10.7251/AGSY1303338A

USE OF VARIOUS YEAST STRAINS TO IMPROVE THE AROMATIC PROFILE OF CHARDONNAY WINES

Oana Arina ANTOCE*, Ioan NAMOLOSANU

University of Agronomical Sciences and Veterinary Medicine of Bucharest, Bucharest, Romania
*(Corresponding author: aantoce@yahoo.com)

Abstract

Chardonnay is a versatile variety which can lead to various styles of wines. Several yeasts are available in the market for the production of varietal wines, some of them designed especially for the fermentation of this cultivar. However, one of the nowadays trends is to produce new styles of wine, in order to attract new consumers. Chardonnay must from Murfatlar vineyard, 2012 vintage, was fermented with 9 commercially available yeasts, among which some recommended for other grape cultivars than Chardonnay. Control wines obtained based on spontaneous fermentations were also produced. Sensory analysis was performed on the resulted wines, by using the standardized methodology of aromatic profiling with a human panel. In parallel, a dual column GC electronic nose was also used to compare and discriminate among the aromatic profiles of wines. Based on the examination of the aromatic profiles given by the human panel and the volatile profiles discriminations achieved by the electronic nose, it was concluded that some of the yeasts did induce important changes in the wine aroma, but the aromatic characteristics of the cultivar are not completely masked by any of the yeasts used. In accordance, it was possible to obtain a consensus profile of the Chardonnay wines of Murfatlar vineyard, irrespective of the yeast strain used.

Keywords: wine, aromatic profile, sensory analysis, electronic nose

Introduction

In accordance to DNA analysis the Chardonnay cultivar of *Vitis vinifera* ssp. *sativa* resulted from the crossing of Pinot noir and an ancient variety native to Balcan peninsula, Gouais Blanc (Harriet *et al.*, 2009). The first one has its origin directly in a wild vine (*Vitis vinifera* ssp. *sylvestris*) (Jackson, 2009), while Gouais Blanc or Heunisch Weiss, a variety yielding poor quality wine (Hunt *et al.*, 2009), was initially cultivated in Eastern Europe under the name of *Belina Drobna* or *Štajerska Belina* on plots of land considered not suitable for noble vine varieties. During Middle Ages, the Gouais Blanc was brought in Eastern France, where it spread in the same territory where Pinot noir was cultivated, making therefore possible the crossing between the cultivars (Bowers *et al.* 1999). The resulted Chardonnay became, in time, one of the most popular grape varieties in the world.

Although in Romania the surfaces with Chardonnay are under 2000 ha (Antoce *et al.*, 2013), in the world Chardonnay occupies a surface of around 175000 ha (Boubals, 1990) and is made in various style of wines, from still wines to sparkling wines, from fruity to creamy and buttery wines, matured or not in the presence of oak (barrels or alternatives).

In some regions Chardonnay got his fame for a certain style, making the job of selection and wine recognition a bit easier by the consumer, who is able to identify the most typical wines of Chablis, Bourgogne, Argentina, Chile, South Africa, Australia or California made out of this variety. However, in recent times, there is a tendency towards innovation,

including in Chardonnay, especially since some consumers got tired of a certain style, leading in the ‘90s even to a movement called ABC, “Anything But Chardonnay”, as a reaction mostly towards the oaked wines.

As a result, the modulation of Chardonnay aroma by fermentation with selected yeasts was attempted by many oenologists, while the producers started to market several strains of yeasts dedicated especially to the production of Chardonnay wine.

The classical buttery note of the typical Chardonnay dominates only in wines which have undergone malolactic fermentation after alcoholic fermentation (due to the formation of diacetyl from citric acid), but it is also present in young wines obtained without this second fermentation. Of course, the malolactic fermentation generates a number of other volatile or non-volatile aromatic compounds (van Vuuren and Dicks, 1993), which makes it desirable for this particular white variety, but in this paper we deal only with the differences induced by the alcoholic fermentation with several yeast strains.

The fruity and floral aroma of a wine is mainly due to the terpenic aroma from grapes and esters produced during alcoholic fermentation, therefore the yeast strain and fermentation temperature play a decisive role in the aromatic profile of a wine, sometimes contradicting the influences of the variety and region/terroir.

In this paper, 9 strains of yeast were used to ferment Chardonnay must and the resulted wines were compared by a panel of winetasters and by a gas chromatograph working on the principle of the electronic nose. The wines were evaluated while young, without any oak flavouring from barrel aging or chips usage, thus focusing on the modulation of Chardonnay aroma by yeast selection.

