LOCATION AS A FACTOR ON THE PRODUCT AND TECHNOLOGICAL POTENTIAL OF THE RHINE AND ITALIAN RIESLING

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ABSTRACT

Tikvesh wine region is located in the centre of the Republic of Macedonia and it's one of the most important wine regions in this country. The wine production in this region dates back from the 4th century BC, and today it covers around 13,000 ha of vineyards which represents one- third of the total grape production in Republic of Macedonia. From the various locations that are part of this region, our focus and interest was on the three localities: Kavadarci, Negotino and Demir Kapija. This research was made on the white wine varieties Italian and Rhine Riesling which today are increasingly spreading on the territory of Republic of Macedonia. Several parameters were examined including: dynamics of maturation, yield, the mechanical composition of the grapes, the chemical composition of must. The purpose of this research is to determine the technological and production potential of these varieties and to determine which of these localities gives the most suitable results for the further spread, both in the Tikvesh region and beyond.

Key words: Vineyard, locality, variety, production potential, technological potential, dynamics of maturation, yield, mechanical composition, chemical composition

INTRODUCTION

The quality of the wine is defined by three factors that are globally represented as the "triangle of quality", namely: the climate and the soil, i.e. location (which affect grape quality), grape variety, and human factors (which include cultivation techniques, production, storage, and grape and wine maturation methods).

The white wine grape varieties Italian Riesling and Rhine Riesling belong to the group of Western European varieties (Proles occidentalis), subgroup Gallica (Subproles gallica). They are international, leading varieties for the production of white wines in a large number of countries. The raw material is used for the production of premium quality and special wines. The wines are quite famous and in demand on the wine markets. In RS Macedonia, the Italian and Rhine Riesling varieties were introduced during the second renewal of the vineyards. Today, they are represented in several vineyards and are recommended varieties for the production of quality and top quality wines. The quality of the raw material for these varieties is highly dependent on the cultivation system, environmental conditions, applied agrotechnical and ampelotechnical practices, health status, degree of maturity, method of harvesting, etc.

With nearly 13,000 hectares of vines, the Tikvesh wine region (Picture 1) represents around one third of all the grapes grown in Macedonia, a place where the southern

Mediterranean climate, full of long and warm summers and the northern continental climate, with mild and rainy winters, combine. The average air temperatures per year are 13.3°C and the vegetation temperatures are 18°C. The summers are long and hot with temperatures that go even beyond 43°C and the winters mild and rainy with an average annual rainfall insufficient and unevenly distributed of 293 mm during the vegetation period. The vineyards are located at an average of 300 metres above sea level, protected by mountains and highlands on three sides, channelling the gentle north winds and Mediterranean climates, creating ideal grape growing conditions.

Grapevines are mostly planted on chernozem, rendzina and vertisol soils, and only occasionally on cinnamonic and diluvial soils.
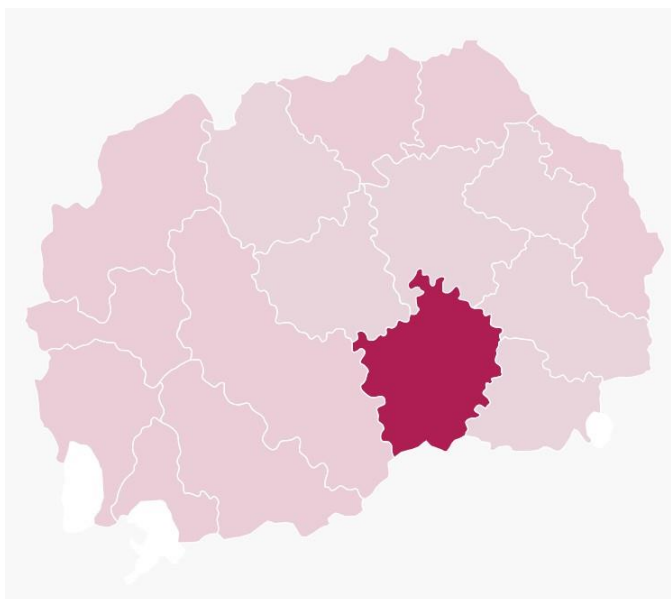
Picture 1. Map showing the Tikvesh wine region

