Scientific Bulletin. Series F. Biotechnologies, Vol. XXIII, 2019
ISSN 2285-1364, CD-ROM ISSN 2285-5521, ISSN Online 2285-1372, ISSN-L 2285-1364

CHARACTERIZATION OF MERLOT DRY RED WINE COMPOSITION ACCORDING TO THE YEAR OF PRODUCTION

Camelia RĂDUCU[1], Vioara MIREȘAN[1], Igori BALTA[1], Adina Lia LONGODOR[1], Ștefania MARIS[2], Aurelia COROIAN[1]

[1]University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca
Faculty of Animal Science and Biotehnology, Mănăştur Str. 3-5, 400272, Cluj-Napoca, Romania
[2]Universitat de Lleida, UDL, Department of Environment and Soil Sciences,
Av. Rovira Roure, 191 25198 Lleida, Spain

Corresponding author email: lia_adina@yahoo.com

Abstract

Knowing the physico-chemical composition of the wine allows it to be authenticated and to detect the frauds that can be encountered in marketed wines. The physico-chemical analysis of wine is the basis for controlling and observing the technological flow of wine production. It is also necessary to evaluate the organoleptic characteristics of wine as there is a close link between the sensory characteristics and the chemical composition of the final product. The raw material and the harvest year significantly influence the final composition of the wine. The temperature and precipitations of the raw material harvest year significantly influence the chemical composition of the wine. Tartaric acid varies between 2.51 ± 0.05 and 2.82 ± 0.04 for red Merlot dry wines. The mean values for malic acid are between 1.01 ± 0.04 and 1.57 ± 0.03. The average citric acid values range from 0.19 ± 0.01 to 0.24 ± 0.01 for red Merlot dry wines. These values correspond to the average values reported by other authors in the literature. The purpose of this study was to characterize the content of tartaric, malic, citric and lactic acid in dry red Merlot wine, as well as sensory and physico-chemical properties according to the year of production.

Key words: *Merlot red wine, malic acid, acidity, pH.*

INTRODUCTION

Wine is an alcoholic beverage obtained exclusively from total or partial alcoholic fermentation of crushed fresh grapes or grape must and continues to surprise consumers with its incredible flavors and aromas. Making wine is a long and laborious process in which the total efficiency of all technological operations ultimately determines the quality and price of the finished products. In recent years, the popularity of red wine consumption has increased worldwide. Due to the increased content of phenolic compounds, primarily anthocyanins, leuco-anthocyanins, flavonols (quercetin) and flavan-3-ols (catechin and epicatechin) red wines are characterized by a high biological value (Liu et al., 2018; Motilva et al., 2016). Consumers demands for red wine quality the necessity of continuous improvement of technological processes of wine production. Specifically, control of extraction processes is required in order to extract optimal amounts of coloring and other groups of phenolic substances and anthocyanins for the achievement of the desired color, preventing their oxidation, and excessive astringency (Shirahigue et al., 2010; Francesca et al., 2014). One of the essential factors determining the specificity of red wines is the accumulation of phenolic compounds formed in the grape berries which are undergoing biochemical changes in the processing of wine raw materials. Phenolic compounds play an important role in the addition of the organoleptic properties of various foods (Cheynier et al., 2012). They are contributing to bitter and astringent properties to the taste of fruits and fruit juices, due to the interaction of phenolic substances mainly procyanidins and glycoproteins. As well, these compounds are the main substances that can attribute the color differences in wines, juices, and products made from fruits and vegetables (Liu et al., 2018). Most of the components of the phenolic complex from grapes and wine belong to the group of biologically active substances, making red wines increasingly used to treat numerous diseases (Giacosa et al., 2013; Biasi et al., 2014; Tresserra et al., 2015). Grape-derived polyphenols are possessing cytoprotective properties and antioxidant properties, thereby effectively binding free radicals and preventing from the diseases such as the risk of cardiovascular disease, metabolic disorders and certain types of cancers (Jiang et al., 2019; Zadnipryany et al., 2017; Agouni et al., 2017; Biasi et al., 2014). Moreover, polyphenols from red wine possess a significant anti-inflammatory action protecting the intestinal barrier integrity (Nunes et al., 2019). For most popular Merlot and Cabernet Sauvignon wines the total flavonoid, phenolic, and anthocyanin content are increasing with the high-altitude. Also, that content is varying due to such factors as climate and soil conditions (Jiang et al., 2019; Jin et al., 2017). Another significantly important characteristics of wines are pH, Brix and the acid composition also known as titratable acidity (TA) composed of acids such as lactic, citric, malic and tartaric acids. An improper harvest treatment can negatively influence these parameters (Casassa et al., 2019). According to (Casassa et al., 2013), Brix from Merlot grapes presented means between (20.18 and 24.9) and pH showed variations between (3.17 and 3.70), respectively. Organoleptic characteristics of the wine are strongly correlated with organic acids and sugars (Coelho et al., 2017). Unwanted quantities of sugars and organic acids presented in grape must or wine can have a negative influence on the taste and Bouquet balance of beverage (Silva et al., 2014). Acetic acid and butyric acid presence in wines can be a precursor of undesirable microbiological alterations that affect the quality of the final product (Lima et al., 2014; Kučerová et al., 2011). Tang et al. (2013) demonstrated cardioprotective effects of malic and citric acids on myocardial ischemia, due to anti-inflammatory and antiplatelet aggregation properties of organic acids. Total amounts of malic and tartaric acids can consist of <80% of the overall amount of acids in grape berries and must. In addition, concentrations of the acids may be different because of factors such as level of maturation, the variety of grapes, climate and so forth (Coelho et al., 2017). Interestingly to the fact that red wines can resist reduced acidities, due to phenolic compounds that have the potential to increase acidity, and also play role in wine maintaining during the aging processes (Kučerová et al., 2011). Therefore, the aims of this study were to evaluate the content of organic acids in Merlot dried wine, as well as sensory and physicochemical parameters.

