ECRONICON OPEN ACCESS

EC NUTRITION
Review Article

Influence of Storage Conditions on the Quality Characteristics of Wines

Sofia Agriopoulou* and Eygenia Stamatelopoulou

Department of Food Technology, Technological Educational Institute of Peloponnese, Kalamata, Greece

***Corresponding Author**: Sofia Agriopoulou, Department of Food Technology, Technological Educational Institute of Peloponnese, 24100 Kalamata, Greece.

Received: March 25, 2017; **Published:** April 19, 2017

Abstract

Wine is a very sensitive and complex combination of chemical components, within the global food and beverage industries. The protection of the integrity of the wine maximizes the contribution of beneficial phytochemical constituents present in human nutrition and ensures that the wine is presented to the consumer in a way that the winemaker it has prepared. Especially the consumption of red wine has been increased given that numerous studies associate beneficial effect of phenolic antioxidants with heart disease. The wines are usually aged for an extended period for the maturation of flavors after alcoholic fermentation. If ideal conditions are present during aging, such as temperature, humidity, and light, the wines undergo significant modifications so that their organoleptic characteristics are improved. Moreover, oxidative phenomena and reactions may occur rapidly in any wine, in some packages, and particularly white wine are typically more prone to oxidation than red ones. Storage conditions, including wine packaging and storage temperature, are the most significant factors when someone wants not only to produce excellent wine, but also to serve into the consumer's glass.

Keywords: *Wines; Storage; Quality; Temperature; Polyphenols; Safety*

Introduction

Wine is the beverage resulting exclusively from the partial or complete alcoholic fermentation of fresh crushed grapes, or fresh uncrushed grapes, or of grape must and its actual alcohol content shall not be less than 8.5% volume [1]. Wine is very popular alcoholic beverage, all over the world, but the most consumed alcoholic beverage is the beer [2]. In the Mediterranean diet wine is an important component, because it is very rich in a lot of healthy antioxidant compounds, such as phenolic acids, flavonols, anthocyanins, and tannins [3]. Epidemiological data display that moderate consumption of red wine decreases the incidences of atherosclerosis, coronary heart disease, and platelet aggregation [3]. The must of red grapes during red winemaking undergoes fermentation, together with the grape pomace and in this step, yeasts convert most of the sugars of the grape juice into ethanol and carbon dioxide, but also phenolic compounds are extracted from the grape skin. Phenolic substances are one of the most important quality parameters of red wine [4], which they play a significant role on the sensorial characteristics of wine because they are responsible for some of organoleptic properties, such as aroma, color, flavor, bitterness and astringency [5]. Particularly, astringency has been described as one of the most important red wine organoleptic characteristics. Actually, it a mouthfeel and a feeling of dryness or roughness to result from increased friction between the tongue and the surfaces in the mouth. The phenolic composition of wine depends on different factors such as, grape variety, climatic conditions, cultural practice and technology. In addition, during the storage period, temperature, bottle position, oxygen content and light may affect the qualitative characteristics of aroma, colour and phenolic composition [6].

Correct storage is a crucial parameter in order to achieve the maximum duration of peak quality of wine. Besides, proper storage is a basic issue to ensure the quality, safety and the nutritional value of each food. Wine may be consumed several weeks or years or decades after its production. During storage wine composition undergoes continuous and significant changes, depending on the conditions of stor-

age such as temperature and humidity and packaging type [7]. The aim of this manuscript was to examine all the parameters which affect the quality characteristics of wines, during the entire storage period.

Chemical structures and role of some wine phenolic substances

Phenolic substances are a large and complex group of secondary metabolites (Figure 1) which are present in both grapes and wine, providing important quality parameters. The characteristic proportions of the total phenolic content can be affected by chemical changes which can display or eliminate new compounds, which contribute to the quality of wine. Phenolic acids (which divided in benzoic acids and cinnamic acids), flavonoids (such as, flavones, flavanones flavonols, flavononols, flavanes, flavanols, anthocyanic pigments, chalcones and dihydrochalcones), tannins, stilbenes, coumarins, lignans and neolignans, and phenylethanol derivatives (tyrosol and hydroxytyrosol) are the main non-volatile phenolic compounds in wine [5]. Figure 2 indicates the chemical structure of some wine phenolic substances.