Materials and methods

Winemaking and Yeasts:

During 2012 vintage (harvest day was September 14th) Chardonnay must from from Murfatlar vineyard, Romania, was fermented with 9 commercially available yeasts, among which some recommended for other grape cultivars than Chardonnay. The wine was obtained in batches of 4 liters each (in triplicate), following a traditional technology for white wines, with skin separation and cold clarification for 48 h before yeast inoculation.

For the alcoholic fermentation the wines were inoculated with 10 g/hl re-hydrated dry yeasts provided by Enologica Vason and Lallemand. The strains were as follows:

Premium Chardonnay: this is a *Saccharomyces cerevisiae* strain, recommened for the production of fine white wines, producing phenylethanol, enhancing floral aroma, but preserving the grape/vineyard aromatic profile;

Premium Blanc 12 V: it is a *Saccharomyces cerevisiae* strain, but with killer phenotype and fast growth, ensuring its rapid prevalence against the wild yeasts. It has *β*-gycosidic enzymes, contributing to an increase of the normal aroma of the grape variety, by splitting the gycoside bonds of glucose combined volatile substances, especially of the terpenic ones (technical sheet, www.vason.com);

Epernay 2: a *Saccharomyces cerevisiae* strain, with low production of unwanted metabolites (acetic acid, acetaldehyde, pyruvic acid, superior alcohols), but able to enhance the various aromatic characteristics of the original must, producing fresher and fruitier wines;

NT116 Anchor: this is an yeast with killer positive phenotype, a *Saccharomyces cerevisiae hybrid*, combining the aromatic potential of a *Saccharomyces cerevisiae* subspecies *cerevisiae* with the fast fermentation capabilities of *Saccharomyces cerevisiae* subspecies *bayanus*. It is not produced by GMO processes, but through a yeast hybridization process, which is a natural method of breeding (van Rensburg P., 2005). Is recommended for the production of fresh and fruity wines, for early release on the market. The producers indicate that “it enhances volatile

thiol aromas (passion fruit, grapefruit and guava) and produces acetate esters (tropical fruit salad). It specifically enhances the citrus aromas in wines". This yeast is recommended for the winemaking of varieties such as Chardonnay, Chenin blanc, Sauvignon blanc and Pinot gris.
NT202 Anchor: a *Saccharomyces cerevisiae hybrid* strain, recommended for fruity red wines, highly tolerant to ethanol and compatible with malolactic fermentation.
Vin 13: is a an yeast with killer positive phenotype, *Saccharomyces cerevisiae hybrid* strain, from South Africa, designed to enhance the floral and tropical fruits aroma of white wines, suitable for white wines aging and compatible with malolactic fermentation.
Premium Sauvignon (PremSauvig): a *Saccharomyces cerevisiae* strain, producing complex and elegant white wines, especially from aromatic varieties, enhanching the original aroma of the grapes, with an intensification of the floral notes
Lalvin QA23: it is a an yeast with killer positive phenotype classified as a *Saccharomyces cerevisiae bayanus* selected from Portugal, being recommended for the fermentation of Chardonnay, Sauvignon blanc, Chenin blanc, Colombard and Semillon in which it produces fresh, fruity, clean aroma. The yeast has good ethanol tolerance (14%). It is intended to enhance aromas of terpenic cultivars through its *β*-glucosydic activity, but it is also an excellent thiol converter, recommended as a complementary yeast for developing passion fruit character in Sauvignon blanc wines.
Bayanus PC: a *Saccharomyces bayanus* strain, dominant in relation with other yeasts, resistant to external adverse factors such as pH, alcohol, SO_2, conferring a specific volatile profile.

