SENSORY METHODOLOGY DEVELOPED FOR THE INVESTIGATION OF SCIACCARELLO WINE CONCEPT

MÉTHODOLOGIE SENSORIELLE DÉVELOPPÉE POUR LA MISE EN ÉVIDENCE D'UN ESPACE SENSORIEL PROPRE : APPLICATION AUX VINS ISSUS DU CÉPAGE SCIACCARELLO

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Abstract : The aim of the present work was to underline the existence of a sensory space relevant to Sciaccarello wines. Twenty-eight wines were selected for viticultural and enological characteristics, using 1/2 Sciaccarello/Non-Sciaccarello ratio. Sensory analyses (orthonasal then overall perceptions) were performed with a panel composed of seventeen judges. All of the judges were experienced in Sciaccarello wines knowledge. Statistical treatment by PCA was first carried out to display the consensus between the assessors. ANOVA was performed to discriminate accurate and inaccurate examples of Sciaccarello wines. This study demonstrated the existence of the sensory space in which most of Sciaccarello wines, described as good examples of the concept, were pooled.

Résumé : Le but de cette étude est d'apporter la preuve de l'existence d'un espace sensoriel propre aux vins issus de cépage Sciaccarello dont la spécificité d'origine est démontrée. Pour cela, 28 vins ont été réunis selon leurs caractéristiques viticoles et œnologiques. L'originalité de cette étude réside dans la confrontation de 14 vins issus du cépage Sciaccarello avec 14 vins issus d'autres cépages rouges. Un panel composé de 17 juges, tous membres de la filière viti-vinicole corse, a évalué ces vins selon deux modalités sensorielles indépendantes : orthonasale (au nez) et globale (au nez et en bouche). Le consensus entre les membres du jury a été vérifié, d'abord par ACP, puis par détermination du coefficient de corrélation de Kendall. Une ANOVA à deux facteurs a, ensuite, été réalisée afin de mettre en évidence les vins considérés comme de bons ou de mauvais exemples de vins issus du cépage Sciaccarello. Cette étude démontre l'existence d'un espace sensoriel dans lequel la grande majorité des vins décrits comme de bons exemples sont issus du cépage Sciaccarello. Pour la modalité orthonasale, six vins sur les sept relatifs au groupe de haut degré d'exemplarité sont issus du cépage Sciaccarello, et neuf vins sur dix pour la modalité globale.

Keywords: red wine, sensory analysis, sensory space, Sciaccarello.

Mots clés : vin rouge, analyse sensorielle, espace sensoriel, Sciaccarello

INTRODUCTION

Sciaccarello is a classical variety, only grown in Corsica. The origins of Sciaccarello are still unknown. In fact, the name Sciaccarello has been associated to typical Corsican term meaning crackling. The qualities of its grapes are appreciated in both table grape and winemaking. While the production of table grape is reducing, the Sciaccarello wine growing regions currently overgrow nearly 700 hectares. The majority of Sciaccarello wines are produced in the south Corsica appellations, such as Ajaccio, Sartène, Figari and Porto-Vecchio, and make up 43 % of red varieties cultivated in Corsica vineyards. Wines elaborated from Sciaccarello variety are red or rosé wines. Sciaccarello is suitable for granite soils, where slopes situation and growing control induce few yields and provide an enhanced expression of its flavour characteristics. Pure red Sciaccarello wines exhibit poor colour what requires

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blending to balance the colour failure. Additional grape varieties are traditionally Nielluccio, Grenache or Syrah in agreement with AOC decrees. Conversely, Sciaccarello wines are well-known for their flavour intensity and complexity, usually described by local winemakers as berry, spicy, woody and herbaceous. However, no comprehensive sensory descriptive study of Sciaccarello wines has previously been attempted.

