Technological characteristic of Chardonnay clone 37-28, grown in the Pleven region

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Abstract
In the period 2011-2013, a technological characteristic of the Ukrainian clone Chardonnay 37-28 was made at the IVE – Pleven. The Bulgarian clone Chardonnay 6-48 was used for control. During the grapes ripening stage, the dynamics of sugar accumulation in the grapes was monitored. Upon technological maturity the indicators of the yields were reported and mechanical analysis was performed. The chemical composition of the must, the obtained wines and their organoleptic qualities were analyzed. Chardonnay 37-28 had a lower average mass per cluster and a lower average yield compared to the Bulgarian clone. In mechanical composition it was typically wine clone and did not differ significantly in the cluster and berry structure from the control, had a high theoretical yield, intense sugar accumulation and lower titratable acids. The experimental wines were of high alcohol content, good titratable acidity, and insignificant differences in the concentration of total phenolic compounds and color intensity. The control wines had better organoleptic properties and were therefore scored higher than those of the Ukrainian clone.

Key words: Chardonnay; clone; grapes; mechanical analysis; wine; chemical composition

Chardonnay has been the most popular white wine variety in the world. However, its origin has not been fully established. It has been cultivated in the regions of Burgundy and Champagne since ancient times and therefore was considered to be a French one (Viala and Vermorel, 1905; Galet, 1958, 1976, 1990). In Bulgaria it started to be widely planted in the early 20th century (Katerov et al., 1990). At present it is mainly grown in the northeastern regions of the country, with an area of 11,93% of the white wine varieties and 4,38% of all vineyards in Bulgaria (Roychev, 2012).

Chardonnay is an early wine variety. Its grapes ripen at the end of August. Deeper, rich calcareous soils are suitable for the variety. It is rather resistant to frost and drought. The variety is characterized by average intensive growth, high fertility and average yield. It is sensitive to rot. Under favorable conditions, the variety shows good sugar accumulation and the sugar content of the grapes might vary from 20,0 to 24,0%, with an acidity of 7-9 g/l (Roychev, 2012).

The variety is one of the most widespread in the world and is widely grown in Asia, Europe, Australia, South Africa, South and North America. It is used for the production of high quality white dry wines with a rich fruity aroma and a specific fresh and harmonious taste, as well as wine materials for naturally sparkling wines. In France, it is associated with some of the most prestigious white champagne wines. In each country, depending on the soil and weather conditions of the growing area, Chardonnay wines have a specific and unique taste. They have the potential for aging and are suitable for aging in oak barrels, which give the wine additional notes of vanilla, smoke and oak, etc. (Roychev, 2012).

Worldwide, the clone selection has been the most common method for extending the structure of

vineyards of varieties within Vitis vinifera. It aims to improve the individual agro-biological, technological and economic characteristics of a variety. As a result, diversification of the vine assortment is achieved, based on the selection of clones with high levels of realization of the potential economic productivity and quality indicators of grapes and wine (Petrov et al., 2009; Meneghetti et al., 2010).

In the various winegrowing countries around the world, many clones of Chardonnay variety have been obtained through clonal selection. In France, they exhibited different productivity and grapes quality. Clones 548 (for quality), 75, 78, 96, 118, 119, 122, 125, 128, 130, 132, 277 (for productivity) and 76, 95, 121, 124, 131, 809 (for productivity and quality) have been more widely spread (Galet, 1990). Of Chardonnay's Italian clones, the most popular has been R8, distinguished for its very good adaptability to different soil and weather conditions (Moretti, 1994, 1998). From Chardonnay clones created in Ukraine, 2 clones have been recommended – Chardonnay 4876 and Chardonnay 4536 (Gadzalo et al., 2015).

In Bulgaria in 1994, Chardonnay 6-48 clone was approved by the State Variety Committee (Executive Agency for *Variety* Testing, Field Inspection and Seed Control), characterized by higher yield and it was suitable for the production of quality white dry wines (Nakov, 2006)

The objective of this study was to make a technological characteristic of the Ukrainian Chardonnay clone 37-28 grown under the soil and weather conditions of the town of Pleven (Central North Bulgaria).