E-nose and Sensory profiles

An electronic nose based on dual-column flash gas-chromatography, named Heracles, from the Alpha MOS company, was used to differentiate and group the variants based on their volatile profiles (Antoce and Namolosanu, 2011). The analytical method applied is developed in our laboratory (Antoce and Namolosanu, 2009; Antoce *et al.*, 2010; Antoce and Namolosanu, 2011) and uses the following parameters: incubation temperature 60°C, incubation time 600 s, injector temperature 200°C, detector temperature 220°C, measurement time 20 s, trap temperature: initial 40°C and 250°C at desorption, preheating trap time 20 s, baking time 60 s, pre-purging time 5 s. The sampling program of the gas chromatograph starts at a temperature of 40°C maintained for 2 s and raised by 5°C/s up to 200°C where it is also maintained for 5 s, then cooled down. The data acquisition time per sample is 40 s. The volatiles of wines are injected into the GC column by headspace sampling, using a HS 100 autosampler and a syringe of 2500 µl, which allows accurate sampling. The data recorded from the two chromatographic columns were processed with the Alpha Soft V11 software for statistical analysis provided by Alpha-MOS with the apparatus. By using the multivariate analysis the accurate differentiation of the samples based on their volatile profile is possible.
Sensory analysis was also performed on all wine variants, using a panel of 15 trained judges recruited from among the master students of University of Agronomical Sciences and Veterinary Medicine of Bucharest majoring in wine technologies, having experience in wine sensory analysis. Each judge evaluated the samples in OIV approved wine glasses containing 20 ml of wine, in random order. The evaluations were performed at 20°C in the time interval from 10:00 to 12:00.
The panelists evaluated the wines focusing mainly on their volatile profile characteristics, using a specially designed score sheet and methodology (Antoce and Namolosanu, 2007). The attributes to choose from were provided to the tasters under the form of a list, and scores were awarded on intensity scales from 1(minimum) to 9 (maximum) (Muratore *et al*., 2007).

The set of attributes provided for the evaluation included 21 aroma attributes, as follows: temperate climate fruits (apple, pear, peach, apricot, melon), tropical climate fruits (banana, pineapple, mango/ guava), citrus fruits (lemon, grapefruit, orange), sweet-floral aroma (accacia, hawthorn, honey), nutty aroma (hazelnut, almonds, nuts), lactic aroma (butter, cheese), other aroma (ethyl acetate, mineral). Out of the 21 descriptors, the most common 10, which were marked by most of the tasters, were retained to obtained a consensus-like Chardonnay profile. This is not a true consensus profile, as ours does not come from discussions among members who individually evaluated the wines and then agreed upon a single score for a certain descriptor, but it is an average value of the intensity scores awarded by all the members for the most cited 10 attributes. The data were graphically represented by making use of spider web diagrams.

Results and discussion

The sensory evaluation of the Chardonnay wines produced with the nine yeasts are presented in Fig. 1 (a-d groups) , as spider web diagrams. The aromatic profiles obtained for the wines show that they tend to fall in 3 distinct groups, depending on their perceived aromatic characteristics. We defined the following groups:
the *Saccharomyces cerevisiae cerevisiae* group: Premium Chardonnay, Premium Blanc 12 V and Epernay 2;
the *Saccharomyces cerevisiae hybrids* group: NT116 Anchor, NT202 Anchor and Vin 13;
the *Saccharomyces cerevisiae bayanus* group: Lalvin QA23 and Bayanus PC;
plus the *Saccharomyces cerevisiae* strain Premium Sauvignon designed to introduce a certain complexity in wines other than Chardonnay.
The “*cerevisiae* group” leads to wines with high minerality, aromatic notes of fruits from temperate regions and citrus fruits; the “hybrids group” provides for wines with enhanced tropical fruits aroma and citrus fruits, while the “*bayanus* group” leads to wines with nutty and floral-fruity aroma. The Premium Sauvignon yeast, although it is a *cerevisiae* yeast, being selected for other style of wines and for the production of other volatile compounds or lyses of other type of aroma precursors than those of Chardonnay, produces wines with an aromatic profile closer to those of the “*bayanus* group”.
The same grouping of aromatic profiles is confirmed by the electronic nose both by PCA analysis (Fig 2.a) and DFA analysis (Fig 2.b,c and d). Wines fermented with Premium sauvignon were classified into the group of *bayanus*, due to the complete different aroma profile than that induced by *cerevisiae* yeasts.
In order to appreciate the odour distances of the wines obtained with other yeasts than the classical Premium Chardonnay, considered here as the control wine, in Fig. 3 we included diagrams for two statistical analyses called SIMCA (Soft Independent Modelling of Class Analogy) and SQC (Statistical Quality Control). Fig. 3 shows that the most different volatile profiles from the classical one obtained by fermentation with Premium Chardonnay yeast are found in the groups obtained with Bayanus PC and QA23 (bayanus group) followed by NT202 (hybrid) and Premium Sauvignon strain (cerevisiae)both atypical for Chardonnay wines.