MATERIALS AND METHODS

Wine description

Commercially Merlot wines from Asconi winery were used in the present study. Asconi company owns about 500 hectares of vineyards located near Geamana village, in the county of Anenii Noi, Moldova. Cultivated varieties of grapes are Merlot, Cabernet Sauvignon, Sauvignon Blanc, Chardonnay and Muscat Ottonel and so on. Grapes are harvested only manually, which prevents the fall of leaves or pieces of a vine in the buckets. Moreover, only matured grapes are harvested. In addition, wines produced in particular harvest year which have benefited from favorable climatic conditions have special qualities that are highly appreciated by consumers but are also reflected in the terms of marketing price.

Wine analysis

Merlot red wine samples were collected according to the year of production (2013-2017). A number of 10 samples were used for each year. FOSS Wine Scanner device that measures many parameters of grape must and wine, based on Fourier Transform Infrared (FTIR) technology to scan a sample of liquid (sample - 50 ml). The measurement results are obtained in only 30 seconds, analysing critical quality control variables. The analyser is connected to a computer, for data interpretation. Facilities regarding software platform allow improved parameter control by measuring and monitoring the results in documents. Final test results help to define the strategy for the next harvest.

RESULTS AND DISCUSSIONS

Wine is not only rich in alcohol but is also rich in content of acids. Acids in wine are arising from grapes as a result of alcoholic fermentation as a by-product or as a result of the treatments, operations of wine caring and clarifying. Grapes derived acids such as (acidic acid, malic acid) have the highest contribution, therefore it is said that acidity of the wine is born in grape must (Ţârdea et al., 2007; Gheorghita et al., 2002; 2006; Bulancea et al., 2009). Table 1 and Table 2 shows the mean values for the main analyzed acids in high quality Merlot red wine.

Table 1. Content in tartaric and malic acid in red Merlot dry wine - superior quality according to year of production

Year	Tartaric acid		Malic acid	
	X±sx	V%	X±sx	V%
2017	2.60±0.11	1.3	1.18±0.15	1.22
2016	2.51±0.05	4.79	1.28±0.06	1.58
2015	2.44±0.06	5.27	1.01±0.04	1.94
2014	2.61±0.05	4.30	1.11±0.17	4.81
2013	2.82±0.04	3.32	1.57±0.03	4.29

(n = 5; sx - standard deviation; V- variability; X - average value)