MATERIAL AND METHODS

The study of Chardonnay clone 37-28 (Figure 1) was carried out during the period 2011 - 2013, at the Experimental Base of the Institute of Viticulture and Enology (IVE) – Pleven. The clone was grown at Ombrella training and planting distance of 3,00/1,30 m. The Bulgarian Chardonnay clone 6-48 was used for control (Figure 2). The applied growing practice was mixed pruning and equal loading – 32 winter eyes per vine (6 spurs of 2 eyes and 2 fruit canes of 10 eyes). During the "grapes ripening" phase, the dynamics of sugar accumulation was monitored by a refractometer to determine technological maturity and harvest time. Upon reaching the technological maturity, the productivity indicators were accounted, and a mechanical and chemical analysis of the grapes was performed (Katerov et al., 1990).

The grapes were processed in the Experimental Winery of IVE – Pleven. The classical technology for dry white wine making was applied under the conditions of micro-vinification (Yankov, 1992) – crushing, destemming, pressing, sulphuring (50 mg/l SO_2), must clarification, adding pure culture dry wine yeast *Saccharomyces cerevisiae Vitilevure B+C,* in amount of 20 g/hl, fermentation temperature 20°C, decanting, sulphuring to 30 mg/l of free SO_2, storage.

The grape must chemical composition was determined according to the following methods (Ivanov et al., 1979): sugars, g/l - areometer of Dujardin; glucose, g/l – iodometric method; fructose, g/l – calculation method; titrable acids (TA), g/l – titra-

Figure 1. Chardonnay clone 37-28

Figure 2. Chardonnay clone 6-48

tion with NaOH; pH - pH-meter; glucoacidometric index (GAI) – calculation method as the ratio of sugars (%) and TA (g/l).

The main indicators of wines chemical composition were analyzed by conventional methods in the wine-making practice (Ivanov et al., 1979; Chobanova, 2007): sugars, g/l – Schoorl's method; alcohol, vol. % - distillation method by the distillate density, Gibertini apparatus with densitometry; total extract (TE), g/l - Gibertini apparatus with densitometry, for the alcoholic-free sample density; sugar-free extract (SFE), g/l - calculation method (the difference between TE and sugars); titratable acids (TA), g/l - titration with NaOH; volatile acids (VA) g/l – distillation method with titration with NaOH; total phenolic compounds (TPC), g/l – method of Singleton et Rossi; colour intensity I, [abs. units] – method of Glories, measuring the absorbance at λ 420 nm; pH – pH-meter.

The organoleptic characteristics of the experimental samples were determined according to 100-score scale for the indicators: colour, aroma, taste and general impression (Tsvetanov, 2001) by a nine-member tasting committee.

RESULTS AND DISCUSSION

At technological maturity of the studied clones, the productivity indicators were accounted, and a mechanical analysis of the grapes was performed (Table 1).

The average mass of a cluster Chardonnay 37-28 was 143,3 g, ranging from 138,0 to 146,5 g. In the control, the mass per cluster was 147,2 g and varied insignificantly from 145,0 to 148,0 g. The average yield per vine from the studied Ukrainian clone was lower (3,993 kg) compared to that of the control (4,690 kg), mainly determined by their actual fertility. During the study period, the yield per vine of Chardonnay clone 37-28 ranged from 3,780 to 4,130 kg while in Chardonnay 6-48 varied over a wider range – from 4,110 to 5,460 kg.

The mechanical analysis revealed that the Ukrainian clone was typically wine one and did not differ significantly in the texture and structure of the cluster and berry from the control. On the average, for the study period, Chardonnay 37-28 cluster had 4,50% rachis and 95,50% berries, while in Chardonnay 6-48 the rachis were 4,69% and the berries 95,31%, respectively. The average mass per 100 berries had very similar rates – 156,67 g of the Ukrainian clone and 152,78 g of the control that also determined the insignificant difference in the structure of their berries. Chardonnay 37-28 berry contained 10,40% skins, 4,27% seeds and 85,33% mesocarp, while in Chardonnay 6-48 the skins were 10,37%, seeds – 4,21% and mesocarp 85,42%. Their theoretical yield was high – 81,49% of the Ukrainian clone and 81,41% of the control, that was determined by

Table 1. Mechanical analysis of grapes from the studied Chardonnay clones for the period 2011-2013.

