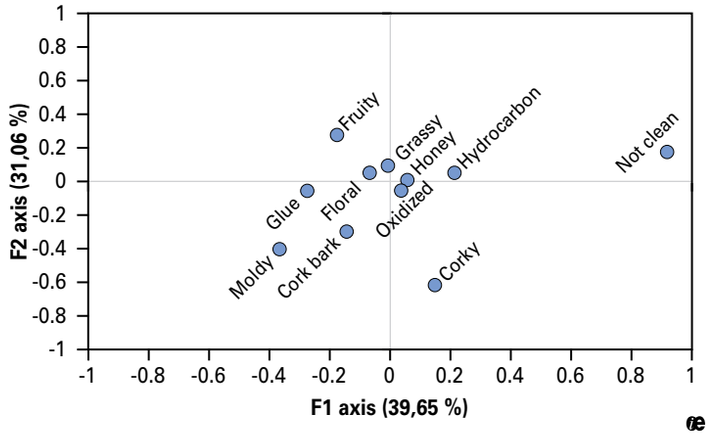
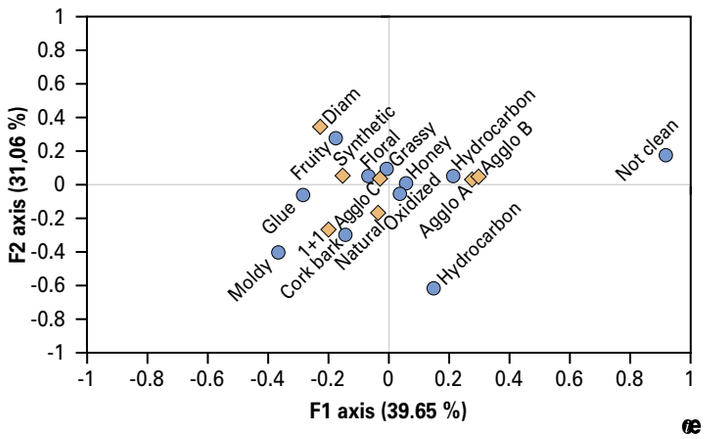


Figure 2: Distribution of aroma descriptors on the plane formed by the 2 axes (F1 and F2: 70.71%) from the FCA.