Table 2. Merlot dry red wine content of citric and lactic acid

Citric acid		Lactic acid	
X±sx	V%	X±sx	V%
0.23±0.02	1.19	0.30±0.01	1.31
0.19±0.01	4.23	0.33±0.01	3.63
0.24±0.01	2.03	0.32±0.02	3.20
0.21±0.02	3.04	0.39±0.02	5.37
0.24±0.01	2.29	0.38±0.03	6.32

(n = 5; sx- standard deviation; V- variability; X - average value)

Tartaric acid in analyzed samples varies between (2.51 ± 0.05) and (2.82 ± 0.04). The mean values for malic acid are between (1.01 ± 0.04) and (1.57 ± 0.03).
The average values for citric acid are between (0.19 ± 0.01) and (0.24 ± 0.01). These values correspond to the average values reported by other authors in the literature (Casassa et al., 2019; Peres et al., 2009).
Figures 1-3 show average values for pH, color intensity and total acidity in superior Merlot dry red wine, depending on the year of production. The values presented for these parameters are consistent with other studies (Casassa et al., 2013; Jin et al., 2017; Jiang et al., 2012; Casassa et al., 2019).

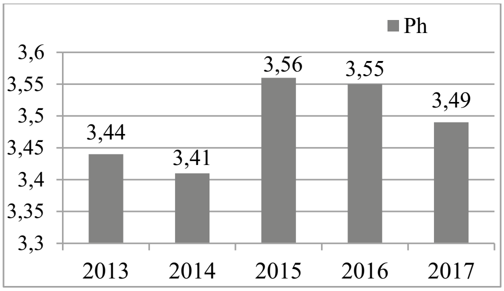

Figure 1. Average pH values for red Merlot red SQ wine

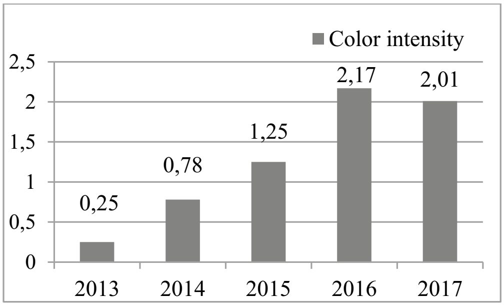

Figure 2. Color intensity for red Merlot red SQ wine

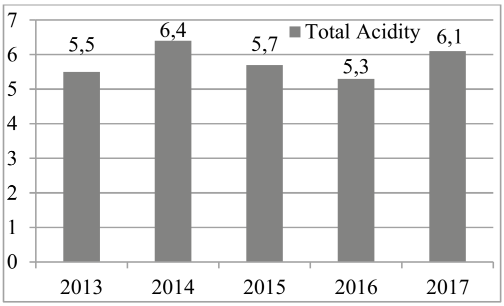

Figure 3. Mean values for total acidity for Merlot red dry wine SQ

Total acidity is the acidity determined by neutralizing acidic functions with a known concentration of (NaOH) solution (alkaline). For this reason, it is also called titratable acidity (TA). The end of dosing is also currently appreciated by a color indicator, such as bromothymol blue, which turns to pH = 7 or phenolphthalein, which turns to pH = 9 (Ţârdea et al., 2007; Gheorghiţă et al., 2002, 2006; Bulancea et al., 2009). According to (Petropulos et al., 2015) chemical composition of Macedonian red wines (Merlot) demonstrated a total acidity of (5.6-6.0) g/l, and color intensity values as it follows (11.41, 12.35, 21.08, and 24.20) in accordance to (OIV 2014). In addition, another study revealed that Macedonian merlot wines can exert maximum antioxidant activity as a consequence of longer exposure to grape pomace (Kostadinović et al., 2012). Total acidity in organic and conventional Merlot wines from different regions of Italy, according to (Garaguso et al., 2015) comprised means between 6.19 and 5.74 g/l, respectively. Organic acid concentrations for Brazilian Merlot wine for tartaric, malic, lactic and acetic acid presented values between (1495 ± 6), (2243 ± 23), (35 ± 4) and (269 ± 20) (mg/l), respectively. Moreover, Merlot red from 2001, showed increased values of lactic acid (7306 ± 35) and acetic acid (671 ± 13) (mg/l), using a capillary electrophoresis method (Peres et al., 2009). Regarding, Merlot grape chemistry content by (Casassa et al., 2013) they found out tartaric acid differences between the maturity levels during 2011 and 2012. Early harvested grapes from 2011 and 2012 season presented significantly higher levels of tartaric acid with the values range of 7.66 and 8.14 g/l. Later berries harvests showed lower values, 5.69 and 6.37 g/l, respectively. Also, the pH of earlier season grapes from 2011 and 2012 showed values of 3.47 and 3.17, followed by late harvest berries with the values between 3.70 and 3.66. Furthermore, Merlot wines from 2011 and presented values of tartaric acid, pH, malic acid and lactic acid as