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OBSERVATION OF THE CHEMICAL PARAMETERS ON IMPORTED AND DOMESTIC WINES FOUND ON THE MARKET IN THE REPUBLIC OF NORTH MACEDONIA

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Abstract

In the Republic of North Macedonia, the production of wine is very well known, but in the markets, there is also a variety of imported wines. Therefore, the aim of our research was to examine the basic parameters which determine the quality of the wine. A total of 106 domestic and imported wines were included in this research. The basic chemical parameters for each of the samples were examined by using standard OIV methods. Verification of the methods was done by determining its accuracy, precision, repeatability and reproducibility using standard reference material and proficiency testing. Depending on the sugar content, wines were divided into 4 groups: dry, semi dry, semi-sweet and sweet wines. The highest alcohol content was observed in dry wines originating from all countries that were subject of this research (up to 13.54 vol %) and the lowest was observed in wines originating from Italy which are mostly used as dessert wines (5.07 vol %). The semi-dry wines originating from France showed the slightest value (min.12.18 mg/L free SO_2 and min.60.20 mg/L total SO_2), which corresponds to their high quality and price on the market. This research is of great interest for the needs of the market and the price of the wine, due to the wine quality standards under the law of Republic of North Macedonia.

Keywords: *wine quality, OIV methods, descriptive analysis, method verification*

INTRODUCTION

As there are several varieties of apple, tomato, etc., there are also several varieties of grapes. But over the years, it was determined which varieties of grapes are most suitable and possess all the necessary characteristics for producing quality wine (pleasant taste, resistance to various diseases and pests, yielding high yields, etc.). The type of grapes used for production largely determines both the quality and the specific characteristics of the wine, such as the taste and colour of the wine, the presence of residual sugar, the content of alcohol, acidity and the presence of tannins. Recently, mostly used grape varieties for production of red wines are Shiraz, Pinot Noir, Cabernet Sauvignon and Merlo and for white wines, those are Sauvignon Blanc and Chardonnay. But there are other important factors that determine the quality and style of the wine. In order to obtain a healthy harvest, grapes need factors that influence and improve the quality, such as favourable climate, enough sunny days, moderate amount of water, heat and proper soil with balanced content of all nutrients. Vineyards are very tolerant and grow on all types of soils, but without proper nutrient content in the soil itself, the product obtained will be of lower quality. Also, in the process of winemaking the most important part is the fermentation, where the grape juice changes the flavours into those of wine and knowing when to end the fermentation process determines the type and the quality of the final product. In the Republic of North Macedonia, the production of wine is very well known and it exists more than 4000 years in this area, but in the markets, there is also a variety of imported wines that can be found. Therefore, the aim of our research was to examine the basic parameters which determine the quality of wine, such as total alcohol content, total and free SO_2, total and volatile acids, reduced sugars, specific gravity and total dry extract, by using standard accredited methods.

MATERIAL AND METHODS

Wine is an alcoholic drink made during the fermentation process from grape juice. The quality of the wine is directly related to the quality of the grape variety and is represented as complex set of interactions, so its quality is easier to detect than define.

A total of 106 samples of red, rose and white imported and domestic wines from different manufacturers were included in this research, originating from Italy (60 samples – 34 white wines, 2 rose wine, 24 red wines), France (20 samples – 8 white wines, 2 rose wines, 10 red wines), Spain (5 white wines), Serbia (16 samples – 7 red wines, 2 rose wines, 7 white wines) and North Macedonia (5 samples – 3 red wines, 2 white wines).

During the research, standard accredited methods were used according to the Law on Wine and Wine Products of the Republic of North Macedonia, as follows: for determining the alcoholic strength in volume percentages OIV-A2 (MA-EAS312-01-TALVOL), (IOVW) method was used by using a pycnometer to measure the distillate density obtained after the distillation of the wine at 20° C. The presence of acids in wine is very important in the process of winemaking and the finished product of wine. They have direct influences on the colour, the balance of the wine and gives fresh and sour taste of the final product. The measurement of the acidity (g/L) in wine is usually known as "total acidity" or "titratable acidity" which originates mainly from the presence of citric, tartaric and malic acid. The method used for determining the content of total acids (such as tartaric acid) was OIV-A10 (MA-EAS313-01-ACITOT), (IOVW). This method includes potentiometric titration with 0.1M NaOH by using standard Titrino Plus titrators. To determine the content of volatile acids (such as acetic acid) the OIV- A11 (MA-EAS313-02-ACITVOL), (IOVW) method was used. This method includes primary distillation of the sample and double titration by using NaOH and Iodine standard solutions. The sweetness is a main indicator of how much sugar wine contains (primarily glucose) and depending on that the wines are classified as dry, semi dry, semi-sweet and sweet wines. The residual sugar is the one that remains after the fermentation stops and usually is measured in g/L. So, for determining the content of reducing sugars the OIV-A4 (MA-EAS311- 01-SUCRED), (IOVW) method was used. This method is based on the reducing characteristics of the sugars present in the grapes by using Fehling solution and then titration with Iodine standard solution. The usage of sulphur dioxide is very critical in the process of winemaking. The presence of free sulphur dioxide keeps the wine from spoilage and oxidation, but too much SO_2 can mask the fruity aromas of the wine and gives metallic, sharp and bitter flavour to the wine which has negative effect on the quality. The presence of total sulphur dioxide is the total amount of free sulphur dioxide plus the one that is bound to sugars, pigment, aldehydes. It is very important the concentration (mg/L) of total and free sulphur dioxide to be in balance due to the quality characteristics of the wine. The OIV-A17 (MA-EAS323-04-DIOSOU), (IOVW) official method was used to determine the content of total and free sulphur dioxide. For determination of free SO_2, standard H_2SO_4 solution is used and for determining the total SO_2 content, standard solutions of NaOH and H_2SO_4 are used and then the samples are titrated by using standard Iodine solution on Titrino plus titrators. The density and specific gravity analysis is used for determining the total alcohol content in g/L and vol. %. For this reason, OIV-A1 (MA-EAS2-01- MASVOL), (IOVW) standard method was used. OIV-A3 (MA-EAS2-03-EXTSEC), (IOVW) method was used to determine the total dry extract content (g/L), by direct evaporation of the volume of the sample.

