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CORRELATION OF THE CHEMICAL PARAMETERS WITH THE SENSORIAL PROPERTIES OF WINE

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Abstract

Wine quality is afforded by chemical properties but also tightly connected to perception of appearance, olfactory and taste properties. In order to assess the most important chemical parameters of wine that are priority for wine consumers, 21 wine samples were studied. This means 3 varieties of bottled wines from 2018 harvest, vinified in dry, medium dry, medium sweet and sweet, from 4 different wine regions and 6 different vineyards from Romania. For assessing the chemical parameters, 9 laboratory analyses were performed (sulphites, total acidity, volatile acidity, pH, alcohol content, anthocyanins, residual sugar, total polyphenols, tannins). Organoleptic analyses were performed according to BLIC test by 26 tasters panel. Using specific attributes, they evaluated the visual aspect, the olfactory properties and the taste and finally a quality overall mark was delivered. The statistical analyses of the correlation between chemical parameters and sensorial characteristics showed the importance of some laboratory determinations on the perception of wine quality by a common consumer. But the results revealed that very good values of the chemical parameters are not a guarantee of high acceptability of the consumers.

Key words: *wine, sensorial characteristics, chemical parameters, statistical analyses, organoleptic analyses.*

INTRODUCTION

Experience and needs could influence consumer preferences. Gender and age influence wine choices, label information have also a positive effect in choices, but knowledge is the most important factor in preferences and consumption of wine (Troiano S. et al., 2020). Highest level of wine expertise could be attained when consumers are able to recognize fine wine properties, like complexity, harmony or persistence, in association with socio-cultural aspects, like origin, winemaking, and performed aesthetic assessments independently from wine enjoyment (Malfeito-Ferreira, 2021). Price and quality differences perceived are not exclusively influenced by features objective of the product. Most of consumers, and even experts, seem not to be able to make difference by sensory characteristics and cannot rank wines according to their price. Consumers tend to consider that a higher price absolutely means a higher quality (Troiano S. et al., 2020).

The first important intrinsic sensory of consumers expectations according to flavor and taste of beverages is the color. (Vinha et al., 2018). Singularity of olfaction (ortho- and retronasal pathways) means to transfer the stimulus from nose receptor cells to orbito-frontal cortex (OFC) where conscious processing takes place without passing through thalamus. Accordingly, these senses contribute to the perception of aroma (Malfeito-Ferreira, 2021). Tongue is not essential for taste perception, by Mahood K et al. (2017) opinion, which means that taste perception could be influenced by nutrition or health implications. For all these variations of perception, some specialists have created different reasoning or quality equation. Visalli et al. (2023) performed a Free-Comment Attack-Evolution-Finish (FC-AEF) which describe temporal aspects of tasting to the free description of wine. They pretend that a predefined list of descriptors can be measured using the Attack-Evolution-Finish (AEF) method described prior also by Mathieu et al. in 2020. AEF was adapted to replace the list of attributes by FC using the so-called Free-Comment AEF method (FC-AEF). FC-AEF provided additional information compared to AEF. FC-AEF can be used both with consumer and expert panels and was used to collect temporal data about two Bordeaux and two Rioja wines. Also, Visalli et al. said in 2023 that consumers are used to assess the influence of culture and expertise on temporal sensory evaluations of wines. The purpose of this study is to analyze the physio-chemical parameters and sensory attributes and then to corelate them to see which of them are important for common consumer.

MATERIALS AND METHODS

Materials

For this study there were collected 21 wine samples from local stores.

There were 3 varieties of authentic Romanian wines (Fetească Neagră - FN, Fetească Albă - FA and Busuioacă de Bohotin - BB) from 2018 harvest year, vinified as dry, medium dry, medium sweet and sweet, from 4 different wine Regions and 6 different vineyards. All the wine samples were bottled in glass (750 ml volume) and had cork closure (Table 1).

