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Innovative solutions for designing a flavored red wine assortment

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Abstract

The creation of aromatized wines, defined as special wines enriched with flavoring additives such as herbs, spices, fruits and other natural flavors, has gained increasing interest nowadays. The aim of this study is to present some technological solutions for the design and development of a Bitter type flavored red wine assortment with particular characteristics, namely, alcohol content 20% vol., sugar 120 g/L and total acidity 3.0 g/L H_2SO_4. Bitter is an aperitif wine made from white or red wine with the addition of sugar, 96% (v/v) food grade ethanol and natural essences of plants and fruits. Compositionally, Bitter differs from Vermouth in that it has a higher alcohol degree and lower acidity. The production of Bitter involved two main stages: the preparation of the base wine and the secondary ingredients (sugar syrup, hydroalcoholic macerate, citric acid solution) and the technological blending. The macerate represents 2% (*v/v*) of the flavored wine. The obtained flavored wine assortment was investigated in terms of quality indices, total phenolic content and antioxidant activity. The techniques accessed for the production of Bitter type flavored wine are recommended for expanding the range of flavored wines with predefined quality characteristics and enhanced functionality. Obtaining aromatized wines may trigger further investigations to exploit the potential of macerates to add value by providing natural flavors and bioactive compounds.

Key words: flavored wine, hydroalcoholic macerate of herbs, spices, fruit and citrus peel, antioxidant properties

1. Introduction

Aromatized wines with different botanicals originated in ancient times, and many of these wines are still produced today in various forms [1]. These wines have been continuously evolved over time to meet changes in consumer preferences, with the addition of fruits, herbs and other flavoring materials being shown to enhance the aroma, taste and health benefits of wine [2–5].

Flavored wine is a type of special wine, fortified with natural flavoring substances such as herbs, spices, fruits and other natural flavors, which has attracted more and more attention in recent years due to its specific sensory characteristics and health benefits [1, 6]. These types of wines have an alcoholic strength of 15.5–25% alcohol by volume (AVB), with an average of 18%, are distinguished by a specific aroma profile, and are obtained from wine with added sugar or must, wine distillate or food grade alcohol and flavoring substances obtained from various herbs, spices and fruits. The volume of the base wine must represent at least 70% of the volume of the aromatized wine obtained [1, 7, 8]. The base wine should be healthy, slightly extractive and with low total acidity [9].

Aromatized wine is obtained in many European countries, where aromatic plants, spices and aromatic food products are legally allowed, according to the legislation in force, for the aromatization of such a type of wine [10].

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The aromatized wines are made from must or wine to which special, authorized treatments are applied during or after processing [11]. Aromatized wines have specific characteristics, determined by the technological properties of the raw material and the technology applied during processing [12]. Compositionally, bitter differs from Vermouth in that it has a higher alcohol content (20-22% vol. as opposed to 14-18% vol.) and lower acidity. From an organoleptic point of view it has a distinct citrus aroma and a stronger bitter taste due to the macerate obtained from herbs, spices, fruit and citrus peel [11]. The quality of the designed bitters largely depends on the number and proportion of herbs and spices used in the manufacturing recipe [13–15].

In our country Bitter is produced from white or red wine, to which sugar, alcohol, natural essences from plants and fruits are added. Caramel and amaranth can be used as colorants. In the macerate used to obtain Bitter flavored wines, fewer types of plant material (plants, dried fruit, spices) are used than in the macerate used to make Vermouth. Food-grade ethyl alcohol is used to extract the components responsible for the specific aroma and taste [9, 12]. Currently, there are few studies focused on the evaluation or optimization of process parameters in the production of wines flavored with herbal extracts. To date, research related to the development of new types of flavored wine is still limited, although it has been reported that the incorporation of botanical flavoring materials into wine improves the sensory and functional quality of the resulting flavored product.

Based on these considerations, the design of flavored wine assortments with a distinct identity is a current concern, which meets the changing consumer preferences. In this regard, the specific aim of the present research is to design and assess the main quality indices as well as antioxidant properties of a Bitter flavored red wine assortment.

2. Material and methods

2.1. Aromatised wine preparation

Obtaining the aromatized wine involved two main stages: the preparation of the base wine and the secondary ingredients such as sugar syrup from sugar ans water, hydroalcoholic macerate of plant materials, citric acid solution and the realization of the technological mixture.

The Merlot red wine (Pâncota, Arad, vintage 2023) was used as the basis to obtain the Bitter flavored wine. The conditioning of raw material wines was performed to reduce protein, pectin, iron and copper contents. Since no further conditioning treatment can be applied in the production of bitter, the base wine must be clear, physico-chemically and microbiologically stable.