Before the analysis, verification on each method was performed by determining accuracy, precision (standard deviation and relative standard deviation), repeatability and reproducibility by using standard reference material and proficiency testing.

The measurement of the control reference material (PT FAPAS 1389 - set 1 and 2, Quality indicators in wine) was performed in 10 repetitions for each method separately and for the calculation of the extended measurement uncertainty as a source of uncertainty were taken into account the repetition, bias, as well as errors arising from the equipment used.

The results for the extended measurement

uncertainty for each method are as follows: volatile acidity ± 6.27 %, total dry extract ± 4.92 %, total SO_2 ± 1.07 %, total acidity ± 1.87 %, sugar content ± 6.06 %, free SO_2 ± 5.33 %, total alcohol content ± 6.19 % and specific gravity ± 0.20 %. (Extended measurement uncertainty for k = 2, 95 % probability level).

RESULTS AND DISCUSSION

Depending on the content of sugars in the wine, they were first divided into four basic groups as dry (up to 4 g/L), semi dry (up to 12 g/L), semi-sweet (up to 45 g/L) and sweet wines (more than 45 g/L) and also, depending of the country of origin. The results shown that most of the wines included in this research belong to the group of semi dry wines (n=62 or 65.72 %) and least in the group of sweet wines (n=6 or 6.36 %). Residual sugar is one that remains in the wine after alcoholic fermentation. Then, each wine group was examined on the basic chemical parameters that were subject of this research. The results showed differences in almost all examined parameters.

Table 1. Reducing sugar content (g/L)

	Type of wine			
Country	Dry	Semi dry	Semi Sweet	Sweet
Italy	10	32	13	5
France	2	17	1	/
Spain	/	/	5	/
Serbia	2	11	2	1
North Macedonia	3	2	/	/
Total number of samples	17= 18.02 %	62 = 65.72 %	21 = 22.26 %	6 = 6.36 %

The sugar content of the grapes is closely related to the alcohol content of the wine. Fermentation is a process where under the action of the yeast (mostly *Saccharomyces cerevisiae*) comes to the utilization of the sugar present in the grape juice, which produces alcohol and carbon dioxide, with at least 12 enzymes included in the process. The longer the fermentation, the higher the alcohol and lower the sugar level. So, this is very important step in the process of winemaking because of the different flavours produced which directly affect the taste of the wine. Therefore, from the results shown we can notice that dry wines originating from all countries included in the research, contain the highest alcohol content (up to 13.54 ± 0.83 vol %), with some minor exceptions, such as two samples of semi dry wine originating from North Macedonia, one sample of semi-sweet wine originating from France and one sample of sweet wine originating from Serbia – vermouth wine. The lowest alcohol content was observed in wines originating from Italy and they are mostly used as dessert wines (5.07 ± 0.31 vol %).

The total acidity in wine usually depends on the presence of non-volatile acids, such as mallic, tartaric or citric acid plus the volatile acids such as acetic acid. These components directly affect the smell and the taste of the wine. Determination of volatile acidity is used routinely as an indicator of wine spoilage. The results shown no significant difference between all groups of wine and the countries of origin such as, for total acidity between 4.81 ± 0.09 g/L - 6.70 ± 0.12 g/L and for volatile acidity between 0.26 ± 0.02 - 0.39 ± 0.02 g/L.

