hnical session #4: Ballroom 4

: David Peterson, Cornell University
c Extension

A disease forecasting system for grape
dew in Ohio. Michael A. Ellis and L.
1. Department of Plant Pathology,
Ohio State University, Wooster, OH

IPM for grape insect pests in Ohio.
liams, Dan Fickle, and Sean Ellis.
t of Entomology, OARDC, Ohio State
Wooster, OH 44691.

Developing an integrated disease
nt program for grapes in the Eastern
es. Michael A. Ellis. Department of
logy, OARDC, Ohio State University,
H 44691. **(40-minute presentation).**

ASEV/ES ANNUAL BUSINESS

- 1:30 pm: LUNCH - "ON YOUR

nical session #5: Ballroom 4

Daniel Carroll, North Carolina State

Survival of *Escherichia coli* O157:H7
ce and wine. D. F. Splittstoesser and J.
Department of Food Science and
, Cornell University, New York State
al Experiment Station, Geneva, NY

nteractions between glucose, fructose
ate utilization by *Leuconostoc oenos.*
Arnink and Thomas Henick-Kling.
t of Food Science and Technology,
iversity, New York State Agricultural
Station, Geneva, NY 14456.

——Start of Student Paper Competition——

2:10 pm: Synthesis and utilization of diacetyl in wine: Kinetics and interaction between yeast and malolactic bacteria. Brigitte Martineau and Thomas Henick-Kling. Department of Food Science and Technology, Cornell University, New York State Agricultural Experiment Station, Geneva, NY 14456.

2:30 pm: Effect of sulfur dioxide and yeast starter culture on chemical composition and sensory quality of Chardonnay wines. Aurea Carrasco, John Barnard, Robert Pool and Thomas Henick-Kling. Department of Food Science and Technology, Cornell University, New York State Agricultural Experiment Station, Geneva, NY 14456.

2:50 - 3:20 pm: Break - Ballroom hallway

Technical session #6: Ballroom 4

Moderator: Christine Bartley, Fresh Express Mid-Atlantic

3:20 pm: Somatic embryogenesis from nucellar tissue for the elimination of viruses from grapevines. Richard K. Schaefers, R. M. Pool and D. Gonsalves. Department of Horticultural Sciences, Cornell University, New York State Agricultural Experiment Station, Geneva, NY 14456.

3:40 pm: Influence of canopy configuration on shoot growth, morphology, and hardiness of Seyval grapevines. Russell P. Smithyman and G. S. Howell. Horticulture Department, Michigan State University, East Lansing, MI 48923.

4:00 pm: Impact of varying numbers of vegetative sinks on canopy development and morphology of Chambourcin grapevines. David P. Miller and G. S. Howell. Department of Horticulture, Michigan State University, East Lansing, MI 48923.

—— End of Student Paper Competition ——

5:00 pm - 6:00 pm: Sparkling wine reception: Ballroom 1 (Name tags required)

6:00 pm - 9:00 pm: Banquet: Ballrooms 3 and 4 (Tickets required)

9:00 pm - 12:00 am: Wine social: Ballroom 1 (Name tags required)

SATURDAY, JULY 16, 1994

8:30 am: Executive Committee "Post-Mortem" meeting: Erie room

9:00 am: Tour of Northeastern Ohio vineyards and wineries (Tickets required)

LIST OF POSTER TITLES (Posters on display in exhibit area)

1. Influence of must oxidation on Chardonel sparkling wine quality. Al Marks, Justin Morris, and Gary Main. Department of Food Science, University of Arkansas, Fayetteville, AR 72703.
2. Further studies on yeast inhibition in grape juice containing sulfur dioxide, sorbic acid, and dimethyldicarbonate. Renee Terrell and Justin Morris. Department of Food Science, University of Arkansas, Fayetteville, AR 72703.
3. Color of Seyval Blanc juice and wine as affected by juice fining and bentonite fining during fermentation. Gary Main and Justin Morris. Department of Food Science, University of Arkansas, Fayetteville, AR 72703.

AMERICAN SOCIETY FOR ENOLOGY AND VITICULTURE

EASTERN SECTION

NINETEENTH ANNUAL MEETING and PINOT GRIS / PINOT BLANC SYMPOSIUM

13 - 16 July 1994

Middleburg Heights Holiday Inn
Cleveland, Ohio

GENERAL PROGRAM

2nd ANNOUNCEMENT

Pinot Gris/Pinot Blanc Symposium

13-14 July 1994

in conjunction with
The 19th Annual Meeting of the Eastern Section of the
American Society for Enology and Viticulture
14-15 July, 1994, Holiday Inn, Middleburg Heights (Cleveland), Ohio

- date: Wednesday, July 13, 8:30 am - 5:30 pm
  Thursday, July 14, 8:00 am - noon
- location: Holiday Inn, Middleburg Heights/Cleveland
  7230 Engle Rd, Middleburg Heights, OH 44310
- program focus: 1½ days of a comprehensive update of all aspects of Pinot Gris/Pinot Blanc including the origin of the cultivars, clonal selection, in-depth discussion of viticultural and winemaking techniques, consideration of viticultural limitations (cold hardiness, fruit maturation), wine styles as affected by the growing conditions (terroir, flavor profile during ripening) and winemaking options, presentation of the major Pinot Gris/Pinot Blanc growing areas in the world, traditional and niche marketing - presented by a panel of internationally renowned experts accompanied by extensive tastings and discussions.
- speakers: **Dr. Rudolf Ries,** Department of Vine Breeding and Grafting, Federal Research Station Geisenheim, Germany.
  Prof. Dr. Alex Schaeffer, Director of the Research Station for Enology and Viticulture INRA, Colmar, France.
  Armin Sütterlin, Director of Production, Badischer Winzerkeller, Breisach am Rhein, Germany.
  Prof. Dr. Giuseppe Versini, Head of Enology, Chemistry Section for Analysis and Research, San Michele all'Adige, Italy.
  Prof. Dr. Dave Ferree, Associate Chair, Department of Horticulture, OARDC, Ohio State University, Wooster, Ohio.
  Dan Kleck, Winemaker Palmer Vineyards, Aquebogue, NY.
  Dr. Andrew Reynolds, Research Scientist Viticulture and Enology, Agriculture Canada, Summerland, Canada.
  Dr. Roland Riesen, Research and Extension Enologist, Dept. of Horticulture, OARDC, Ohio State University, Wooster, Ohio.
  Barney Watson, Senior Instructor and Enology Extension Specialist, Dept. of Food Science, Oregon State University, Oregon

- registration: $ 100.-

  The registration fee includes:

  Tastings: Each presentation is accompanied by an extensive tasting and discussion of representative wines.

  Lunch: "International Tribute to Pinot Gris/Pinot Blanc"

  A Creative Match of the Local Cuisine with the best Pinot Gris/Pinot Blanc.
  With: Panel discussion with experts in Viticulture and Enology and the Chef.
  Wednesday, July 13, noon - 2 pm.

  Reception: "Ohio Wine in a G(C)lass by itself"
  Reception by the Ohio Wine Producers Association
  Wednesday, July 13, 7:00 - 9:00 pm.

- tours: "Northeast Ohio"

  A guided tour of Northeast Ohio vineyards and wineries is offered in cooperation with the Ohio Agricultural Research and Development Center/Ohio State University and the Ohio Wine Producers Association

  date: Saturday, July 15, 8:00 am - 5:00 pm.
  fee: $ 25.- , includes transportation and lunch.

- information: For registration information please contact:
  Don Splittstoesser, NYSAES, Cornell University,
  Geneva, NY 14456-0462, ph: 315-787 2275, fax: 315-787 2397.
  For program information please contact:
  Roland Riesen, OARDC, Department of Horticulture,
  Wooster, OH 44691, ph: 216-263 3814, fax: 216-263 3685.

- **deadline:** **Seating is limited to 75 participants!**
  The registrations will be accepted in the order they are received

  REGISTER EARLY!

THE OHIO STATE UNIVERSITY
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AMERICAN SOCIETY FOR ENOLOGY AND VITICULTURE, EASTERN SECTION
19TH ANNUAL MEETING AND PINOT GRIS/PINOT BLANC SYMPOSIUM
13 - 16 JULY 1994, CLEVELAND, OHIO

INVESTIGATION OF ANALYTICAL PARAMETERS CHARACTERIZING PINOT BLANC AND PINOT GRIS MUSTS AND WINES, AND COMPARED TO OTHER NON-FLORAL VARIETIES

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Abstract

The vine variety diffusion and wine production in Italy for Pinot Blanc and Pinot Gris and the main component variation in the grapes in comparison to the Chardonnay, as well as short considerations about winemaking technology and the most frequent colour and aroma descriptors, are preliminarly presented.

After a first comparison between amino acid and primary aroma contents of Italian Pinot Blanc and Chardonnay musts, volatiles (free varietal, prefermentative and fermentative compounds) and varietal-bound compounds - which could possibly characterize Italian and German wines - were investigated and submitted to univariate and multivariate data treatments. Both national wines were separated rather on the basis of the production winery than of the variety. This winery influence can determine also interesting sensorial effects.

As for the free compounds considered, almost the same choice of discriminant variables was considered for both countries . Among the bound forms more different variables, including α-terpineol and dihydroxylated derivatives of linalool, geraniol and α-terpineol, as well as aromatic compounds, were useful for variety discrimination.

A peculiar district effect on Pinot Blanc wines was observed among the German wines, for which the grape ripeness degree seems to influence markedly the level of vinylphenols giving an important sensorial contribution.

Bound compound profiles in Italian and German wines are similar, but with a noticeably higher level of many compounds in German wines.

1. Introduction

1.1 Preliminary considerations

1.1.1 Vine variety diffusion and wine production in Italy

Pinot Blanc and Pinot Gris represent together with Chardonnay the most widespread non-autochthonous grapes for obtaining white wines in a wide part of Northern Italy. As for this area and the vintage 1991, the relevant quantities for wines with Origin

Appellation (DOC) and variety name declaration on the bottle label, are shown in Table 1. Pinot Gris is prevailing on Pinot Blanc and on Chardonnay in most districts, except in Trentino-Alto Adige, where Chardonnay is dominant. Furthermore, inside this district, the northern part called Alto-Adige or South Tyrol, presents traditionally a dominance of Pinot Blanc or Weißburgunder, while the southern part or Trentino shows a remarkable production of Chardonnay, in this respect being that of Pinot Blanc less than one tenth. For the same district, the evolution of grape production from these varieties with reference to the total production and to that of white grapes respectively, is presented in Table 2.

The first importer of Pinots in Italy should have been the general Emilio di Sambuy in the first half of the 19th century, who brought vines from Burgundy to a small town in Piedmont, from where they spread in Northern Italy (Pittaro and Plozner, 1982).

Both quoted Pinots - probably coming directly from the German areas - were planted in the South Tyrol district in the second half of the 19th century and mostly located in peculiar pedoclimatic areas (Mach, 1894). Up to about 20 years ago, as it can be seen in Table 2, Pinot Blanc and Chardonnay were registered together in the land-register of this region as Pinots, even if well distinguished by the winegrowers on the basis of the green and yellow colour of the grape, respectively, and were correctly classified since then according with the requirements of the Origin Appellation rules.

In Table 3, we present the Italian situation of the grafted vines production for the last four years and the mentioned varieties compared to the total production. An evolution tendency with generally a maximum between 90/91 and 91/92 vintages is shown; the Pinot Blanc variety is less planted (about one tenth of Chardonnay) and less selected (ratio between certified and standard vines).

1.1.2 Main component variation in the grape

More systematic results are available for Pinot Blanc and Chardonnay - the most important varieties in our region - than for Pinot Gris.

For the same vineyard in Trentino and for four vintage-years, the mean values and standard deviations of the data for 8 clones of Pinot Blanc and 19 of Chardonnay, the grapes of which were picked at the same technological ripening stage, are shown in Table 4. We observe that Chardonnay grapes present for all parameters slightly higher values than the Pinot Blanc, in particular for the sugar (+1 °Bx) and the malic acid (+0.7 g/l) content with a different salification situation (higher total acidity, pH, K and tartaric acid), in spite of a higher crop per vine. Both varieties present a very similar weight per bunch, but Chardonnay shows a higher fertility of the buds.

The same tendency for the total acidity values was observed in three vineyards of South-Tyrol at different altitude, by considering five vintage-years (Figures 1a and 1b). In particular, the acidity is higher in Pinot Blanc than in Chardonnay in the first part of the ripening-time, and becomes lower in proximity of the ripeness. No univocal tendency is stated for the sugar content of grape: a different situation per year was found, so that the mean value is very similar for the two varieties.

The evolution of some of such parameters for Pinot Gris grape in comparison to Pinot Blanc and Chardonnay during ripening time in the same vineyard in South-Tyrol, is shown in Fig. 2: the Pinot Gris seems to present a lower level of malic acid.

1.1.3 Most frequent colour and aroma descriptors

Very little attention has been paid to the aroma descriptions of both Pinot wines. The best wines from both Pinot varieties are considered those obtained in Northern Italy from vines planted on hilly, medium clayey-calcareous and well drained soils in rather cold areas (Pittaro and Plozner, 1982), even though typical Pinot Gris wines are also produced in temperate areas. The same authors attributed them, just after the fermentation, a straw-yellow colour with green nuances and a flowery-fruity subtle scent, which evolve, during the ageing, into a bread crust aroma and later into an artemisia-almond flower-like aroma, to significate probably a peculiar flowery-spicy-green note. A little bitter aftertaste is also present. For South-Tyrol Pinot Blanc young wines the most used aroma descriptor is an apple-kiwi hint (Aurich, personal communication).

Pinot Gris aroma is fruity for young wine and evolves into a large-pungent smell of hay, walnut husk and roasted almonds, while the colour goes to a golden hue during the ageing.

1.1.4 Short considerations about winemaking technology in Italy

The ripeness degree of grape at harvest can vary in order to obtain different kinds of products. In fact, both Pinot Blanc and Chardonnay grapes can be used both for sparkling and normal wine production, while Pinot Gris grape is usually picked at a good ripeness degree, for the production of only full-bodied straw-coloured wines.

For all the quoted varieties, a normal vinification with a soft pressing of sound berries is used. A short skin-contact is even more used, above all, for the Chardonnay for all kinds of products for improving varietal characteristics, so that a fermentative-fruity note does not prevail.

In Trentino as well as in Friuli, a small part of Pinot Gris is also produced by skin fermentation, to obtain a "copper-coloured" full-bodied wine with a peculiar varietal aroma. Particular care must be put for the extraction of the little content of anthocyanins from grape-skins, possibly before the fermentation and with a frequent pumping of the liquid over the cap in presence of enough SO_2 and with grapes having a rather high acidity.

For Pinot Gris wines, the malolactic fermentation is better avoided or only partly allowed, because of a total acidity usually lower than that of wines from the other cited varieties. A possible off-flavour of reduction is also frequent.
In the case of Pinot Blanc wines, the malolactic can originate a not for everybody pleasant acacia-honey flavour.

1.2 Aims of the research

In this work, possible analytical parameters which could characterize Pinot Blanc and Pinot Gris musts and wines, mainly of the Trentino-South Tyrol district, are investigated. Our attention was focused on the amino acid profile and level as well as on varietal, prefermentative and fermentative aroma compounds. Among the varietal compounds, the free and bound forms mainly of terpenols were taken into account. Amino acids and free and bound forms were compared with those available for another non-floral variety, the Chardonnay.