Vintage	Average mass of a cluster g	Average yield per vine kg	Cluster texture		Average mass per 100 berries g	Berry structure			Theoretical yield %
			rachis %	berry %		skins %	seeds %	mesocarp %	
Chardonnay 6-48									
2011	148,0	4,500	4,76	95,24	168,33	10,10	3,68	86,22	82,12
2012	145,0	5,460	4,86	95,14	145,00	10,82	4,75	84,43	80,33
2013	148,0	4,110	4,45	95,55	145,00	10,20	4,20	85,60	81,79
average	*147,2*	*4,690*	*4,69*	*95,31*	*152,78*	*10,37*	*4,21*	*85,42*	*81,41*
Chardonnay 37-28									
2011	145,5	4,070	4,19	95,81	165,00	10,18	3,94	85,88	82,28
2012	146,5	4,130	4,80	95,20	150,00	11,33	4,53	84,14	80,10
2013	138,0	3,780	4,52	95,48	155,00	9,67	4,35	85,98	82,09
average	*143,3*	*3,993*	*4,50*	*95,50*	*156,67*	*10,40*	*4,27*	*85,33*	*81,49*

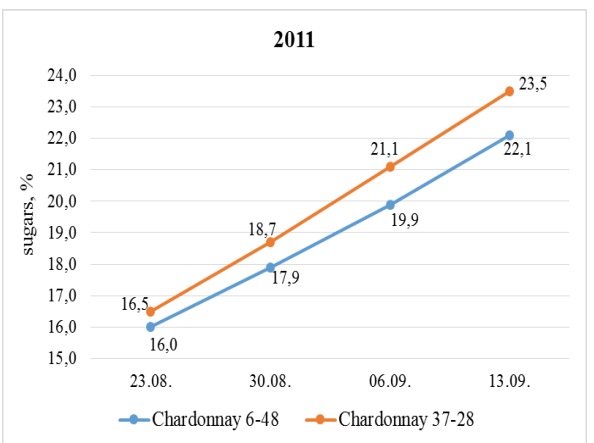
the insignificant difference in the berries and mesocarp ratio.

The dynamics of sugar accumulation in the grapes of the studied clones, during the ripening phase, over the study period is shown in Figure 3 (a, b, c).

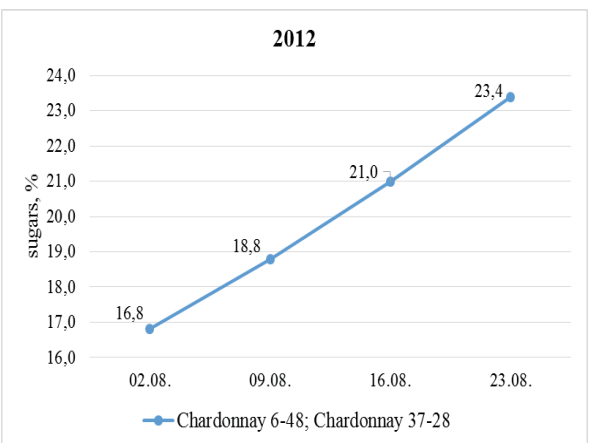
The first accounting of sugars in 2011 was made on 23 August: 16,0% for Chardonnay 6-48 and 16,8% for Chardonnay 37-28. The following readings showed a gradual increase in the rate of sugar accumulation from 1,9% (23.08.-30.08.) to 2,2% (06.09.-13.09.) for the control, and for the Ukrainian clone – by 2,2%, for the period 23.08.-30.08., and by 2,4% thereafter (Figure 3a). As a result, by mid-September (13th September), the sugar content of the grapes from the control was 22,1%, with 7,80 g/l of titratable acids. In Chardonnay, 37-28 the sugars were significantly more 23,5%, with lower titratable acidity – 7,43 g/l.

On 02.08.2012 the same amount of sugars was reported for the clone and the control – 16,8%. The same intensity of sugar accumulation was observed that year in both clones 6-48 and 37-28 – by 2,0% (02.08.-09.08.), by 2,2% (09.08.-16.08.) and by 2,4% (16.09.-23.08.) (Figure 3b). The chemical analysis showed that on 23.08. their grapes had reached technological maturity and the sugars were 23,4%. The titratable acidity of the control was higher – 7,95 g/l compared to that of clone 37-28 – 7,28 g/l.