It is generally accepted that the character of wines changes with the regional effect of soils, climate, cultural practices, winemaking procedures and storage. Despite these different sources of variation, such wines are frequently elaborated from major, indeed, unique grape variety. Consequently, it is reasonable to predict the existence of joint sensory characters within such a product-space. In this context, the aim is to know if exists relationship between a product-space and a sensory space. In fact, this relationship was frequently depicted as an overlap and not as a perfect superposition. Only some wines belonging to a delimited category have expected sensory quality and are considered as better examples than others. MOIO *et al.* (1993) reported that within the Burgundy Chardonnay wine's category, only some of them were depicted as good examples. GUICHARD *et al.* (1990) showed that some apricot varieties seemed to match poorly the internal apricot concept of the panellists. Ballester et al. (2003a and b) have recently established a sensory procedure to demonstrate the existence of a sensory space related to wines produced from Chardonnay variety. The reported procedure required to compare pure Chardonnay wines with various wines from other pure varieties. The authors showed that the sensory space in which Chardonnay wines predominate, may be shared with wines produced from other grape varieties such as Aligoté and Melon de Bourgogne.

The purpose of this work was to confirm the existence of a sensory space in which wines elaborated from Sciaccarello were predominant. The wines sampling was evaluated by two consecutive sensory modalities: orthonasal then overall perceptions. Analyses of variance (ANOVA) and principal component analysis (PCA) were applied to the results.

MATERIALS AND METHODS

Wines. The sampling consisted of 28 wines. Fourteen were produced from Sciaccarello (Sc) grape variety and the others from eight red varieties (NSc). The selection of wines was based on regular significance parameters: the wines came from several French vineyards and from three vintages (2000, 2001 and 2002). The selected wines were fermented and stored in stainless steel tanks prior to bottling according to usual winemaking practices applied to Sciaccarello wines.

The fourteen Sciaccarello wines were produced in Corsica. They were elaborated from pure or blended grapevine, containing at least 60% of Sciaccarello. In this experiment, the additional grape varieties were Grenache, Nielluccio and Syrah.

In agreement with the concept matching method reported by Dacremont and Vickers (1994), the other fourteen wines were selected on additional parameters related to their ability to be compared with Sciaccarello wines. They were produced from the subsequent eight pure grape varieties: Gamay (2), Merlot (1), Mondeuse (2), Nielluccio (2), Pinot Noir (3), Poulsard (1), Syrah (2) and Trousseau (1). Moreover, only awarded wines were retained in order to guarantee the lack of basic defects. Four prize lists were prospected and some wines were chosen: Vinalies 2004

Tableau I - Nature des cépages, des degrés d'assemblage, des millésimes et des codes des 28 vins étudiés.

Nature of grapevines, blending ratio, vintages and codes for the sampling (28 wines).

Grapevine	Blending [a]	Vintage	Code	Grapevine	Vintage	Code
Sciaccarello	70	2002	Sc1	Gamay	2001	Gam1
Sciaccarello	80	2002	Sc2	Gamay	2002	Gam2
Sciaccarello	100	2002	Sc3	Merlot	2002	Mer
Sciaccarello	100	2002	Sc4	Mondeuse	2001	Mon1
Sciaccarello	60	2001	Sc5	Mondeuse	2001	Mon2
Sciaccarello	70	2001	Sc6	Nielluccio	2002	Nie1
Sciaccarello	100	2001	Sc7	Nielluccio	2002	Nie2
Sciaccarello	100	2000	Sc8	Pinot noir	2001	Pin1
Sciaccarello	60	2001	Sc9	Pinot noir	2002	Pin2
Sciaccarello	90	2001	Sc10	Pinot noir	2001	Pin3
Sciaccarello	75	2002	Sc11	Poulsard	2001	Pou
Sciaccarello	100	2002	Sc12	Syrah	2001	Syr1
Sciaccarello	80	2002	Sc13	Syrah	2001	Syr2
Sciaccarello	60	2002	Sc14	Trousseau	2001	Tro

a : % of Sciaccarello

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(5 wines), "Concours Général Agricole de Paris" 2002 (1 wine) and 2003 (4 wines), "Concours des Vins de Mâcon" 2002 (1 wine) and "Guide Hachette des vins" 2004 (1 wine). Two wines were produced from Nielluccio and were collected from wineries in Corsica according to the constraints described above. Interviews with producers of labelled wines were carried out to have entire information regarding the conformity of wines with retained parameters. Thus, the interviews allowed to achieve the wines selection. Table I shows the 28 wines collected for the experiment.

