

**GENOTYPE-ENVIRONMENT INTERACTION OF THREE
CULTIVARS OF VITIS VINIFERA L. CULTIVATED IN TWO
DIFFERENT ENVIRONMENTS OF THE ISCHIA ISLAND: EFFECT
ON PRODUCTION AND QUALITY; ASPECTS OF THE QUALITY OF
THE OBTAINED WINES**

**INTERACTION ENVIRONNEMENT-GÉNOTYPE DANS TROIS
CEPAGES DE VITIS VINIFERA L. CULTIVÉES DANS DEUX
DIFFÉRENTS TERROIRS DE L'ÎLE D'ISCHIA : EFFET SUR LA
PRODUCTION ET LA QUALITÉ; ASPECTS DE LA QUALITÉ DES
VINS OBTENUS**

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Mots clés : Cépages, terroir, vins.

ABSTRACT

During a three year period the productive and qualitative behaviour of three grapevines, all native of the Campania region (Southern Italy), in two distinguished environments of the Ischia island it has been studied, with the aim to obtain some preliminary indications on the productive and qualitative grapevines behaviour and on the quality of the obtainable wines. The results indicate the nonexistence, for all the tested cultivars, of limiting factors their cultivation in the considered environments. The grapevines behaviour and the quality of the obtained wines mostly were influenced by the "grapevine factor" than by the "terroir factor". Biancolella wine was categorised as "acceptable", Greco and Fiano as "good".

RESUME

Pendant une période de trois années le comportement productif et qualitatif de trois cépages tous indigènes de la région de Campania (Italie méridionale) dans deux terroirs de l'île d'Ischia a été étudié; ceci pour obtenir quelques indications préliminaires sur le comportement productif et qualitatif des cépages et sur la qualité des vins. Les résultats obtenus indiquent la non-existence de facteurs limitants pour la culture de tous les cultivars

testés dans les terroirs considérés. Le comportement des cépages et la qualité des vins obtenus la plupart du temps ont été plus influencée par le «facteur cépages» que par le «facteur terroir». Le vin de Biancolella a été catalogué comme «acceptable» Greco et Fiano comme «bon».

INTRODUCTION

The effect of the combination grapevine-environment on quality expression of a cultivar and wine quality is well known.

The image of many famous wines is strongly dependent by the grapevine and the *terroir* in which they're cultivated.

Both the wine consumption reduction and the increased demand of high quality wines observed in last years all over the world, currently determine the necessity to adequate the production of wine to the changed demand of the consumers.

In the last years, a tendency to produce wine using few international varieties like Chardonnay, Merlot, Cabernets, Pinots was observed, with the consequence of an excessive simplification of the consumers taste.

A possible answer to one-variety tendency observed, in order to reach the objective to obtain wines characterised by an high originality and to increase and diversify the world offer of wines, may be obtained studying the interactions between internationally unknown but potentially interesting varieties, and different environments.

In the delineate context, in the present research the effect induced by two different *terroir* of the Ischia Island (Campania region, southern Italy) on three grapevines, all autochthon of the Campania region, was studied.

MATERIALS AND METHODS

Observations were carried out in the three-year-period, '99-2001, on a total number of 600 six-year-old plants of the Biancolella, Fiano and Greco grapevines, all grafted onto Berlandieri x Rupestris 1103P, grown at two "Pietratorcia" vineyards characterised by different environments, situated at

Ischia island (province of Naples, Campania region, Southern Italy). The first vineyard was located at "Cuotto"; the second at "Panza", in a different place of the isle. The plants, arranged according to the rectangular plan of 1.50 x 1.00 m, were trellis trained and Guyot pruned, leaving with the winter pruning a bud load of 12 on the cane and three on the spur. One hundred vines per each grapevine/terroir were utilised; they were divided into two groups (treatments): the first of 20 being used for periodical analyses conducted on samples of clusters, while the plants of the second group were left indisturbed up to complete ripening so as to carry out customary yield analyses at harvest and all used for winemaking. In December of each year, the same bud load of 15 + 3 was left on the plants of the two treatments (the first number denotes the number of buds left on the cane and the second indicates those left on the spur with winter pruning). At harvest, the following were measured: number and weight of clusters; berry weight, grape yield per plant; and for the must, the refractometric sugar content (°Brix), the pH and the titratable acidity (g/l). Bud fertility and Ravax's index were calculated. Harvest took place on the basis of must characteristics, when the refractometric degree was from 17 (Biancolella) to 22.0 °Brix, (Fiano and Greco), the pH of 3.10 (Greco), 3.20 (Fiano) and 3.40 (Biancolella), and the titratable acidity of 5.0