A research with similar aims on the basis of aroma compounds was already performed on German wines from both Pinots in relation with other non-floral and floral varieties (Rapp et al., 1993). Even if Pinots wines can be discriminated from each other and even more from Silvaner and Riesling by using the LDA multivariate data treatment, they present very similar characters. Pinot Gris wines prove, as for the varietal compounds, to be characterized by comparatively higher contents of bound geraniol and 3-oxo-α-ionol than Pinot Blanc wines.

It was interesting to verify a discrimination possibility also between Pinot wines produced in Italy and, at the same time, after reinvestigating that for some German wines, to underline possible differences between products from the two climatically different areas, the Italian Trentino-South Tyrol and the German Palatinate, following what already performed with good results for the Rhine Riesling wines, in this last case also in relation to the South African products (Marais et al., 1992).

2. Materials and methods

Musts of different vintage-years from grapes of clonal vineyards mostly of Northern Italy and wines only of the last vintage have been considered. The wines have been produced with a rather similar technology at the microvinification cellars of the Istituto Agrario in Trentino and of the Experimental Centre of Laimburg in South-Tyrol.

The musts were stored frozen, while the wines at around 15°C until the analyses. The wines have been analysed between April and July of this year.

Varietal pure mostly 1993 wines were provided by different wineries of the Palatinate and soon analysed.

2.1 Analytical methods

The content of different amino acids was determined with an automatic amino acid analyzer (C. Erba) according to the procedure reported in the literature (Margheri et al., 1982).

Some of the volatile compounds in wines, namely methanol, acetaldehyde, ethyl acetate, and higher alcohols were analysed on the distillate 1:1 from wine at pH 7, directly by GC with a packed column [2m x 2 mm i.d., Carbopack C 60/80 mesh, 0.2% CW 1500] (Gabri and Salvagiotto, 1980).

Other volatile compounds under free and bound forms were analysed with capillary GC after enrichment through adsorption on Amberlite XAD-2 resin and separate elution of the two forms with different organic solvents. Bound forms were quantified as aglycons after enzymatic hydrolysis. Details on the method were already published (Versini et al., 1992).

Data evaluation was carried out by using the SAS 6.06 package on a DEC VAX 8250 computer, under VMS 5-5.1 operating system.

3. Results and discussion

3.1 Discrimination between Pinot Blanc and Chardonnay on the basis of amino acid and varietal compound content of musts

3.1.1 Amino acids

Being Pinot Gris must samples not available at the time, the contents of 23 amino acids for 10 Pinot Blanc musts were compared with the corresponding of 84 Chardonnay samples of three different vintages, mostly sampled for every year in the same vineyards. Mean amino acid values in mg/L and in % of the total sum, are presented as histograms in Figures 3a and 3b, respectively.

The Pinot Blanc is confirmed, like the Pinot Noir and other Pinots, to be an arginine-rich variety in comparison with the proline-rich Chardonnay (Kliewer, 1970).

Most amino acid contents were discriminant between the two groups.

All both the data under the two different units of measurement were submitted separately to a multivariate analysis, the Principal Component Analysis (PCA), in order to reduce the dimensionality of the system and to observe possible groupings of the objects. In effect, in both cases the scores in the plane defined by the first two eigenvectors are separated into the two varietal groups (Figures 4a and 4b). As for the data in mg/L, the separation was performed principally on the basis of the second eigenvector, which is mostly charged positively by aspartic acid, asparagine, alanine, cystine and proline, and negatively by threonine, isoleucine, leucine and arginine. In the other case - data in % -, the first eigenvector mostly accounted for the separation: it is mainly charged by the same amino acids as before, but with opposite sign.

Good correlations between some amino acids, already found for Chardonnay, are confirmed for Pinot Blanc as well, but in some cases with a little different slope.

A discrimination between Chardonnay and Pinots - Noir and Meunier - was already obtained for the musts of the Champagne by Millery et al. (1986), using variables expressed as percentage of the total amino acid content. If comparing those profiles with ours expressed as percentage, we observe, in the presence of a good similarity for Chardonnay and Pinot Noir (data here not reported), that the Pinot Blanc musts seem to differ from the other Pinots (Pinot Noir and Meunier) in a higher level of proline at about 23% in comparison to that at about 6-10% for the others.

3.1.2 Varietal compounds

By evaluating the Fisher weights (P>95%) for all free and bound compounds (Tables 5a and 5b), 20 variables among 31 free and bound forms considered, discriminated 11 Pinot Blanc from 57 Chardonnay musts.

Besides, just the bound α-terpineol and its allylic hydroxylation product, the p-menth-1-en-7,8-diol (Versini et al., 1991), which were in traces in Chardonnay musts but p-menth-1-en-7,8-diol was not quantified, could be discriminant in this case for the comparison with the Pinot Blanc - and, generally, with all the Pinots -, because of the significative presence in them (Versini, 1991).

Also the unsupervised multivariate PCA data treatment on all free and bound compounds, mainly monoterpenols, showed in the plane determined by the first and third functions a good separation between the two categories (Fig. 5), mostly on the basis of the first eigenvector charged by both forms.

3.2 Discrimination of Italian Pinot Blanc and Pinot Gris wines on the basis of varietal, prefermentative and fermentative compounds

The variables considered can be divided in two groups on the basis of their biochemical origin and presence under free or bound form. We chose to include in one group all the 22 free compounds (Tab. 6), namely some representative varietal (linalool, α-terpineol and geraniol), prefermentative (methanol, 1-hexanol and 3-hexen-1-ol isomers) and fermentative variables, the last referred either to the glycolysis like total alcohol, higher alcohols and β-phenylethanol, some acetates and ethyl esters, acetaldehyde and one amide, or to the decarboxylation activity of the yeasts on some cinnamic acids, like 4-vinylphenol and 4-vinylguaiacol. The other group includes 20 strictly varietal bound compounds (Tab. 7), which are generally rather stable through the time and therefore possible variety tracers for many years, differently from the free forms. It includes mainly monoterpenols, some norisoprenoids, and benzyl and phenethyl alcohol.

A possible discrimination between the two varietal wine groups (24 Pinot Blanc and 10 Pinot Gris) was investigated separately for both quoted groups of variables, whose variability was also controlled in relation to other factors like the winery and the grapes native district.

3.2.1 Free varietal, prefermentative and fermentative compounds

A first investigation on possible information enclosed in the data for the selected 22 variables can be realized by an unsupervised reduction of the dimensionality of the system through the Principal Component Analysis (PCA). The only groupings of the scores in the planes defined by the first eigenvectors, and particularly in the one determined by the first two (49.8% of total variance), are related to the wineries, the South Tyrol Pinot blanc wines resulting however in a rather homogeneous group (Figures 6a and 6b).

This situation emphasizes the possible importance also of technological factors in determining most of the variance of the data system.

The profiles per winery on the basis of some compounds or groups of them, are reported in Fig. 7.

As for the investigation of variables discriminating between the two Pinots, two different approaches were attempted: the first univariate by considering the Fisher weights at P>95%; the second following the multivariate stepwise discriminant analysis in connection with the Linear Discrimination Analysis (LDA).

The resulting discriminating variables are:

- for the univariate analysis, ethyl acetate, trans 3-hexen-1-ol, N(3-methylbutyl)-acetamide, 1-hexanol, 1-propanol, 2-methyl-1-propanol, alcoholic proof and methanol;
- for the stepwise discriminant analysis, the same first three variables and 4-vinylphenol. In this case, the frequency plot on the discriminant score is reported in Fig. 8. The classification of the objects in the groups fitted for all samples, except for one for each variety.

None of the monoterpenols resulted to be discriminant.

All the selected compounds from univariate analysis are higher in Pinot Gris than in Pinot Blanc wines: some of them (methanol, 1-hexanol, trans 3-hexen-1-ol and the amide) could be connected to a little higher skin fragility under pressing for Pinot Gris grapes, richer in sugar, while the others to a peculiar substrate composition, which can influence the biosynthesis of some higher alcohols and of ethyl acetate, even though the products are obtained in different wineries. Both 1-propanol and ethyl acetate content could be linked positively to that of total free amino acids in musts (Rapp and Versini, 1991).

3.2.2 <u>Bound varietal compounds</u>

The mean profiles of both Pinots are typical of non-floral varieties, dihydroxylated monoterpene forms prevailing on the other compounds considered (Fig. 9).

A preliminary application of PCA on the data of 20 variables, does not show any grouping of the scores on the basis of the already mentioned criteria. This fact seems to prove, differently from the above discussed variables, no prevailing contribution of the accounted variability sources on this variable group.

α-Terpineol, trans 8-hydroxylinalool, 2-exo-hydroxycineol, 7- and 8-hydroxygeraniol have been found as compounds which singularly discriminate the two populations at least at 95%. Pinot Gris wines are characterized by the higher values of such compounds as so as found for the previously non-varietal selected variables. As typical as for both these varieties, seems the comparatively high content of 8-hydroxygeraniol in comparison with geraniol, differently from what found for a geraniol-rich variety, the Gewürztraminer (unpubl. results).

The Pinot Blanc wine aroma profile is in agreement with that of the above discussed musts. All the above cited compounds as well as the p-menth-1-en-7,8-diol, are much more lower in Chardonnay wines. On the contrary, in Chardonnay the cis 8-hydroxylinalool is much more prevailing on the trans form.

By using a different selection approach like the stepwise discriminant analysis to find out the more discriminating variables, 5 bound compounds were selected with a significance higher than 95%, i.e. α-terpineol, ho-diendiol (I), trans 8-hydroxylinalool, 8-hydroxygeraniol and benzyl alcohol, some of them already evidenced in the univariate approach. Scores frequences on the canonical function from LDA, are presented in Fig. 10: the classification of the samples through this function fits for all Pinot Blanc wines, except for one, and for 8 of the 10 Pinot Gris.

It worth mentioning that bound geraniol, already found by Rapp et al. (1993) as most discriminating monoterpene by LDA for the same varieties, was the first following discarded variable in the stepwise treatment.

3.3 *Discrimination of German Pinot Blanc and Pinot Gris wines by using the same groups of free compounds*

We recall that the study about the discrimination possibility between Pinot Blanc and Pinot gris wines was already performed by Rapp et al. (1993) by studying German wines of floral and non-floral varieties. The present research provided us the possibility to investigate again about this differentiation possibility as for the two Pinots, but working with the same groups of variables considered for the Italian wines.

3.3.1 Free varietal, prefermentative and fermentative compounds

The preliminary overview of the data through the PCA treatment allows us to discriminate on the plane determined by the first two eigenvectors (45.4% and 19.3% of the total variance, respectively) and mostly through the first of them, all the wines in function of the production wineries, as above found for Italian products (Figures 11a, 11b and 11c) and partially in function of the wine quality degree.

The profiles per winery on the basis of some compounds or groups of them, are reported in Fig. 12 and those per variety in Tab. 8. A great variability among them can be observed. We underscore here, for the possible influence on the wine flavour, the differences in the esters, β-phenylethanol and vinylphenols levels. In particular, both vinylphenols are markedly higher than in Italian wines, but only for the quality degrees higher than the "QbA"-level, namely for wines from riper and/or selected grapes (Fig. 13). This fact, connected with a dominance of 4-vinylphenol on 4-vinylguaiacol, was already found by us (Versini et al., 1990) for Chardonnay wines from a late harvest and in that occasion we hypothesized a sensorial relevance of both phenols - recently confirmed by Chatonnet et al. (1993) -, which can determine an interesting peculiar spicy, broom flower-like scent. This scent is modified during the ageing in relation to the transformation of both vinylphenols in the corresponding ethoxyethers, having a flowery note, too (Dugelay et al., 1993). We can suppose also a higher hydroxycinnamylester content and/or hydrolytic activity on these esters in well ripened grapes, which increase suitable compounds, i.e. the hydroxycinnamic acids, for the decarboxylation activity of the yeasts.

Besides, the univariate discrimination between the varieties was possible through only the cis 3-hexen-1-ol content, and through ethyl acetate, 1-hexanol, cis 3-hexen-1-ol and 4-vinylguaiacol as for multivariate stepwise feature selection. Frequences of data scores along the canonical variate are shown in Fig. 14. The classification of all the samples was 100%.

It is worth mentioning that such variables are the same or strictly related (cis 3-hexen-1-ol to trans 3-hexen-1-ol and 4-vinylguaiacol to 4-vinylphenol) to some chosen for Italian wines.

We emphasize also that the level of some monoterpenols could influence, differently from what found for the Italian products, the floral scent of the German wines.

3.3.2 Bound varietal compounds

First of all, we observed that all Pinot Blanc and Gris products of one of the three main wineries supplying the wines, presented a markedly higher content of most compounds under both forms, however preserving a rather similar profile (Fig. 15, Tab. 9). This very interesting fact could provide evidence of a marked influence of the native area on the grape characteristics.

Even if in presence of this situation, we considered all the wines in the statistical data treatment. p-Menth-1-ene-7,8-diol was the only discriminant variable by univariate treatment, while it came out together with trans geranic acid and phenethyl alcohol in the case of the multivariate stepwise approach. The same results were obtained, if we do not consider the group of wines markedly different from the others. All such chosen compounds are strictly related to some of those selected for Italian wines. The classification of the wines was successful for all of them, except for one for both varieties. In Fig. 15 the frequences of the scores on the canonical variate are shown.

If we compare Italian and German wines on the basis of the varietal compounds considered, it is evident the much higher content of German products for both Pinots in almost all the terpene components and even more if considering separately the peculiar products of one German winery (Tab. 10).

4. Conclusions

A good differentiation of Italian musts of Pinot Blanc in comparison with those of Chardonnay - being missing Pinot Gris samples -, was performed on the basis of amino acids and varietal compounds.

As for the characterization of both Italian and German wines, the higher role of technological factors in comparison with varietal/climatic indexes was demonstrated. These aspects can influence considerably the wine flavour, indipendently from the variety.

Primary, prefermetative and fermentative compounds - some common for Italian and German wines - have been however spotted out for discriminating the products on the basis of the variety. Less common are those found under the bound forms. Very interesting for the sensorial influence is the increased content of both vinylphenols in German wines from riper grapes.

The German wines show a similar varietal profile in comparison to the Italian ones, but with a mean content markedly higher for all, particularly for those of Pinot Blanc from one winery: another case of a marked effect was demonstrated - probably an environmental-climatic one - on the terpene composition of wines as already found for Rhine Riesling wines, but in this case concerning non-floral varieties.

5. Aknowledgement

We wish to thank P. Barchetti, S. Inama, M. Marchio and L. Ziller of the Istituto Agrario for the analysis support, and M. Aurich of the Sperimental Centre of Laimburg for supplying viticultural data.