Table 1.1. Mean values of physical-chemical parameters in dry wines from different countries

	Dry wines						
Country	Total alcohol content (vol %)	Total acidity (g/L)	Volatile acidity (g/L)	Free SO_2 (mg/L)	Total SO_2 (mg/L)	Total dry extract (g/L)	Specific gravity (MU = ± 0.0019 for all wines)
Italy	14.55 ± 0.90	4.98 ± 0.09	0.44 ± 0.03	66.75 ± 3.55	150.80 ± 1.61	32.25 ± 1.58	0.9796
	14.00 ± 0.86	5.92 ± 0.11	0.37 ± 0.02	38.16 ± 2.03	90.66 ± 0.97	25.85 ± 1.27	0.9801
	12.50 ± 0.77	4.85 ± 0.09	0.22 ± 0.02	18.85 ± 1.00	88.21 ± 0.94	20.40 ± 1.00	0.9810
	12.78 ± 0.79	4.46 ± 0.08	0.22 ± 0.02	30.41 ± 1.62	98.82 ± 1.05	18.39 ± 0.90	0.9816
	14.12 ± 0.87	4.15 ± 0.08	0.20 ± 0.02	24.68 ± 1.31	68.17 ± 0.72	26.02 ± 1.28	0.9801
	14.55 ± 0.90	4.25 ± 0.08	0.26 ± 0.02	25.70 ± 1.36	75.50 ± 0.80	25.50 ± 1.25	0.9796
	13.55 ± 0.83	5.30 ± 0.10	0.26 ± 0.02	28.15 ± 1.50	69.25 ± 0.74	24.12 ± 1.18	0.9807
	13.30 ± 0.82	5.17 ± 0.10	0.25 ± 0.02	27.03 ± 1.44	68.35 ± 0.73	23.52 ± 1.15	0.9810
	13.50 ± 0.83	5.10 ± 0.10	0.36 ± 0.02	27.20 ± 1.45	60.20 ± 0.64	20.22 ± 0.99	0.9807
	12.55 ± 0.77	6.10 ± 0.11	0.33 ± 0.02	30.20 ± 1.61	105.19 ± 1.12	20.25 ± 0.99	0.9818
	MV=	**MV =**	**MV=**	**MV=**	**MV=**	**MV=**	**MV=**
	13.54 ± 0.83	**5.03 ± 0.09**	**0.29 ± 0.02**	**31.71 ± 1.69**	**87.51 ± 0.93**	**23.65 ± 1.16**	**0.9806**
France	12.55 ± 0.77	6.01 ± 0.11	0.38 ± 0.02	44.80 ± 2.38	97.56 ± 1.04	15.70 ± 0.77	0.9818
	13.00 ± 0.80	5.43 ± 0.10	0.40 ± 0.03	38.71 ± 2.06	132.94 ± 1.42	16.70 ± 0.82	0.9813
	MV=	**MV=**	**MV=**	**MV=**	**MV=**	**MV=**	**MV=**
	12.77 ± 0.79	**5.72 ± 0.11**	**0.39 ± 0.02**	**41.75 ± 2.22**	**115.25 ± 1.23**	**16.20 ± 0.79**	**0.9815**
Spain	/						
Serbia	13.50 ± 0.83	4.78 ± 0.09	0.25 ± 0.02	20.80 ± 1.10	139.52 ± 1.49	17.25 ± 0.84	0.9807
	13.05 ± 0.80	4.85 ± 0.09	0.35 ± 0.02	30.52 ± 1.62	75.90 ± 0.81	19.55 ± 0.96	0.9813
	MV=	**MV=**	**MV=**	**MV=**	**MV=**	**MV=**	**MV=**
	13.27 ± 0.82	**4.81 ± 0.09**	**0.30 ± 0.02**	**25.66 ± 1.36**	**107.71 ± 1.15**	**18.40 ± 0.90**	**0.9810**
North Macedonia	11.83 ± 0.73	5.62 ± 0.10	0.25 ± 0.02	28.98 ± 1.54	85.20 ± 0.91	21.20 ± 1.04	0.9827
	13.77 ± 0.85	5.25 ± 0.10	0.27 ± 0.02	36.66 ± 1.95	101.17 ± 1.08	17.56 ± 0.86	0.9805
	13.86 ± 0.85	5.08 ± 0.09	0.25 ± 0.02	29.57 ± 1.57	84.76 ± 0.90	16.87 ± 0.83	0.9804
	MV=	**MV=**	**MV=**	**MV=**	**MV=**	**MV=**	**MV=**
	13.15 ± 0.81	**5.31 ± 0.10**	**0.26 ± 0.02**	**31.73 ± 1.69**	**90.37 ± 0.96**	**18.54 ± 0.91**	**0.9812**

Table 1.2. Mean values of physical-chemical parameters in semi dry wines from different countries