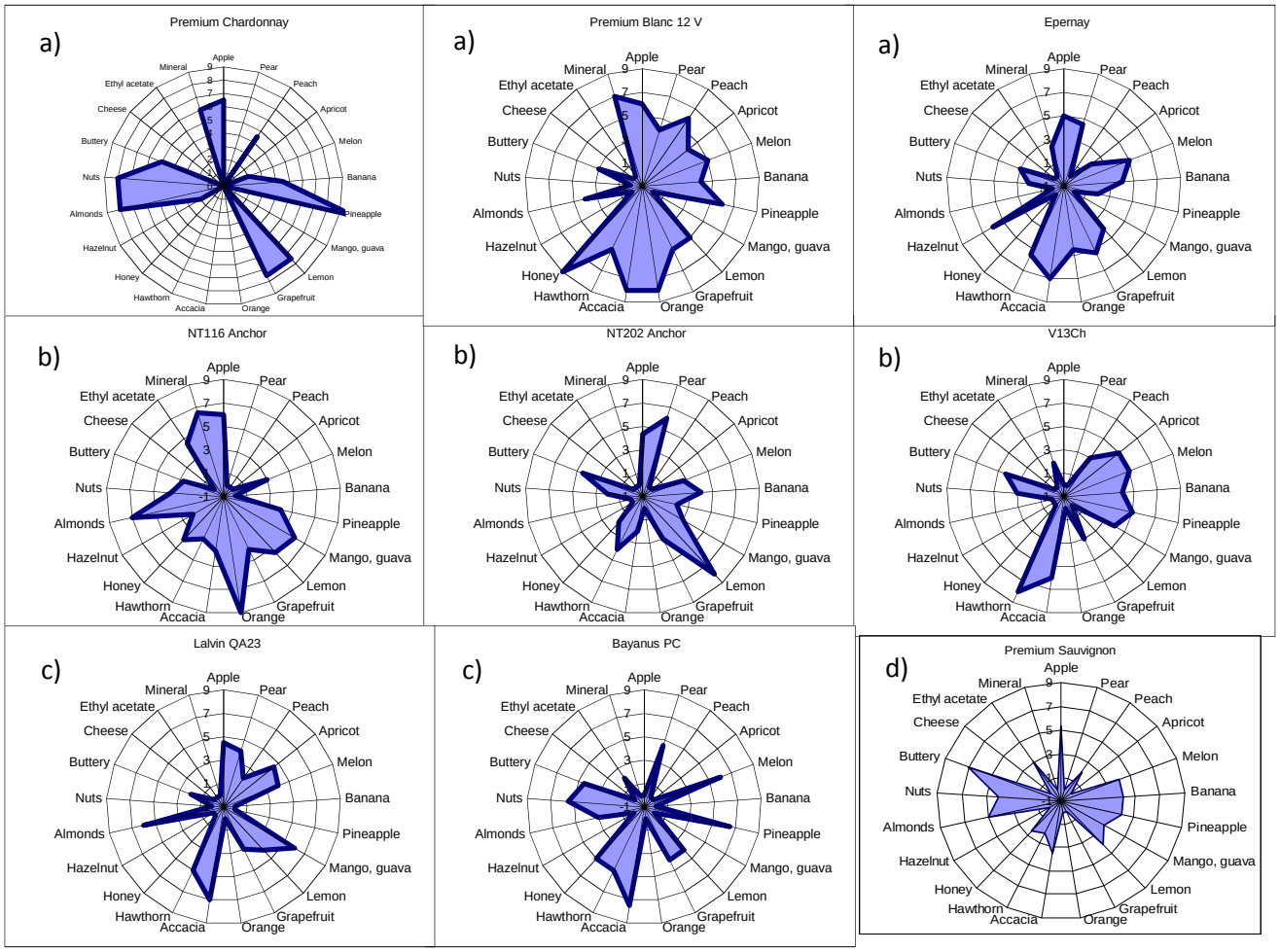

Fig. 1. The sensory profile of the Chardonnay wines fermented with different selected yeasts: a) *cerevisiae* group (Premium Chardonnay, Premium Blanc 12 V and Epernay 2); b) *hybrids* group (NT116 Anchor, NT202 Anchor and Vin 13); c) *bayanus* group (Lalvin QA23 and Bayanus PC) and d) *Saccharomyces cerevisiae* strain Premium Sauvignon