Table 1. Wine samples used for experiments

no. of sample	sample code	color	taste	region	vineyard	quality
1	FN1	red	dry	Transylvanian Plateau	Lechința	PDO
2	FN2	red	dry	Muntenia and Oltenia's Hills	Dealu Mare	PDO
3	FN3	red	dry	Muntenia and Oltenia's Hills	Pietroasele	PGI
4	FN4	red	dry	Muntenia and Oltenia's Hills	Severinului	PDO
5	FN5	red	dry	Dobroga's Hills	Murfatlar	PDO
6	FN6	red	dry	Moldova's Hills	Cotnari	PDO
7	FN7	red	medium dry	Muntenia and Oltenia's Hills	Dealu Mare	PGI
8	FN8	red	medium dry	Muntenia and Oltenia's Hills	Severinului	V
9	FA1	white	dry	Moldova's Hills	Cotnari	PDO
10	FA2	white	dry	Muntenia and Oltenia's Hills	Dealu Mare	PGI
11	FA3	white	dry	Muntenia and Oltenia's Hills	Pietroasele	PGI
12	FA4	white	dry	Transylvanian Plateau	Lechința	PDO
13	FA5	white	dry	Dobroga's Hills	Murfatlar	PDO
14	FA6	white	medium dry	Moldova's Hills	Cotnari	PDO
15	FA8	white	medium dry	Muntenia and Oltenia's Hills	Dealu Mare	PDO
16	FA8	white	medium dry	Muntenia and Oltenia's Hills	Severinului	V
17	BB1	rose	dry	Muntenia and Oltenia's Hills	Pietroasele	PGI
18	BB2	rose	medium dry	Moldova's Hills	Cotnari	PDO
19	BB3	rose	medium sweet	Moldova's Hills	Cotnari	PDO
20	BB4	rose	medium sweet	Muntenia and Oltenia's Hills	Pietroasele	PGI
21	BB5	rose	sweet	Muntenia and Oltenia's Hills	Pietroasele	PGI

Methods

All the 21 wine samples were analyzed in laboratory for their chemical and physical characteristics. *Determination of total sulfites* is a spectrophotometric method and was done by enzymatic kit EnzytecTM Liquid SO_2 Total (Sulfite UV Method for the determination of sulfurous acid in food stuffs and other materials, Boehringer Manheim/R-Biopharm Enzymatic BioAnalysis/Food Analysis, Roche, Cat.no.10 725 854 035) and UV-VIS Cintra 10e device (SR 6182 – 13/2009).

Total acidity (SR 6182 – 1/2008) and *volatile acidity* (SR 6182 – 2/2008) were performed by potential method using 0.1N NaOH solution, 7 pH buffer solution and a Metrohm 794 Basic Titrino titrator device. The results presented in Table 2 for total acidity and volatile acidity represented the arithmetic average of triplicate.

Determination of alcohol concentration was performed using an alcoholmeter device (STAS 6182/6-70) and for determination of pH weas used a pH meter device (Mettler Toledo) which was calibrated (SR 6182 – 14/2009) with pH solutions (pH 4,01 pH 7,00 and pH 10,01).

The anthocyanins were determined by pH variation method using UV-VIS Cintra 10e device (SR 6182/35 – 75; OIV-MA-AS2-07B).

Determination of reducing carbohydrates (residual sugar) was performed by enzymatic method using an enzymatic kit D-Glucose/D-Fructose (Sucrose/D-Glucose/D-Fructose UV Method for the determination of sucrose, D-glucose and D- fructose in foodstuffs and other materials, Boehringer Mannheim/R-Biopharm Enzymatic BioAnalysis/Food Analysis, R-Biopharm, Roche, Cat.no. 10 716 260 035) and a spectrophotometer UV-VIS Cintra 10e.

Determination of total polyphenols (TPC) was performed by Folin-Ciocâlteau method, using Folin-Ciocâlteau reagent, 80% methanol solution, 20% Na_2CO_3 solution, galic acid 100 ug/ml stock solution and the same spectrophotometer UV-VIS Cintra 10e. (Folin Ciocâltrau method by Singleton and colab. version, 1999).