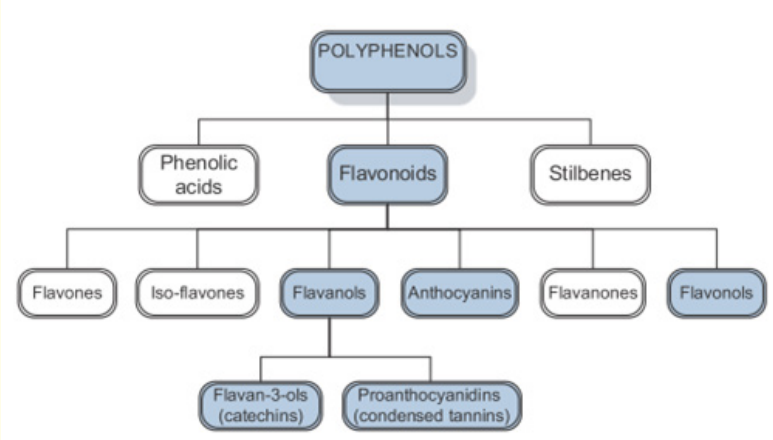

Figure 1: *Structural classes of phenolic substances in wine [8].*

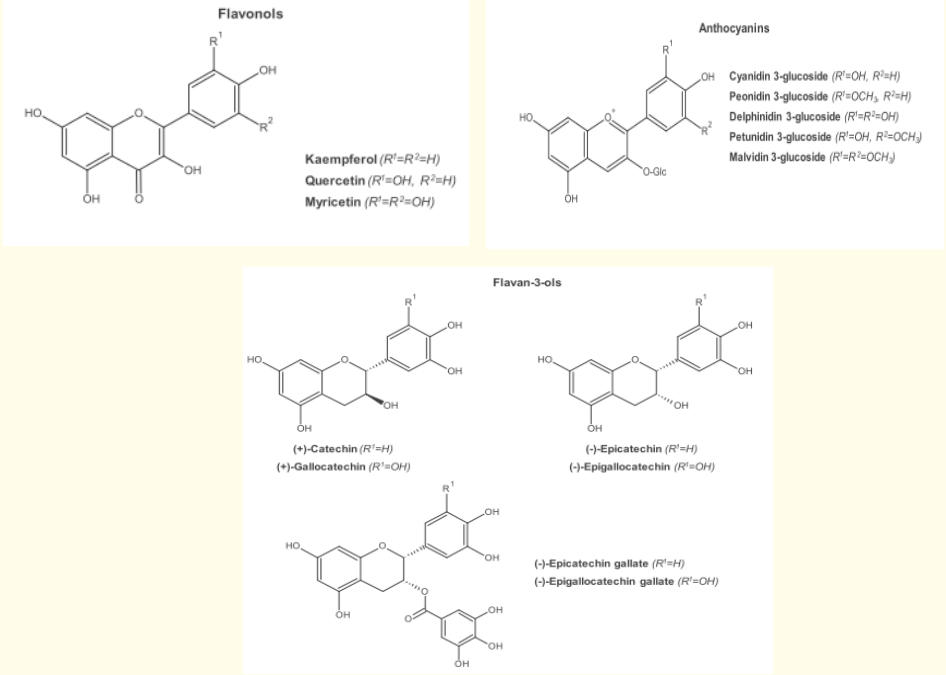

Figure 2: *Chemical structure of some wine phenolic substances [5].*

The knowledge of the relationship between the quality of a particular wine and its phenolic composition is, at present, one of the major challenges in enology research [5]. Organoleptic properties such as aroma, bitterness, color, flavor and astringency of wines as well as the antioxidant activity of wines, are influenced largely by the phenolic compounds. The winemaking technology, the fermentation, the aging conditions, the harvest date, the region's climate, and the soil of the vineyard are several factors that affect the composition of the wine in phenolic compounds [9]. Given that most of phenolic compounds are unstable, take place in reactions that occur during the aging of the wine, in particular, oxidation, polymerization and copigmentation. Actually, polyphenols have a poor long-term stability, as they are affected by different factors, such as, pH variation, oxygen, enzymatic activities, light, temperature, and presence of metal ions. During wine evolution, anthocyanins, which are responsible for the perception of astringency, bitterness, and the colour of red wines, form with various co-factors such as flavanols and hydroxycinnamic acids, molecular associations or complexes (copigmentation). Furthermore, during ageing, rearrangement reactions between phenolic compounds take place that influence the wines mean degree of polymerization. For the wines ageing in bottles, if the bottle closures allow oxygen ingress, are subject to oxidative reactions [6]. Table 1 shows the effects of storage conditions on phenolic compounds in some types of wine.

Type of wine	Storage conditions	Effect of quality	Reference
Rose	582 days and 45^{0}C	Total decomposition of all anthocyanins	10
Freeze-dried encapsulated red wine	145 days and 0.58 water activity	70% reduction of Malvidin 3-G and total anthocyanins	3
White	12 months and daily and seasonal temperature variations	Reduction of the phenolic compounds	11
White	8 months and 16 h exposing in artificial light conditions	The lowest concentration of total phenols in the Flint bottle	12
White	10 months, room temperature with light exposure and bottle in vertical position	Modifications in the phenolic composition of wines	13
Young red wines	26 months of aging in bottle	Reduction of total anthocyanins	14
White	18 months	25% reduction of the phenolic compounds	15
White	After 9 months of storage	Reduction of most phenols	16
Red wine	Over 7 months in the dark	88-91% reduction of anthocyanins	17

Table 1: *Effects of storage conditions on phenolic compounds of some types of wines.*

The correct storage and the quality characteristics of wines

The maintenance of the wine quality characteristics for the maximum desirable period concerns many different parameters. The significant role of storage temperature, of the packaging type, and of the humidity, during the lifetime of wine, can influence its quality.

