Relationship between terroir and vegetative potential, productivity, yield and must composition of *Vitis Vinífera* L. *Cvs*. Cabernet Sauvignon under warm climate conditions.

Rapport entre terroir et potentiel végétatif, productivité, rendement et composition des moûts de *Vitis Vinífera L. Cvs.* Cabernet Sauvignon dans des conditions climatiques chaudes.

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Summary

One cultivar could produce distinct wines with typical properties and qualities different depending on its cultivated and its mesoclimatic conditions.

This work has been developed in several zones of Cádiz town: Arcos de la Frontera, Jerez de la Frontera (Gibalbín), Jerez de la Frontera (Macharnudo), Jerez de la Frontera (Torrecera) and Sanlúcar de Barrameda. It was selected parcels with Cabernet Sauvignon cultivars and with similar growing characteristics. It was studied mesoclimatic factors, physiological and agronomic behaviour of the plant and grape, must properties of 2006 and 2007 harvest over all the zones.

Our mesoclimatic factors results show difference amount zones studied, these are strongly influenced mainly by the proximity or distance to the cost. This effect modified physiological characteristic of the plant and grape, must and wine properties, and its obtained significant differences over the several zones studied. Besides, it's observed differences amount wines related to zones characteristic.

Keywords: terroir, Cabernet Sauvignon, vegetative potencial, must.

Introduction

Situated in south of Spain, Cádiz is where are produced Jerez wines, has a long-standing vine-growing tradition. Its considerate a warm climate zone and vines are grown in more than 10.000 ha with a only variety, whose are vineyards recognized officially by a important and historic DO. Today exists a tendence to grow vines for other varieties, nationals and internationals, to produce other kind of wines.

It is known that soil and climate are primary environmental factors to which the grapevine is subjected. Terroir related studies therefore mainly focused on effects of soil and climate on typicity and quality expression of wine (Vaudour, 2000). Seasonal morphological development of bunches and eventual chemical composition of the berry result from the interaction between the chosen soil and accompanying climate and consequences of long term practices (establishment techniques, row direction, vine spacing, trellising and pruning system), short term practiques (seasonal irrigation, fertilisation, canopy management programs), and harvest criteria applied by growers (Hunter and Archer, 2001a). Despite the dependence of proper physiological functioning of the grapevine on climate, like temperature, humidity and wind velocity, threshold values of regions and terroirs for various quality-important physiological processes, such as photosynthesis of leaves as well as colour development, sugar and organic acid formation, mineral accumulation and flavour development of grapes (Hunter, 2004). Also the development of sea breezes in the afternoon is also a phenomenon associated with the ripening period of grapes cultivated in this coastal area.

Mesoclima has an important role about development grapevine and the grape ripening, and also influence on pedoclimatic characteristic and on the level captation of the available solar power (Kliewer, 1970). Nowadays the bioclimatic index to understand the behaviour of grapevine with

different climatic parameters was known and operational. Some of these index are heliothermic index (IH) and Fresh night index (IF) (Tonietto, 1999).

The terroir allows the production of wines characterized by organoleptic typicality, the zoning approach becomes and important commercial vector for the wine productive sector. In order to obtain high typicality of wines and constancy in the years it is very important to use the dynamic concept of site evaluation, able to combine in a multidimensional analysis all the factors involving variability and to consider the system terroir-vine-wine as a whole (Iacono and Scienza, 1999).

The objective of this research was to establish how different locations of vineyards influenced on grape and wine quality of Cádiz town. Plant, grapes and wine were analyzed from each location for harvest 2006 and 2007.

Material and methods

Material and experimental design

The research has been realized on the cv. Cabernet Sauvignon, red grapevine which is recognized internationally by its good adjustment to different zones producing wines of high quality. Nowadays in the province of Cádiz is one of the varieties that the vine-growers are choosing to diversify with other wine products different from those of the zone.

Five specific locations have been chosen for this research. Those are: Arcos (Ar), north-eastern part of town; Gibalbín (Gi), northern part of town; Macharnudo (Ma), central part of town; Sanlúcar (Sa), southern part of town, at the coast; Torrecera (To), south-eastern part of town. In all case, soils are limestone with high water-holding capacity and on all locations a growing form was prune double cord and vertical espalier and 161-49 Couderc rootstock.

Variables measured

For climatic characterisation we have used data of temperature, rainfall and relative humidity, collected by 5 automatic meteorological stations belonging to the Consejería de Agricultura y Pesca (Junta de Andalucía). These data were measured during 2000 – 2007 season. Bioclimatic indexes (IH e IF) were calculated for every stations.

Vegetative and productive measurements were made from July until harvest: Leaf external Area (SA), Leaf area index (LAI), balance between LAI and SA, balance between yield and leaf area. All parameters were calculated using 20 control vines randomized for every locations. At harvest time, yield, number of clusters, size and bunch mass, number of grape by cluster, berry mass and rachis mass were measured on each control vine. In winter pruning weight were measured on each control vine too and was calculated Ravaz index.