Determination of tannins was performed by 35% hydrochloric acid, 96% ethyl alcohol and a spectrophotometer UV-VIS Cintra 10e. (SR 6182 – 45/2009)

Organoleptic properties were assessed by a panel of 26 tasters, unauthorized but passionate of wine, being graduates of a basic wine course. There was not followed a high qualified opinion but of common consumer. They evaluated a series of sensorial characteristics of wine samples, characteristics about aspect, smell and taste, like color intensity, color hue, overall smell, aroma intensity, aroma quality, acidity, astringency, alcohol, smoothness, sourness, harmony and overall quality. Finally applied BLIC technique (Balance, Length, Intensity, Complexity) to every wine sample with a grade from 1 to 5, where 1 means a poor wine and 5 means an outstanding wine.

Statistical correlation between the individual components (chemical parameters) and the sensorial characteristics (determined by panel tasters) was calculated using Anova function by Excel Microsoft Office 2021.

RESULTS AND DISCUSSIONS

Laboratory analysis

All samples were analyzed and the results are presented in Table 2.

Table 2. Physio-chemical parameters of wine sample

no. of sample	sample code	sulfites (mg/L)	total acidity* (g tartric acid/L)	volatile acidity* (g acetic acid/L)	pH	tannins (mg/L)	antho cyanins (mg/L)	alcohol (% vol)	residual sugar (g/L)	TPC (g/L)
1	FN1	106.51	4.71	0.54	3.70	3.00	117.38	13.80	0.21	1.33
2	FN2	127.29	6.02	0.87	3.76	5.60	105.95	14.80	0.27	2.01
3	FN3	129.04	6.10	1.68	3.98	4.60	66.31	14.90	0.19	1.82
4	FN4	113.51	6.11	1.05	3.77	8.30	130.71	14.30	0.19	2.61
5	FN5	122.34	6.28	0.72	3.83	7.49	56.40	14.60	0.20	1.98
6	FN6	123.19	5.45	0.88	3.84	5.70	106.65	14.70	0.47	2.00
7	FN7	118.55	5.39	0.54	3.51	4.90	137.96	13.70	0.67	1.80
8	FN8	107.59	4.46	0.96	3.97	5.69	92.99	13.10	1.01	2.35
9	FA1	119.56	6.14	0.21	3.25	0.72	0.00	13.50	2.12	0.35
10	FA2	100.42	5.87	0.18	3.38	0.46	0.00	13.50	0.65	0.26
11	FA3	108.57	6.42	0.27	3.21	1.12	0.00	13.10	1.64	0.40
12	FA4	100.12	6.24	0.20	3.41	0.45	0.00	13.40	3.98	0.27
13	FA5	109.60	6.54	0.27	3.31	1.40	0.00	13.20	2.44	0.39
14	FA6	126.28	5.78	0.33	3.25	0.97	0.00	13.10	4.09	0.30
15	FA7	157.16	5.31	0.45	3.47	0.87	0.00	13.00	5.55	0.29
16	FA8	125.07	4.74	0.71	3.44	0.91	0.00	13.40	7.93	0.30
17	BB1	123.61	4.80	0.42	3.46	2.72	10.29	13.30	3.99	0.50
18	BB2	132.73	4.52	0.39	3.19	1.70	10.67	12.90	4.42	0.41
19	BB3	130.45	5.51	0.48	3.34	5.35	20.20	12.90	12.52	0.43
20	BB4	193.04	6.16	0.66	3.56	8.08	20.96	14.30	12.22	0.56
21	BB5	167.66	5.86	0.84	3.84	7.28	39.63	14.10	19.58	0.59

**values are arithmetic average of triplicate*

Sulfites

According to the obtained data, FA wines ranged between 100.12 mg/L and 157.16 mg/L of total SO_2, FN wines ranged between 106.51 mg/L and 129.04 mg/L of total SO_2 and BB wines ranged between 123.61 mg/L and 193.04 mg/L of total SO_2. These results complied with the values stipulated in Romanian and European legislation. Colibaba C. et al., 2009, obtained in their study regarding BB from 2008, 128.80 mg/L total SO_2. Tartian A.C. et al., (2015) obtained in BB from 2014, ranged between 70.54 and 133.47 mg/L of total SO_2. According to Ivanova Petropulos V. and Mitrev S. (2014) sulfites have an antioxidant role and could be an antimicrobial agent, as well as potential for bleaching the pigments and elimination of unpleasant odors. They obtained in red wines values ranged between 60.16 mg/L and 103.76 mg/L of total SO_2 and also in white wines values ranged between 89.60 mg/L and 131.80 mg/L of total SO_2