There are over 20 different grapes varieties grown in the Tikvesh district including many indigenous and international varieties such as red varieties including Vranec, Kratosija, Kadarka, Cabernet Sauvignon, Merlot, Pinot Noir, Syrah in addition to Žilavka, Župljanka, Graševina, Plavec, Smederevka, Chardonnay, Sauvignon Blanc, Muscat Ottonel, R'kaciteli and Riesling for the whites. (http://winesofmacedonia.mk/tikves-wine-district/)

Because of the extraordinary potential of high quality grape and wine production, the Tikvesh wine region is the subject of interest in this research. Our goal is to give more precise recommendations in the production practices regarding the further spread and cultivation of these two white wine varieties in the Tikvesh wine region and beyond.

MATERIALS AND METHODS

The research was done on the vineyards of three localities in the Tikvesh wine region. The varieties of our interest were Rhine and Italian Riesling, white wine grape varieties with great potential for expansion in this wine region. The plantations were on three locations: Negotino, Kavadarci and Demir Kapija where from each variety 60 vine plants in full maturity were taken as examples for this research.

The dynamics of sugar and total acids content were determined by repetitions of measurements in every 7 days. The harvest was made at the full technological and phenolic maturity of the grapes. The yield (kg/m²) was determined by using mathematical calculation. The bunch weight was determined by measuring the weight of 21 representative bunches of each variety. The sugar content in grape must was measured with an Oechsle meter. Total

acidity in grape must was measured by potentiometric titration using the indicator bromothymolcine.

In the obtained results for the individual parameters were calculated the average value, standard deviation and coefficient of variation CV%. Analysis of variance (ANOVA) was also applied for hypothesis testing and the obtained average values were compared with LSD test.

RESULTS AND DISCUSSION

The results obtained during the field and laboratory analysis of the studied varieties on different locations are divided into two groups:
1. Production characteristics: bunch weight and yield;
2. Technological characteristics: dynamics of grape ripening and chemical composition of must.

1.1. Bunch weight

The weight of the bunch depends on several factors such as: the variety and the clone, the rootstock, the pruning method, the cultivation method, the agrotechnical and ampelotechnical measures applied in the vineyard etc.

Table 1. Bunch weight of Rhine and Italian Riesling expressed in grams

Variety	Indicator	Kavadarci	Negotino	Demir Kapija
Rhine Riesling	$\bar{x}$	144,00 a	145,00 a	139,00 b
	CV%	0,81	0,64	0,67
	LSD 0.05 = 0.141749			
Italian Riesling	$\bar{x}$	163,53 a	166,69 b	168,67 c
	CV %	0,83	0,89	0,99
	LSD 0.05 = 0.990698			

The highest average bunch weight of Rhine Riesling was obtained in Negotino, and the lowest was in Demir Kapija. A significant difference at the level of $p = 0.05$ occurs in the variant grown at the Demir Kapija locality compared to the Negotino and Kavadarci localities (Table 1). There are several researches and literary data in which the bunch weight of the Rhine Riesling has been ascertained within the obtained values such as those of Božinović (2010), Cindric (1990) and Garić (1993). The authors Cvetkovic (1991), Giorgio et al. (2012) and Boshkov (1996) obtained somewhat lower values in relation to the weight of the bunch of Rhine Riesling. For the Italian Riesling variety, the highest average weight was obtained in Demir Kapija, and the lowest in Kavadarci. Significant difference at the $p = 0.05$ level is noticed among all three variants. Confirmation of similar values in relation to the weight of the bunch of Italian Riesling was also obtained by the authors: Jevtimova(1994), Cindrich et al. (1977−1984) and Avramov et al. (1994) and slightly lower values were found by the authors: Petrović (2012), Bunea et al. (2010), Babrikov (2000), Kozina (1999), Avramov et al. (1968), Boshkov (1996) and Cvetkovic (1991).