Sensory analysis. The panel consisted of seventeen assessors (15 males and 2 females). They were enologists, winemakers and CIVAM's staff members, all established in Corsica. They had extensive knowledge of Sciaccarello wines and most had previously participated in tasting sessions offered by the CIVAM. They were considered as experts in accordance with the definition supplied in several previous studies (MELCHER and SCHOOLER, 1996; BENDE AND NORDIN, 1997; PARR *et al.*, 2002). The panellists were therefore particularly able to answer the single question about inclusion or exclusion of wines from Sciaccarello wine concept. In contrast, judges were not familiarised with the sensory methodology.

The panel was divided into two groups, eight assessors in the first group and nine in the second. Each group took part in two sessions in the morning over two days. At each session, judges evaluated a set of 14 wines with the same 1/2 Sc/NSc ratio. According to the methodology reported by BALLESTER *et al.* (2003a and b), two modalities of assessment were conducted. Wines were first evaluated by orthonasal perception (sniffing after swirling), then, independently, by overall perception (i.e. orthonasal perception, then retronasal perception, taste and mouthfeel). Each session was scheduled in four parts: seven wines were assessed by orthonasal perception; 5 minutes short break; replicate seven wines were re-randomised and assessed by overall evaluation; 20 minutes break; the seven other wines were assessed by orthonasal perception; 5 minutes short break and, finally, the replicate re-randomised last seven wines were evaluated by overall evaluation.

Samples (25 mL) were served at 16 °C in 250 mL INAO-approved black glasses. Glasses were labelled with three-digit random numbers and covered by plastic Petri dishes to prevent volatile loss. The presentation was monadic and, the Sciaccarello and non-Sciaccarello wines were balanced and randomised across the panel members. Moreover, the order of presentation was different for each panellist and each assessment modality. The experimental design was therefore established to reduce biases related to the order, carry-over or expectation effects (MACFIE *et al.*, 1989).

The question and the related instructions were the following: "Imagine that you must explain to a friend what is a wine produced from Sciaccarello. To explain, you can have him taste a wine. For each wine presented, you must answer the following question: Do you consider that this wine is a good or a bad example to illustrate to your friend what is a wine produced from Sciaccarello?" It was indicated that the assessors would not be judged on their results because there is neither accurate, nor wrong response: "For different reasons due to growing or enological practices, it is not excluded that Sciaccarello wine does not seem to you as a good example of what this variety allows to obtain. On the other hand, wine made with another variety could seem to you a good example. Our interest is in your personal appreciation."

The responses, represented by a vertical line, were given on unstructured scales (one scale per wine), ranging from "very bad example" to "very good example". Data were subsequently read in optical mode using a device controlled by FIZZ software (Biosystems, Couternon, France). Consequently, data were automatically converted into exemplarity scores from 0 to 10.

Statistical analysis. Principal component analyses (PCA) were performed using WinStat2 (CIRAD, Montpellier, France). PCA were executed separately on the orthonasal and overall data, and were conducted on the scores assigned to each wine by each panellist. The panel was considered as randomised factor. PCA were performed considering wines as individuals and judges as variables (coded from J1 to J17). Data were not standardised in order to impute more importance to the assessors using the complete rating scale than those using only the middle part of the scale. Interjudge consistency was determined by Kendall's coefficient of concordance (W) using Statistica (Statsoft, Inc., Tulsa, OK). The complete data sets were subjected to PCA to show also relationships among samples. Analyses of variance (ANOVA) and multiple comparison tests were performed using Statgraphics Plus, version 3.1 (Statistical Graphics System, Manugistics, Rockville, MD). The exemplarity level of wines rated by the judges was subjected to double-factors (wine, subject) ANOVA separately applied to the orthonasal and overall modalities. Sample mean exemplarity levels were compared using the Fisher's Least Significant Difference (LSD, notified $a = 0.05$) multiple comparison procedure in order to carry out a wine selection for further analyses.