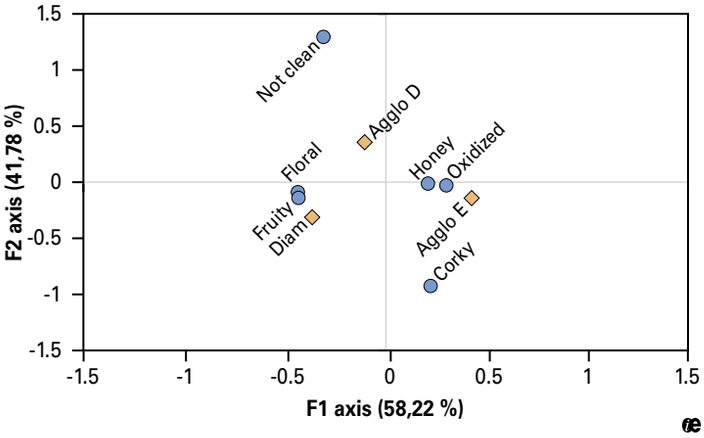


– The Synthetic and Agglomerate C closure types are also grouped together, with a negative x-coordinate close to zero,
– The Diam closure, in contrast, is isolated on the positive y-coordinate.
The olfactory descriptors form four groups, as presented in ***figure 2:***
– One group seems to form on the negative part of the y-axis. These are the cork bark, moldy and corky descriptors,
– The fruity descriptor is isolated at the top of the figure, on the positive end of the y-axis,
– Another descriptor, referred to as "not clean" in this study, since it is difficult to describe, and which is associated with "cork bark, vanilla and mushroom" notes, is isolated and quite separate from the other typical "cork taint" descriptors (positive end of x-axis),
– Lastly, the other descriptors do not seem to be really separate and differentiated, but rather grouped around the origin of the figure.
We can note that no synthetic, glue or solvent notes were found in this study, regardless of the closures tested. The interpretation of Figure 3 containing the individuals (wine/closure pairs) and the variables (descriptors) provides some information. The figure matches the different descriptors with the different wine/closure pairs, and as such, the "cork bark", "moldy" and "corky" notes are correlated with the Natural and 1+1 cork closure types. The "fruity" descriptor is associated with the Diam closure type, whereas the "not clean" descriptor seems to be closer to Agglomerates A and B. The other descriptors are grouped together, and no

■ **Figure 3: Correlation between aroma descriptors and closure types by FCA (F1 and F2: 70.71%).**



■ **Figure 4: Correlation between aroma descriptors and closure types by Factorial Correspondence Analysis.**



differentiation really seems possible to distinguish the other two closure types: Synthetic and Agglomerate C.

Study B: Descriptive sensory analyses

Factorial correspondence analyses on white wine:
This analysis was only performed on the white wine, whose taste differences were the most distinctive. In ***figure 4,*** the Diam closure is the closest to the fruity and floral characters and is opposite from the Agglomerate E closure, which is differentiated by the notes of bottle age (more permeable formulation). The Agglo D prototype is found in ***figure 4*** between the Diam closure (fruity character) and the Agglo E prototype (honey, oxidized) and slightly closer to the "not clean" descriptor, as were the other agglomerated closures A and B in the previous study A.

Conclusion of studies A and B

These two studies were specially performed in order to monitor the evolution of the organoleptic parameters of different wines bottled with different closures, and they have revealed a certain number of points:

The preference tests from studies A and B show that:
– The Diam closure is always ranked first,
– The natural cork and synthetic closures were ranked close to each other in terms of preference,
– The Agglomerate C and A cork closures also had the same average ranking after one year of bottle aging,
– The Agglomerate B cork closure is the lowest ranked and thus the least preferred closure.

The seven closure types from study A can be grouped into four closure families:
– The fine-grain agglomerates family: Agglomerates A and B,
– The natural cork family: natural and 1+1,
– The Agglomerate C and Synthetic closure family,
– Lastly, the Diam closure, which is not associated with any other family.

This study reveals: the qualities of the Diam closure, which shows no defects during tasting in either of the two studies and which is systematically preferred by the panel of experienced tasters. It is statistically correlated with the "fruit" aromas and is far from the other descriptors, which themselves are correlated with the fine-grain agglomerated cork closures A, B and C.

The preference tests from study B, which deal with TCA-free fine-grain agglomerated cork closures obtained using either a steam process or the Diamant process, have shown that:
– The Diam closure is always ranked first,
– The fine-grain Agglomerates D and E are rather close to each other, and they are differentiated mostly by the difference in permeability (factor 10).

The Diam closure in study B, after 1 year of bottle aging, is again the highest rated, when compared with the fine-grain Agglomerates D and E, which like the other fine-grain agglomerated cork closures tested in study A sometimes yield "not clean" perceptions in wine. Furthermore, the Diam closure is always associated with the fruit criteria and does not display any organoleptic defects.

This study, which only involves TCA-free closures (< 0.5 ng/l), proves that the organoleptic neutrality of the Diam closure is much greater than that obtained with a steam-treated closure. This very great neutrality can be explained by the very high number of aroma molecules extracted by the process, in addition to TCA, as set forth in a previous article *(published in Revue des Oenologues – July 2006, No. 120, pp. 13-18).*

Comment: the conventional wine analyses (SO_2, CO_2 and OD 420) performed during this study are not mentioned in this article, since they do not include truly significant and relevant results. The differences in concentration were all within the measurement uncertainty, and it was not possible to draw any significant conclusions as to the influence of each closure. ■

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