1.2. Yield

The amount of harvested grapes depends on the variety, the cultivation system, the environmental conditions, the agrotechnical and ampelotechnical measures etc. The quality of the grapes is directed by planning and controlling the yield.

Table 2. Amount of grapes picked from the Rhine and Italian Riesling varieties (kg/m²)

Variety	Indicator	Kavadarci	Negotino	Demir Kapija
Rhine Riesling	x̄	1,23 a	1,14 b	1,07 bc
	CV%	0.18	0.15	0.16
	LSD 0.05 = 0.074267			
Italian Riesling	x̄	1,53 a	1,43 a	1,26 b
	CV %	0.21	0.25	0.21
	LSD 0.05 = 0.126158			

In both varieties, the highest average yield per m² were achieved at the locality in Kavadarci, while the lowest in Demir Kapija (Table 2).
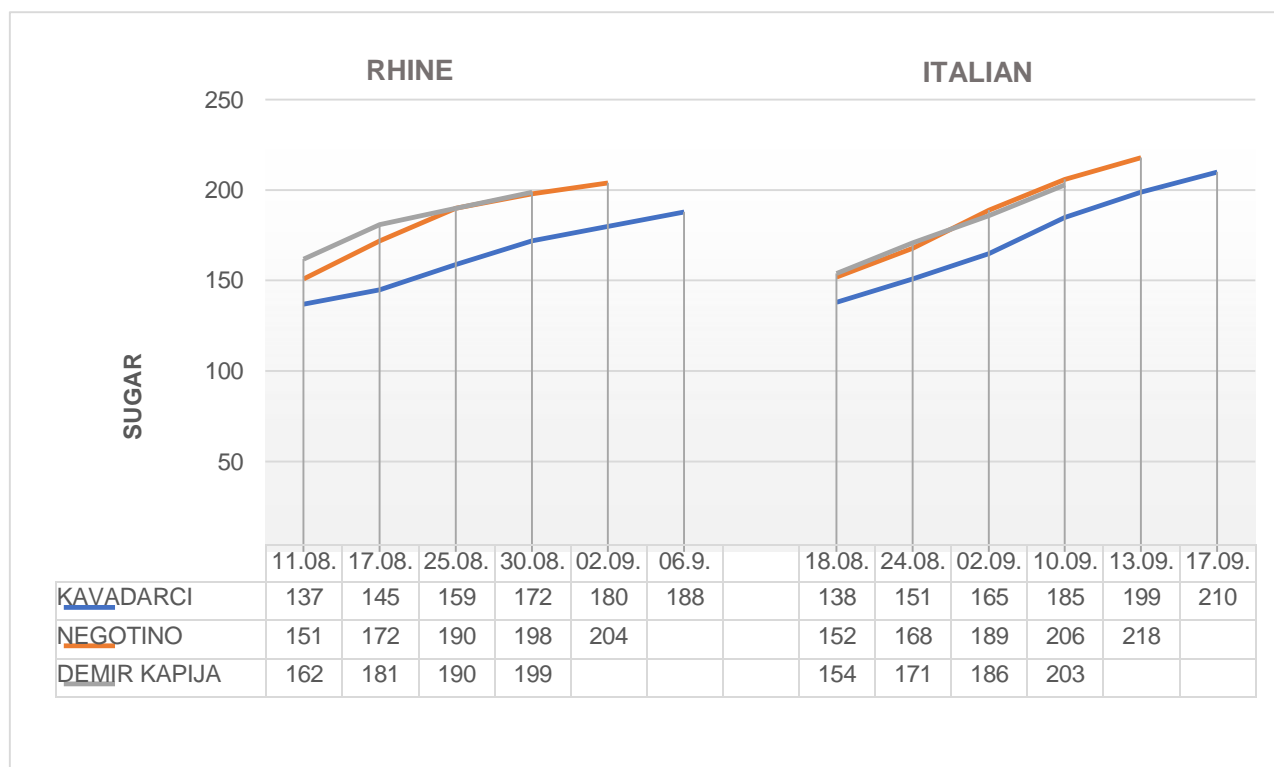
According to the statistical processing of the results obtained for the Rhine Riesling, the amount of grapes picked in Kavadarci is significantly different in relation to the amount of grapes picked in Negotino and Demir Kapija, and for the Italian Riesling variety, the amount of grapes picked in Demir Kapija is significantly statistically lower in relation to the amount of grapes picked in the varieties of the localities Kavadarci and Negotino (Graph 1).
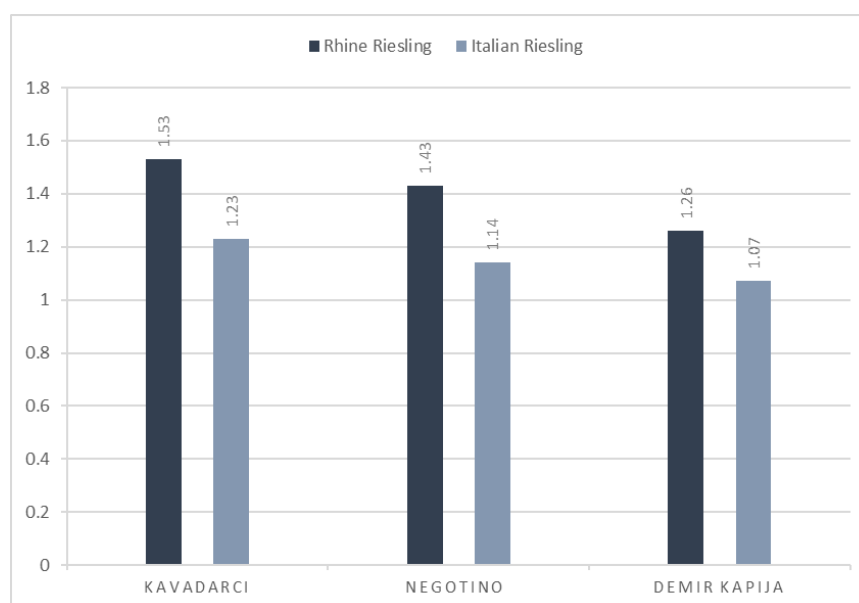
Graph 1. Average yield of Rhine and Italian Riesling varieties (kg/m²)