Total acidity, Volatile acidity, pH

Total acidity for FA wines was ranged between 4.74 g /L tartaric acid and 6.54 g /L tartaric acid and Volatile acidity for FA was ranged between 0.18 g/L acetic acid and 0.71 g/L acetic acid. Also, pH results were ranged between 3.21 to 3.47 for FA.

Total acidity for FN was ranged between 4.46 g/L tartaric acid and 6.28 g/L tartaric acid and volatile acidity for FN was ranged between 0.54 g/L acetic acid and 1.68 g/L acetic acid. pH determined for FN was ranged between 3.51 and 3.97 values. Total acidity for BB was ranged between 4.80 g/L tartaric acid and 6.16 g/L tartaric acid and volatile acidity for BB was ranged between 0.39 g/L acetic acid and 0.84 g/L acetic acid. pH determined for BB was ranged between 3.19 to 3.84 values. In conclusion, total acidity was in regulated limits for all of 21 samples and volatile acidity was higher for sample FN3 (with the value 1.68 g/L acetic acid). Results also highlighted that 2 samples (FN4 and FN8) had high values to volatile acidity and also high values to pH. This could mean that volatile acidity and pH values are directly influenced. Increasing in pH values could be accompanied by a decreasing of total acidity (Lima S.M. et al., 2015). Also in Syrah, Lima S.M. et al., 2015 obtained total acidity registered between 4.55 g/L tartaric acid and 21.49 g/L tartaric acid and volatile acidity between 0.17 g/L tartaric acid and 0.54 g/L tartaric acid. Antoce and Cojocaru (2018) obtained in their study, total acidity between 4.30 g/L tartaric acid and 6.20 g/L tartaric acid and pH between 3.54 and 3.97 in FN. Balla G. et. al. (2023) determined in FN from 2018, 6.11 g/L tartaric acid for total acidity content. Artem V. et al. in their study published in 2014 identified 7.72 g/L tartaric acid when they determined total acidity in FN from 2013 harvest. Dobrei A. et al. (2018) obtained 6.85 g/L tartaric acid for total acidity characteristic in FN from 2016 and 6.57 g/L tartaric acid for total acidity characteristic for FN from 2017. Bunea C.I. (2014) studied FA and obtained 4.71 g/L tartaric acid for total acidity parameter and 3.80 pH.value. Tartian et al., 2015, registered values between 0.31 g/L acetic acid and 0.39 g/L acetic acid for volatile acidity parameter, values between 5.40 g/L tartaric acid and 6.28 g/L tartaric acid for total acidity parameter and pH value between 3.76 and 3.84 for BB from 2014. Colibaba C. et al., 2009, determined in BB from 2008, 0.50g/L acetic acid for volatile acidity. Tartian et al., 2017, determined total acidity in BB from 2014 and 2015 and obtained 5.70 g/L tartaric acid for 2014 harvest and 5.41 g/L tartaric acid for 2015 harvest. To the same variety, determined pH with values registered between 3.77 and 3.80 for BB from 2014 and pH with values between 3.30 and 3.35 for BB from 2015. Total acidity is generally higher in FA wine samples than FN wine samples and BB wine samples. Volatile acidity is clearly higher in FN wine samples and decreases progressively in BB wine samples and the lowest values are in FA wine samples.