(Biancolella), 6.0 (Fiano), 9.0 (Greco) grams per liter. According to the opinion of vinemakers, these values were considered optimal to obtain good wines using Biancolella, Greco and Fiano.

During the fermentation the must-wine daily was monitored for sugars, titratable acidity and fermentation temperature (data not reported). At the end of the fermentation, for the obtained wines the main chemical customary analyses were made. The wines also underwent sensory evaluation by a panel of tasters from the University of Tarragona. The test results were submitted to analysis of variance and differences highlighted with Fisher's test.

RESULTS

The trial was conducted on a sand-subalkaline soil, characterized by a low phosphorous and a rich K content (Table 1). No appreciable differences between *terroir* emerged in the main chemical components.

Degradation and accumulation kinetics of components in the berry

The evolution of the sugars in the berry (Figure 1A) was similar among the two *terroir*; however, appreciable differences emerged between the grapevines. The sugar content, increased slowly and was quite similar among the three cultivars during the first period of accumulation, from 181th to 201th julian day. The rapid increase of sugars began the 181th and ended the 251th julian day: during this period Fiano showed a faster accumulation than Greco, Biancolella the slowest. In the following period, up to ripening and beyond, the mass of sugars increased slowly for the tested cultivars: during this period Fiano and Greco had a quite similar evolution, while Biancolella showed a different pattern, assuming lower values.

As to the sugars, also pH (Figure 1B) showed no appreciable differences between the two *terroir*, while some differences among grapevine emerged. The Greco, in particular, starting from the 211th julian day, showed a lower pH level than others and reached, at the end of the evolution, the lowest values both in Cuotto and Panza vineyards.

As regards to the titratable acidity, (Figure 1C), different kinetics between grapevines were observed; no appreciable differences, among the two *terroir* (Figure 1C), emerged. The highest values for Biancolella, Greco and Fiano were of 53, 40, 52 grams per liter and were registered on the 181th 191th 181th julian day, respectively.

Like what observed for quality parameters, berry weight (Figure 1 D), showed a different pattern in the three cultivars, with plants of Greco having substantially smaller berries than Fiano; Biancolella showed the highest berry weight. No substantial differences due to *terroir* were observed; however a slight tendency to a faster weight increase for Biancolella and Greco in Panza was registered while an opposite tendency was observed for Fiano.

Harvest: production and quality

As stated above, the date of harvest (Table 2), according to the exigency of the winemaker, varied between grapevines and occurred for Biancolella, Fiano and Greco on 281th, 270th, 268th julian day, respectively. Yield (Table 2), showed some differences between the grapevines and the two *terroir*. In particular, for Biancolella and Fiano the tendency of a higher production in Panza (respectively of 2.56 and 2.29) was registered, while for Greco a slightly higher production (2.1) in Cuotto, was observed. However, no statistical significant differences between grapevines and *terroir* were observed. As to production, a tendency of a

higher number of clusters in Panza for Biancolella (9.9 clusters) and Fiano (12) and a lower number for Greco (15.4) was registered. Statistically significant differences for the parameter, between grapevines, were registered.

The weight of clusters varied between grapevines and *terroir*. For Biancolella a weight of 310 and 259 g respectively in Cuotto and Panza, was registered. For Fiano, in the some *terroir*, a weight of 165 and 191 was weighted, while for Greco almost the same weight in the two *terroir* was registered. Thus, no statistically appreciable differences due to “*terroir* effect” in yield of clusters, were observed. Statistically significant differences in the weight of the clusters due to “grapevine effect” were registered.