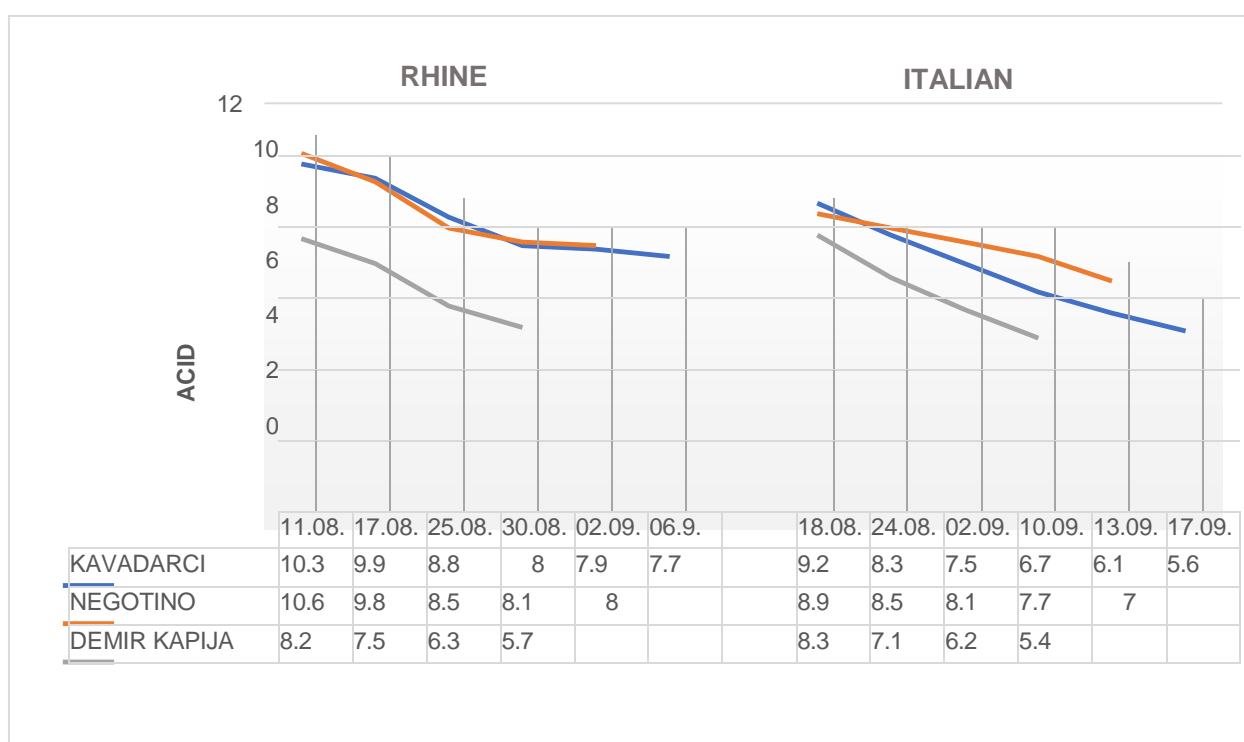## 2.1. Sugar and acids dynamics of grape ripening