After post-veraison, weekly were analyzed several parameters. The vines were marketed previously and a sample of grapes per location was picked, weighted and crushed. The sample was picked of bunch situated in different orientation of vine and in different part of bunch. For the follow-up of the technological ripeness, the following parameters have been analyzed: average weight of the berry, degree Baumé, total acidity, pH, potassium and index of ripeness (Official Community Methods, 1990).

Once harvested the grape was weighed to know the yield, there was controlled phytosanitary conditions and destemmed and crushed. The must were centrifuged and there were calculated the following parameters: degree Baumé, total acidity, pH, acids tartaric and málic, potassium and Folin-Ciocalteu's Index (Official Community Methods, 1990).

The results were subjected to analysis of variance, using a factorial design with type of location as main factor. The statistical analysis was carried out using the statistics programme STATISTIX 8.0.

Results and Discussion

Its observed differences between locations gathered to temperatures máx. and min. The most coast zone, Sanlúcar has termed amplitude minor than other zones more interiors. Beside that zone has mayor humidity, because its more influenced by sea breezes. Too, this zone presents minor sun radiation and lower rainfall. Table 1.

	Arcos	Gibalbín	Macharnudo	Sanlúcar	Torrecera
Temp. Max. (ºC)	24,5	24,5	24,1	23,0	24,6
Temp. Min. (ºC)	10,4	10,9	11,5	11,6	11,2
Temp. Mean (ºC)	17,5	17,5	17,6	17,2	17,4
Relative Humidity (%)	63,4	66,7	65,9	69,0	65,1
Speed of the wind (m/s)	1,9	1,8	1,5	2,4	2,1
Global Radiation (MJ/m^{2}dia)	6588,6	6394,1	6609,1	5580,3	6695,4
Mean Rainfall (mm)	553,0	572,6	596,4	434,6	549,7
ETo (mm/dia)	4,0	3,8	3,6	3,9	3,7

Table 1 Mesoclimatics variables. Average of seasons 2000 and 2007.

The bioclimatic index IF do not present differences alone between locations and all the values are into idem classification of warm nights (Tonnieto et al., 1999). By other hand, the bioclimatic index IH presents lower values in coaster location, Sanlúcar, and higher values in the most interior location, Arcos. (Serrano et al., 2006).

When we compare between two harvests studied, we find differences that is because the climatic conditions influence something over all these parameters. In 2006 season, it not observed significative differences about SA, LAI and LAI/SA for every location. The number of bunch and yield appear like highly significant. The weight of dry matter and the balance between yield and leaf area and Ravaz index are significant. Table 2.

	2006					
	Arcos	Gibalbín	Macharnudo	Sanlúcar	Torrecera	Signification levels
SA	1,049 c[(1)]	1,175 b	1,346 a	0,998 c	1,0535 c	-
LAI	5,2575 a	5,1955 a	4,2725 ab	3,6565 bc	2,4250 c	-
LAI/SA	5,1445 a	4,5260 ab	3,2825 bc	3,8650 ab	2,3580 c	-
Number of bunch	38,6 a	24,5 b	17,8 c	21,5 bc	20,2 c	**
Weight of bunch	250,03 a	245,17 a	224,16 ab	183,85 b	210,62 ab	-
Yield	8,0750 a	4,7650 b	2,0650 c	4,2625 b	2,9300 c	**
Weight of the pruning	1,0750 b	1,6875 a	0,7525 c	0,8425 bc	0,4450 d	*
SA/KG	0,3735 d	0,7275 c	2,0065 a	0,6570 cd	1,2060 b	*
Ravaz Index	10,155 a	2,868 d	2,772 d	5,308 c	7,133 b	*

(1) Different letters within the same file denote significant differences (p<0.05). Analysis of variance, signification levels: - (ns), * (p<0,05), ** (p<0,01)

Table 2 Vegetative and productive variables. 2006 season.

In 2007 season, the development vegetative denote significant differences idem to dry matter and the balance SA/Kg. However, yield and Ravaz index are not significant. Table 3.

	2007					
	Arcos	Gibalbín	Macharnudo	Sanlúcar	Torrecera	Signification levels
SA	2,5685 a[(1)]	2,2485 a	1,2755 b	1,3895 b	2,8935 a	**
LAI	5,0425 ab	7,5060 a	3,7495 b	3,0950 b	3,5460 b	**
LAI/SA	2,5245 ab	3,5130 a	3,0360 a	2,3505 ab	1,4325 b	-
Number of bunch	19,800 b	18,200 b	32,850 a	20,833 b	18,650 b	*
Weight of bunch	161,98 c	240,86 ab	188,86 bc	258,12 a	241,16 ab	-
Yield	4,2560 a	4,9420 a	5,5190 a	5,6850 a	4,8890 a	-
Weight of the pruning	0,9330 b	1,6815 a	0,7900 b	1,1010 b	0,7520 b	**
SA/KG	1,8130 a	1,2840 ab	0,6240 b	0,8645 b	1,8660 a	**
Ravaz Index	7,3705 a	3,4960 b	7,3375 a	5,0775 ab	7,2650 a	-