follows: 5.31 and 5.75 g/l, 3.73 and 3.47, 39 and 27 mg/l, 0.84 and 0.97 g/l, respectively. In addition, extended maceration of Merlot wines presented tartaric acid content of 5.55 g/l with the pH 3.63, malic acid concentration of 39 mg/L and lactic acid 0.92 g/l. (Casassa et al., 2013) find similar results when they finished Merlot red wines at bottling presenting average values of titratable acidity between 5.4-5.6 g/l tartaric acid, with pH 3.76-3.82, malic acid and lactic acid, 0.10-0.13 g/l and 1.26-1.53 g/l, respectively. According to Jin et al. (2017), red Merlot wines from Northern China regions presented values of tartaric acid with a range between 5.38-6.44 g/l, with a pH 3.48-3.30 and color intensity of 7.9-9.4 AU (absorbance unit). Merlot grapes composition obtained from Uruguay showed total acidity (61.2 ± 2.0) in meq l^{-1}, pH of 3.57 and sugar content (221.5±1.9) g l^{-1} (González-Neves et al., 2015). Jiang et al. (2012) compared general composition of Merlot wine and musts from different regions of China, founding out that titratable acidity for wine varied from 6.7 to 8.3 g/l with a pH from 3.0 to 3.6 and for the must, 6.9 and 8.9 g/l, with 3.0 and 3.3 pH, respectively. In addition, a recent study regarding the chemical composition of Merlot grapes from China, presented values for titratable acidity varying from 6.7 to 8.3 g/l having a pH from 3.0 to 3.6. Additionally, tartaric acid of Cabernet Sauvignon grapes was differing (from 6.3 to 7.3), depending on the region of China (Jiang et al., 2019). Recently (Casassa et al., 2019), performed a physicochemical analysis on Merlot wines from Argentina, using three different harvests of grapes (from 3 Feb., 27 Feb., and 29 Mar.). Wines made from the first harvest showed a pH of 3.43 ± 0.09, titratable acidity 5.57 ± 0.03, tartaric acid 2.32 ± 0.03, citric acid 0.31 ± 0.05, malic acid 0.50 ± 0.06 and lactic acid contents of 1.53 ± 0.03, measurements units where expressed in g/l. Second harvest obtained wines presented a pH of 3.60 ± 0.07, TA 5.53 ± 0.17, tartaric acid 1.73 ± 0.10, citric acid 0.37 ± 0.05, malic acid 0.93 ± 0.06, and lactic acid 1.49 ± 0.06. Beverages obtained third harvest (29 Mar.), demonstrated a pH of 3.58 ± 0.09, TA (5.08 ± 0.12) was significantly lower compared to previous harvests, tartaric acid (2.11 ± 0.06), citric acids presented a significantly decrease (0.05 ± 0.02), malic acid (0.50 ± 0.11) and a slight decline in lactic acid content (1.33 ± 0.03) (g/l) compared to the first and second harvests was observed, respectively. Altogether, our results provide some useful information on high-quality Merlot wine production.

CONCLUSIONS

In conclusion, obtained results showed that these wine varieties fall below the maximum admissible limit for parameters such as total acidity, and pH indicating that these wines are of superior quality. Thus, the year of production influences the chemical composition, namely the total acidity, and the physicochemical composition of wines.

REFERENCES

Agouni, A., Mostefai, H. A., Lagrue, A. H., Sladkova, M., Rouet, P., Desmoulin, F., Pechanova, O., Martinez, M. C., Andriantsitohaina, R. (2017). Paradoxical Effect of Nonalcoholic Red Wine Polyphenol Extract, Provinols™, in the Regulation of Cyclooxygenases in Vessels from Zucker Fatty Rats (fa/fa), *Oxidative Medicine and Cellular Longevity*, 1-12.