The dynamics of grape ripening depends on several factors, such as: environmental conditions, the variety, the load of the vine with a crop, agrotechnical and agrotechnical measures etc.

In the course of our research for both studied varieties, the measurements of the grape ripeness showed that in Demir Kapija, after a certain degree of maturity, the content of total acids began to drop sharply, which initiated a faster harvest compared to the other localities.

RHINE	11.08.	17.08.	25.08.	30.08.	02.09.	06.9.	ITALIAN	18.08.	24.08.	02.09.	10.09.	13.09.	17.09.
KAVADARCI	137	145	159	172	180	188		138	151	165	185	199	210
NEGOTINO	151	172	190	198	204			152	168	189	206	218	
DEMIR KAPIJA	162	181	190	199				154	171	186	203		

Graph 2. Sugar dynamics during the grape maturation

The highest value for the average sugar content (Graph 2) during maturation of Rhine Riesling was reached in Negotino, with a total of 204 g/l sugars at the time of harvest. The lowest amount of sugars was measured in Kavadarci, a total of 188 g/l during harvest.

RHINE	11.08.	17.08.	25.08.	30.08.	02.09.	06.9.	ITALIAN	18.08.	24.08.	02.09.	10.09.	13.09.	17.09.
KAVADARCI	10.3	9.9	8.8	8	7.9	7.7		9.2	8.3	7.5	6.7	6.1	5.6
NEGOTINO	10.6	9.8	8.5	8.1	8			8.9	8.5	8.1	7.7	7	
DEMIR KAPIJA	8.2	7.5	6.3	5.7				8.3	7.1	6.2	5.4		

Graph 3. Acidity dynamics during the grape maturation

In the case of the Italian Riesling variety, the lowest reduction of total acids (Graph 3) was observed in Negotino, while the highest reduction was noticed in Demir Kapija. During the third sampling, a more noticeable increase in the level of sugars was observed in Negotino and Demir Kapija. The highest amount of acids for both varieties was registered in Negotino, and the lowest was in Demir Kapija.