	Semi dry wines						
Country	Total alcohol content (vol %)	Total acidity (g/L)	Volatile acidity (g/L)	Free SO_2 (mg/L)	Total SO_2 (mg/L)	Total dry extract (g/L)	Specific gravity (MU = ± 0.0019 for all wines)
Italy	11.00 ± 0.68	5.46 ± 0.10	0.28 ± 0.02	30.14 ± 1.60	90.20 ± 0.96	26.55 ± 1.30	0.9836
	11.10 ± 0.68	5.95 ± 0.11	0.31 ± 0.02	26.50 ± 1.41	86.65 ± 0.92	27.66 ± 1.36	0.9836
	11.00 ± 0.68	5.87 ± 0.11	0.30 ± 0.02	27.18 ± 1.44	89.76 ± 0.96	28.20 ± 1.38	0.9836
	11.50 ± 0.71	5.82 ± 0.11	0.25 ± 0.02	42.15 ± 2.24	140.55 ± 1.50	25.15 ± 1.23	0.9830
	12.00 ± 0.74	5.82 ± 0.11	0.41 ± 0.03	30.25 ± 1.61	150.94 ± 1.61	33.75 ± 1.66	0.9824
	12.50 ± 0.77	5.12 ± 0.10	0.25 ± 0.02	22.84 ± 1.21	98.50 ± 1.05	21.71 ± 1.06	0.9810
	15.95 ± 0.98	5.49 ± 0.10	0.31 ± 0.02	30.11 ± 1.60	151.01 ± 1.61	38.86 ± 1.91	0.9781
	12.00 ± 0.74	5.18 ± 0.10	0.29 ± 0.02	28.20 ± 1.50	120.82 ± 1.29	23.65 ± 1.16	0.9824
	12.17 ± 0.75	5.28 ± 0.10	0.30 ± 0.02	21.40 ± 1.14	100.53 ± 1.07	21.12 ± 1.03	0.9823
	11.74 ± 0.72	5.57 ± 0.10	0.32 ± 0.02	19.84 ± 1.05	73.58 ± 0.78	24.62 ± 1.21	0.9828
	13.05 ± 0.80	4.90 ± 0.09	0.34 ± 0.02	26.76 ± 1.42	78.10 ± 0.83	27.18 ± 1.33	0.9813
	11.95 ± 0.73	4.95 ± 0.09	0.30 ± 0.02	28.16 ± 1.50	119.40 ± 1.27	23.76 ± 1.16	0.9824
	12.45 ± 0.77	5.10 ± 0.10	0.25 ± 0.02	22.85 ± 1.21	98.42 ± 1.05	21.70 ± 1.06	0.9810
	12.50 ± 0.77	7.77 ± 0.14	0.40 ± 0.03	13.11 ± 0.69	74.75 ± 0.79	27.21 ± 1.33	0.9819
	13.00 ± 0.80	4.80 ± 0.09	0.28 ± 0.02	25.60 ± 1.36	60.75 ± 0.65	24.95 ± 1.22	0.9813
	12.00 ± 0.74	5.15 ± 0.10	0.30 ± 0.02	28.85 ± 1.52	120.80 ± 1.29	24.50 ± 1.20	0.9824
	15.23 ± 0.94	6.18 ± 0.11	0.32 ± 0.02	25.55 ± 1.36	98.00 ± 1.04	33.37 ± 1.20	0.9789
	14.06 ± 0.87	4.90 ± 0.09	0.30 ± 0.02	27.18 ± 1.44	60.75 ± 0.65	26.60 ± 1.30	0.9801
	12.50 ± 0.77	4.90 ± 0.09	0.22 ± 0.02	20.22 ± 1.07	85.16 ± 0.91	20.16 ± 0.99	0.9818
	13.05 ± 0.80	4.85 ± 0.09	0.28 ± 0.02	25.55 ± 1.36	59.62 ± 0.63	25.18 ± 1.23	0.9813
	12.00 ± 0.74	5.12 ± 0.10	0.30 ± 0.02	29.00 ± 1.54	123.98 ± 1.32	24.78 ± 1.21	0.9824
	12.54 ± 0.77	4.87 ± 0.09	0.20 ± 0.02	19.87 ± 1.05	90.52 ± 0.96	19.21 ± 0.94	0.9818
	14.00 ± 0.86	4.78 ± 0.09	0.29 ± 0.02	24.66 ± 1.31	58.80 ± 0.62	25.88 ± 1.27	0.9801
	13.50 ± 0.83	5.10 ± 0.10	0.33 ± 0.02	30.16 ± 1.60	80.02 ± 0.85	26.68 ± 1.31	0.9807
	12.00 ± 0.74	5.90 ± 0.11	0.42 ± 0.02	31.25 ± 1.66	152.80 ± 1.63	33.80 ± 1.66	0.9824
	14.56 ± 0.90	4.63 ± 0.09	0.26 ± 0.02	30.69 ± 1.63	81.10 ± 0.86	27.20 ± 1.33	0.9796
	14.00 ± 0.86	4.95 ± 0.09	0.22 ± 0.02	25.80 ± 1.37	80.10 ± 0.85	25.38 ± 1.24	0.9801
	13.56 ± 0.83	5.07 ± 0.10	0.20 ± 0.02	27.60 ± 1.47	65.59 ± 0.70	26.35 ± 1.29	0.9807
	11.00 ± 0.68	5.13 ± 0.10	0.23 ± 0.02	23.32 ± 1.24	142.08 ± 1.52	25.12 ± 1.23	0.9836
	11.05 ± 0.68	6.00 ± 0.11	0.34 ± 0.02	32.87 ± 1.75	108.50 ± 1.16	26.30 ± 1.29	0.9836
	9.50 ± 0.58	4.87 ± 0.09	0.30 ± 0.02	27.58 ± 1.47	112.75 ± 1.20	28.10 ± 1.38	0.9854
	11.50 ± 0.71	5.55 ± 0.10	0.42 ± 0.03	40.16 ± 2.14	133.00 ± 1.42	35.18 ± 1.73	0.9830
	MV=	**MV=**	**MV=**	**MV=**	**MV=**	**MV=**	**MV=**
	12.50 ± 0.77	**5.34 ± 0.10**	**0.30 ± 0.02**	**27.04 ± 1.44**	**99.61 ± 1.06**	**26.55 ± 1.30**	**0.9818**