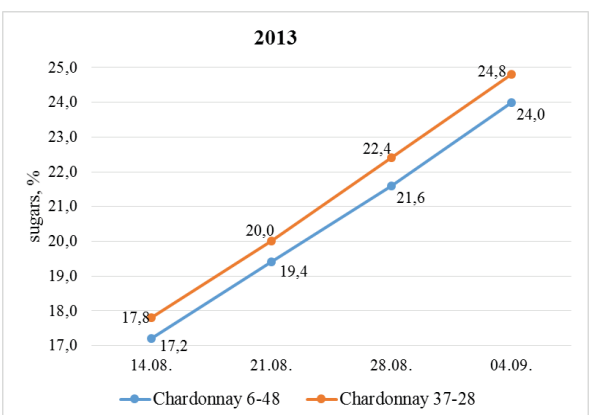
In 2013, the accounting of the sugar dynamics of both clones started in the middle of August (14.08.) as for 37-28 it was recorded 17,8% sugars and for 6-48 – 17,2%. In the following measurements, it was found that the sugar accumulation in the Ukrainian clone was more intensive: by 2,2% (14.08. - 21.08.) and by 2,4% for the periods from 21.08. to 28.08. and from 28.08. to 04.09. In the control, the sugar content increased by 2,2% for the period 14.08. -



a)



b)



c)

Figure 3. Changes in sugars during the grapes ripening period of the studied Chardonnay clones

21.08. and 21.08. to 28.08. and by 2,4% from 28.08. to 04.09. (Figure 3c). The analysis of grape must demonstrated that on 04.09. in Chardonnay 37-28, it was recorded 24,8% sugars and 6,15 g/l titratable acids, while in Chardonnay 6-48 – 24,0% sugars and 6,38 g/l titratable acids.

Upon reaching technological maturity of the studied Chardonnay clones, the grapes were harvested. The data on the must composition are presented in Table 2. During the study period, the Ukrainian clone and the control revealed high sugar accumulation, with their average rates being 239,00 g/l (Chardonnay 37-28) and 231,70 g/l (Chardonnay 6-48). Of the monosaccharides identified in the grape must, the fructose was predominant in both clones – 87,32 g/l glucose and 144,54 g/l fructose (average) for 6-48 and 84,41 g/l glucose and 154,59 g/l fructose (average) for 37-28. It was a proof that at harvest the grapes were at technological maturity. The clones had the typical acidity for Chardonnay variety. For the study period, higher acids (average 7,38 g/l) were analyzed in the must from the control compared to the Ukrainian clone (average 6,95 g/l). GAI had higher rates in Chardonnay 37-28 grapes (average 3,47) than in Chardonnay 6-48 (average 3,18). That indicated that the must from the Ukrainian clone had better technological indicators for the production of wines with optimal chemical composition and quality. In both studied clones, the 2013 grapes had a higher content of sugars, GAI rates and lower titratable acidity due to the more favorable weather conditions during the "ripening phase".

The chemical composition of the experimental wines obtained from the studied Chardonnay clones is presented in Table 3.

The experimental wines of both clones were characterized by high alcohol content – 13,81 vol. % (Chardonnay 37-28) and 13,88 vol. % (Chardonnay 6-48), as a result of the good sugar accumulation in their grapes. The highest alcohol and residual sugars were reported in the samples of 2013 vintage. The differences in the alcohol concentration of the samples from both clones per harvests and the average rates were negligible.

An important indicator of the wine composition has been the sugar-free extract content. Its rates varied within the typical ranges for Chardonnay – in 6-48 samples from 17,67 to 19,99 g/l, while in 37-28 samples – from 17,60 to 20,70 g/l. In the 2011 and 2012 vintages, the wines from the control exceeded those of the Ukrainian clone. In 2013, the reverse trend was observed. The experimental samples had normal titratable and volatile acidity. The wines from the control clone contained more titratable acids (average 6,83 g/l) compared to the wines of the Ukrainian clone (average 6,30 g/l). The phenolic substances concentration and the colour intensity of the experimental samples were also within the range, typical of white wines, as the differences between the wines of the studied clone and the control were insignificant.