The weight of berries of Biancolella and Greco in the two *terroir* was almost similar; for Greco in Cuotto a higher weight (143 g) was registered. As to cluster number and weight, strong differences in berry weight between grapevines, were observed and statistically significant differences due to “grapevine effect”, were registered. No statistically appreciable “*terroir*” and “grapevine x *terroir*” interaction effects were registered.

The refractometric degree of must for Biancolella, Greco and Fiano, in Cuotto, was respectively of 17.1, 22.1, 21.5; as stated above, the berry sugar content was almost similar in Panza, respectively of 17.2, 21.9, 22.2 °Brix.

Similarly to sugars, the pH resulted almost homogeneous between the two *terroir*, while some differences emerged between the grapevines: for Biancolella, Greco, Fiano in Cuotto values respectively of 3.4, 3.2, 3.1 were registered; respective values of 3.5, 3.2, and 3.1 in Panza were measured.

As to sugars and pH the titratable acidity showed some statistical differences between grapevines: for Biancolella, Greco, Fiano, values respectively of 5.1, 5.9, 9.7, in Cuotto, were obtained; respective values of 4.6, 5.5, 8.5, in Panza, were registered. As reported, a tendency to lower values for the three cultivars in Panza was registered; however no statistical effects due to “*terroir*” or “grapevine x *terroir*” interactions were registered.

Statistically strong significant differences between grapevines for all the quality parameters tested were registered; while no statistically significant variations due to “*terroir* effect” and to “grapevine x *terroir*” interactions were registered.

No substantial variations in bud fertility, between grapevines, emerged: the obtained values oscillated from 0.75 (Fiano, Cuotto) to 0.91 (Biancolella, Panza). However, statistically appreciable differences, between the two *terroir*, emerged: for Biancolella and Fiano, the highest values (respectively of 0.91 and 0.86), were registered in Panza; for Greco, in Cuotto (0.83).

There were no appreciable variations in Ravax's index values among the two *terroir*; for Biancolella, Greco, Fiano, the registered values in Cuotto and Panza were respectively: 5.5, 2.6, 1.4 and 5.2, 2.2, 2.7.

Chemical analyses of wines

Results for the alcohol content (Table 3) of the wines showed that grapevine had a greater effect than *terroir*. Biancolella had a lower alcohol content (9.77 and 10.39) than Greco (11.96 and 11.64), while the Fiano variety had a higher level (13.19 and 13.02).

Variety and *terroir* both affected total acidity. The effect of variety was clear: the acidity of Greco wines was higher than that of the other two varieties (values of around 8), while the acidity of Biancolella and Fiano was between 6 and 7 (in terms of g/l of tartaric acid). As for

terroir, there were differences of 0.5 g/l between wines of the same variety. The highest concentrations were in the wines from Cuotto. The Fiano variety had the lowest concentration of malic acid (0.8 and 0.7), and the Biancolella variety had the next lowest (1.29 and 1.23). The Greco had the highest concentration of malic acid (1.39 and 1.47). The results for gluconic acid, which indicate the risks of the grape being contaminated by botrytis, showed that rotting grapes are a risk in the Biancolella variety. They also showed that *terroir* also had an effect, since the concentrations of gluconic acid were higher in the wines from Panza than in the wines from Cuotto (1.43 and 0.95, respectively).

The intensities of the colors of the wines we analyzed were similar. The shades of yellow were slightly less intense in the Biancolella. This cultivar also had the lowest amounts of phenolic compounds. There were varietal and *terroir* effects: in one hand, the yellow color tended to increase in Fiano, in another hand, there were higher levels of phenols in Cuotto than in Panza.

Sensorial analysis of wines

For the evaluations, reference was made to the form proposed by Vedel (1972) according to which the score attributed to the wine is inversely proportional to its quality.

Appearance:

The scores (Table 4) ranged from 4.0 to 6.1. There were practically no differences between the wines. However, statistical results showed that there was a preference for the colors of the Fiano wines, whose scores were the lowest (between 4.6 and 4).

Nose:

Aroma analysis clearly showed that there were differences between cultivars. The types and complexity of aromas were more pleasant in the Greco and Fiano varieties than in Biancolella. There were no statistical significant differences between the wines produced in the two different *terroir*. However, the quality of the wines from Panza tended to be higher.