Alcohol content

According to the obtained data alcohol content for all samples was registered between 12.90 % alc. and 14.90% alc. Alcohol concentration for FA was ranged between 12.90% alc. and 14.90% alc. FA wine samples registered homogeneous values regarding to alcohol content, the values varied by half units per cent. Alcohol concentration for FN was ranged between 13.10% alc. and 14.60% alc. The higher alcohol concentrations were ranged in FN samples wine, especially in dry FN. Artem V. et. al. in their study published in 2014 identified 13.55% alcohol content in FN from 2013. Dobrei A. et al. (2018) obtained 12.3% alc. in FN from 2016 and 13.4% alc. in FN from 2017. Balla G. et al. (2022) determined in FN from 2018 a value of 13.64% alcohol content. Alcohol concentration for BB was ranged between 12.9% alc.and 14.80% alc. BB wine samples ranged medium values, between FN and FA. According to Colibaba C. et al., (2009), alcohol content in BB from 2008 was 12.90% alc. The alcohol concentration of BB from 2014 was ranged between 13.91% alc. and 14.41% alc. and BB from 2015 was ranged between 14.55% alc. and 15.24% alc. (Tartian et al., 2017). This means that climate factors influence the alcohol content.

Tannins and Anthocyanins

According to the obtained data tannins were ranged between 0.45 mg/L (in FA) and 1.40 mg/L (in FA), in FN were ranged between 3.00 mg/L and 8.30 mg/L and in BB were ranged between 1.70 mg/L and 8.08 mg/L. The highest values of tannins content were determined in FN wine samples. These values are higher than the values registered in FA wine samples, while in BB wine samples registered very different values. For two of them was registered comparable values with the values of FN wines samples (BB3, BB4 and BB5).

Anthocyanins values in FA were N/A because are not find in white wines. Anthocyanins values in FN were ranged between 56.40 mg/L and 137.96 mg/L and in BB were ranged between 10.29 mg/L and 39.63 mg/L. Low values of anthocyanins were ranged in BB5. Results are highlighted in Table 2. Lima S. M. et al., 2015, studied Syrah and obtained tannins with values ranged between 0.93 g/L and 2.61 g/L and total anthocyanins values ranged between 55 mg/L and 669 mg/L. Specialists obtained 325.92 mg/L anthocyanins in FN from 2014 (Artem V. et al., 2013), 231.20 mg/L anthocyanins in FN from 2016 and 240 mg/L anthocyanins in FN from 2017 (Dobrei A. et al., 2018).

Residual sugar

According to the obtained data in FN wines were registered values between 0.19 g/L and 1.01 g/L residual sugar, with the highest value to a medium dry wine (FN8). In FA wines the residual sugar was registered between 0.65 g/L and 7.93 g/L, with the highest value to a medium dry wine (FA8). In BB wines the residual sugar determined was between 3.99 g/L and 19.58 g/L, with the highest value to a sweet wine (BB5). Results are centralized in Table 2. The highest values were ranged in BB wine samples, followed by FA wine samples values and then by FN wine samples values. FN samples registered very low values, keeping at low level even FN7 and FN8 (medium dry). FA samples ranged values a little higher than FN samples, this being explained by correlation with the low alcohol content. Higher values were ranged to samples FA6, FA7 and FA8 (medium dry). Similar, the BB samples ranged the highest values in residual sugar, these being correlated with the low alcohol content. Analysis for determination of residual sugar registered values according with the regulated limits but against of regulated results, the registration into a category of taste according to these obtained values and legislative rules is different compared to the taste specified on the label for few samples. Vlassa M. et al., (2010) analyzed 31 samples of bottled wines especially for the purpose of monitoring the quality of commercial wine and observed similar situation about wines that belong to be different as declared on the label.

Ivanova-Petropulos V. Mitrev S. (2014) determined less than 1.5 g/L residual sugar in red wines. Paraschiv et al., (2023), determined 170.7 g/L residual sugar in FA. Colibaba C. et al., 2009, obtained in their study 30.4 g/L residual sugar in BB from 2008. Residual sugar was also determined in BB from 2014 with the value 248.4 g/L and in BB from 2015 with the value 230.0 g/L (Tartian et al., 2017). Paraschiv et al., (2023), concluded in their study that content in sugars of FA wine is influenced by the dose of fertilizers used in soil where the wine variety grew up.