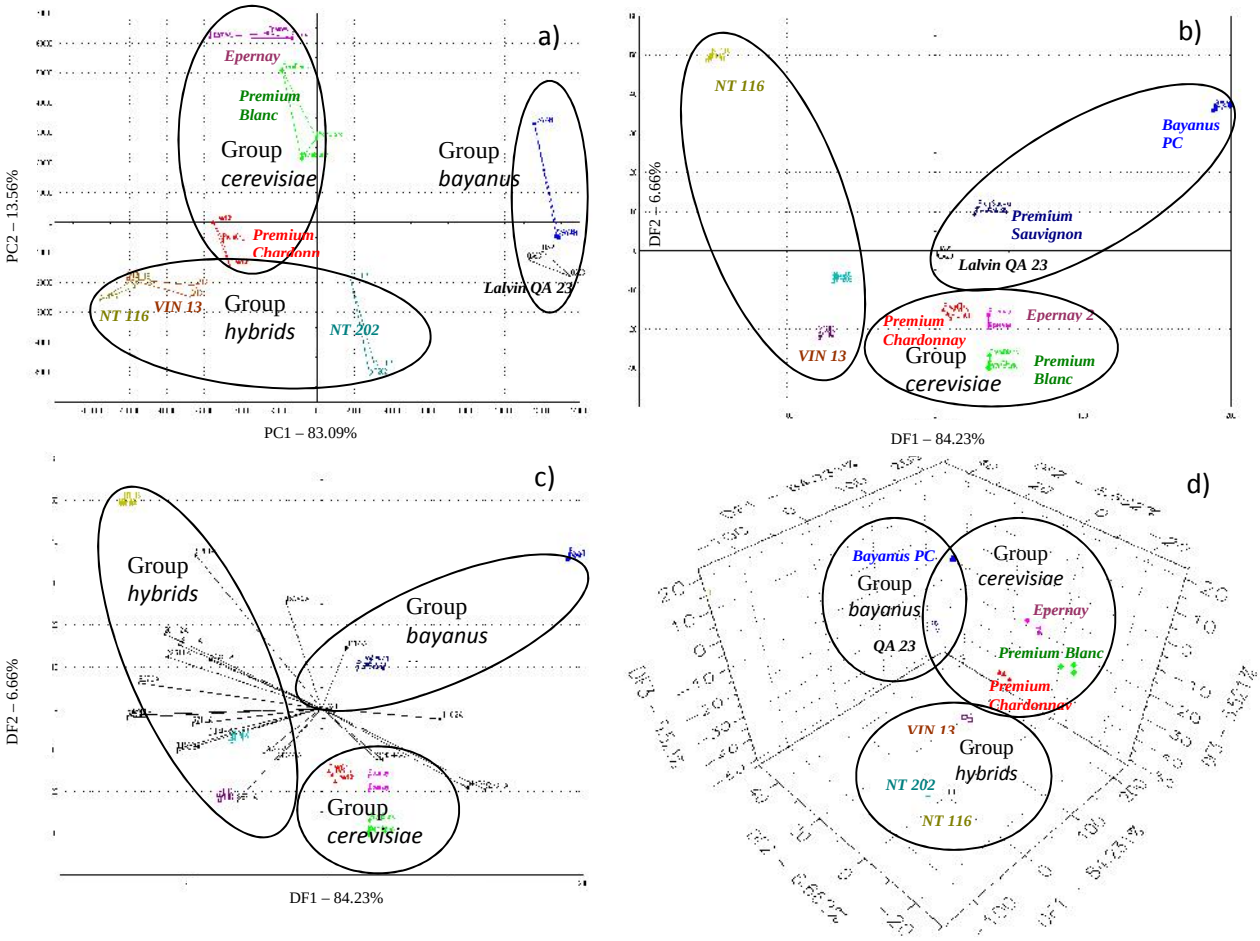

Fig. 2. Classification of Chardonnay wines in accordance to their volatile profile: a) PCA diagram; b) DFA diagram; c) DFA diagram loadings; d) 3-D DFA diagram