The bouquet of the wines of the Biancolella grapevine, had a predominant and intense herbaceous component. There were mixtures of rather unpleasant resin, varnish and medicine aromas, which were stronger in the Biancolella wines from Cuotto. In the Greco, although the aroma was less intense, it was a pleasant aroma, reminiscent of the citrus family. This cultivar also contained aromas of ripe fruits such as apple and pear. In the Fiano variety, the aromas were of mixtures of acid fruits and nuts such as hazelnuts.

Palate:

Statistically, there were appreciable differences between the Biancolella and Fiano grapevines. The wine tasting notes showed that the taste of the wines of the Biancolella grapevine was less complex, and that rather too intense herbaceous and medicinal tastes were perceived. Acidity was found in all the wines. The greatest sensation of acidity was found in Greco and Fiano wines, particularly in the Greco from Cuotto. The Fiano wine from Cuotto had a slightly sweet taste, which helped to counteract the acidity. Chemical analyses of that wine (Fiano-Cuotto) showed that the small quantity (4 g/l) of residual sugars might have caused this effect. The Fiano wines were more consistent and more glyceric than the others.

Harmony:

The equilibrium in the Biancolella wines was not suitable because there was a predominance of a herbaceous taste and there was a lack of consistency. Statistically, they were different from the other wines (except for the Greco wine from Cuotto) at a high level of significance. Greco wines, being more fruity, were more pleasant, although they lacked intensity and glycerine. Of these wines, the Greco wine from Cuotto, because of its acidity, was the least pleasant. On the other hand, the Fiano wines were fruitier and more complex. They also had a higher content of the alcohol and glycerol that give wine greater consistency.

Scores

The results for harmony were repeated in the final scores. The Biancolella wines were statistically different from the others. The best wine was the Fiano from Panza (50.6), closely followed by the Fiano wine from Cuotto (52.4), and the Greco wine from Panza (54.8). The Greco wine from Cuotto (59.6) and the Biancolella wines (69.3 and 74.2) were the last ones. Biancolella wines resulted clearly distinguished from the other ones with high statistical significance.

CONCLUSION

Our results enabled us to make the following considerations:

Grapevines

- Nonexistence of limiting factors the cultivation of the Biancolella, Greco and Fiano grapevines in the two-tested *terroir*;
- The seasonal kinetics of the components in the berries and the customary parameters recorded at harvest, mostly were influenced by the grapevine, with high statistic significance.
- Except for the bud fertility, no statistical appreciable variations of the production and of the main quality parameters between the two *terroir* and grapevine x *terroir* interactions were registered.

Wines

Biancolella wines resulted clearly distinguished from the other ones with high statistic significance. These wines were categorised as acceptable, but they do not had a good equilibrium. Also, they were too light and too herbaceous.

Greco and Fiano wines were categorised as "good". Fiano wines, however, had more body and more consistency than Greco wines. Fiano wine from Panza had the highest score. The effect of grapevine resulted clear from the results. *Terroir* also had an effect on the Greco and Fiano wines because the wines from Panza were of a higher quality than those from Cuotto.

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Table 1 – Soil analyses.
Tableau 1 – Analyse du sol.

TESI	Sand	Lime	Clay	pH	CaCo3	Organic matter (%)	N (Kjeldahl)	P (ppmP2O5)	K (ppmK2O)
Cuotto 0-30	35.0	17.0	13.0	6.5	1.0	2.30	0.083	29	470
Cuotto 30-60	37.2	12.5	12.1	7.0	2.0	0.91	0.035	14	327
Panza 0-30	34.1	18.8	13.7	6.7	1.8	2.17	0.078	15	512
Panza 30-60	33.3	19.5	13.8	6.7	1.8	1.13	0.049	11	359

Table 2: Yield and quality parameters recorded at harvest (mean of years 1999-2001).

Tableau 2: paramètres de rendement et de qualité enregistrés à la vendange (moyen des années 1999-2001).