Effect of temperature

Knowledge of the effect of temperature on the chemical composition of red wines, must be significant, since the improper storage is likely to reduce the shelf life, to reduce the sensory quality of the wine, and it has a profound impact on its aging reactions [18,19]. The ideal storage temperature for wines is considered the temperature between 15-20^{o}C. Actually, this temperature is not necessarily applied during storage or transport of wine which the wines are exposed to higher and fluctuating temperatures [20-22]. Many white wines are stabilized with bentonite fining, so that exposure to excessive heat is not displayed as a visual defect, for example, by a considerable haze.

They are also stabilized during the winter, so that exposure to low temperatures, for example, does not result in the precipitation of natural tartrate crystals [19].

In general, there is no 'ideal' storage temperature for wine because the development of a wine is a careful balance between complexity and maturity to develop and preventing qualitative characteristics from taking hold. When the temperature is low, (e.g. < 10°C) wine will clearly benefit from a reduced risk of spoilage, but will also take much longer to develop [8]. A natural ingredient in almost all fermented foods and drinks known as ethyl carbamate can be increased when the wine is exposed to excessive heat during transportation and constitutes a wine quality indicator. The ethyl carbamate is also known as urethane and formed in wine by urea as a precursor, which can be released from the yeast in wine during or at the end of fermentation. Urea can spontaneously react with the alcohol in wine to form carbamates. The chemical reaction between urea and ethanol seems to exponentially accelerate when a wine is stored at an elevated temperature. Ethyl carbamate has been classified as a Group 2A carcinogen by the International Agency for Research on Cancer (IARC) [23].

Effect of packaging type

Among minor constituents of wine, a large number of volatile compounds play a critical role directly affecting product quality. So, alcohols (lower and higher), ketones organic esters, methoxypyrazines, volatile organic acids, aldehydes, lactones, phenols, sulphur containing compounds, norisoprenoids, and terpenes, all contributing to wine aroma [24]. The main aim of packaging is the protection and maintenance of the original quality of the food and drinks as much as possible. Primary physicochemical properties that allow the package to fulfill its mission is barrier properties to oxygen, carbon dioxide, moisture, light and aroma compound. The classic packaging material for wine is glass, due to, two outstanding advantages, the inactivity and clarity. Dark coloured bottles such as amber and green offer greater protection from light than clear and light coloured bottles. However, in the last twenty years, various polymeric materials have been used for the packaging of wine, such as packaging in polyethylene terephthalate bottles (PET), Tetrabrik formula containers (laminates) and Bag-in-Box type containers [25,26].