(1) Different letters within the same file denote significant differences (p<0.05). Analysis of variance, signification levels: - (ns), * (p<0,05), ** (p<0,01)

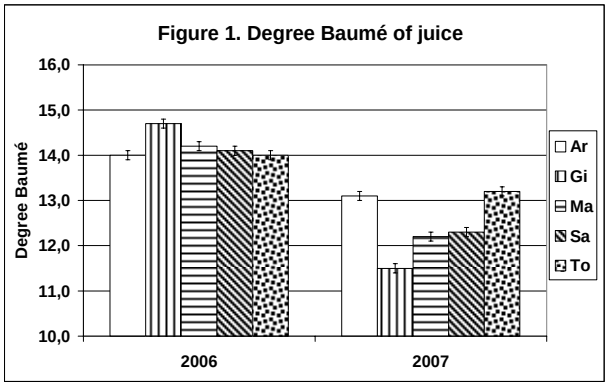
Table 3 Vegetative and productive variables. 2007 season.

Both of season the indicate values are higher than optimum values to a good vegetative development over vertical trelling (Smart, 1991). It's observed more yields into 2007 season for all locations. Gibalbín is the location with minor Ravaz index for two seasons and his value is under optimum range (Hidalgo, 1993).

Before commenting on the results of the musts, it is necessary to indicate that, the ripening in 2007 was anomalous enough from the climatological point of view, with temperatures lower than the average. On the other hand, in someone of the studied locations it rained torrentially in August and September. Therefore, only the results of 2006 are commented though in the graphs and table there appear the results of both seasons.

The degrees Baumé reached (in 2006) are the habitual ones of this variety in zones of hot climate (Fig. 1), which reached a value superior was Gibalbín, not being observed scarcely differences between the others.

The total acidity values found were abnormally low (Table 4 and 5) in Arcos and Gibalbín locations, and they presented values of pH more high (Fig. 2).



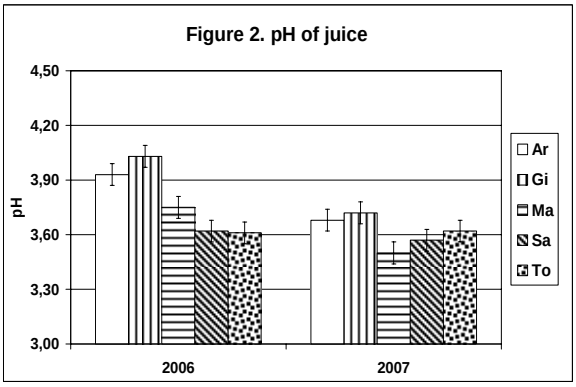


Figure 1 Degree Baumé of juice

Figure 2 pH of juice

	2006				
	Arcos	**Gibalbín**	**Macharnudo**	**Sanlúcar**	**Torrecera**
Date of harvest	31-ago	5-sep	31-ago	5-sep	29-ago
Degree Baumé	14,0	14,7	14,2	14,1	14
Total acidity (g/L TH2)	3,91	3,98	4,81	5,54	6,07
pH	3,93	4,03	3,75	3,62	3,61
Tartaric acide (g/L)	5,14	6,46	6,51	7,58	4,61
Malic acide (g/L)	1,49	1,66	1,27	1,26	1,19
Potassium (mg/L)	2063	2889	2348	2101	2409
Folin-Ciocalteu Index	9,5	13,9	13,2	12,7	16,1

Parameters were measured by triplicate and CV < 10 %

Table 4 Oenological parameters. Harvest 2006.

	2007				
	Arcos	**Gibalbín**	**Macharnudo**	**Sanlúcar**	**Torrecera**
Date of harvest	29-ago	13-sep	1-oct	20-sep	18-sep
Degree Baumé	13,1	11,5	12,2	12,3	13,2
Total acidity (g/L TH2)	5,19	5,70	4,78	5,73	4,55
pH	3,68	3,72	3,50	3,57	3,62
Tartaric acide (g/L)	6,30	6,50	6,40	6,66	5,33
Malic acide (g/L)	2,27	3,12	1,41	1,89	1,83
Potassium (mg/L)	2353	2452	1896	2102	1731
Folin-Ciocalteu Index	9,7	7,4	9,2	8,2	8,9
Parameters were measured by triplicate and CV < 10 %					

Table 5 Oenological parameters. Harvest 2007.

Conclusions

Summarized, all results show how not only the variety but also location of vineyard "terroir" has a strong impact on the quality of plant, grape and wine. This demonstrates that location of vineyard can result potentially significant between vineyard, variability in grapevine physiology, vegetative growth, yield and berry composition, with implications for wine style and quality. All this research continue in following years and we hope to obtain decisive results for Cadiz town characterization.

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