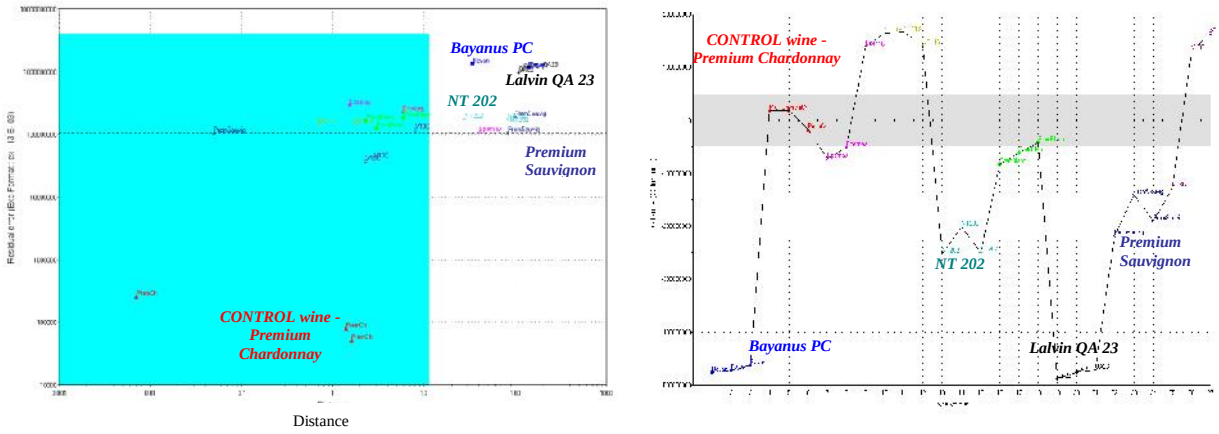

Fig. 3. SIMCA (a) and SQC (b) diagrams showing the distances of the groups of wines from the control wines produced with Premium Chardonnay yeast strain

Based on both sensory analyses and the confirmation of the classification into groups with similar aroma we were able to establish 3 styles of wines possible to obtain by modulation of the aroma with specific yeast strains. However, in all the wines there are common traits that should also be emphasized. To do this, we proceeded to the reduction of the number of descriptors for the wines and we retained the 10 main attributes that ranked highest during winetasting. The resulted reduced sensory profiles of the Chardonnay wines fermented with different selected yeasts are all included in diagram Fig. 4a, which shows us that the differences among wine profiles were very much reduced, too. By averaging all the scores for these main attributes we can obtain a consensus-like profile of Chardonnay (Fig. 4b) which shows that the main traits of imposed by the terroir on the wine profile are still present in all the produced wines, irrespective of the style induced by the yeast. Thus, we can conclude that the aroma of Chardonnay can be modulated by certain yeast strains, but even so, the characteristics of the Chardonnay cultivar are still recognizable by the tasters.

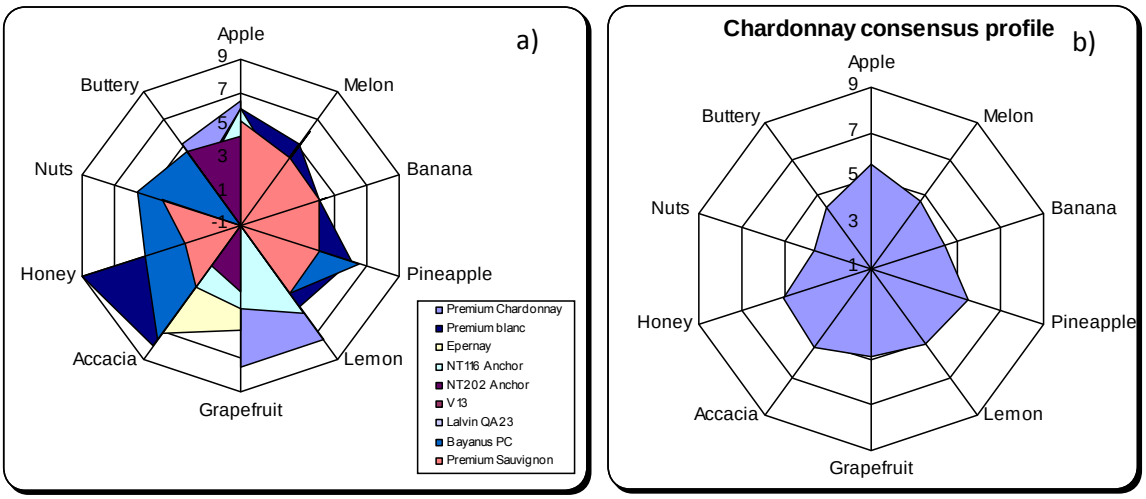

Fig. 4. The reduced profile for the Chardonnay wines (a) and the consensus sensory profile for all the wines, irrespective of the selected yeas used for fermentation (b)