RESULTS AND DISCUSSION

Relationships among panellists. The relationships among the variables are shown in PCA plots. In figure 1a, the first three principal components accounted for 50.0 % of the total variation in the orthonasal data set with 23.0

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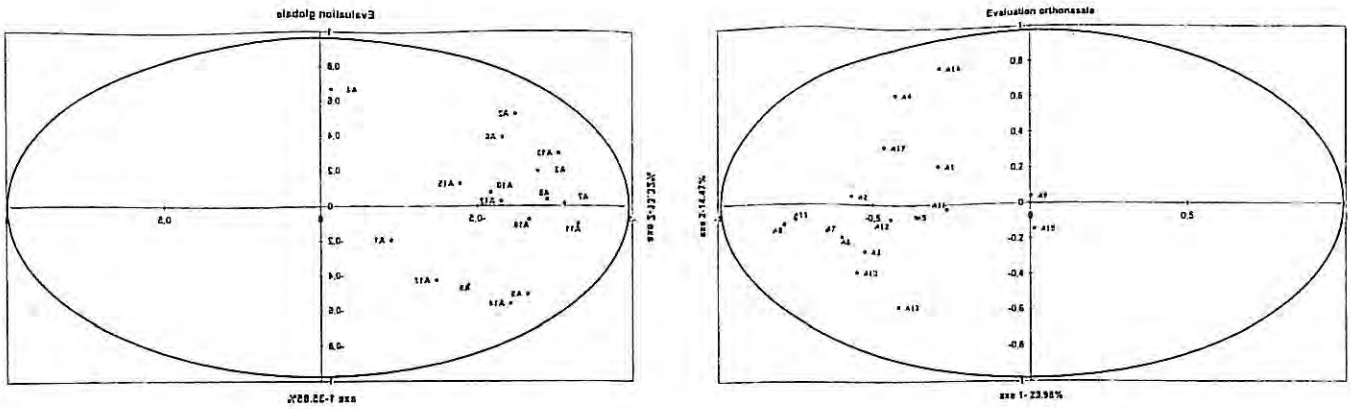

Figure 1a et 1b - Projection des sujets (variables) sur les composantes principales 1 et 2 des ACP ; cercles de corrélation.

Projection of judges (variables) on principal components 1 and 2 of PCA; circles of correlation.

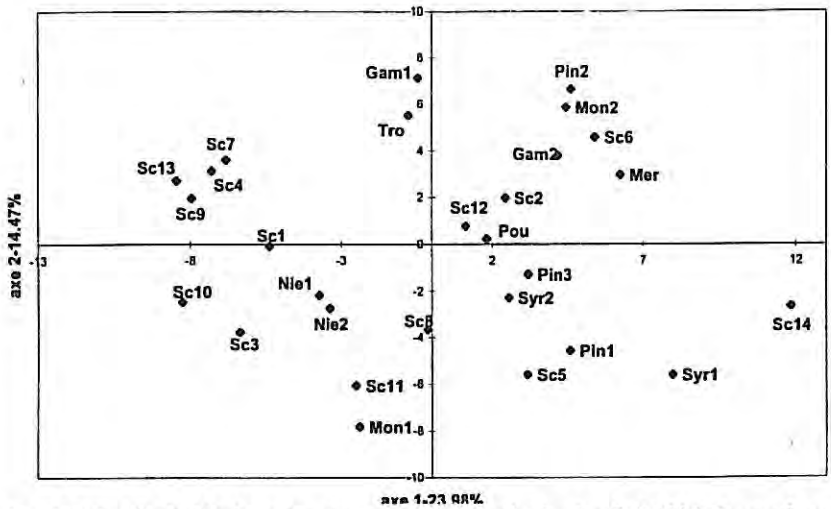

Figure 2 - Projection des vins (individus) sur les composantes principales 1 et 2 de l'ACP pour la modalité orthonasale.