Polyphenols (TPC)

According to the ranged data, polyphenols values in FA were between 0.262 g/L and 0.401 g/L, in FN were between 1.300 g/L and 2.609 g/L and in BB were between 0.409 g/L and 0.585 g/L. FN wine samples showed higher values than FA samples and BB samples due to the contribution of the tannins and anthocyanins (which are not specific to FA samples) to this total content (TPC). The values of FN samples were lower than Antoce and Cojocaru (2018) (between 26.2 g/L and 81.80 g/L) but closer to those assessed by Bărbulescu et al., (2022), (453.77 mg GAE/100 ml in BB from 2022).

Organoleptic analysis

According to the taste panel there were determined three sensorial characteristics with specific attributes to each one: visual aspect (color intensity and color hue), olfactory (overall smell, aroma intensity and aroma quality), taste (acidity, astringency, alcohol, smoothness, sourness and harmony). Finally, overall quality was appreciated. Every specific attribute was evaluated with grades from 1 to 5, where 1 means a poor wine, 2 means an acceptable wine, 3 means a good wine, 4 means a very good wine and 5 means an outstanding wine. Tasters were consisted in 26 testers, actually 15 men and 11 women, from 22 to 57 years old, superior education all of them. They applied BLIC equation (balance. length. intensity. complexity) for this determination. Finally, there were calculated arithmetic averages for the obtained grades (Table 3).

Table 3 Sensorial characteristics of the wine samples

			visual aspect		olfactory			taste						quality overall
no. of sample	sample code	wine type	color intensity	color hue	overall smell	aroma intensity	aroma quality	acidity	astringency	alcohol	smoothness	sourness	harmony	
1	FN1	dry	4.85	4.65	4.85	5.00	4.96	4.96	4.88	5.00	4.85	4.23	4.42	4.92
2	FN2	dry	4.92	5.00	4.62	4.85	4.88	4.58	4.58	4.92	4.88	4.62	4.77	4.81
3	FN3	dry	4.81	4.92	4.81	4.81	4.77	4.85	4.85	5.00	4.88	4.19	4.42	4.65
4	FN4	dry	4.73	4.54	4.88	5.00	4.00	4.77	4.69	5.00	4.15	4.12	4.23	4.69
5	FN5	dry	4.58	4.92	4.81	5.00	5.00	4.96	4.96	4.77	4.54	4.27	5.00	4.92
6	FN6	dry	5.00	4.92	4.88	4.65	4.23	4.73	4.19	4.31	4.19	4.15	4.27	4.65
7	FN7	medium dry	4.88	4.81	4.54	4.62	4.31	4.62	4.62	5.00	4.73	3.88	4.00	4.38
8	FN8	medium dry	5.00	5.00	4.77	5.00	4.81	4.81	4.65	4.92	4.85	4.31	4.81	4.69
9	FA1	dry	3.96	4.08	4.42	4.15	4.31	4.77	4.81	4.35	4.04	3.58	4.04	4.19
10	FA2	dry	3.58	4.15	4.38	3.92	4.08	4.23	4.46	4.46	4.00	3.81	4.00	4.19
11	FA3	dry	4.08	4.08	4.08	3.88	3.96	4.46	4.15	4.00	3.96	3.96	4.04	4.04
12	FA4	dry	4.04	4.65	5.00	4.19	4.12	4.04	4.00	4.27	4.00	3.88	4.00	4.15
13	FA5	dry	4.00	4.27	4.27	4.12	4.27	4.31	4.31	4.00	4.00	3.81	4.00	4.08
14	FA6	medium dry	4.27	4.38	4.12	3.85	4.00	4.46	4.46	4.46	3.96	3.65	4.04	4.35
15	FA7	medium dry	3.62	4.19	4.23	3.96	4.00	4.46	4.50	4.46	3.92	3.77	4.58	4.46
16	FA8	medium dry	3.96	4.08	4.50	4.46	4.73	4.65	4.62	4.31	4.15	3.77	4.12	4.15
17	BB1	dry	3.62	4.73	4.65	4.54	4.58	3.65	3.65	3.81	4.19	2.77	4.08	4.19
18	BB2	medium dry	3.85	4.50	4.77	4.42	4.46	3.12	3.00	3.69	4.15	2.65	4.04	4.08
19	BB3	medium sweet	3.62	4.23	4.81	4.54	4.58	3.08	2.85	3.69	4.19	2.46	4.08	4.23
20	BB4	medium sweet	3.62	4.69	4.65	4.58	4.69	3.46	3.58	3.77	4.19	3.27	4.12	4.42
21	BB5	sweet	4.38	4.77	4.85	4.85	4.69	3.46	3.50	3.73	4.38	3.12	4.27	4.38