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Table 1: PRODUCTION OF D.O.C. WINES REPORTING THE VARIETY NAME IN LABEL (source MAF-AEI 1991)

DISTRICT	D.O.C.	PINOT BLANC (tons)	CHARDONNAY (tons)	PINOT GRIS (tons)
VALLE D'AOSTA	Valle d'Aosta	-	-	5.8
LOMBARDIA	Oltrepo Pavese	-	-	1092.4
TRENTINO	Trentino	668.4	6971.2	1801.1
	Valdadige	-	-	1562.1
ALTO ADIGE	Alto Adige	2558.8	2346.6	1795.5
	Terlano	701.9	39.0	-
	Valle d'Isarco	-	-	4.5
VENETO	Valdadige	-	-	143.9
	Breganze	288.0	-	100.0
	Colli Berici	302.0	-	-
	Lison Pramaggiore	103.3	886.8	617.0
	Piave	185.7	-	397.3
	Colli Euganei	288.6	-	-
FRIULI	Aquileia	514.7	108.8	393.6
	Colli Orientali	384.4	178.4	384.4
	Grave	1982.9	1954.1	3949.1
	Latisana	93.0	56.5	78.6
	Collio	712.4	311.5	1636.0
	Isonzo	562.9	409.0	713.2
	Lison Pramaggiore	6.3	28.1	19.1
EMILIA ROMAGNA	Colli Piacentini		-	243.9
	Colli Bolognesi	357.7	-	-
PUGLIA	Castel del Monte	112.8	135.4	-

Table 2: GRAPE PRODUCTION IN TRENTINO (ITALY)

YEAR	HA	TOTAL PRODUCTION (TONS)	WHITE GRAPES % OF THE TOTAL PRODUCTION	PINOT BLANC % OF THE TOTAL PRODUCTION	CHARDONNAY % OF THE TOTAL PRODUCTION	PINOT GRIS % OF THE TOTAL PRODUCTION
1975	9700	105676	15.0	5.8	-	1.4
1980	8802	134441	16.8	0.8	7.3	1.6
1985	8806	120957	24.8	2.2	11.7	2.2
1990	8850	100222	40.2	1.6	21.3	7.0
1993	8788	101947	52.0	2.1	28.4	11.6

Table 3: GRAFTED VINES PRODUCTION

YEAR	TYPE	PINOT BLANC		CHARDONNAY		PINOT GRIS	
		x 1000	%	x 1000	%	x 1000	%
89/90	base	4.0	1.08	32.5	8.78	3.0	0.81
	certified	434.1	1.92	3734.4	16.56	1488.2	6.60
	standard	447.4	1.14	593.2	1.51	403.0	1.03
90/91	base	3.4	1.39	22.8	9.33	2.0	0.83
	certified	500.7	1.72	5288.3	18.12	1691.9	5.80
	standard	411.0	1.08	846.4	2.23	432.7	1.14
91/92	base	8.5	2.57	25.8	7.81	2.0	0.61
	certified	494.5	1.47	5503.4	16.38	1389.2	4.13
	standard	532.2	1.36	622.6	1.59	285.1	0.73
92/93	base	4.0	0.77	24.5	4.69	12.0	2.30
	certified	488.4	1.38	4437.2	12.54	1282.5	3.62
	standard	581.5	1.31	701.4	1.58	268.7	0.61

PARAMETERS		CHARDONNAY		PINOT BLANC	
1.		mean	st. dev.	mean	st.dev.
crop/vine	Kg	4.71	4.68	3.76	1.84
weight (100 berries)	hg	1.38	0.19	1.44	0.15
cluster weight	hg	1.37	0.32	1.44	0.40
fertility	cluster/bunch	1.74	0.45	1.32	0.38
2.					
°Brix		20.60	1.52	19.59	1.92
acidity (as tartaric acid)	g/l	7.21	0.86	6.86	0.81
pH		3.40	0.08	3.32	0.11
malic acid	g/l	3.01	0.75	2.32	0.56
tartaric acid	g/l	6.82	0.84	6.61	0.62
potassium	g/l	1.66	0.22	1.40	0.25

Table 4: Comparison between 19 clones of Chardonnay and 8 clones of Pinot Blanc for 4 vintages-years (1990-1993). 1: some characteristics of vines and clusters; 2 : quality parameters of must.

Fig. 1a

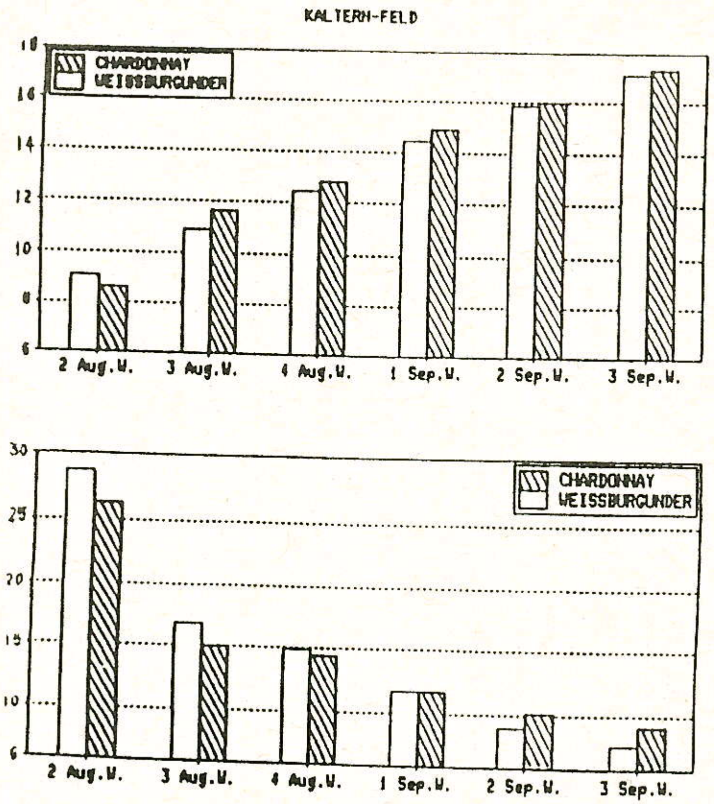


Fig. 1b

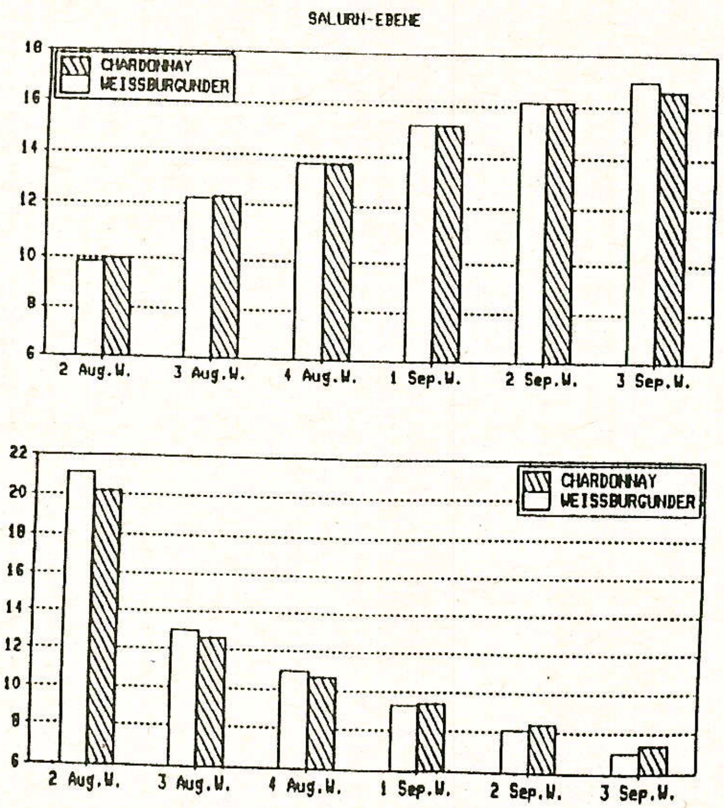
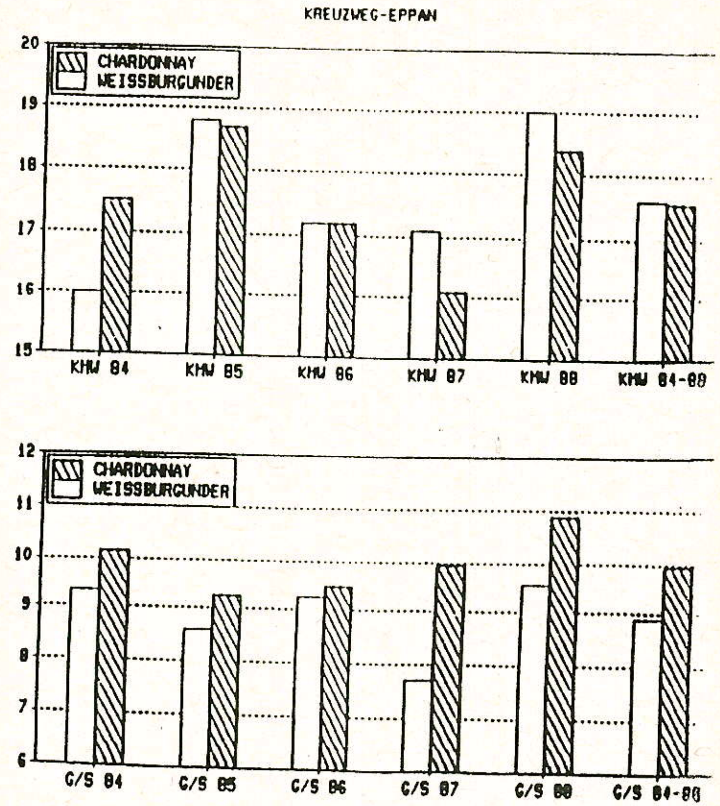
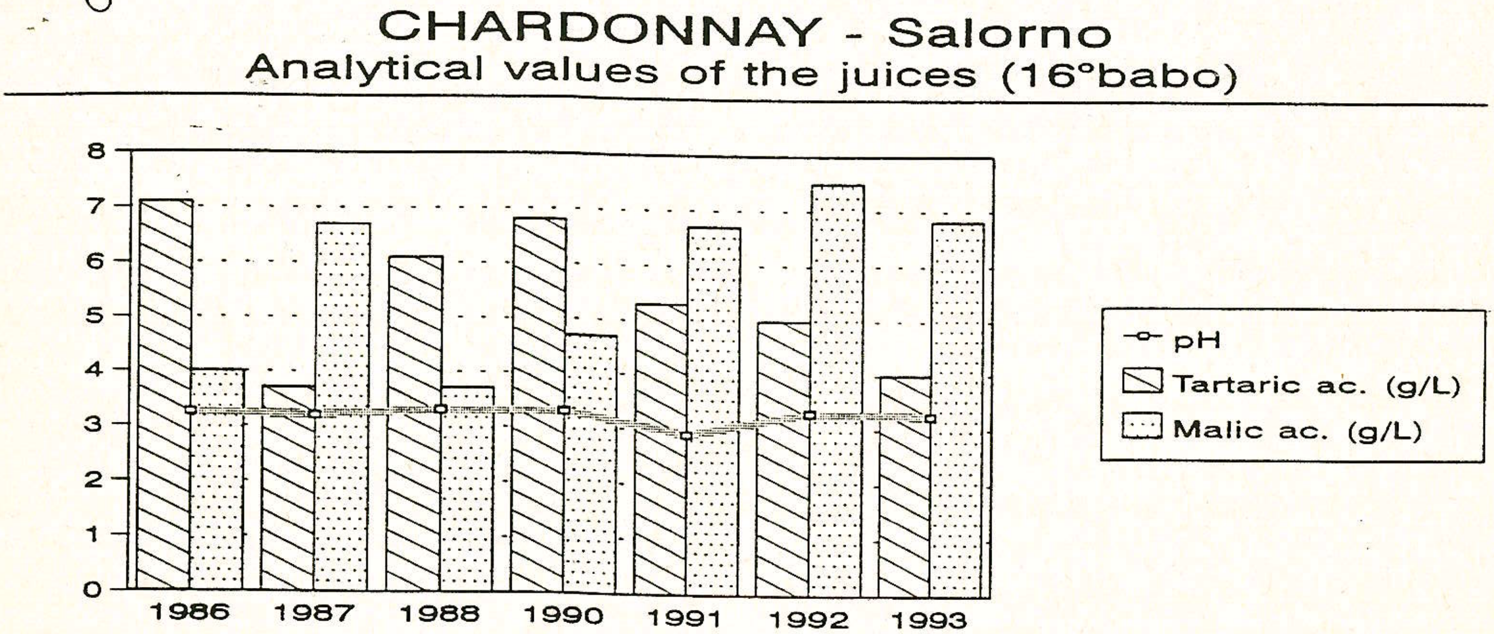


Fig. 1c

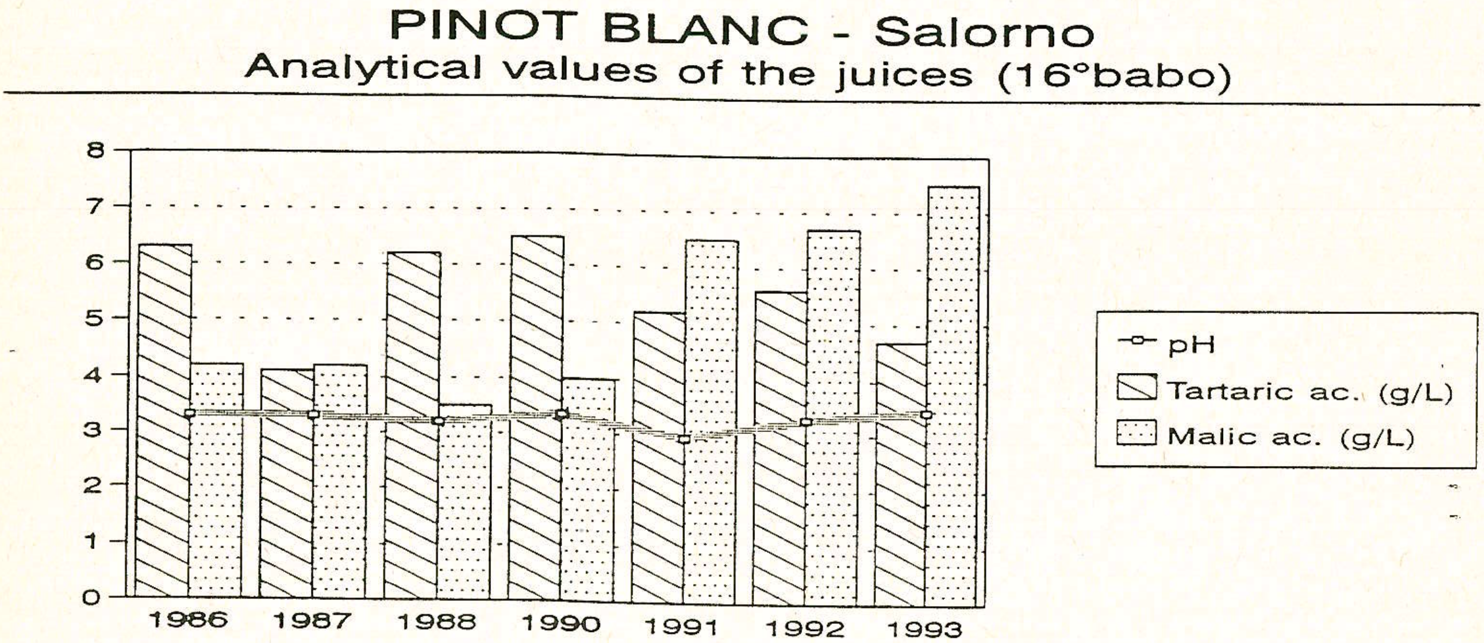


ig. 1a and 1b: Variability of the mean content of sugar (upper part: °Babo Klosterneuburg=KMW) and total acidity (lower part: as tartaric acid in mg/l) of Chardonnay and Pinot gris grapes from wo different vineyards (Kaltern-Feld and Salurn-Ebene) at the same sampling date for the vintage-years 1984-1988.
ig. 1c: Mean content of sugar and total acidity for the same grape varieties at the vintage time of the years 1984-1988 (see the indications in Fig. 1a and 1b).