Table 2. Chemical composition of grape must from the studied Chardonnay clones, for the period 2011-2013.

Vintage	Date of harvest	Sugars/ g/l	Glucose/ g/l	Fructose/ g/l	Titratable acidity/ g/l	GAI	pH
Chardonnay 6-48							
2011	13.09.	221,00	98,80	122,20	7,80	2,83	3,27
2012	23.08.	234,00	77,40	156,60	7,95	2,94	3,25
2013	04.09.	240,00	85,76	154,82	6,38	3,76	3,34
average		*231,70*	*87,32*	*144,54*	*7,38*	*3,18*	*3,29*
Chardonnay 37-28							
2011	13.09.	235,00	98,80	136,20	7,43	3,16	3,28
2012	23.08.	234,00	81,00	153,00	7,28	3,21	3,25
2013	04.09.	248,00	73,44	174,56	6,15	4,03	3,36
average		*239,00*	*84,41*	*154,59*	*6,95*	*3,47*	*3,30*

Table 3. Chemical composition of wines from the studied Chardonnay clones, in the period 2011-2013

Vintage	Alcohol vol. %	Sugars g/l	Total extract g/l	SFE g/l	Titratable acidity g/l	Volatile acidity g/l	pH	TPC g/l	Colour intensity I [abs. units]	Tasting score
Chardonnay 6-48										
2011	13,72	1,33	19,00	17,67	6,75	0,68	3,12	0,62	0,012	77,44
2012	13,67	1,71	21,70	19,99	7,13	0,70	3,18	0,49	0,008	77,29
2013	14,24	5,26	23,20	17,94	6,20	0,66	3,25	0,48	0,130	79,33
average	*13,88*	*2,77*	*21,30*	*18,53*	*6,69*	*0,68*	*3,18*	*0,53*	*0,050*	*78,02*
Chardonnay 37-28										
2011	13,17	1,40	19,00	17,60	6,83	0,66	3,14	0,63	0,013	75,78
2012	13,40	1,95	20,30	18,35	5,63	0,80	3,21	0,59	0,007	74,43
2013	14,86	6,30	27,00	20,70	6,05	0,66	3,28	0,49	0,116	78,33
average	*13,81*	*3,22*	*22,10*	*18,88*	*6,17*	*0,71*	*3,21*	*0,57*	*0,045*	*76,18*

The results of the chemical and organoleptic analysis did not show a direct correlation between the SFE content, the titratable acids and the tasting evaluation of the samples. The 2013 vintage wines had the lowest rates of TPC, but at tasting they were assessed higher. During the study period, the control samples surpassed in organoleptic qualities those of the Ukrainian clone. The average tasting score of Chardonnay 6-48 wines was 78,02 points, and of Chardonnay 37-28 wines was 76,18 points (Table 3). That had indicated that the control samples had better tasting characteristics in terms of aromatic and taste indicators, harmony and balance between them.

CONCLUSIONS

On the basis of the obtained results from the comparative technological study of both Chardonnay clones, grown under the soil and weather conditions of Pleven region, it could summarised:

• Chardonnay 37-28 had less average mass per cluster and a lower average yield per vine compared to the control.

• In its mechanical composition, the Ukrainian clone was typically wine one and it did not differ significantly in the texture and structure of the cluster and berry from the control. The theoretical yield of both clones was high – 81,49% (Chardonnay 37-28) and 81,41% (Chardonnay 6-48).

• Both clones exhibited high sugar accumulation with average rates of 239,00 g/l (37-28) and 231,70 g/l (6-48), with higher titratable acids for the control.

• The experimental wines from both clones had high alcohol content. In 2011 and 2012, the control wines surpassed those of clone 37-28 in SFE. Wines from clone 6-48 contained more titratable acids (average 6,83 g/l) than wines from the Ukrainian clone (average 6,30 g/l). The differences in the TPC concentration and the colour intensity were insignificant between the studied clone and the control.

• No direct correlation was found between SFE content, titratable acidity and the tasting score of the samples. The wines from the control (clone 6-48) had better organoleptic characteristics and respectively higher average scores (78,02 points) compared to the Ukrainian clone (76,18 points).

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