The hydroalcoholic macerate obtained from the extraction of a mixture of different herbs, spices, dried fruits and citrus peels presented in Table 1, with 45% v/v ethanol/water, was used as a flavoring agent. The plant material:solvent ratio was 1:10 (2500 mL of 45% *v/v* ethanol/water was added to 250 g of plant material).

Table 1. Quantity of plant materials used for hydroalcoholic macerate

Plant name	Plant parts	Weight (g)
Gentiana lutea	roots	15
Achillea millefolium	flowers	5
Artemisia absinthium	stems	15
Syzygium aromaticum	flowers	20-
Carum carvi	seeds	10
Thymus serpyllum	flowers	10
Urtica dioica	leaves	5
Hippophae	fruits	15
Hyssopus officinalis	flowers	10
Ocimum basilicum	leaves	3
Silybum marianum	fruits	5
Cinnamomum verum	bark	7
Foeniculum vulgare	fruits	5
Mentha piperita	leaves	10
Origanum vulgare	leaves	10
Salvia Rosmarinus	stems	15
Cynara cardunculus var. Scolymus	flowers	10
Coriandrum sativum	fruits	10
Citrus paradisi	peels	20
Citrus limon	peels	25
Citrus sinensis	peels	25

The maceration was carried out at a temperature of 20°C for 14 days, the mixture being stirred vigorously every 12 hours. The clear extract resulting after filtering the macerate was stored in glass containers, closed with a stopper and kept in the refrigerator (4°C) until use. The plant macerate was incorporated in the manufacturing recipe of aromatized wine at a level of 2% *v/v*.

The materials used for preparing the aromatized red wine were calculated on the

bases of total material balance as well as partial material balance in alcohol and sugar [10, 12].

The technological mixture for the production of red Bitter flavored wine consisted of base wine, clear extract resulting after filtering the macerate, sugar syrup and food grade ethanol 96% ABV. Finally, the composition of the mixture was checked and the total acidity was corrected by adding citric acid, previously dissolved in wine. One of the basic requirements of bitters technology is the perfect homogenization of the product. For this purpose, the resulting mixture was stored for 40 days at a temperature of 15°C, allowing homogenization and harmonization of the components. The flavored crude wine was then filtered and bottled.

2.2. Chemical analysis

The main quality indices of both base wine and aromatized wine, such as alcoholic strength, total acidity, reducing sugars, total dry extract and non-reducing dry extract were determined according to the International Methods of Wine and Must Analysis [16].

The total phenolic content (TPC) of the both base wine and aromatized wine was measured according to the Folin-Ciocalteau method [17], with minor modifications as presented by Poiana et al. [9] and expressed as mM gallic acid equivalent (GAE)/L.

Total antioxidant activity was assessed by ferric reducing antioxidant power (FRAP) assay following the procedure of Benzie and Strain [18], with minor modifications as presented by Poiana et al. [9]. This method is based on the ability of compounds exhibiting antioxidant properties contained in the investigated wine samples to reduce Fe^{3+} to Fe^{2+} in the presence of tripyridyltriazine (TPTZ). The total antioxidant capacity (FRAP value) of wine was expressed as mM Fe^{2+}/L.

2.3. Stasistical Analysis

All determinations were performed in triplicate and results were given as average± standard deviation (SD). Statistical processing of the data obtained for TPC and FRAP was performed by one-way analysis of variance (ANOVA) and the recorded differences were statistically significant at a probability $p < 0.05$. Tukey's post-hoc test and Levene's test for equal variance were also included for means comparison.

3. Results and Discussion

The base wine was obtained from Merlot grapes, did not show undesirable physico-chemical and microbiological changes, and has the main quality indices shown in Table 2.

Table 2. The main quality indices of Merlot base wine

Quality indices	Values
Total acidity (g/L H_2SO_4)	3.8± 0.02
Alcoholic strength (%, v/v)	13.5 ± 0.02
Sugar (g/L)	0.75 ± 0.01
Total dry extract (g/L)	26.31 ± 0.04
Non-reducing dry extract (g/L)	25.56 ± 0.03

The Merlot base wine is naturally acidic and has a low sugar content (0.75 g/L), which puts it in the class of dry wines. The acidity makes this red wine feel fresh and refreshing. Too much acidity, however, negatively impacts the sensory profile of the wine, making it perceived sharp, strident [9].

The quantities of raw materials required for the preparation of 5 L of Bitter type flavored red wine, calculated on the base of the material balance both total and partial in the main components alcohol and sugar, are given in Table 3.