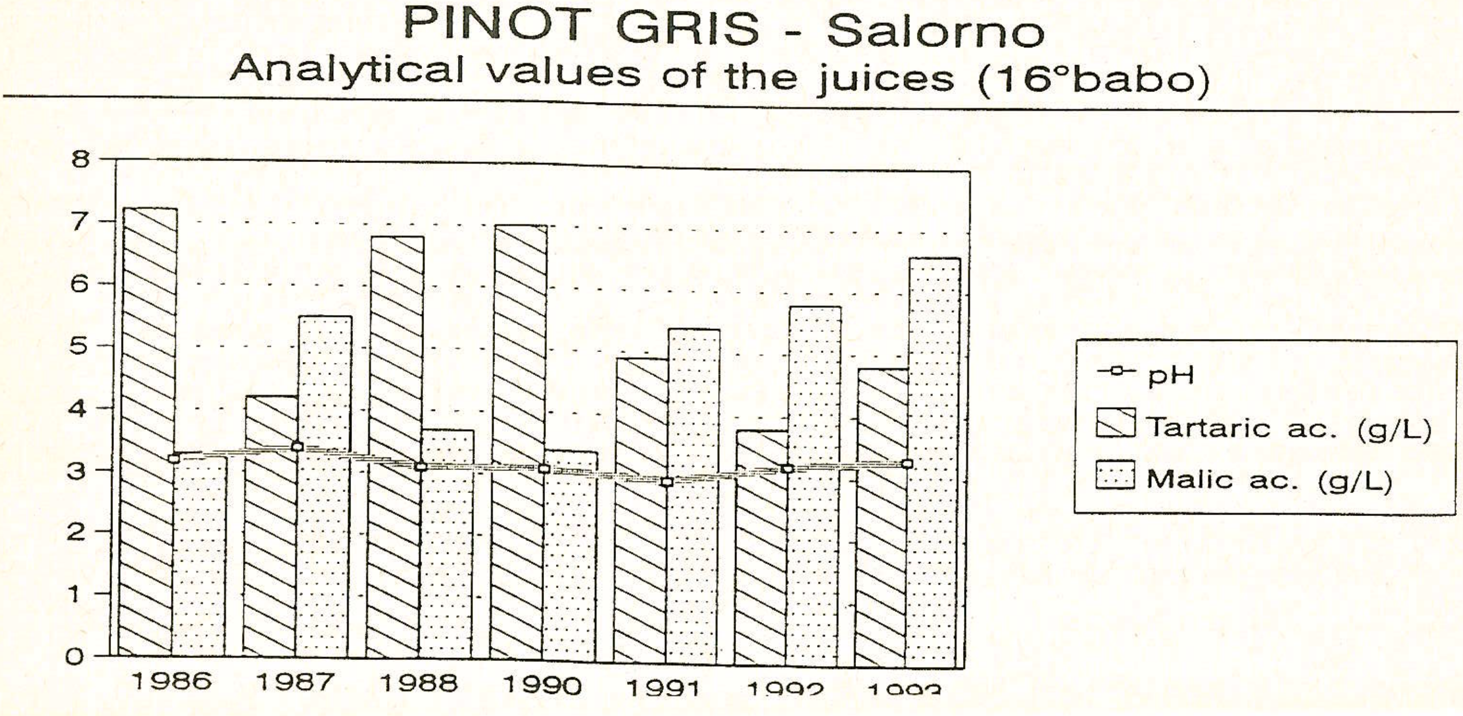
Fig. 2



CHARDONNAY - Salorno
Analytical values of the juices (16°babo)
8
7
6
5
4
3
2
1
0
1986
1987
1988
1990
1991
1992
1993
pH
Tartaric ac. (g/L)
Malic ac. (g/L)



PINOT BLANC - Salorno
Analytical values of the juices (16°babo)
8
7
6
5
4
3
2
1
0
1986
1987
1988
1990
1991
1992
1993
pH
Tartaric ac. (g/L)
Malic ac. (g/L)



PINOT GRIS - Salorno
Analytical values of the juices (16°babo)
8
7
6
5
4
3
2
1
0
1986
1987
1988
1990
1991
pH
Tartaric ac. (g/L)
Malic ac. (g/L)

COMPOUNDS	CHARDONNAY (57)		PINOT BLANC (11)	
	MEAN VALUE	STD DEV	MEAN VALUE	STD DEV
TRANS FURAN LINALOOL OXIDE	1.33	1.479	0.65	0.366
*CIS FURAN LINALOOL OXIDE	0.28	0.432	1.14	0.696
LINALOOL	3.23	7.672	0.60	0.712
*α-TERPINEOL	2.47	2.583	6.45	2.806
*TRANS PYRAN LINALOOL OXIDE	5.39	5.180	1.04	0.612
*CIS PYRAN LINALOOL OXIDE	3.05	2.950	0.28	0.197
CITRONELLOL	0.23	0.256	0.19	0.082
NEROL	0.36	0.448	0.34	0.355
GERANIOL	1.23	1.325	0.95	0.801
TRANS GERANIC ACID	5.07	23.70	1.12	2.956
*HO-DIENDIOL (I)	11.9	11.48	4.82	2.429
*BENZYL ALCOHOL	28.6	12.48	20.4	5.46
PHENETHYL ALCOHOL	105.1	184.34	93.2	103.20

Tab. 5a.

COMPOUNDS	CHARDONNAY (57)		PINOT BLANC (11)	
	MEAN VALUE	STD DEV	MEAN VALUE	STD DEV
*TRANS FURAN LINALOOL OXIDE	3.32	2.124	0.44	0.213
CIS FURAN LINALOOL OXIDE	0.69	0.605	0.49	0.234
*LINALOOL	3.91	3.176	0.29	0.231
*α-TERPINEOL	0.41	0.340	1.42	0.489
*TRANS PYRAN LINALOOL OXIDE	1.39	1.251	0.19	0.089
CIS PYRAN LINALOOL OXIDE	0.65	0.789	0.21	0.236
*CITRONELLOL	0.60	0.764	0.14	0.067
*NEROL	1.69	1.181	0.91	0.311
GERANIOL	4.62	2.815	3.38	1.180
*TRANS GERANIC ACID	10.9	8.06	2.75	1.075
*HO-DIENDIOL (I)	3.95	6.194	9.48	5.237
*2,6-DIMETHYLOCT-7-EN-1,6-DIOL	13.0	9.04	3.65	1.612
*TRANS 8-OH-LINALOOL	36.0	25.56	7.27	4.969
*CIS 8-OH-LINALOOL	77.7	47.43	25.4	14.50
*MEGASTIGMA-4,7-DIENE-3,9-DIONE	85.4	65.49	11.0	10.94
3-OXO-α -IONOL	250.8	177.16	182.9	63.92
*BENZYL ALCOHOL	223.9	61.77	136.8	41.29
*PHENETHYL ALCOHOL	144.7	125.50	28.8	6.55

Tab. 5b.

Free (Tab. 5a) and bound (Tab. 5b) varietal compounds (μg/l) in different Italian Chardonnay and Pinot Blanc musts (* indicates the variables discriminating the varieties at the Fisher test, P>95%).

COMPOUNDS		PINOT BLANC (24) MEAN VALUE	STD DEV	PINOT GRIS (10) MEAN VALUE	STD DEV
ETHANOL	(%vol.)	11.33	1.154	12.25	0.701
METHANOL	(mg%ml p.A.)	19.7	5.80	27.0	3.68
1-PROPANOL	"	15.9	10.56	29.1	22.60
2-METHYL-1-PROPANOL	"	28.8	11.56	45.1	25.27
2-METHYL-1-BUTANOL	"	28.1	9.30	28.2	9.60
3-METHYL-1-BUTANOL	"	150.9	35.73	145.0	31.07
HIGHER ALCOHOLS	"	224.1	45.60	247.4	53.42
ACETALDEHYDE	"	31.8	25.61	53.5	40.53
ETHYL ACETATE	"	19.3	14.94	50.0	31.29
ISOAMYL ACETATE	(μg/L)	936.2	848.56	1351.5	785.6
ETHYL CAPROATE	"	474.7	216.31	411.5	117.5
ETHYL CAPRYLATE	"	564.3	274.56	500.5	128.5
1-HEXANOL	"	2035.6	623.06	2566	370.3
trans 3-HEXEN-1-OL	"	71.7	39.84	150	108.8
cis 3-HEXEN-1-OL	"	52.5	34.48	42.8	20.20
PHENETHYL ALCOHOL	"	42235	16563.0	31847	12275.1
N(3-METHYLBUTYL)-ACETAMIDE	"	210.7	381.76	1228	1586.3
4-VINYLPHENOL	"	38.7	73.00	69.0	137.3
4-VINYLGUAIACOL	"	11.5	13.37	19.1	12.87
LINALOOL	"	2.93	2.660	3.83	2.199
α -TERPINEOL	"	3.24	1.943	4.89	4.232
GERANIOL	"	2.94	2.455	3.60	1.901

Tab. 6: Free compounds in Italian Pinot Blanc and Pinot Gris wines.

COMPOUNDS	PINOT BLANC (24)		PINOT GRIS (10)	
	MEAN VALUE	STD DEV	MEAN VALUE	STD DEV
TRANS FURAN LINALOOL OXIDE	1.91	1.718	2.28	2.287
CIS FURAN LINALOOL OXIDE	1.14	0.799	1.56	0.923
LINALOOL	0.24	0.489	0.27	0.299
α -TERPINEOL	2.29	1.708	4.61	1.397
TRANS PYRAN LINALOOL OXIDE	0.59	0.557	0.93	0.850
CIS PYRAN LINALOOL OXIDE	0.37	0.287	0.43	0.390
CITRONELLOL	0.18	0.105	0.22	0.147
NEROL	1.24	0.560	1.51	0.451
GERANIOL	4.71	1.831	6.12	3.019
TRANS GERANIC ACID	4.54	3.986	3.57	1.176
HO-DIENDIOL (I)	2.38	1.775	2.35	1.466
TRANS 8-OH-LINALOOL	9.10	3.494	14.2	5.02
CIS 8-OH-LINALOOL	21.1	10.45	22.4	13.25
3-OXO-α -IONOL	226.5	66.09	210.1	35.38
2-EXO-OH-1,8-CINEOL	0.62	0.471	0.94	0.409
7-OH-GERANIOL	2.87	2.505	5.18	3.868
8-0H-GERANIOL	22.9	9.84	42.1	49.50
P-MENTH-1-EN-7,8-DIOL	13.6	7.72	15.6	4.47
BENZYL ALCOHOL	75.2	36.75	80.2	26.00
PHENETHYL ALCOHOL	139.9	90.80	130.1	89.25

Tab. 7: Bound compounds (μg/L) in Italian Pinot Blanc and Pinot Gris wines.

COMPOUNDS		PINOT BLANC (10) MEAN VALUE	PINOT BLANC (10) STD DEV	PINOT GRIS (10) MEAN VALUE	PINOT GRIS (10) STD DEV
ETHANOL	(% vol.)	12.69	1.069	13.27	1.334
METHANOL	(mg%ml p.A.)	37.8	5.94	41.4	10.43
1-PROPANOL	"	26.3	10.00	28.9	16.31
2-METHYL-1-PROPANOL	"	76.9	32.22	77.6	35.48
2-METHYL-1-BUTANOL	"	42.6	21.28	45.4	22.99
3-METHYL-1-BUTANOL	"	177.5	106.33	170.7	83.99
HIGHER ALCOHOLS	"	313.4	110.88	322.6	115.65
ACETALDEHYDE	"	15.7	14.04	26.3	26.76
ETHYL ACETATE	"	24.8	5.78	27.3	8.17
ISOAMYL ACETATE	(μg/L)	1532.3	566.24	1421.0	352.74
ETHYL CAPROATE	"	399.2	125.63	345.7	139.83
ETHYL CAPRYLATE	"	484.6	122.41	391.1	144.47
1-HEXANOL	"	2639.4	398.68	2406.4	769.52
trans 3-HEXEN-1-OL	"	43.1	7.71	44.1	16.88
cis 3-HEXEN-1-OL	"	101.0	30.21	66.3	24.03
PHENETHYL ALCOHOL	"	54071	32225.4	60722	35327.4
N(3-METHYLBUTYL)-ACETAMIDE	"	5879.8	3142.76	4931.7	2494.08
4-VINYLPHENOL	"	316.0	214.78	299.1	229.74
4-VINYLGUAIACOL	"	65.4	36.82	44.8	32.09
LINALOOL	"	22.5	16.19	17.4	13.09
α -TERPINEOL	"	15.5	9.92	15.1	6.76
GERANIOL	"	11.2	6.38	9.65	5.56

Tab. 8: Free compounds in German Pinot Blanc and Pinot Gris wines.

COMPOUNDS	PINOT BLANC		PINOT GRIS	
	MEAN VALUE (8)	MEAN VALUE (2)	MEAN VALUE (7)	MEAN VALUE (3)
TRANS FURAN LINALOOL OXIDE	12.5	51.7	14.0	15.6
CIS FURAN LINALOOL OXIDE	11.1	71.3	11.4	11.0
LINALOOL	3.18	7.00	3.46	3.60
α-TERPINEOL	12.9	14.3	15.4	10.9
TRANS PYRAN LINALOOL OXIDE	4.62	25.3	5.68	6.23
CIS PYRAN LINALOOL OXIDE	2.17	6.55	4.00	2.30
CITRONELLOL	0.24	4.15	0.41	0.37
NEROL	5.90	53.8	6.20	6.20
GERANIOL	18.4	95.7	19.3	18.5
TRANS GERANIC ACID	14.3	97.6	11.3	19.2
HO-DIENDIOL (I)	8.91	31.4	15.8	12.2
TRANS 8-OH-LINALOOL	25.6	102.4	29.3	39.7
CIS 8-OH-LINALOOL	36.7	125.7	38.1	56.3
3-OXO-α-IONOL	316.9	322.0	325.0	282.0
2-EXO-OH-1,8-CINEOL	1.59	3.00	3.26	3.70
7-OH-GERANIOL	14.4	53.1	18.3	14.7
8-0H-GERANIOL	42.7	70.0	46.5	64.0
P-MENTH-1-EN-7,8-DIOL	9.84	25.6	22.3	18.4
BENZYL ALCOHOL	111.4	128.0	160.7	146.7
PHENETHYL ALCOHOL	146.6	487.5	200.6	290.7

Tab. 9: Bound compounds (μg/L) in German Pinot Blanc and Pinot Gris wines. The wines of one winery (I) are reported separately.