## 2.2.   Chemical composition of must

The environmental conditions, the variety, the level of ripeness, the health conditions of the grapes, the applied agricultural techniques etc. are some of the factors which define the chemical composition of the grape must. This parameter is one of the main factors for determining the quality of the grapes provided by the variety in a certain production area.

Sugar and total acids content are in direct correlation with the quality of the grapes, thus defining the style and quality of the wine.

Table 3. Chemical composition of must

| Variety	Indicator	Kavadarci	Negotino	Demir Kapija	LSD 0.05
Rhine Riesling	sugar (g/l)	188 b	204 a	199 a	1,66
	total acid (g\l)	7,70 a	8,00 a	5,70 b	1,46
Italian Riesling	sugar (g/l)	210 b	218 a	203 b	1,66
	total acid (g\l)	5,60 b	7,00 a	5,40 b	1,46

Regarding the content of sugars (Graph 4), the highest value for both varieties was obtained at the location in Negotino. For the Rhine Riesling variety, according to the statistical calculation of the data at the level of p=0.05, a statistically significantly lower value was observed in the variant from Kavadarci compared to the variants from Negotino and Demir Kapija. In the case of the Italian Riesling variety, the variants from Kavadarci and Demir Kapija showed a statistically significantly lower value compared to the variant from Negotino at the level of p=0.05 (Table 3).
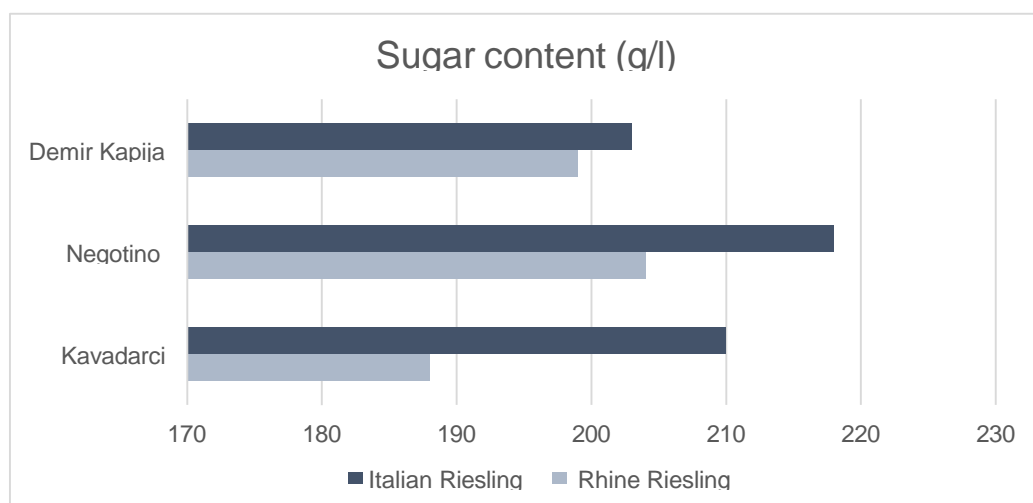
Graph 4. Amount of sugars in must

The results regarding the sugar content of the Rhine Riesling variety are correlated with the results obtained by Giorgio et al. (2012), Cvetkovic (1991), Boshkov (1996) and Tarailo et al. (2018), and for Italian Riesling are similar to the results obtained by the authors: Bunea et al. (2010), Boshkov (1996), Jevtimova (1994) and Cvetkovic (1991).