France	12.00 ± 0.74	7.33 ± 0.14	0.32 ± 0.02	13.20 ± 0.70	66.65 ± 0.71	21.90 ± 1.07	0.9824
	12.00 ± 0.74	7.59 ± 0.14	0.30 ± 0.02	12.18 ± 0.64	60.20 ± 0.64	22.20 ± 1.09	0.9824
	12.00 ± 0.74	7.60 ± 0.14	0.33 ± 0.02	15.16 ± 0.80	62.18 ± 0.66	23.10 ± 1.13	0.9824
	12.54 ± 0.77	6.75 ± 0.12	0.24 ± 0.02	15.20 ± 0.81	78.80 ± 0.84	24.18 ± 1.18	0.9818
	12.50 ± 0.77	6.90 ± 0.13	0.28 ± 0.02	16.18 ± 0.86	79.92 ± 0.85	23.75 ± 1.16	0.9818
	14.77 ± 0.91	4.50 ± 0.09	0.28 ± 0.02	26.27 ± 1.40	83.48 ± 0.89	27.28 ± 1.34	0.9794
	15.05 ± 0.93	4.33 ± 0.09	0.26 ± 0.02	27.21 ± 1.45	96.69 ± 1.03	27.96 ± 1.37	0.9791
	13.55 ± 0.83	5.06 ± 0.10	0.40 ± 0.03	37.48 ± 1.99	118.66 ± 1.26	26.53 ± 1.30	0.9807
	13.50 ± 0.83	4.27 ± 0.08	0.38 ± 0.02	45.52 ± 2.42	90.78 ± 0.97	29.82 ± 1.46	0.9807
	13.00 ± 0.80	4.70 ± 0.09	0.41 ± 0.03	38.15 ± 2.03	107.20 ± 1.14	25.20 ± 1.23	0.9813
	15.05 ± 0.93	4.68 ± 0.09	0.35 ± 0.02	38.78 ± 2.06	132.94 ± 1.42	29.71 ± 1.46	0.9790
	12.50 ± 0.77	6.86 ± 0.13	0.37 ± 0.02	19.76 ± 1.05	105.65 ± 1.13	23.09 ± 1.13	0.9818
	12.50 ± 0.77	4.19 ± 0.08	0.44 ± 0.03	31.95 ± 1.70	79.87 ± 0.85	23.05 ± 1.13	0.9818
	12.52 ± 0.77	4.33 ± 0.09	0.42 ± 0.03	32.20 ± 1.71	81.15 ± 0.86	24.80 ± 1.22	0.9818
	12.55 ± 0.77	4.58 ± 0.09	0.30 ± 0.02	50.18 ± 2.67	105.16 ± 1.12	30.88 ± 1.51	0.9818
	11.00 ± 0.68	6.60 ± 0.12	0.40 ± 0.03	44.59 ± 2.37	125.77 ± 1.34	25.65 ± 1.26	0.9836
	11.00 ± 0.68	5.90 ± 0.11	0.39 ± 0.02	40.90 ± 2.17	120.15 ± 1.28	32.82 ± 1.61	0.9836
	MV=	**MV=**	**MV=**	**MV=**	**MV=**	**MV=**	**MV=**
	12.82 ± 0.79	**5.65 ± 0.11**	**0.33 ± 0.02**	**29.70 ± 1.58**	**93.83 ± 1.00**	**25.99 ± 1.27**	**0.9777**
Spain	**/**						
Serbia	12.50 ± 0.77	4.48 ± 0.09	0.28 ± 0.02	28.31 ± 1.50	53.79 ± 0.57	24.42 ± 1.20	0.9818
	12.05 ± 0.74	5.41 ± 0.10	0.32 ± 0.02	18.48 ± 0.98	127.82 ± 1.36	22.12 ± 1.08	0.9824
	11.53 ± 0.71	4.90 ± 0.09	0.29 ± 0.02	20.80 ± 1.10	110.50 ± 1.03	21.60 ± 1.06	0.9830
	13.43 ± 0.83	5.89 ± 0.11	0.35 ± 0.02	44.24 ± 2.35	139.11 ± 1.48	21.32 ± 1.04	0.9808
	12.00 ± 0.74	7.03 ± 0.13	0.40 ± 0.03	61.49 ± 3.27	136.52 ± 1.46	22.56 ± 1.10	0.9824
	14.05 ± 0.86	6.76 ± 0.12	0.39 ± 0.02	48.97 ± 2.61	115.02 ± 1.60	27.49 ± 1.35	0.9801
	13.30 ± 0.82	5.62 ± 0.10	0.33 ± 0.02	43.65 ± 2.32	130.79 ± 1.39	32.41 ± 1.59	0.9810
	14.00 ± 0.86	6.23 ± 0.12	0.37 ± 0.02	51.61 ± 2.75	136.78 ± 1.46	33.04 ± 1.62	0.9801
	11.40 ± 0.70	5.02 ± 0.09	0.31 ± 0.02	28.22 ± 1.50	73.16 ± 0.78	30.78 ± 1.51	0.9831
	12.00 ± 0.74	4.80 ± 0.09	0.28 ± 0.02	30.13 ± 1.60	70.88 ± 0.75	31.85 ± 1.56	0.9824
	12.45 ± 0.77	5.20 ± 0.10	0.30 ± 0.02	23.20 ± 1.23	69.20 ± 1.55	32.80 ± 1.61	0.9819
	MV=	**MV=**	**MV=**	**MV=**	**MV=**	**MV=**	**MV=**
	12.61 ± 0.78	**5.57 ± 0.10**	**0.33 ± 0.02**	**36.28 ± 1.93**	**105.77 ± 1.13**	**27.30 ± 1.34**	**0.9817**
North Macedonia	14.57 ± 0.90	5.71 ± 0.11	0.28 ± 0.02	40.24 ± 2.14	90.29 ± 0.96	33.99 ± 1.67	0.9796
	15.61 ± 0.96	5.99 ± 0.11	0.38 ± 0.02	42.55 ± 2.26	92.24 ± 0.98	38.67 ± 1.90	0.9785
	MV=	**MV=**	**MV=**	**MV=**	**MV=**	**MV=**	**MV=**
	15.09 ± 0.93	**5.85 ± 0.11**	**0.33 ± 0.02**	**41.39 ± 2.20**	**91.26 ± 0.97**	**36.33 ± 1.78**	**0.9790**