An important drawback of such polyolefinic (polypropylene, polyethylene) packaging materials in direct contact with wine is their ability to highly adsorb numerous volatile flavour components of wine resulting to substantial product flavour deterioration. For non-polar volatiles sorption capacity is higher due to the hydrophobic nature of polyolefins [27]. Revi., *et al*. have reported considerably higher aroma sorption for a period of storage of dry white wine of Greek variety Vilana for 6 months at 20°C, in the LDPE (low density polyethylene) lined pouch, as compared to EVA (ethylene vinyl acetate). Also, an important portion of the wine aroma compounds was adsorbed by the plastic materials or lost to the environment through leakage of the valve fitment whilst glass proved to be the most inert packaging material for wine [24]. On the other hand, Hopfer., *et al*. reported significant ($p < 0.05$) differences in ''oxidised'' flavour and L*/ (lightness) and b*/ (degree of blue–yellow hue) in Chardonnay wine stored in Bag in Box and glass bottles after 3 months of storage at 20°C [28]. According to Ghidossi., *et al*. white wine was significantly influenced after 6 months of conservation in polyethylene terephthalate bottles [29].

Effect of humidity

The moisture present in the surrounding area where the wines are kept also plays a very important role in their quality. So, a low humidity level could dry the cork out and cause deformation. If the cork shrinks, cracks or even to loosens, excessive air is allowed to enter the bottle and comes into contact with the wine to speed the changes caused by oxygen. On the other hand, a high humidity (above 80%) can create the risk of mold in the cork. In addition, the wine should not be subjected to excessive amounts of light which can cause certain undesirable odors. Besides the wine cellars must be designed in such a way that all the parameters that affect aging to be controlled [30].

Conclusions

Quality is not easy to define, but, it should be related to intrinsic visual, taste, or aroma characters which are perceived as above average for that type of wine. Pre-winery and the post-winery handling of wines as it concerns the storage are significantly contribute to the quality of the wines. The wine exposure to heat can be detrimental to physical and chemical stability as well as to its sensory properties,

because of newly formed chemical compounds, that are highly temperature depended. Also, the choice of the wine packaging must be taken seriously during the marketing and distribution of wine since oxidative phenomena can be occurred quickly in certain packaging configurations. Moreover, some factors such as, humidity levels, light, and bottle position, affect the aroma, color and phenolic composition during the storage period.

Bibliography

1. OIV. International code of oenological practices. Organisation Internationale de la Vigne et du Vin (2012).

2. Baiano A., *et al*. "Wine Processing: A Critical Review of Physical, Chemical, and Sensory Implications of Innovative Vinification Procedures". *Critical Reviews in Food Science and Nutrition* 56.14 (2016): 2391-2407.

3. Rocha-Parra DF., *et al*. "Influence of storage conditions on phenolic compounds stability, antioxidant capacity and colour of freeze-dried encapsulated red wine". *LWT - Food Science and Technology* 70 (2016): 162-170.

4. Puértolas E., *et al*. "Potential applications of PEF to improve red wine quality". *Trends in Food Science and Technology* 21 (2010): 247-255.

5. Garrido J., *et al*. "Wine and grape polyphenols - A chemical perspective". *Food Research International* 54 (2013): 1844-1858.

6. Chira K., *et al*. "Cabernet sauvignon red wine astringency quality control by tannin characterization and polymerization during storage". *European Food Research and Technology* 234.2 (2012): 253-261.

7. Arapitsas P., *et al*. "The influence of storage on the ''chemical age'' of red wines". *Metabolomics* 10.5 (2014): 816-832.

8. Scrimgeour N., *et al*. "Exploring the effect of elevated storage temperature on wine composition". *Australian Journal of Grape and Wine Research* 21.1 (2015): 713-722.