Projection of wines (individuals) on the principal components 1 and 2 of the PCA for orthonasal modality.

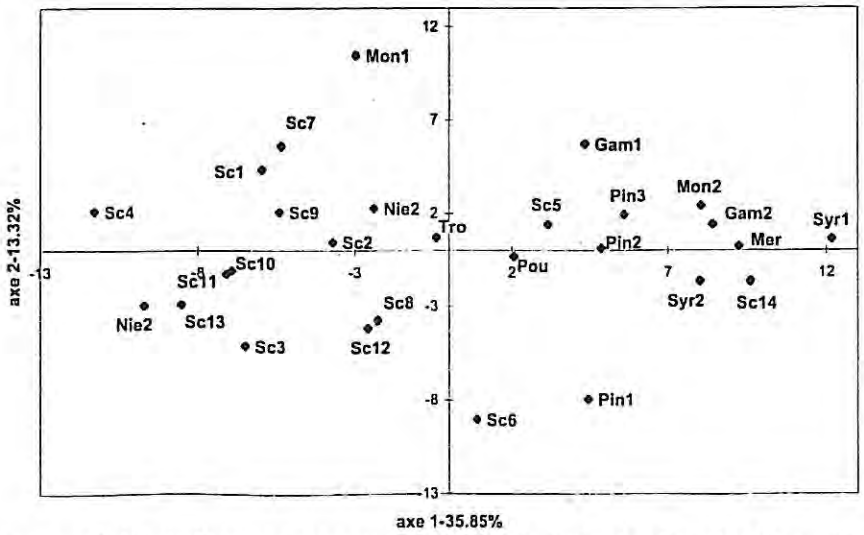

Figure 3 - Projection des vins (individus) sur les composantes principales 1 et 2 de l'ACP pour la modalité globale.

Projection of wines (individuals) on the principal components 1 and 2 of the PCA for overall modality.

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Tableau II - Résultats de l'analyse de variance à deux facteurs pour chaque modalité d'évaluation.
Complete two-factors analysis of variance data for each assessment modality.

	Variation source	Sum of squares	Df	Mean square	F-Ratio	Significance level [a]
Orthonasal evaluation	wine	485,12	26	18,66	2,90	***
	subject	217,27	16	13,58	2,11	**
	Residual	2673,53	416	6,43		
	Total	3375,92	458			
	Variation source	Sum of squares	Df	Mean square	F-Ratio	Significance level [a]
Overall evaluation	wine	965,60	26	37,14	6,89	***
	subject	241,53	16	15,10	2,80	***
	Residual	2242,81	416	5,39		
	Total	3449,94	458			

a Significance level: ** $p < 0.01$; *** $p < 0.001$

Tableau III - Comparaison multiple des moyennes (LSD, $\alpha = 0.05$) relative à chaque modalité d'évaluation.
Multiple comparison procedure (LSD, $\alpha = 0.05$) for each assessment modality.

Orthonasal modality			Overall modality		
Code	Mean scores	Homogeneous groups	Code	Mean scores	Homogeneous groups
Mer	3,10	X	Syr1	1,46	X
Syr1	3,33	XX	Syr2	2,30	XX
Gam2	3,40	XX	Mer	2,37	XX
Pin1	3,50	XXX	Gam2	2,64	XX
Sc6	3,56	XXX	Mon2	2,69	XX
Sc5	3,64	XXX	Pin2	3,06	XX
Pin3	3,88	XXXX	Pin1	3,20	XXX
Mon2	3,93	XXXX	Pin3	3,33	XXX
Pin2	4,04	XXXXX	Pou	3,58	XXXX
Syr2	4,09	XXXXX	Gam1	3,62	XXXXX
Sc2	4,16	XXXXX	Sc5	3,67	XXXXX
Pou	4,28	XXXXXX	Sc6	4,40	XXXXX
Sc12	4,29	XXXXXX	Tro	4,57	XXXXXX
Gam1	4,50	XXXXXXX	Nie1	4,65	XXXXXX
Sc8	4,67	XXXXXXXX	Sc8	4,92	XXXXXX
Mon1	5,01	XXXXXXXX	Sc12	4,96	XXXXXX
Sc11	5,12	XXXXXXX	Mon1	5,16	XXXXX
Tro	5,13	XXXXXXX	Sc9	5,27	XXXX
Nie1	5,21	XXXXXXX	Sc2	5,38	XXXX
Sc1	5,57	XXXXXX	Sc7	5,52	XXXXX
Nie2	5,65	XXXXX	Sc3	5,65	XXXXX
Sc7	5,90	XXXX	Sc11	5,90	XXXXX
Sc3	5,96	XXXX	Sc10	6,01	XXXX
Sc13	6,09	XXX	Sc1	6,09	XXXX
Sc10	6,16	XXX	Sc13	6,17	XXX
Sc9	6,26	XX	Nie2	6,40	XX
Sc4	6,67	X	Sc4	7,03	X