COMPOUNDS	PINOT BLANC		PINOT GRIS	
	ITALY	GERMANY	ITALY	GERMANY
	MEAN VALUE (24)	MEAN VALUE (10)	MEAN VALUE (10)	MEAN VALUE (10)
FREE FORM				
LINALOOL	2.93	22.5	3.83	17.4
α-TERPINEOL	3.24	15.5	4.89	15.1
GERANIOL	2.94	11.2	3.60	9.65
BOUND FORM				
TRANS FURAN LINALOOL OXIDE	1.91	20.4	2.28	14.5
CIS FURAN LINALOOL OXIDE	1.14	23.1	1.56	11.3
LINALOOL	0.24	3.94	0.27	3.50
α -TERPINEOL	2.29	13.2	4.61	14.1
TRANS PYRAN LINALOOL OXIDE	0.59	8.76	0.93	5.85
CIS PYRAN LINALOOL OXIDE	0.37	3.05	0.43	3.49
CITRONELLOL	0.18	1.02	0.22	0.39
NEROL	1.24	15.5	1.51	6.20
GERANIOL	4.71	33.9	6.12	19.1
TRANS GERANIC ACID	4.54	30.9	3.57	13.7
HO-DIENDIOL (I)	2.38	13.4	2.35	14.7
TRANS 8-OH-LINALOOL	9.10	40.9	14.2	32.4
CIS 8-OH-LINALOOL	21.1	54.5	22.4	43.5
3-OXO-α -IONOL	226.5	317.9	210.1	312.1
2-EXO-OH-1,8-CINEOL	0.62	1.87	0.94	3.39
7-OH-GERANIOL	2.87	22.1	5.18	17.3
8-0H-GERANIOL	22.9	48.1	42.1	51.8
P-MENTH-1-EN-7,8-DIOL	13.6	13.0	15.6	21.2
BENZYL ALCOHOL	75.2	114.7	80.2	156.5
PHENETHYL ALCOHOL	139.9	214.7	130.1	227.6

Tab. 10: Free and bound compounds (μg/L) in Italian and German Pinot Blanc and Pinot Gris wines.

Figure 3a. Amino acid mean profiles of 76 Chardonnay (vintages 1986 - 1988) and 10 Pinot Blanc (vintage 1993) musts of Trentino, Italy.

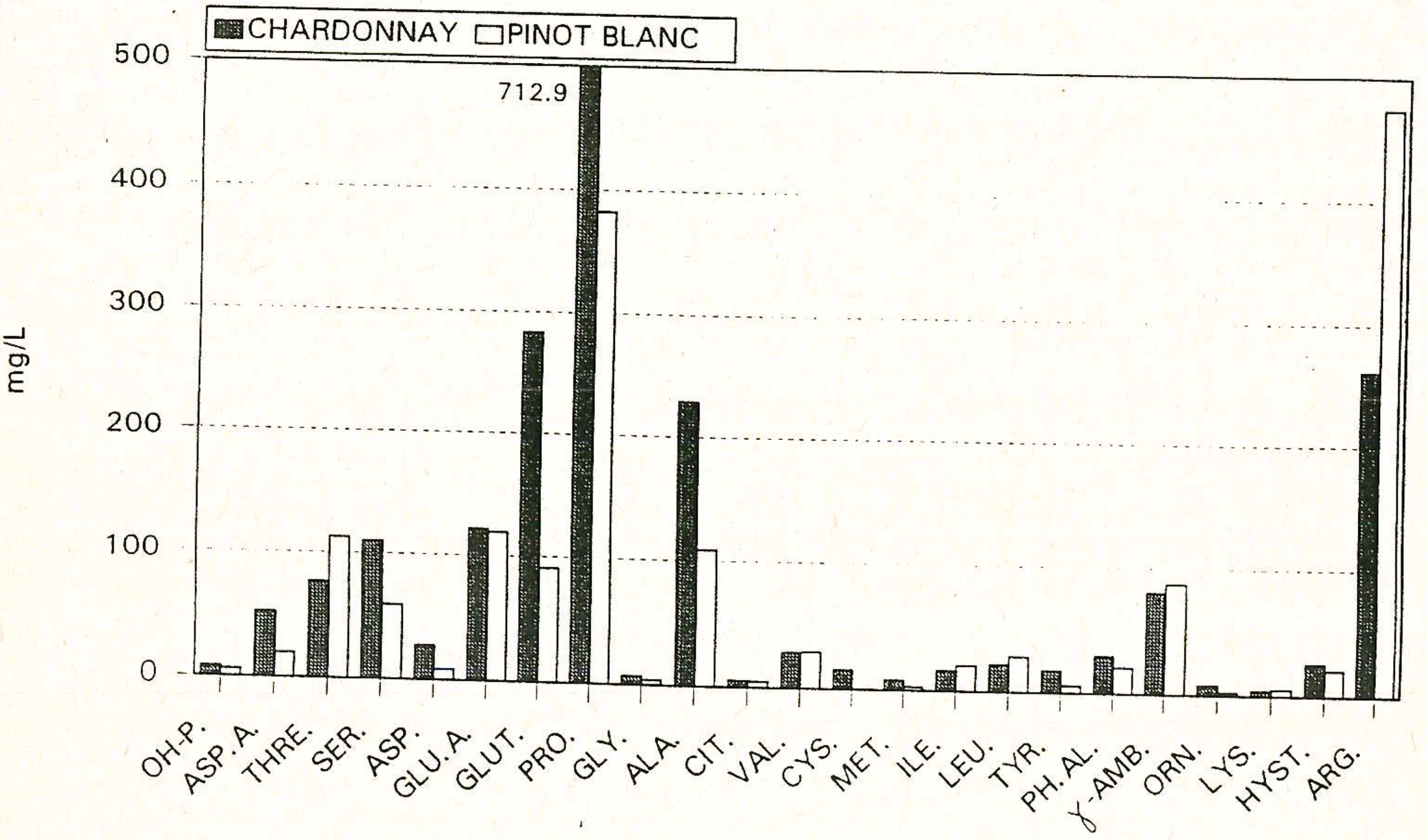


Figure 3b. Amino acid mean profiles (% of total sum) of 76 Chardonnay (vintages 1986 - 1988) and 10 Pinot Blanc (vintage 1993) musts of Trentino, Italy.

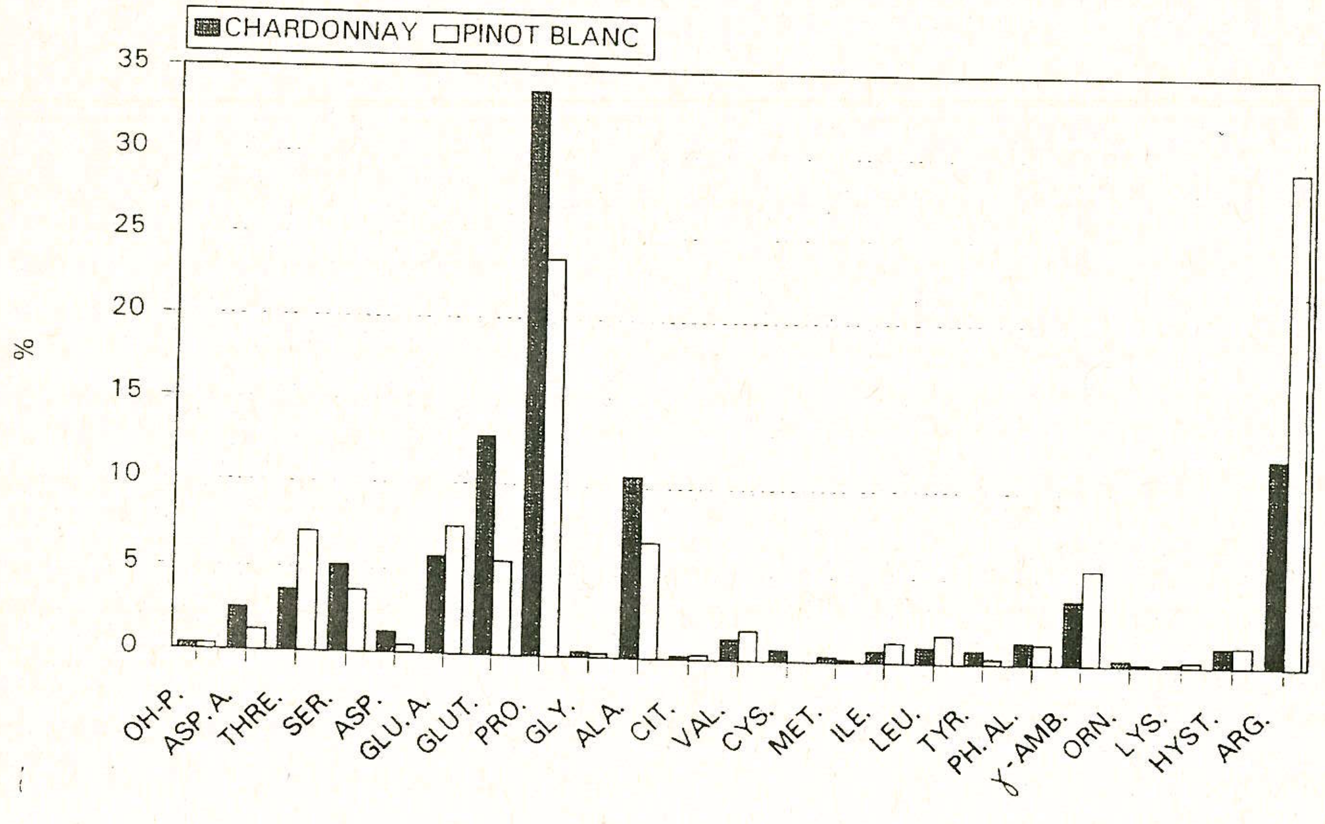


Figure 4a. Data set musts (23 amino acid in mg/L): scores on eigenvectors 1 and 2.

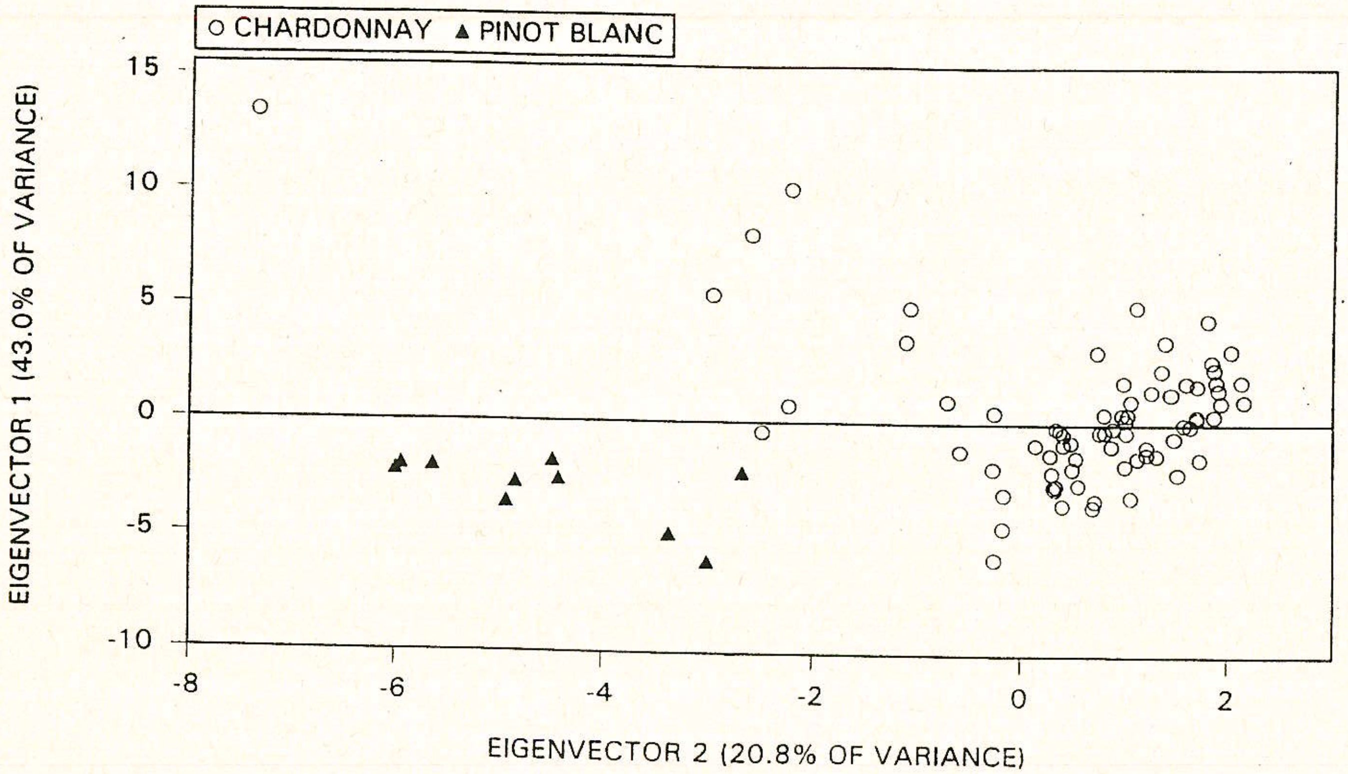


Figure 4b. Data set musts (23 amino acid in % of total sum): scores on eigenvectors 1 and 2.

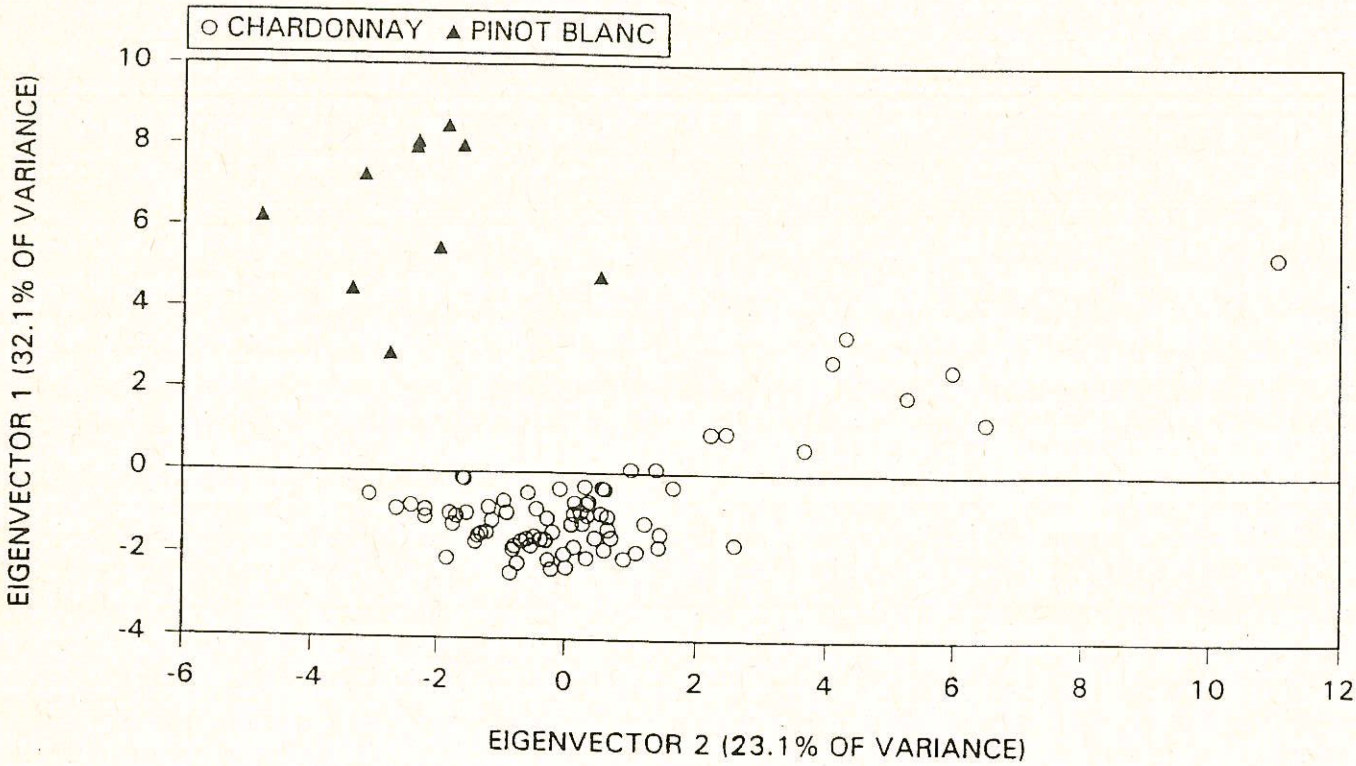


Figure 5. Data set musts (24 varietal free and bound compounds in $\mu g/L$): scores on eigenvectors 1 and 3.