Conclusions

The paper evaluates the sensory impact of the yeast strain on the style of Chardonnay wine possible to be obtained in the same terroir. Although the main Chardonnay profile imposed by the origin of grapes was still recognisable in all wines, a modulation of aroma was observed, induced by the fermentation with a certain yeast. We identified 3 main groups of yeasts, which affected the aroma of the wines and lead to obtaining 3 styles of Chardonnay wine. The Chardonnay wines with temperate fruits aroma and citrus were obtained by the fermentation with *Saccharomyces cerevisiae cerevisiae* yeasts; the Chardonnay with tropical fruits aroma and citrus can be produced by fermenting the must with *Saccharomyces cerevisiae hybrid* yeasts, and Chardonnay wines with nutty and floral aroma resulted from the fermentation with *Saccharomyces cerevisiae bayanus* yeasts. These groups of wines were derived by sensory analysis and then confirmed by the results of multivariate analysis performed on the volatile profiles of the wines, obtained with an electronic nose.

References

Antoce O. A., Năməloşanu I., Duşa D., Mereanu D., Rebigan C., Nicolau V., Călugăru L., 2013, “Some considerations regarding the grapevine variety assortment and wine categories in Romania in recent years”, *Bulletin de l’OIV*, vol. 86, ian-feb-mar 2013, No. 983-984-985, ISSN 0029-7127.

Antoce O. A., Năməloşanu I., Peltea E., 2010, “The flavouring of Feteasca neagra wines with oak chips and tannin and its influence on the colour and sensory parameters of young wines”, *Lucrări ştiinţifice U.Ş.A.M.V.B.*, Seria B, **vol. LIV**, 2010, Section Viticulture & Oenology, pp. 494-499.

Antoce, A. O. and Năməloşanu, C. I., 2007, “Methodology for a sensory profile used to define and evaluate wine tipicality”, Published in Official Bulletin for industrial property BOPI 6/2007, Romanian Patent No. 123129 issued on 30.11.2010.

Antoce, A. O. and Năməloşanu, C. I., 2009, “Differentiation of Feteasca Neagra wines from various agro-ecosystems by the use of an electronic nose”, XXXIX Annual Meeting of the European Society for New Methods in Agricultural Society, Book of Abstracts, p. 79, ISBN 978-80-7375-319-1.

Antoce, A. O. and Năməloşanu, C. I., 2011, “Rapid and precise discrimination of wines by means of an electronic nose based on gas-chromatography”, Revista de Chimie, Vol. 62, No. 6, p. 593-595.

Boubals D., 1990, “The success of Chardonnay throughout the world: an example to reflect on”, presentation for IIe Colloque Professionnel des Vins de Bourgogne, January 31st, 1990 –NOLAY and Revue des Œnologues n°65s - Le Progrès Agricole et Viticole n° 4.

Bowers, J.E., Boursiquot, J.-M., This, P., Chu, K., Johansson, H. and Meredith, C.P., 1999, “Historical genetics: the parentage of ‘Chardonnay’, Gamay, and other wine grapes of Northeastern France”, Science, Vol 285, p. 1562-1565.

http://www.vason.com/eng/prodotti.php?sector=vason&cat=10&product=146, Premium blanc yeast, Technical Sheet, Enologica Vason,retrieved on July 10th, 2012.

Hunt H., C. Lawes M., Bower M., Haeger J. and Howe C, 2009, “A banned variety was the mother of several major wine grapes”, *Biology Letters*, Published online before print 16 December 2009 doi: 10.1098/rsbl.2009.0810 Biol. Lett. rsbl20090810.

Jackson, R. S. 2009, Wine Science: Principles and Applications, Academic Press, Amsterdam.

Muratore G., Asmundo C.N., Lanza C.M., Caggia C., Licciardello F. and Restuccia C, 2007, “Influence of *S. uvarum* on Properties of Malvasia Wine”, *Food Technol. Biotechnol.* 45 (1) 101–106.

Van Rensburg P., 2005, “Hybrid wine yeasts, offering the winemaker a unique fermentation tool”, The Australian & New Zealand Grapegrower & Winemaker, p. 56-60, http://www.anchorwineyeast.com/pdf/Natural_Hybrid_Article.pdf

Van Vuuren H.J, Dicks L., 1993, “Leuconostoc oenos: a review”, *Am J Enol Vitic*, Vol. 44, p. 99–112.