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Tableau IV - Composition des groupes opposés significativement différents.
Composition of the significant opposite groups.

	Orthonasal modality		Overall modality	
	Wrong examples	Accurate examples	Wrong examples	Accurate examples
Sciaccarello	2	6	1	9
Non-Sciaccarello	6	1	10	1

% and 14.5 % explained by PC1 and PC2, respectively. An additional 12.5 % was explained by PC3 (data not shown). In figure 1b, PCA of the overall data accounted for a total of 58.2 % of the variation in the data set using three principal components: PC1 (35.8 %), PC2 (13.3 %) and PC3 (9.1 %; data not shown). In both figures, all variables (judges) were loaded in the negative direction on PC1. As suggested by the angles separating their vectors, the panellists were more related with both the PC1 and each other for the overall than for the orthonasal data. In figure 1a, the PC2 was primarily a contrasting function of the inversely correlated judges J14, J4 and J13. In figure 1b, judge vectors except J4 had low loadings on PC2. In agreement with the higher percentage of variation explained by PC1, the loadings for judge components on PC2 were lower for overall than orthonasal data. The apparent clustering of the judges, concerning especially the overall perception, suggested a factual consensus between panellists. To confirm the relationships among the judges, Kendall's coefficients of concordance (W) were calculated ($W = 0.204$; $W = 0.327$; $p < 0.001$ for orthonasal and overall modalities, respectively). Kendall's coefficients are both significant, but their few values reported dissension within the panel. Nevertheless, there was no reason to eliminate anyone. Consequently, such results justified to conduct further analyses on the mean exemplarity scores. Moreover, the higher Kendall's coefficient related to overall data suggested that powerful consistency between the expert's scores was obtained by more comprehensive sensory evaluation.

Pattern of wine sampling. The position of the 28 wines on these PCA plots provided graphic representations of wines' exemplarity level assessed by orthonasal then overall perceptions (figures 2 and 3). In both figures, the best distribution of the wines was achieved along the PC1 which consistently corresponds to the exemplarity level axis, what might be expected. The correlation coefficients (r) between the mean exemplarity scores given by the seventeen panellists and the co-ordinates of corresponding wines on PC1 were calculated. The correlation coefficients were significant ($r = -0.978$ and -0.992, $p < 0.001$) for orthonasal and overall data, respectively, what means that wines located to the right of the plot were associated with lower exemplarity level, whereas wines located to the left side were characterised by a greater exemplarity level. Such coefficients indicated that the more agreeing responses given by the panel during overall assessment also allowed to emphasise the separation of wines into two opposite groups. For each subject, it seems that the Sciaccarello wine concept would consist of several components of which one, joint to all the subjects, would be rather preponderant so that it appears on PC1.