Table 1.3. Mean values of physical-chemical parameters in semi-sweet wines from different countries

	Semi sweet wines						
Country	Total alcohol content (vol %)	Total acidity (g/L)	Volatile acidity (g/L)	Free SO_2 (mg/L)	Total SO_2 (mg/L)	Total dry extract (g/L)	Specific gravity (MU = ± 0.0019 for all wines)
Italy	11.50 ± 0.71	5.55 ± 0.10	0.41 ± 0.03	40.22 ± 2.14	120.55 ± 1.28	34.88 ± 1.71	0.9830
	11.60 ± 0.71	6.19 ± 0.12	0.40 ± 0.03	55.20 ± 2.94	140.10 ± 1.49	31.20 ± 1.53	0.9904
	11.50 ± 0.71	6.12 ± 0.12	0.35 ± 0.02	38.15 ± 2.03	140.16 ± 1.49	38.20 ± 1.87	0.9831
	9.65 ± 0.59	6.80 ± 0.13	0.36 ± 0.02	12.50 ± 0.66	128.66 ± 1.37	55.60 ± 2.73	0.9850
	11.00 ± 0.68	5.80 ± 0.11	0.40 ± 0.03	30.10 ± 1.60	150.75 ± 3.08	35.15 ± 1.72	0.9836
	10.05 ± 0.62	6.50 ± 0.12	0.38 ± 0.02	29.50 ± 1.57	130.88 ± 1.40	76.15 ± 3.74	0.9848
	10.02 ± 0.62	5.94 ± 0.11	0.40 ± 0.03	29.20 ± 1.55	180.14 ± 1.92	66.80 ± 3.28	0.9848
	12.03 ± 0.74	5.07 ± 0.10	0.30 ± 0.02	28.67 ± 1.52	100.53 ± 1.07	29.33 ± 1.44	0.9813
	11.00 ± 0.68	5.66 ± 0.11	0.40 ± 0.03	30.15 ± 1.60	154.18 ± 1.64	35.20 ± 1.73	0.9836
	9.55 ± 0.59	5.07 ± 0.09	0.35 ± 0.02	26.88 ± 1.43	130.20 ± 1.39	60.80 ± 2.99	0.9804
	10.85 ± 0.67	5.37 ± 0.10	0.22 ± 0.02	16.36 ± 0.87	109.29 ± 1.16	28.01 ± 1.37	0.9845
	18.10 ± 1.12	4.10 ± 0.08	0.15 ± 0.02	15.22 ± 0.81	58.18 ± 0.62	55.18 ± 2.71	0.9850
	7.55 ± 0.46	5.38 ± 0.10	0.40 ± 0.03	40.60 ± 2.16	128.16 ± 1.37	34.65 ± 1.70	0.9878
	MV=	**MV=**	**MV=**	**MV=**	**MV=**	**MV=**	**MV=**
	11.10 ± 0.68	**5.65 ± 0.10**	**0.34 ± 0.02**	**30.21 ± 1.61**	**128.59 ± 1.37**	**44.70 ± 2.19**	**0.9844**
France	13.40 ± 0.82	6.70 ± 0.12	0.36 ± 0.02	32.10 ± 1.71	110.28 ± 1.17	41.25 ± 2.02	0.9808
Spain	11.53 ± 0.71	5.24 ± 0.10	0.22 ± 0.02	18.12 ± 0.96	115.69 ± 1.23	36.55 ± 1.79	0.9830
	11.50 ± 0.71	5.11 ± 0.10	0.32 ± 0.02	14.49 ± 0.77	103.53 ± 1.10	52.51 ± 2.58	0.9830
	11.50 ± 0.71	5.24 ± 0.10	0.32 ± 0.02	16.30 ± 0.86	103.53 ± 1.10	52.50 ± 2.58	0.9830
	11.50 ± 0.71	5.11 ± 0.10	0.22 ± 0.02	14.49 ± 0.77	115.68 ± 1.23	36.54 ± 1.78	0.9830
	11.50 ± 0.71	5.17 ± 0.10	0.27 ± 0.02	18.12 ± 0.96	109.60 ± 1.17	44.52 ± 2.19	0.9830
	MV=	**MV=**	**MV=**	**MV=**	**MV=**	**MV=**	**MV=**
	11.50 ± 0.70	**5.17 ± 0.10**	**0.27 ± 0.02**	**16.30 ± 0.86**	**109.60 ± 1.17**	**44.52 ± 2.19**	**0.9830**
Serbia	12.16 ± 0.75	6.65 ± 0.12	0.38 ± 0.02	72.83 ± 3.88	145.92 ± 1.56	27.53 ± 1.35	0.9823
	12.03 ± 0.74	6.38 ± 0.12	0.36 ± 0.02	63.67 ± 3.39	123.34 ± 1.31	24.16 ± 1.18	0.9824
	MV=	**MV=**	**MV=**	**MV=**	**MV=**	**MV=**	**MV=**
	12.10 ± 0.75	**6.51 ± 0.12**	**0.37 ± 0.02**	**68.25 ± 3.63**	**134.63 ± 1.44**	**25.84 ± 1.27**	**0.9824**
North Macedonia	/						