Biasi, F., Deiana, M., Guina, T., Gamba, P., Leonarduzzi, G., Poli, G. (2014). Wine consumption and intestinal redox homeostasis. *Redox Biology*, *2*, 795-802.

Bulancea, M., Râpeanu, G. (2009). *Autentificarea și identificarea falsificărilor produselor alimentare*. Editura Didactică și Pedagogică R.A., București.

Casassa, L. F., Beaver, C. W., Mireles, M. S., Harbertson, J. F. (2013). Effect of extended maceration and ethanol concentration on the extraction and evolution of phenolics, colour components and sensory attributes of Merlot wines. *Australian Journal of Grape and Wine Research*, *19*, 25–39.

Casassa, L. F., Beaver, C. W., Mireles, M., Larsen, R. C., Hopfer, H., Heymann, H., Harbertson, J. F. (2013). Influence of Fruit Maturity, Maceration Length, and Ethanol Amount on Chemical and Sensory Properties of Merlot Wines. *Am. J. Enol. Vitic.*, *64*, 437–449.

Casassa, L. F., Sari, S. E., Bolcato, E. A., Fanzone, M. L. (2019). Microwave-Assisted Extraction Applied to Merlot Grapes with Contrasting Maturity Levels: Effects on Phenolic Chemistry and Wine Color. *Fermentation*, *5*(1), 15.

Coelho, E. M., Padilha, C. V. D. S., Miskinis, G. A., Barroso, A. G., Pereira, G. E., Azevedo, L. C., Lima, M. D. S. (2018). Simultaneous analysis of sugars and organic acids in wine and grape juices by HPLC: Method validation and characterization of products from northeast Brazil. *Journal of Food Composition and Analysis*, *66*, 160–167.

Garaguso, I., Nardini, M. (2015). Polyphenols content, phenolics profile and antioxidant activity of organic red wines produced without sulfur dioxide/sulfites addition in comparison to conventional red wines. *Food Chemistry*, *179*, 336–342.

Gheorghiță, M., Băducă, C. C., Muntean, C., Giugea, N. (2002). *Oenologie, Vol. II, Obținerea, păstrarea și condiționarea produselor vinicole*. Editura Sitech, Craiova.

Gheorghiță, M., Băducă, C. C., Muntean, C., Giugea, N. (2006). *Oenologie, Vol. I, Bazele Industriei vinicole*. Editura Sitech, Craiova.

Giacosa, A., Barale, R., Bavaresco, L., Gatenby, P., Gerbi, V., Janssens, J., Johnston, B., Kas, K., La Vecchia, C., Mainguet, P., Morazzoni, P., Negri, E., Pelucchi, C., Pezzotti, M., Rondanelli, M. (2013). Cancer prevention in Europe: The Mediterranean diet as a protective choice. *European Journal of Cancer Prevention*, *22*(1), 90–95.

González Neves, G., Favre, G., Piccardo, D., Gil, G. (2015). Anthocyanin profile of young red wines of Tannat, Syrah and Merlot made using maceration enzymes and cold soak. *Int. J. Food Sci. Technol.*, *51*, 260–267.

Jiang, B., Zhang, Z. W. (2012). Comparison on Phenolic Compounds and Antioxidant Properties of Cabernet Sauvignon and Merlot Wines from Four Wine Grape-Growing Regions in China. *Molecules*, *17*(8), 8804–8821.

Jiang, B., Zhang, Z. W. (2019). Free Radical-scavenging Activity and Anthocyanin Profiles of Cabernet Sauvignon and Merlot Wines from Four Wine Grapegrowing Regions in China. *S. Afr. J. Enol. Vitic.*, *40*(1).

Jin, X. D., Wu, X., Liu, X. (2017). Phenolic characteristics and antioxidant activity of Merlot and Cabernet Sauvignon wines increase with vineyard altitude in a high-altitude region. *S. Afr. J. Enol. Vitic.*, *38*(2), 132–143.

Kostadinović, S, Wilkens, A., Stefova, M., Ivanova, V., Vojnoski, B., Mirhosseini, H., Winterhalter, P. (2012). Stilbene levels and antioxidant activity of Vranec and Merlot wines from Macedonia: Effect of variety and enological practices. *Food Chemistry*, *135*(4), 3003–3009.