Regarding the total content of acids (Graph 5), for both varieties the highest content was obtained in Negotino, and the lowest in Demir Kapija. The coefficient of variation (CV%) between the variants of the Rhine Riesling variety is 17.53%, and there is a significant difference in the variant from Demir Kapija in relation to the variants from the Negotino and Kavadarci localities. For Italian Riesling, the coefficient of variation (CV%) is 14.53%, and a significant difference occurs in the variants from Kavadarci and Demir Kapija in relation to the variant from Negotino.
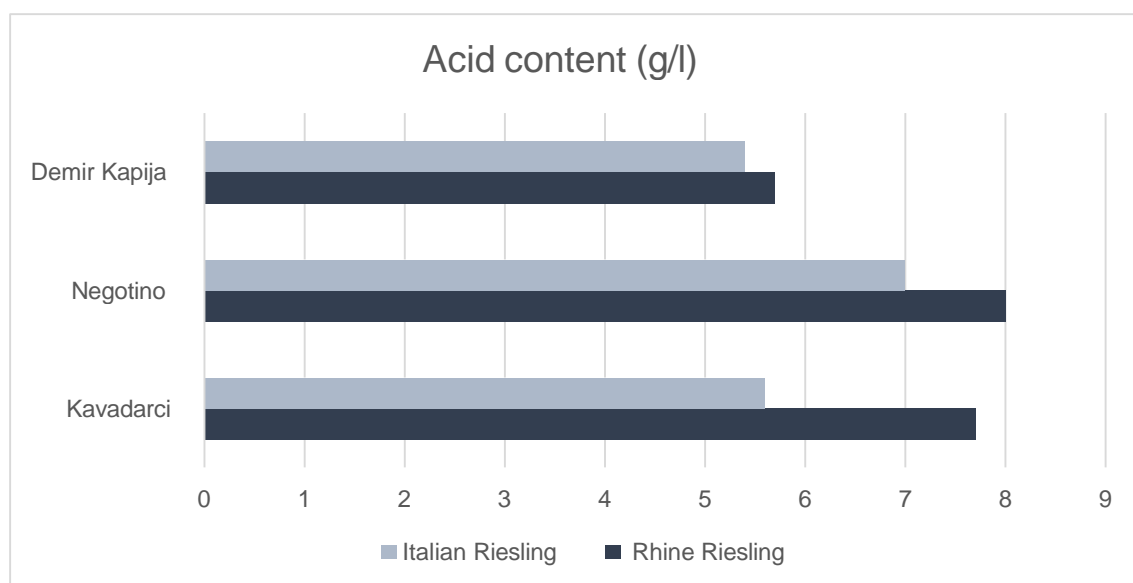
Graph 5. Total content of acids in must

The content of total acids in the Italian Riesling variety in our results for the variants from Kavadarci and Demir Kapija is lower compared to the one obtained by the following authors: Avramov et al. (1994), Zunic et al. (1994), Nakalamic et al. (1994), Cvetkovic et al. (1994), Kozina (1999), Jevtimova (1994), Cvetkovic (1991) and Bozinovic (2010).

CONCLUSIONS

From the results presented so far, we point out the following significant results as conclusions:
1.   Italian and Rhine Riesling varieties are characterized by very good production and technological potential and should remain in the assortment in the Tikvesh wine region. In terms of yield, for both varieties, the highest average yields per m² were achieved at the locality in Kavadarci, while the lowest at the locality in Demir Kapija. The highest average weight of the bunch in the Rhine Riesling variety was obtained in the variant from Negotino, and the lowest in the variant from Demir Kapija. For the Italian Riesling variety, the highest average weight was obtained in Demir Kapija, and the lowest in Kavadarci. The chemical composition of must shows that in both varieties, the highest amount of sugar and total acids were obtained in the Negotino locality variant.
2.   Taking into account that a larger number of researchers have worked on the investigated varieties and their measurements were carried out in different localities and in different vineyards, under different climatic conditions, in different years of harvest and other factors, it

is quite expected that there will be certain variations in the results for the same ones.

3.   Although there is some variation in the results between variants for each variety individually, they still range within the values characteristic of these varieties. Therefore, it can be concluded that the Tikvesh wine region is suitable for cultivation of the white wine varieties Rhine and Italian Riesling in all three localities, and we recommend in the future the spread of these two varieties not only in these vineyards, but also more widely.

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