Table 1.4. Mean values of physical-chemical parameters in sweet wines from different countries

	Sweet wines						
Country	Total alcohol content (vol %)	Total acidity (g/L)	Volatile acidity (g/L)	Free SO_2 (mg/L)	Total SO_2 (mg/L)	Total dry extract (g/L)	Specific gravity (MU = ± 0.0019 for all wines)
Italy	15.00 ± 0.92 12.34 ± 0.76 7.38 ± 0.45 12.03 ± 0.74 5.07 ± 0.31 **MV=** **10.36 ± 0.64**	5.60 ± 0.10 4.93 ± 0.09 6.43 ± 0.12 5.10 ± 0.10 5.83 ± 0.11 **MV=** **5.57 ± 0.10**	0.27 ± 0.02 0.21 ± 0.02 0.38± 0.02 0.31 ± 0.02 0.22 ± 0.02 **MV=** **0.27 ± 0.02**	20.20 ± 1.07 12.62 ± 0.67 33.74 ± 1.79 28.66 ± 1.52 38.78 ± 2.06 **MV=** **26.80 ± 1.42**	98.18 ± 1.05 70.94 ± 0.75 146.56 ± 1.56 100.51 ± 1.07 181.09 ± 1.93 **MV=** **119.45 ± 1.27**	61.10 ± 3.00 185.76 ±9.13 78.03 ± 3.83 79.35 ± 3.90 177.26 ±8.72 **MV=** **116.30 ±5.72**	0.9790 0.9821 0.9881 0.9813 0.9911 **MV=** **0.9843**
France	/						
Spain	/						
Serbia	16.09 ± 0.99	4.88 ± 0.09	0.30 ± 0.02	9.11 ± 0.48	91.19 ± 0.97	170.55 ± 8.39	0.9779
North Macedonia	/						

Table 2. The mean values, standard deviation and relative standard deviation were calculated for each physical-chemical parameter depending on the type of wine

Parameters	Dry wine	Semi dry wine	Semi sweet wine	Sweet wine	Standard deviation (SD)	Relative standard deviation (RSD)
Total alcohol content (vol %)	12.77-13.54	12.50-12.82 15.09*	11.10-12.10 13.40*	10.36 – 16.09	0.38 %	3.09 %
Total acidity (g/L)	4.81-5.72	5.34-5.85	5.17-6.70	4.88-5.57	0.03 g/L	0.68 %
Volatile acidity (g/L)	0.26-0.39	0.30-0.33	0.27-0.37	0.27-0.30	0.01 g/L	3.12 %
Free SO_2 (mg/L)	25.66-41.75	27.04-41.39	16.30-68.25	9.11-26.80	0.19 mg/L	0.56 %
Total SO_2 (mg/L)	87.51-115.25	91.26-105.77	109.60-134.63	91.19-119.45	0.22 mg/L	0.38 %
Total dry extract (g/L)	16.20-23.65	25.99-36.33	25.84-44.70	116.30-170.55	0.58 g/L	2.42 %
Reduced sugar content (g/L)	up to 4 g/L	up to 12 g/L	up to 45 g/L	more than 45 g/L	0.04 g/L	1.74 %