In figure 2, three wines (Gam1, Tro and Sc8) were centrally located. Among the eleven wines situated to the left of the PC1, eight of them were elaborated from Sciaccarello, and three from Nielluccio or Mondeuse. In contrast, among the fourteen wines located to the right side, nine of them were produced from other grapevines. Furthermore, five Sciaccarello wines, more particularly Sc14 located furthest to the right, were found within this group. In figure 3, only two wines (Tro and Sc6) had an intermediate position. Fourteen wines were located to the left side: eleven of them were produced from Sciaccarello, and the three others (Nie1, Nie2 and Mon1) were those already situated to this side for orthonasal perception. Except Sc5 and Sc14, the additional ten wines located to the right side were produced from other grapevines. Mon1, Sc6 and Pin1 have high co-ordinates on PC2. Their individual scores reflected heterogeneous overall evaluation. Thus, the distribution of wines provided by the PC2 especially revealed the disagreement between panellists.

In both figures, the distribution of samples showed that eight and eleven out of fourteen Sciaccarello wines were located to the left of the PC1, for orthonasal and overall data, respectively. Such results demonstrated that the greater exemplarity levels were preferentially attributed to Sciaccarello wines. Inversely, the opposite exemplarity scores were principally given to the wines produced from Syrah, Merlot, Pinot noir, Gamay and, to a lesser extent, Poulsard varieties. Concerning the two samples from Mondeuse, Mon2 was rather located to the right of the PC1, within wines produced from other grapevines than Sciaccarello, while Mon1 was situated to the left side, close to Sciaccarello space. Moreover, the position of Sc14 disclosed an obvious anomaly. Despite off-flavours, such as horse's sweat and stable, detected during the tasting prior to presentation usually conducted for all the samples, Sc14 was served to keep the consistence of the experimental design. Such a defect was probably due to contamination by Brettanomyces yeasts responsible for the development of phenolic characters in red wines (CHATONNET *et al.*, 1995 ; LICKER *et al.*, 1998). Sc14 was consequently omitted from further data analyses.

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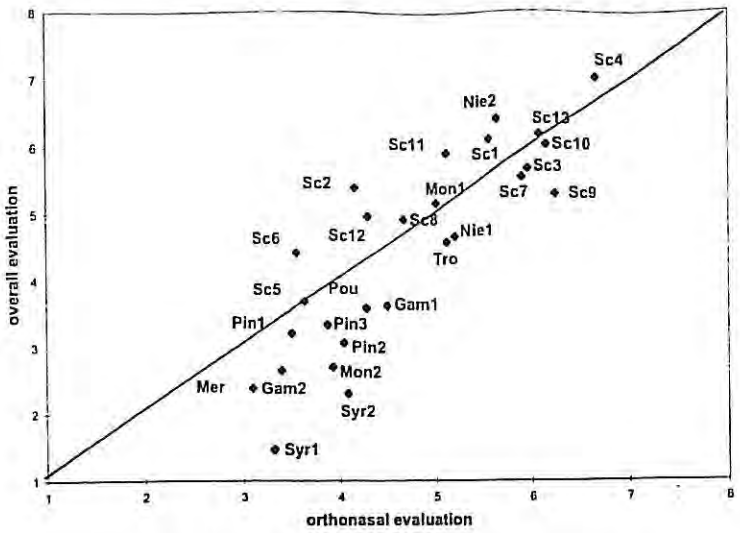

Figure 4 - Corrélation entre les notes moyennes obtenues pour les deux modalités d'évaluation.

Correlation between orthonasal and overall mean scores.

Cleavage between two product-spaces, one consisted of wines mainly elaborated from Sciaccarello and another one composed of wines almost exclusively produced from the other varieties, seems to prove the existence of the sensory space where Sciaccarello wines were predominant. Such a distribution was consistently accentuated when wines were evaluated by overall perception.