Kučerová J., Široký J. (2011). Study of changes organic acids in red wines during malolactic fermentation. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, *59*(5), 145–150.

Lima, M. D. S., Silani, I. D. S. V., Toaldo, I. M., Correa, L. C., Biasoto, A. C. T., Pereira, G. E., Luiz, M. T. B., Ninow, J. L. (2014). Phenolic compounds, organic acids and antioxidant activity of grape juices produced from new Brazilian varieties planted in the Northeast Region of Brazil. *Food Chemistry*, *161*, 94–103.

Liu, Y., Yan, J., Li, Q., Wang, J., Shi, Y. (2018). Effect of Training Systems on Accumulation of Flavan-3-ols in Cabernet Sauvignon Grape Seeds at the North Foot of Mt. Tianshan. *S. Afr. J. Enol. Vitic.*, *39*(1).

Motilva, M. J., Macià, A., Romero, M. P., Rubió, L., Mercader, M., Ferrero, C. G. (2016). Human bioavailability and metabolism of phenolic compounds from red wine enriched with free or nano-encapsulated phenolic extract. *Journal of Functional Foods*, *25*, 80–93.

Nicola, F., Romano, R., Sannino, C., Grottaglie, L. L., Settanni, L., Moschetti, G. (2014). Evolution of microbiological and chemical parameters during red wine making with extended post-fermentation maceration. *International Journal of Food Microbiology*, *171*, 84–93.

Nunes, C., Freitas, V., Almeida, L., Laranjinha, J. (2019). Red wine extract preserves tight junctions in intestinal epithelial cells under inflammatory conditions: implications for intestinal inflammation. *Food Funct Journal*.

OIV (2014). International Organization of Vine and Wine. *Compendium of International Methods of Analysis of Wines and Musts 1*.

Peres, R. G., Moraes, E. P., Micke, G. A., Tonin, F. G., Tavares, M. F. M., Rodriguez-Amaya, D. B. (2009). Rapid method for the determination of organic acids in wine by capillary electrophoresis with indirect UV detection. *Food Control*, *20*(6), 548-–552.

Petropulos, V. I., Ricci, A., Nedelkovski, D., Dimovska, V., Parpinello, G. P., Versari, A. (2015). Targeted analysis of bioactive phenolic compounds and antioxidant activity of Macedonian red wines. *Food Chemistry*, *171*, 412–420.

Shirahigue, L. D., Plata Oviedo, M., De Alencar, S. M., D'Arce, M. A., De Souza Vieira, T. M., Oldoni, T. L., Contreras Castillo, C. J. (2010). Wine industry residue as antioxidant in cooked chicken meat. *International Journal of Food Science and Technology*, *45*, 863–870.

Silva, F. L. N., Schmidt, E. M., Messias, C. L., Eberlin, M. C., Sawaya, A. C. H. F. (2015). Quantitation of organic acids in wine and grapes by direct infusion electrospray ionization mass spectrometry. Royal Society of Chemistry, *Anal. Methods*, *7*, 53–62.

Tang, X., Liu, J., Dong, W., Li, P., Li, L., Lin, C., Zhen, Y., Hou, J., Li, D. (2013). The Cardioprotective Effects of Citric Acid and L-Malic Acid on Myocardial Ischemia/Reperfusion Injury. *Evidence-Based Complementary and Alternative Medicine*, 11.

Țârdea, C., Sârbu, G., Țârdea, A. (2000). *Tratat de vinificație*. Editura "Ion Ionescu de la Brad", Iași.

Tresserra-Rimbau, A., Medina-Remón, A., Lamuela-Raventós, R., Bulló, M., Salas-Salvadó, J., Corella, D., Estruch, R. (2015). Moderate red wine consumption is associated with a lower prevalence of the metabolic syndrome in the PREDIMED population. *British Journal of Nutrition*, *113*(2), 121–130.

Veronique, C. (2012). Phenolic compounds: from plants to foods. *Phytochemistry Reviews*, *11*(2-3).

Zadnipryany, I. V., Sataieva, T. P., Tretiakova, O. S., Kubyshkin, A. V., Zukow, V. (2017). Grape polyphenols concentrate demonstrates cardioprotection in terms of hypoxic myocardial injury. *Russian Open Medical Journal*, *6*(4).