9. Fang F., *et al*. "Effects of grape variety, harvest date, fermentation vessel and wine ageing on flavonoid concentration in red wines". *Food Research International* 41 (2008): 53-60.

10. Stávek J., *et al*. "Effect of Storage Conditions on Various Parameters of Colour and the Anthocyanin Profile of Rosé Wines". *International Journal of Food Properties* 15.5 (2012): 1133-1147.

11. Recamales ÁF., *et al*. "The effect of time and storage conditions on the phenolic composition and colour of white wine". *Food Research International* 39 (2006): 220-229.

12. Cáceres-Mella A., *et al*. "Chemical and Sensory Effects of Storing Sauvignon Blanc Wine in Colored Bottles under Artificial Light". *Journal of Agricultural and Food Chemistry* 62.29 (2014): 7255-7262.

13. Ferreira-Lima NE., *et al*. "Characterization of Goethe white wines: influence of different storage conditions on the wine evolution during bottle aging". *European Food Research and Technology* 237.4 (2013): 509-520.

14. Monagas M., *et al*. "Evolution of the phenolic content of red wines from *Vitis vinifera* L. during ageing in bottle". *Food Chemistry* 95.3 (2006): 405-412.

15. Del Caro A., *et al*. "Effect of Bottle Storage on Colour, Phenolics and Volatile Composition of Malvasia and Moscato White Wines". *South Africa Journal for Enology and Viticulture* 35.1 (2014): 128-138.

16. Kallithraka S., *et al*. "Changes in phenolic composition and antioxidant activity of white wine during bottle storage: Accelerated browning test versus bottle storage". *Food Chemistry* 113 (2009): 500-505.

17. Zafrilla P., *et al*. "Changes during storage in conventional and ecological wine: phenolic content and antioxidant activity". *Journal of Agricultural and Food Chemistry* 51.16 (2003): 4694-700.

18. Mattivi F., *et al*. "Influence of Storage Conditions on the Composition of Red Wines". *Advances in Wine Research* (2015): 29-49.

19. Butzke CE., *et al*. "Effects of heat exposure on wine quality during transport and storage". *Journal of Wine Research* 23.1 (2012): 15-25.

20. Robinson AL., *et al*. "Effect of simulated shipping conditions on sensory attributes and volatile composition of commercial white and red wines". *American Journal of Enology and Viticulture* 61 (2010): 337-347.

21. Cejudo-Bastante MJ., *et al*. "Accelerated aging against conventional storage: effects on volatile composition of chardonnay white wines". *Journal of Food Science* 78.4 (2013): C507-C513.

22. Pereira V., *et al*. "Volatile profiling of Madeira wines submitted to traditional accelerated ageing". *Food Chemistry* 162 (2014): 122-134.

23. Stevens DF and Ough CS. "Ethyl carbamate formation: Reaction of urea and citrulline with ethanol in wine under low to normal temperature conditions". *American Journal of Enology and Viticulture* 44 (1993): 309-312.

24. Revi M., *et al*. "Effect of packaging material on enological parameters and volatile compounds of dry white wine". *Food Chemistry* 152 (2014): 331-339.

25. Robertson GL. "Food packaging. Principles and practice, 2nd edn". *Boca Raton, FL: CRC Press* (2006).

26. Grant-Preece P., *et al*. "Light-induced changes in bottled white wine and underlying photochemical mechanisms". *Critical Reviews in Food Science and Nutrition* 57.4 (2017): 743-754.

27. Brody A. "Flavor scalping in plastic packaging". *Food Technology* 6.1 (2007): 82-87.

28. Hopfer H., *et al*. "The combined effects of storage temperature and packaging type on the sensory and chemical properties of Chardonnay". *Journal of Agricultural and Food Chemistry* 60 (2012): 10743-10754.

29. Ghidossi R., *et al*. "The influence of packaging on wine conservation". *Food Chemistry* 23 (2012): 302-311.

30. Chung HJ., *et al*. "Effect of vibration and storage on some physico-chemical properties of a commercial red wine". *Journal of Food Composition and Analysis* 21 (2008): 655-659.

Volume 8 Issue 3 April 2017