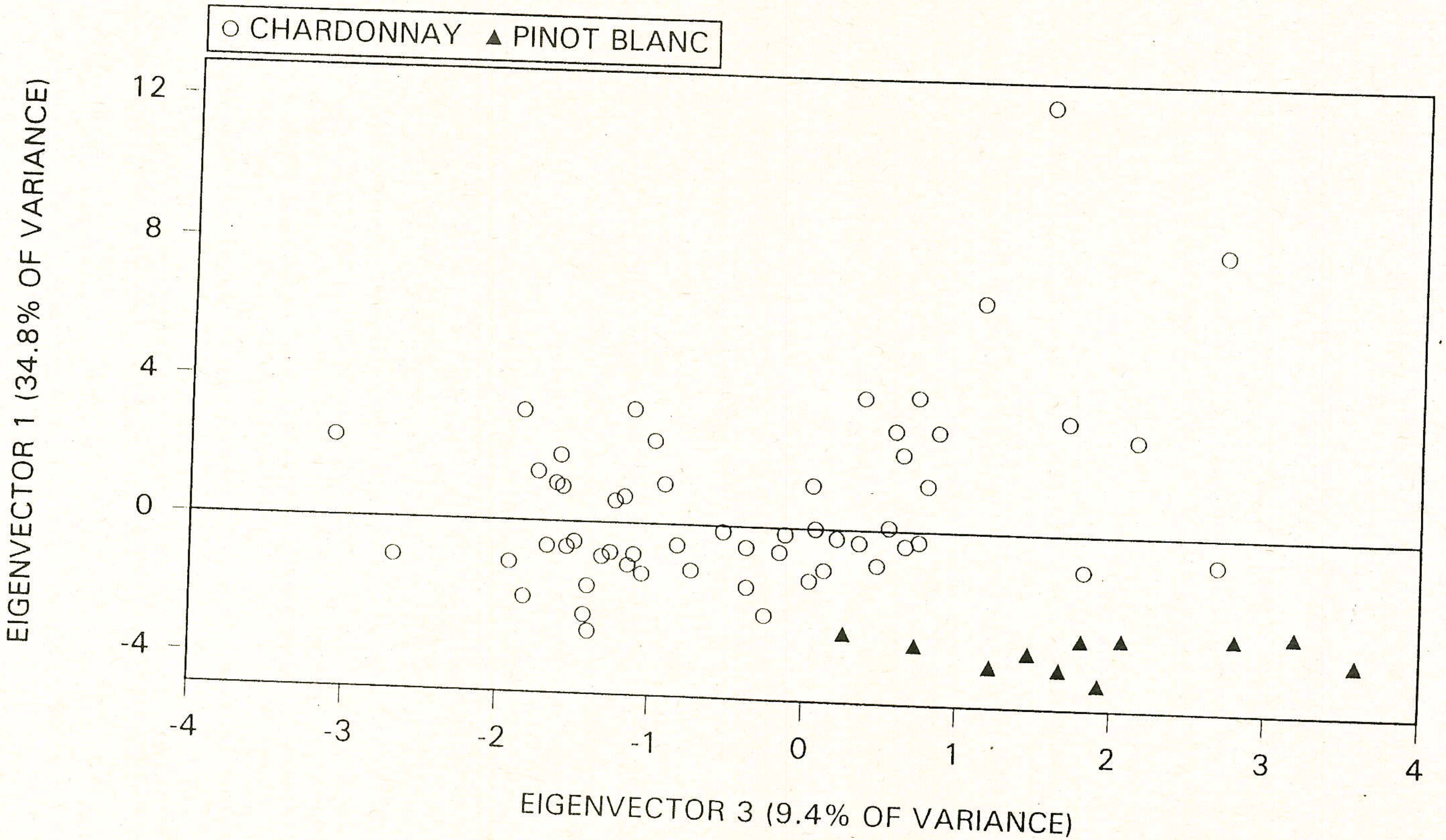


Figure 6a. Data set Italian Pinot Blanc and Pinot Gris wines - the labels indicate the wineries (22 free compounds): scores on eigenvectors 1 and 2.

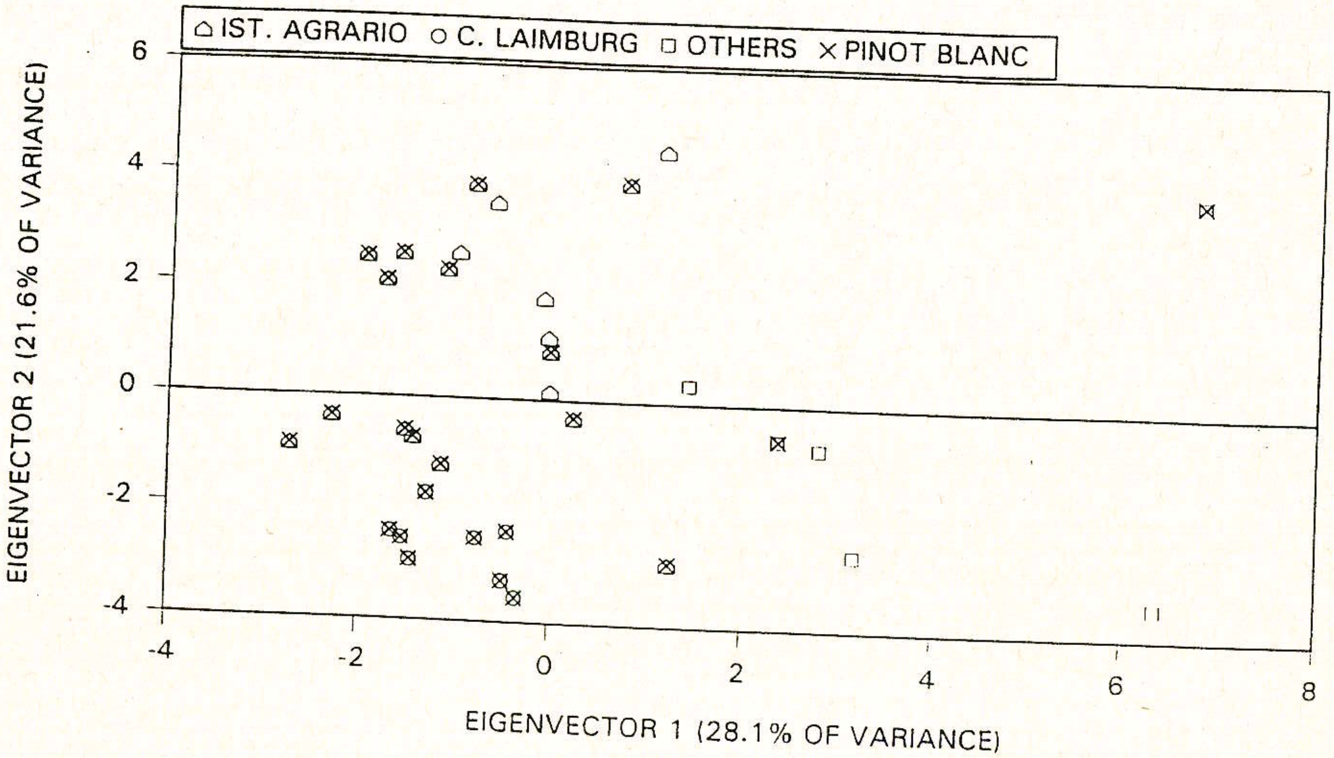


Figure 6b. Same results of figure 6a - the origin districts of wines are evidenced.

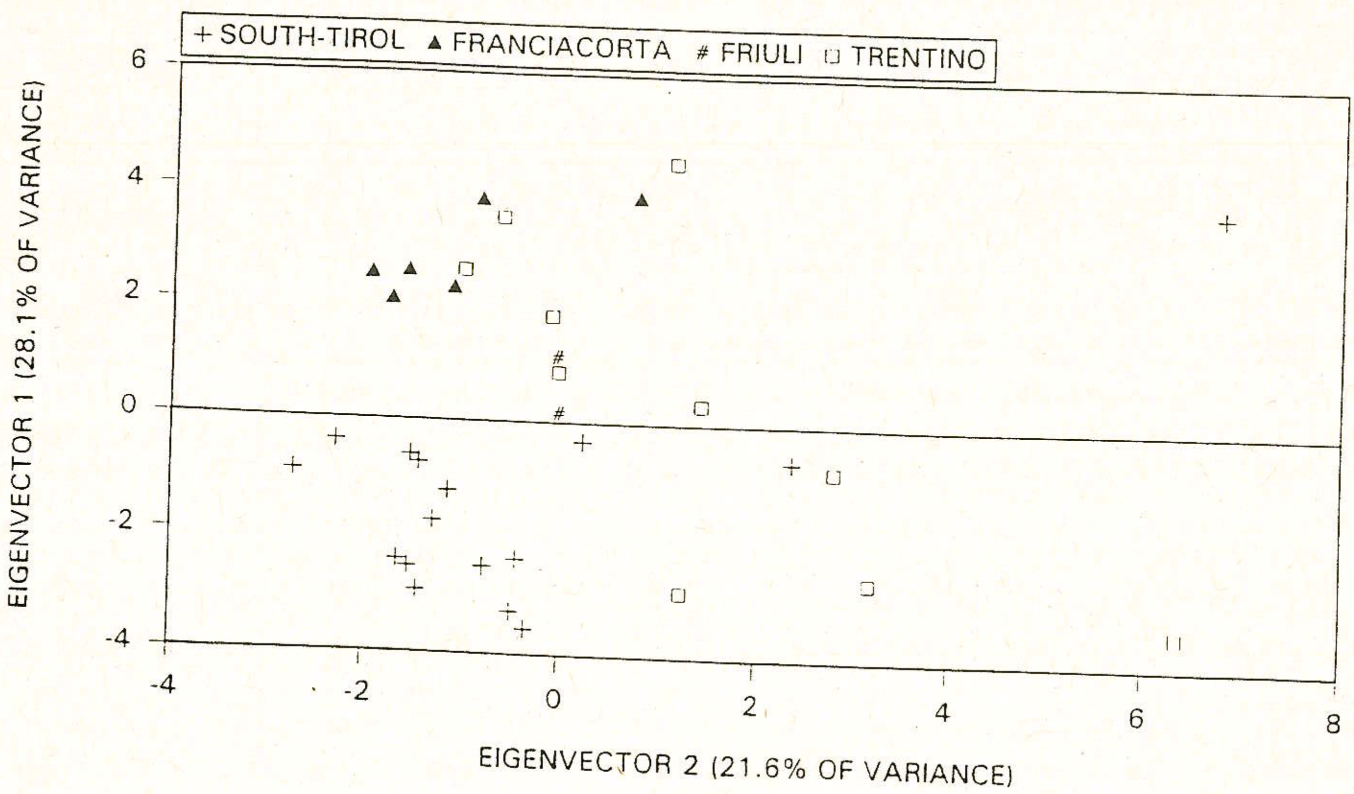


Figure 7. Mean contents of some free compounds in Pinot Blanc and Pinot Gris wines of different Italian wineries.

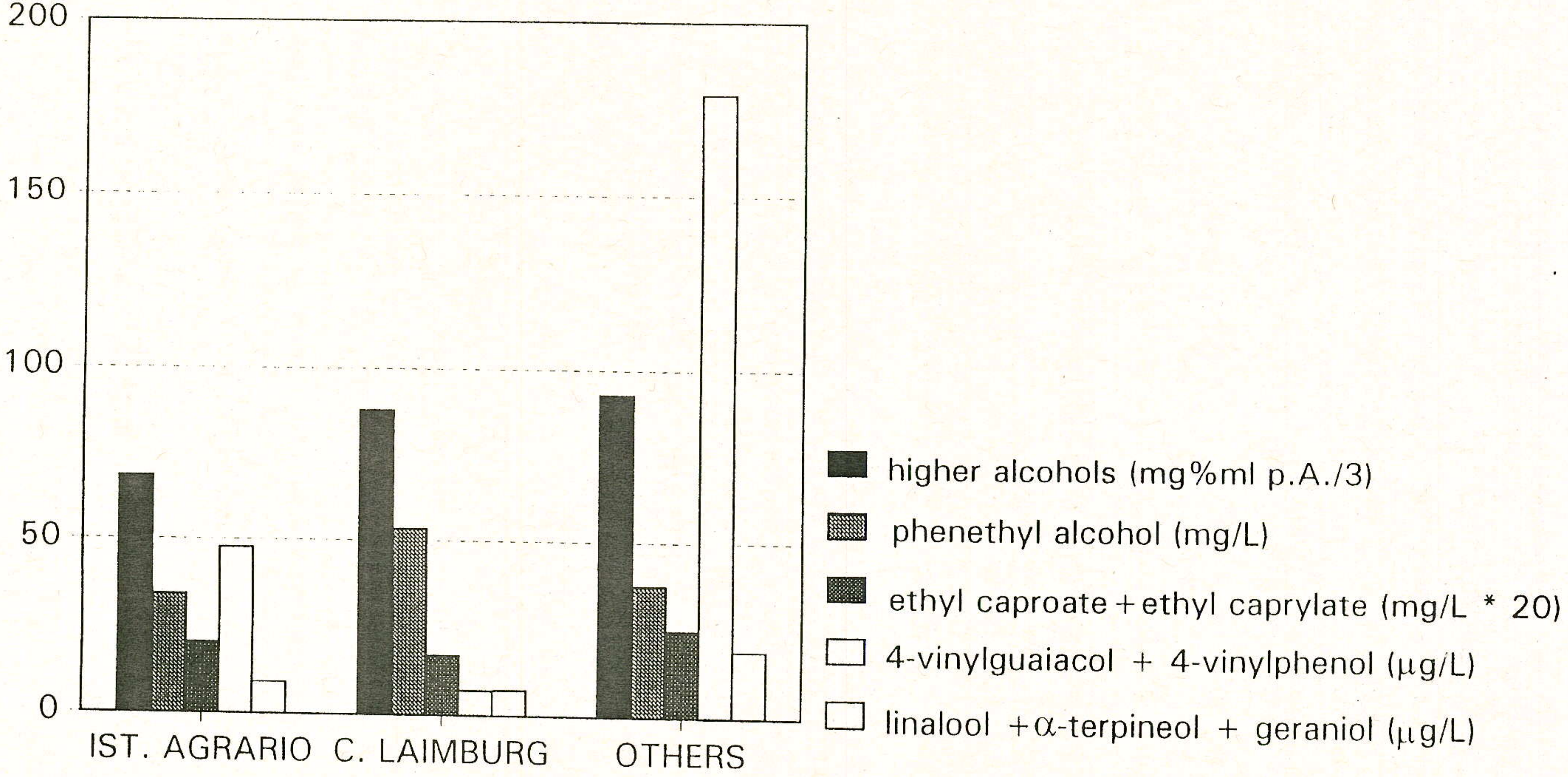


Figure 8. LDA on free compounds in Italian Pinot Blanc and Pinot Gris wines: frequency plot on the discrimination score.