Vine	Terroir	Julian day	Yield/vine (Kg)	Cl/ vine (No)	Cl. weight (g)	100 berry weight (g)	Sugars (°Brix)	pH	Titr. acidity (g/l)	Bud fertility	Ravax's index
Bianc.	Cuotto	281	2,26±0.28	7,3±0.8	310±37	254±6	17,06±0.14	3,39±0.03	5,10±0.20	0,79±0.024	5,47±0.4
Bianc.	Panza	281	2,56±0.23	9,9±1.0	259±34	256±9	17,25±0.17	3,46±0.04	4,65±0.13	0,91±0.020	5,2±0.4
Greco	Cuotto	270	2,10±0.29	17,4±1.4	120±21	172±6	22,13±0.24	3,08±0.03	5,91±0.19	0,83±0.033	2,58±0.5
Greco	Panza	270	1,89±0.24	15,4±1.4	123±23	168±6	21,89±0.23	3,10±0.04	5,49±0.21	0,78±0.024	2,16±0.4
Fiano	Cuotto	268	1,29±0.29	7,8±0.9	165±28	143±8	21,59±0.16	3,25±0.05	9,71±0.26	0,75±0.034	1,42±0.7
Fiano	Panza	268	2,29±0.41	12,0±1.0	191±33	126±9	22,16±0.15	3,22±0.02	8,49±0.37	0,86±0.034	2,74±0.5
Effects											
a grapevine			n.s.	***	**	***	***	***	***	n.s.	**
b terroir			n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	**	n.s.
a x b interactions			n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

Table 3 - Wines analyses.

Tableau 3 – Analyse des vins.

Wine	Terroir	Degree % vol	Av g/l	IC ua	Malic g/l	Glucónic g/l	Att g/l	pH	Phenols mg/l gallic	Sr g/l
Biancolella	Cuotto	9.77	0.27	0.073	1.29	0.95	6.55	3.19	240	2.83
Biancolella	Panza	10.39	0.28	0.085	1.23	1.43	6.14	3.23	247	3.01
Greco	Cuotto	11.96	0.33	0.093	1.39	0.36	8.83	2.89	370	1.53
Greco	Panza	11.64	0.29	0.09	1.47	0.63	7.88	3.01	321	1.14
Fiano	Cuotto	13.19	0.43	0.118	0.8	0.54	6.73	3.28	317	4.23
Fiano	Panza	13.02	0.46	0.116	0.7	0.37	6.01	3.43	254	2.78

Av= volatile acidity; IC= color intensity; Att= total acidity (g/l tartaric acid); Sr= residual sugars.

Table 4: Sensory analysis of wines (year 2001).

Tableau 4 : Analyse sensorielle des vins (anne 2001).

Wine	Terroir	Appearance	Nose	Palate	Harmony	Score
Biancolella	Cuotto	5.5± 1.1 a	20.8± 0.4 a	30.6± 4.9 a	18.0± 0 a	74.2± 6.6 a
Biancolella	Panza	6.1± 1.6 a	18.5± 4.0 a	28.4± 2.9 a	16.0± 3.9 a	69.3± 9.7 a
Greco	Cuotto	5.6± 1.5 ab	15.1± 3.9 b	26.3± 1.8 bc	14.0± 4.5 ab	59.6± 7.6 ab
Greco	Panza	4.9± 2.0 b	15.5± 3.6 B	25.9± 2.4 BC	7.5± 3.8 bc	54.8± 6.7 bc
Fiano	Cuotto	4.6± 1.9 B	15,3± 4.5 B	24.8± 2.5 BC	7.8± 2.7 bc	52.4± 7.8 bc
Fiano	Panza	4.0± 1.4 C	12,4± 4.1 B	24.0± 2.8 C	8.0±2.1 bc	50.6± 7.7 C

Significance level

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A, B and C indicate differences between to grapevine or terroir. Level of significance: *=p 0.05; **=p 0.005; ***=p= 0.001.

Figure 1: degradation and accumulation kinetics of components in the berries (mean of years '99-2001). A=sugars; B=Titrateable acidity; C=pH; D=100 berries weight (B.C.=Biancolella Cuotto; B.P.= Biancolella Panza; F.C.= Fiano Cuotto; F.P.= Fiano Panza; G.C.= Greco Cuotto; G.P.= Greco Panza)

Figure 1: Cinétique de dégradation et d'accumulation des composants dans les baies (moyen des années '99-2001).