* exceptions from the mean values

The usage of sulphur dioxide (SO_2) as preservative in the winemaking industry is known for a long time. It has a direct impact on the wine quality and is used to ensure microbial, oxidative and antiseptic stability. The presence of total SO_2 in wine is usually the total amount of free and bound SO_2 and also there is a molecular form of SO_2. Molecular SO_2 has broad-spectrum of antimicrobial properties (Divol du Toit et al., 2012), so it can kill or inhibit most of the spoilage yeast and bacteria that could affect wine. The free SO_2 concentration is defined as molecular SO_2 plus bisulphites and gives oxidative stability in concentrations between 20-40 mg/L. But its use is of crucial importance and must be regulated because too much SO_2 can mask the fruity aromas and gives metallic, sharp and bitter flavour to the wine which has negative effect on the quality. In our research, the concentrations of free and total sulphur dioxide in all samples are in balance, but there were semi-dry wines originating from France which showed the slightest value (min.12.18 ± 0.64 mg/L free SO_2 and min.60.20 ± 0.64 mg/L total SO_2), which corresponds to their high quality and price on the market.

In the past, the content of the total dry extract was considered as a basic parameter for determining the possible falsification of the wine, or it's dilution with water. But nowadays it is generally accepted that the content of the total dry extract depends mostly on the variety of grapes, seasonal variations as well as the method of wine production. The composition of the total dry extract represents all non-volatile matter which in specific conditions do not volatilize (Florin Dumitru BORA et al., 2015). From the chemical aspect, the total dry extract consists of: sugars, tannins and dyes, organic acids such as (tartaric, malic, succinic acid, lactic acid), glycerol, 2,3 butylene glycol, nitrogen, pectin, gums, etc. The higher the extract, the fuller the body and greater aroma and flavour of the wine. In ideal conditions, the dry extract should be in balance with the sugar, acidity and alcohol levels in wine. In our research, we can notice that the content of the total extract is continuously growing as the content of sugars in the samples increases. So, the lowest content is observed in the dry wines originating from all countries (16.20 ± 0.79 g/L) and the highest in the sweet wines (up to 170.55 ± 8.39 g/L).

CONCLUDING REMARKS

Based on the results from the research, we came to the conclusion that all types of white, rose and red imported and domestic dry, semi dry, semi-sweet and sweet wine, satisfy the quality standards prescribed in Law of wine and wine products of the Republic of North Macedonia and the Regulations of wine of the European Commission.

In the markets across the country, many types of wine of different quality, price, and different countries of origin, can be found. Our research included wines commonly found on the market and by examining their basic parameters that determine the quality, we managed to establish that most of the imported and domestic wines satisfy the quality standards prescribed in the Law of wine and wine products of the Republic of North Macedonia, although some have a lower, and others have a higher market price.

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ОПРЕДЕЛУВАЊЕ НА ХЕМИСКИТЕ ПАРАМЕТРИ НА УВЕЗЕНИ И ДОМАШНИ ВИНА НА ПАЗАРОТ ВО РЕПУБЛИКА СЕВЕРНА МАКЕДОНИЈА

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Резиме

Во Република Северна Македонија производството на вино е многу добро познато, но на пазарите има и разновидни увозни вина. Значи, целта на нашето истражување беше да ги испитаме основните параметри кои го одредуваат квалитетот на виното. Во ова истражување беа опфатени вкупно 106 домашни и увозни вина. Основните хемиски параметри за секој од примероците беа испитани со користење на стандардни OIV методи. Верификацијата на методите беше направена со одредување на точноста, прецизноста, повторливоста и репродуктивноста со користење на стандарден референтен материјал и тестови на оспособеност. Во зависност од содржината на шеќер, вината беа поделени во 4 групи: суви, полусуви, полуслатки и слатки вина. Највисока содржина на алкохол е забележана кај сувите вина со потекло од сите земји кои беа предмет на ова истражување (до 13,54 вол.%), а најниска е забележана кај вината со потекло од Италија кои најчесто се користат како десертни вина (5,07 вол.%). Полусувите вина со потекло од Франција покажаа најмала вредност (min.12,18 mg/L слободен SO_2 и мин.60,20 mg/L вкупен SO_2), што одговара на нивниот висок квалитет и цена на пазарот. Ова истражување е од голем интерес за потребите на пазарот и цената на виното, поради стандардите за квалитет на виното според законот на Република Северна Македонија.

Клучни зборови: *квалитет на вино, OIV методи, описна анализа, верификација на метод.*