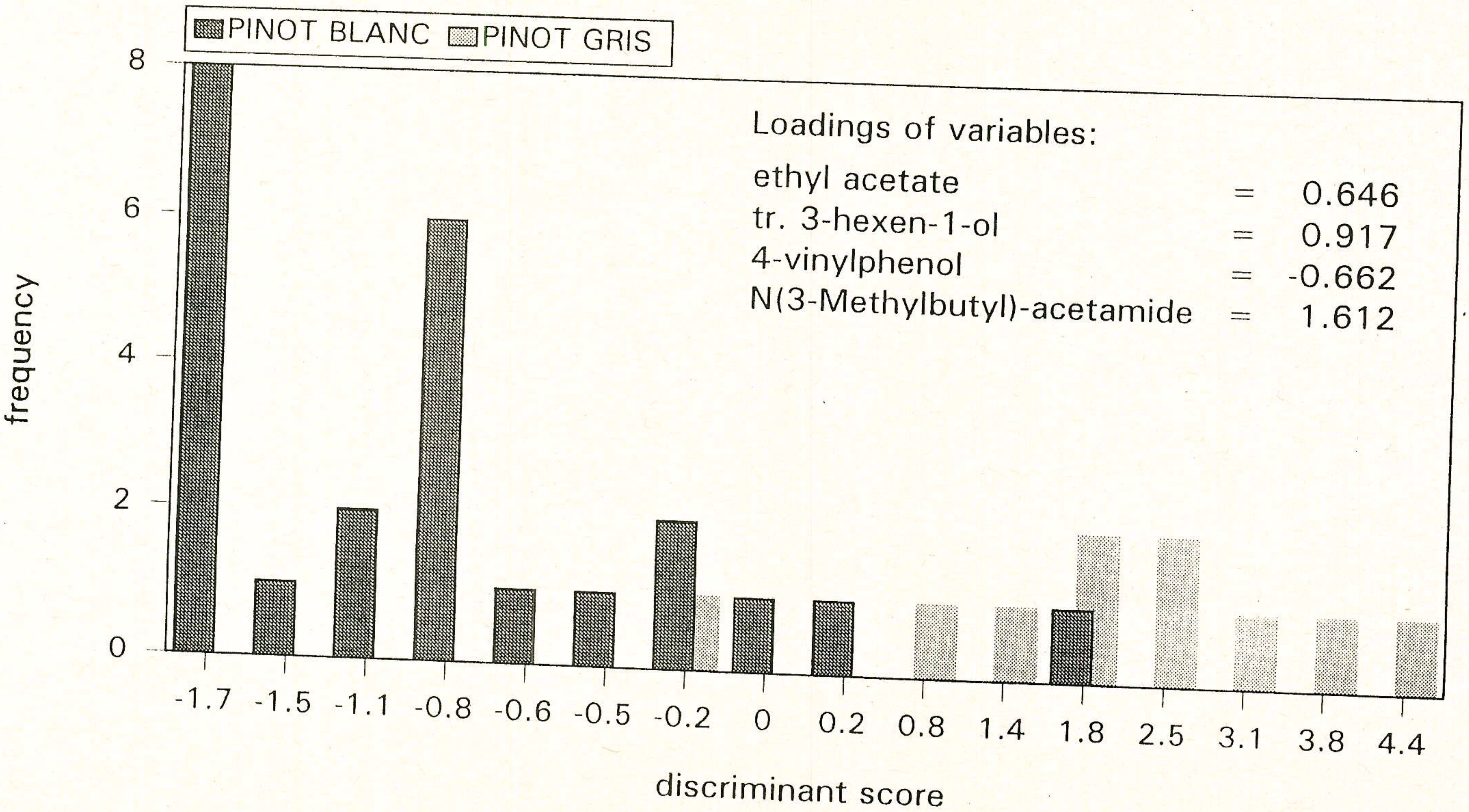


Figure 9. Histograms of the mean contents of some bound compounds in Italian Pinot Blanc and Pinot Gris wines.

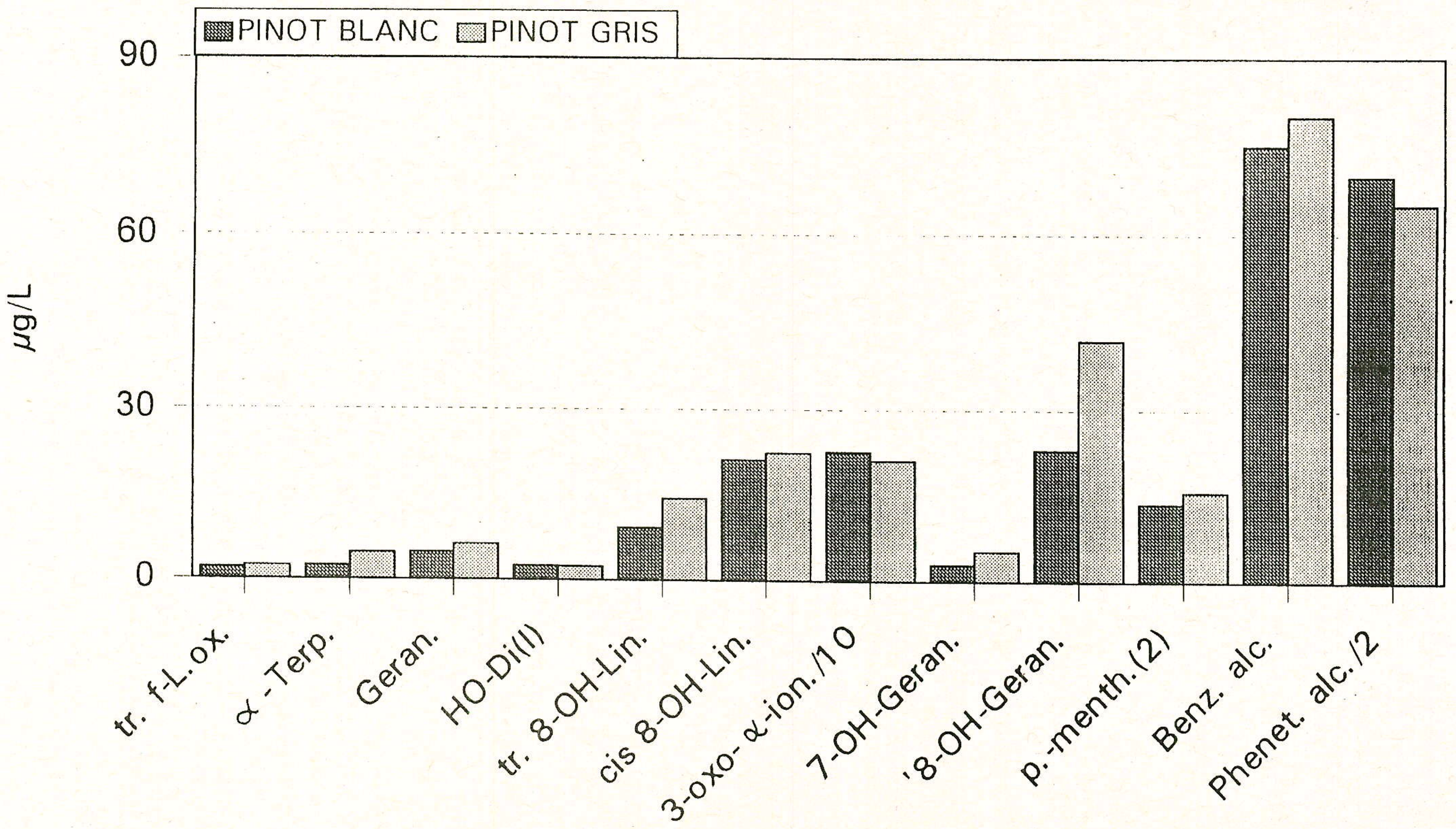


Figure 10. LDA on bound compounds in Italian Pinot Blanc and Pinot Gris wines: frequency plot on the discriminant score.

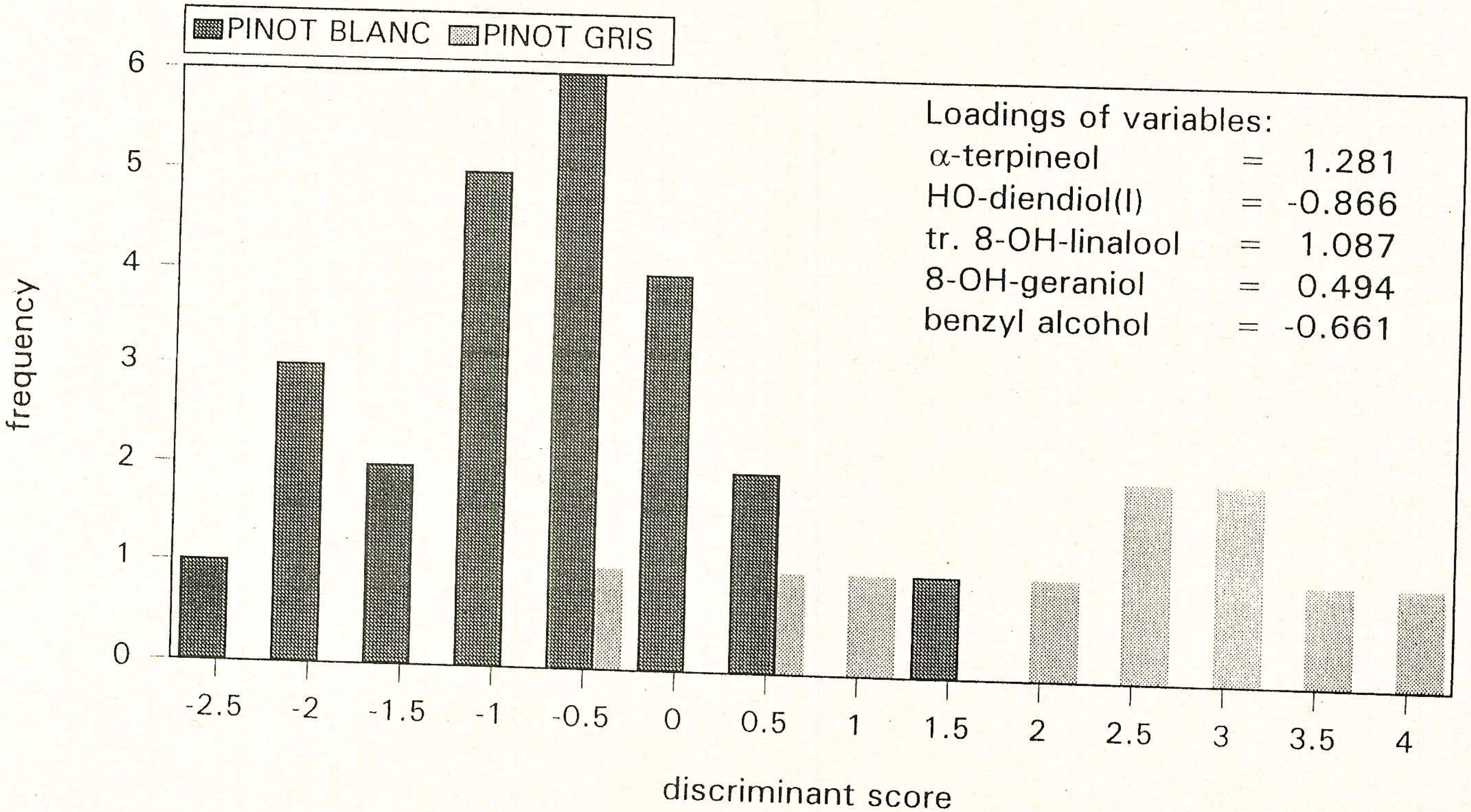


Figure 11a. Data set German Pinot Blanc and Pinot Gris wines (22 free compounds): scores on eigenvectors 1 and 2.

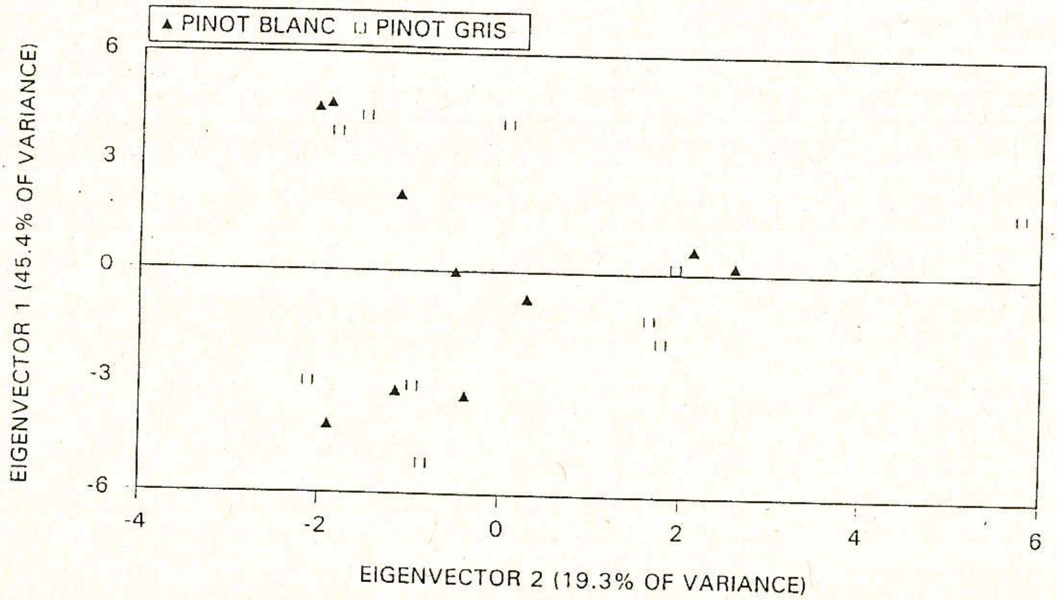


Figure 11b. Data set German Pinot Blanc and Pinot Gris wines - the labels indicate the wineries (22 free compounds): scores on eigenvectors 1 and 2.