Visual aspect

Color intensity was evaluated with grades from minimum 3.58 to maximum 5.00. Color intensity was the most appreciated in FN wine samples and the least appreciated in BB wine samples.

Color hue was evaluated with grades from 4.08 to 5.00. Color hue was the most appreciated in FN wine samples and then following the BB wine samples and the least appreciated in FA wine samples. FA samples ranged very homogenous values.

The best grades for visual aspect were awarded by FN. Generally, the FN samples with highest anthocyanins content, were more appreciated by color hue. For BB wine samples, the highest value was ranged in BB5, being the most appreciated and also having the highest anthocyanins content and having a superior aspect.

Olfactory

Overall smell was evaluated with grades between 4.08 and 4.88. Excepting FA4, the least appreciated were FA samples. The BB wine samples were appreciated quite good, close to the highest values of FN wines samples.

Aroma intensity was evaluated with grades between 3.85 and 5.00. Obviously, the highest appreciated wine samples were FNs. and the least appreciated wine samples were FAs.

Aroma quality was evaluated with grades between 4.00 and 4.96. Although the highest content of sulfites was in BB and the highest values in volatile acidity was ranged in FN, the FA wine samples were the most depreciated to this characteristic.

Taste

Acidity was evaluated with grades between 3.08 and 4.96. The lowest acidity was appreciated in BB (less than 3.5) and the most appreciated samples by acidity were FN samples. This could be explained by the lowest values of total acidity ranged in BB.

Astringency was evaluated with grades between 2.85 and 4.96. Results highlighting that the astringency wines are preferred by consumers. Although, the tannins content in BB was significant, these were the least appreciated to the mentioned attribute.

Alcohol was evaluated with grades between 3.69 and 5.00. The alcohol perception as an attribute of taste is correlated with the alcohol content (% alc.) as a chemical parameter. Regarding to the alcohol influence in sensorial properties of wine, it was proved that FN wine samples were the highest appreciated and the BB wine samples were the lowest appreciated, this being explained by alcohol content ranged in tested samples.

Smoothness was evaluated with grades between 3.92 and 4.88.

Sourness was evaluated with grades from 2.46 to 4.62. The highest appreciated wine samples were the FN. BB and FA were medium appreciated, with comparable grades. To FN wines are two exceptions, FN4 and FN6, which were lower appreciated, these being characterized by a high content of anthocyanins and tannins.

Harmony was evaluated with grades between 4.00 and 5.00. The highest appreciated were FN wine samples, excepting FN4 and FN6 which were medium by harmony. The BB wines and FA wines were comparable.

Overall quality

According with panel tasters evaluation, overall quality was between 4.04 and 4.92. Evaluating the attributes, overall quality was appreciated, which proved to be the highest in FN, with the best values in FN1, FN4 and FN8, which had low content in sulfites, higher content in anthocyanins and medium alcohol content. Sensory tests of red wines from 2018 harvest, highlighted those favorite wines was Cadarcă (89 points), Fetească Neagră (85 points), Merlot (84 points) and Cabernet Sauvignon (82 points) (Artem V. et. al. 2014). Perception of women tasters/consumers were more open for medium sweet or sweet wines then for dry wines. Women have also a preference for white and rose wines by color. On the other hand, the men prefer dry and tannic wines by taste and red wines by color. Studies or professional training did not present a tie-breaking criterion.