Comparison between orthonasal and overall modalities. A two-dimensions representation was plotted to compare mean exemplarity scores related to orthonasal and overall assessments (figure 4). Both modalities were correlated ($r = 0.859$, $p < 0.001$). In detail, twelve out of fourteen non-Sciaccarello wines had lower scores in overall than in orthonasal assessment. As shown in figure 4, most of NSc were therefore located below the bisecting line. The overview is especially notable for the subset composed of ten wines found in the lower plane. For orthonasal and, more particularly, for overall perception, the ten wines were considered as inaccurate examples of Sciaccarello. Actually, overall perception improved the coincidence of the responses and the clustering into two product-spaces because most of non-Sciaccarello wines were also quite recognised as excluded to the concept while the scores attributed to Sciaccarello wines were unchanged. This fact was illustrated by the median of mean scores distributions: for non-Sciaccarello wines, 4.07 and 3.27 from orthonasal and overall evaluations, respectively; for Sciaccarello wines, 5.57 and 5.52 from orthonasal and overall evaluations, respectively. Concerning exclusively the above-mentioned subset of ten lower wines, the median of their mean scores changed from 3.90 (orthonasal) into 2.88 (overall).

Discrimination of wines. The complete ANOVA data are given in table II. Results of two-factors analyses of variance revealed a significant subject effect ($p < 0.01$ and $p < 0.001$ for orthonasal and overall assessments, respectively) on the exemplarity level rating. Subjects used the rating scales differently. Judge variation has been previously reported in the literature (LEE *et al.*, 1999; GIRARD *et al.*, 2001; MARTIN *et al.*, 2002) and was primarily due to scoring differences. Despite the local expert's well-knowledge of Sciaccarello wines, the exemplarity level rating is dependent on individual judgements which could also explain the subject effect. Such subject effect was recently observed by BALLESTER *et al.* (2003a) concerning similar procedure applied to the Chardonnay wine concept.

As suggested by the above-mentioned PCA (figures 2 and 3), ANOVA also revealed the significance of the exemplarity level for characterising differences among the 27 wines (for both assessment modalities, $p < 0.001$).

The subsequent LSD multiple comparison procedures, shown in table III, illustrate a continuum or gradient of mean scores along the rating scale. Such a distribution of the mean scores induced an overlapping of homogeneous groups. Consequently, intermediate wines category (in white in table III), centred on the medians of the complete distributions (4.50 and 4.65 for orthonasal and overall perceptions, respectively) was discarded in order to significantly discriminate two opposite wines categories (in grey in table III). The intermediate category reflected panel difficulties about recognising some wines as obvious examples of Sciaccarello or non-Sciaccarello wines. It was interesting to underline that the middle category was composed of twelve and only six wines for orthonasal and

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overall modalities, respectively. The extent of these intermediate groups therefore advanced in hypothesis of more effective discrimination when wines were subjected to overall than orthonasal evaluation.

In table IV, the composition of opposite categories for each assessment modality is shown. Such results definitively demonstrated that judges succeeded to discriminate furthest wine categories, the higher one mainly consisted in Sciaccarello wines and, the opposite one preferentially composed of non-Sciaccarello wines. The nature and the ratio of the wines underlined the existence of a relevant sensory space where Sciaccarello wines were quite predominant. However, as shown in table III, the mean scores attributed to Nielluccio wines, especially Nie2, gave an indication on their sensory profile which may be confused with those of Sciaccarello ones. Nielluccio grapevine was frequently introduced in blending with Sciaccarello what probably encouraged judges to include one of the Nielluccio wines among Sciaccarello sensory space. In contrast, the Sciaccarello ratio (from 60 to 100 %) in blending was never correlated with the mean exemplarity scores.

CONCLUSION

This study laid the foundations for demonstrating the existence of a sensory space in which one predictive category of wines, chosen on viticultural and/or enological criteria, was rather regrouped. In the context of this study, wines elaborated from Sciaccarello were presented among other wines produced from non-Sciaccarello varieties. The sensory methodology was successfully developed for this work to delimit the sensory space where most of Sciaccarello wines were pooled. The results definitively confirmed the existence of Sciaccarello wine concept. They accredit subsequent analyses such as odour and aroma profiling, GC-O analysis and, finally, identification of odour-active compounds by GC-MS. This study therefore constituted only a preliminary investigation. Further work related to several Sciaccarello wines representative of the concept is required before any definitive conclusions can be formulated.

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