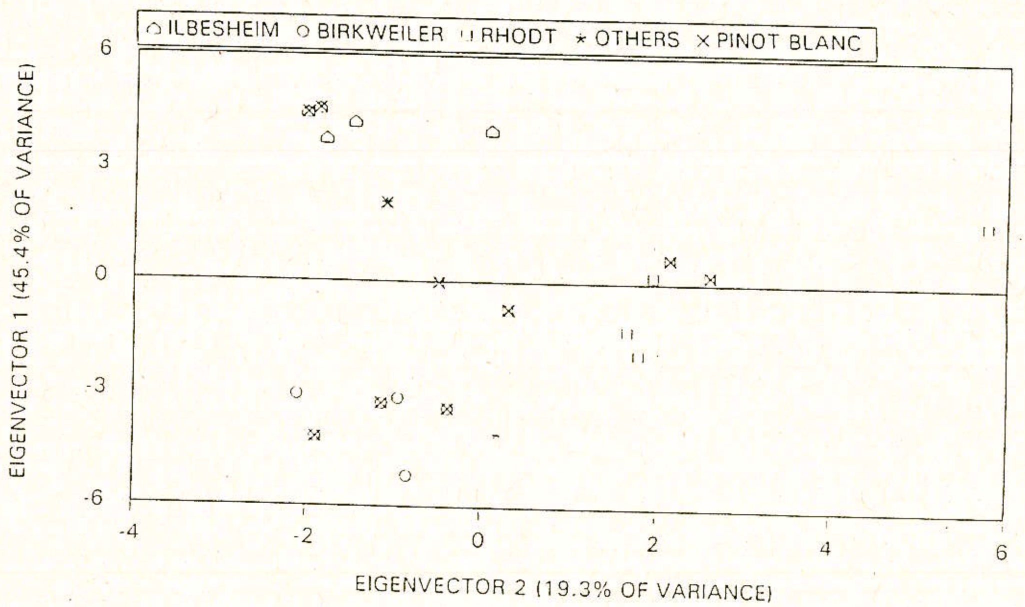


Figure 11c. Same results of figure 11a - the different quality of wines are evidenced.

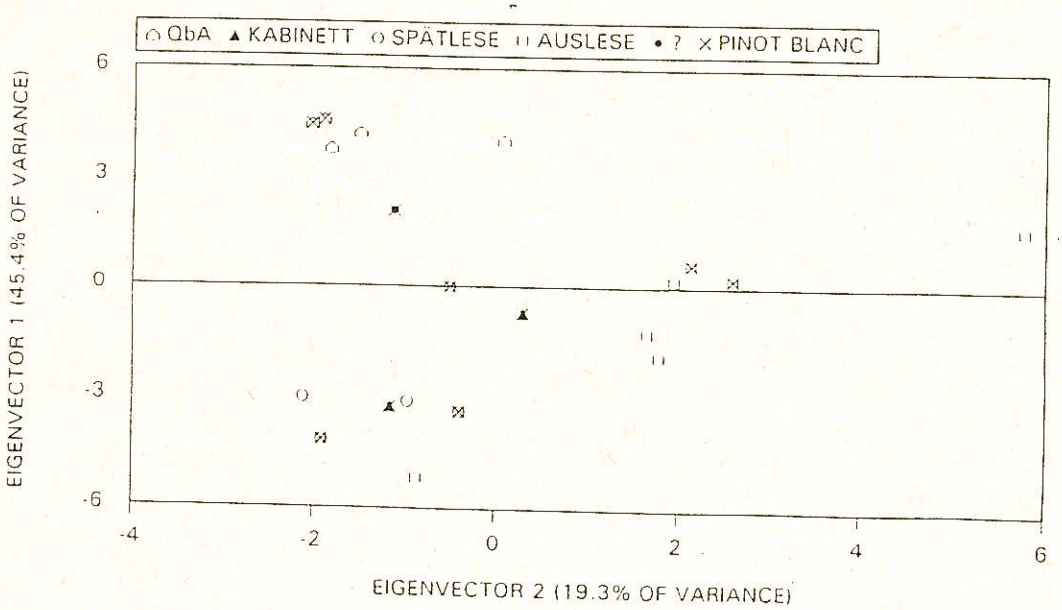


Figure 12. Mean contents of some free compounds in Pinot Blanc and Pinot Gris wines of different German wineries.

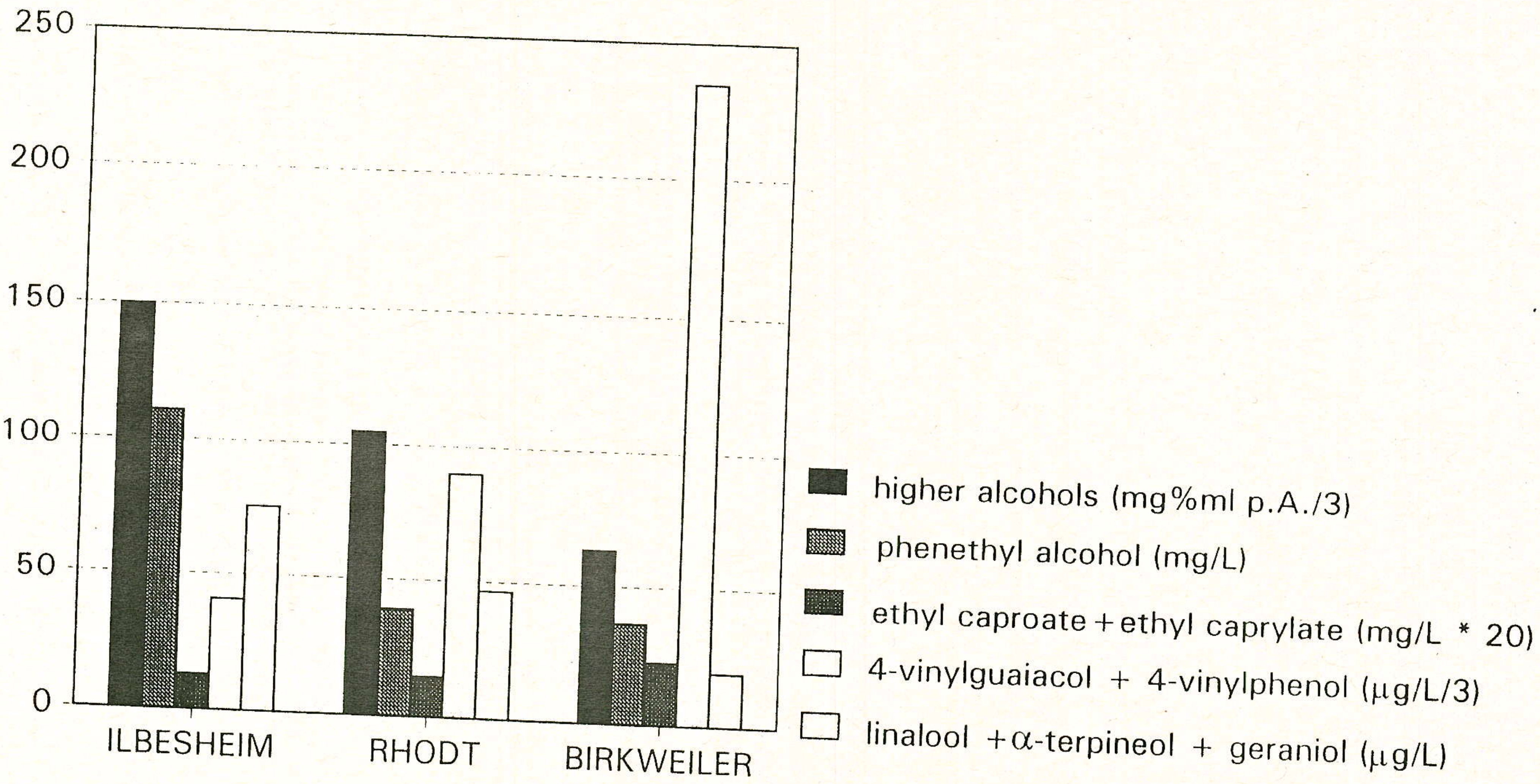


Figure 13. Mean contents of vinylphenols in different types of 1993 German Pinot Blanc and Pinot Gris wines.

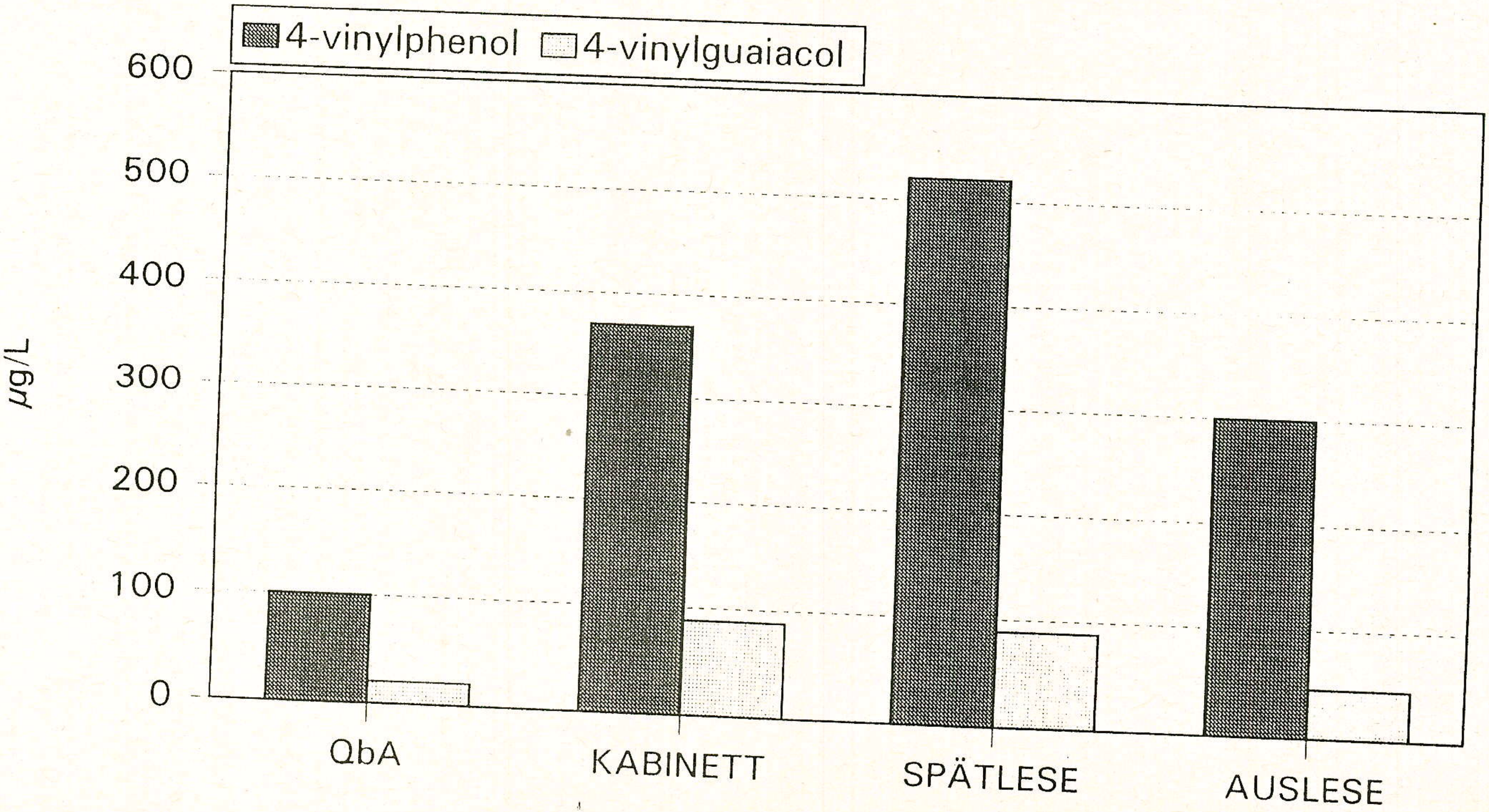


Figure 14. LDA on free compounds in German Pinot Blanc and Pinot Gris wines: frequency plot on the discriminant score.

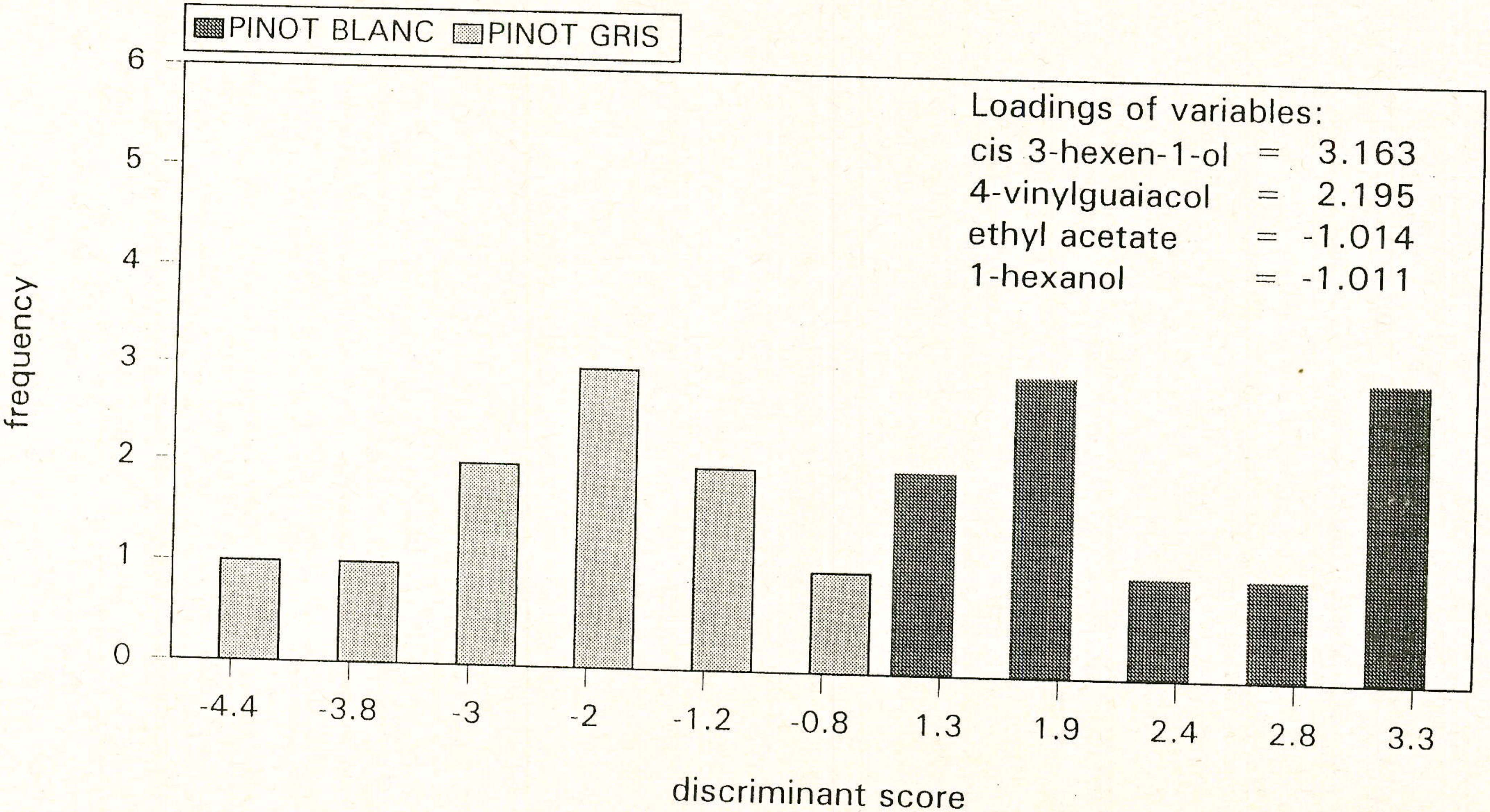


Figure 15. LDA on bound compounds in German Pinot Blanc and Pinot Gris wines: frequency plot on the discriminant score.