Fine wines are more appreciate by olfactory characteristics then visual aspect or taste. The arithmetic average of arithmetic averages of each sensorial characteristics of wine samples were calculated and the values are highlighted in Figure 1. Common consumer prefers wines first by olfactory, second by visual aspect and finally by taste.

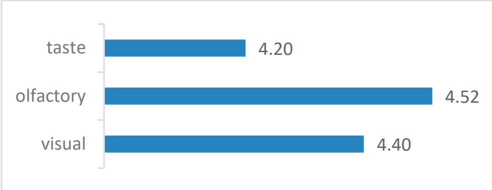

Figure1 Overall sensorial characteristics

Correlation of physio-chemical properties with sensorial characteristics of tasted wines

There were assessed correlations for finding out which of the chemical parameters have higher influence when choosing a wine by a common consumer. There were correlated the all values of parameters with each evaluated attribute (Table 4). The most relevant is the content in phenolic compounds. The pH and TPC had a higher correlation. TPC essentially influence the color intensity, color hue and also aroma intensity and smoothness. The anthocyanins, alcohol content, volatile acidity and tannins content had also a high correlation with color, aroma intensity and astringency. The results suggest that anthocyanins content highly influents the perception of color intensity and also the aroma intensity and smoothness. Although overall quality is highly correlated with the alcohol content, this chemical parameter is reasonable correlated with almost all the sensorial attributes. Volatile acidity is highly correlated with aroma intensity, smoothness, color (intensity and hue) and has a wicked correlation with acidity and astringency. Tannins content is highly correlated with aroma intensity and color hue. Although the residual sugar is lower correlated with overall quality, it could be observed a highly negative correlation with acidity, astringency, alcohol and sourness, the results may suggest that residual sugar content it is not important for common consumer preferences. Sulfites and total acidity expressed an almost non-existent correlation with most of the sensorial atributes. It seems that if the value is within the regulated limits, doesn't influence the consumer perception.

Table 4. Correlation of physio-chemical parameters with the values of sensorial attributes

	color intensity	color hue	overall smell	aroma intensity	aroma quality	acidity	astrin-gency	alcohol	smooth-ness	sour-ness	harmony	overall quality
sulfites (mg/L)	-0,277	0,109	0,026	0,098	0,208	-0,472	-0,406	-0,417	-0,061	-0,396	0,070	0,036
total acidity (g tartric acid/L)	-0,050	-0,112	-0,206	-0,249	-0,305	0,111	0,158	-0,015	-0,253	0,243	-0,100	-0,064
volatile acidity (g acetic acid/L)	0,627	0,623	0,487	0,717	0,305	0,305	0,262	0,459	0,650	0,365	0,519	0,633
pH	0,728	0,792	0,606	0,822	0,549	0,403	0,368	0,546	0,728	0,521	0,718	0,825
alcohol (% vol)	0,587	0,646	0,458	0,607	0,401	0,370	0,363	0,434	0,517	0,510	0,445	0,684
antho-cyanins (mg/L)	0,865	0,679	0,494	0,764	0,309	0,458	0,378	0,692	0,740	0,524	0,433	0,761
Residual sugar (g/L)	-0,449	-0,153	0,107	-0,014	0,145	-0,717	-0,668	-0,688	-0,243	-0,662	-0,228	-0,320
TPC (g/L)	0,867	0,726	0,485	0,777	0,334	0,554	0,470	0,728	0,708	0,622	0,624	0,809
tannins (mg/L)	0,477	0,668	0,578	0,803	0,462	-0,025	0,428	0,177	0,502	0,109	0,464	0,632

CONCLUSIONS

According to the obtained data, almost all the values of *physio-chemical properties* of wine samples were in data range of the Romanian and EU regulation. The FN wine samples registered higher values in alcohol content, volatile acidity, anthocyanins, TPC and tannins. The FA wine samples ranged higher values to total acidity and the BB wine samples ranged higher values to residual sugar and sulfites. The FN wine samples were the highest appreciated by *sensorial characteristics*. The *correlation* highlights that the most important parameters for common consumers are pH, TPC and anthocyanins and the lowest influence have been total acidity and sulfites.

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