Table 3. The materials required for 5 L of Bitter flavored red wine

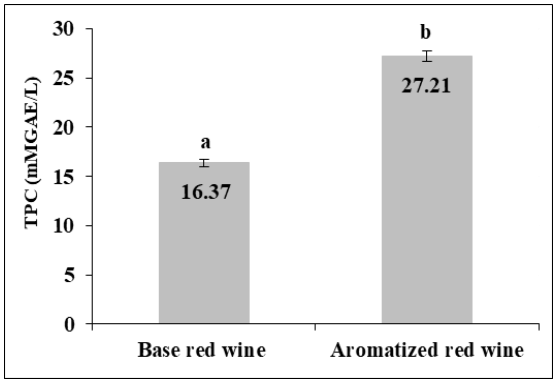
Materials	Values
Red wine Merlot (mL)	3628
Food grade ethanol 96% ABV (mL)	522
Sugar (g)	635
Macerate (mL)	100
Water (mL)	357
Citric acid (g)	1.71

It can be observed that the amount of water incorporated in the manufacturing recipe does not exceed 10% of the volume of the flavored wine. Practically, the water accounted for 7.14% (*v/v*) of the volume of flavored wine. From the production recipe, Table 3, it can be also seen that to obtain 1 L of flavored wine, 725.6 mL of base wine are required. Thus, the base wine represents 72.56% (*v/v*) of the flavored wine. The quality of a wine is not only related to the content of substances but also to their quantitative ratios. The quality of a wine is given precisely by the harmony of these different tastes, when none of them must dominate the others. The main quality characteristics of Bitter type flavored red wine assortment are summarized in Table 4.

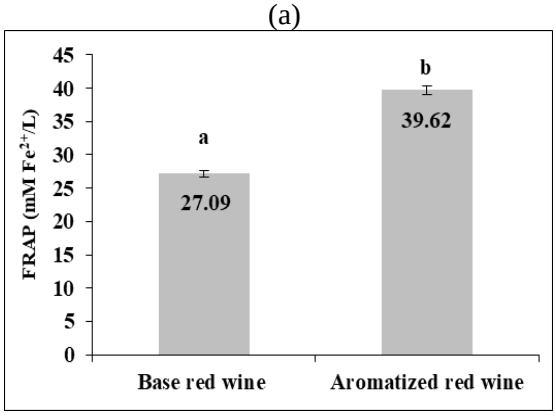
Table 4. The quality characteristics of Bitter flavored red wine

Quality indices	Values
Total acidity (g/L H_2SO_4)	3.0 ± 0.02
Alcoholic strength (%, *v/v*)	20.0 ± 0.03
Sugar (g/L)	120 ± 0.06
Total dry extract (g/L)	138.64 ± 0.07
Non-reducing dry extract (g/L)	18.64 ± 0.03

The total phenolic content and the ferric reducing antioxidant power value of analyzed wine samples are shown in Figure 1.



(a)



(b)

Figure 1. TPC (a) and FRAP (b) of base wine and flavored wine**.** Results are given as the mean of three independent analyses ± standard deviation (SD). One-way ANOVA test was used to compare the mean differences among base wine and aromatized wine. Values for bars with different letters are significantly different ($p < 0.05$).

Significant differences ($p < 0.05$) in TPC and FRAP value can be observed between the Merlot base wine and the prepared flavored wine.

It is notable that flavoring the base wine results in a boost in polyphenolic compound content and a significant increase in antioxidant activity. Thus, the TPC showed an increase of 66.22%, compared to the base wine, while the FRAP value in the flavored wine increased by 46.25%, compared to the value recorded in the base wine. This finding reinforces the results reported by Lakićević et al. [19] which states that the addition of aromatic herbs in wine can significantly enhance the level of total phenolic compounds including flavonoids in developed flavored wine.

Considering that the base wine represents 72.56% (v/v) of the prepared flavored wine, the base wine contributes 11.88 mM GAE/L to the TPC content of the flavored wine. Therefore, the difference between the TPC of the flavored wine and that of the base wine required to obtain 1 L flavored wine is attributed to the macerate, i.e. 15.21 mM GAE/L. Following the same reasoning regarding the antioxidant activity, the contribution of the base wine to the FRAP value of the flavored wine is 19.74 mM Fe^{2+}/L, and the contribution of the macerate is 19.88 mM Fe^{2+}/L.

The hydroalcoholic macerate accounted for 2% (*v/v*) of the volume of flavored wine obtained. Considering that 20 ml of macerate is required to obtain 1L of aromatized wine, at a closer look it can be observed that 1 ml of macerate practically provides a total phenolic compound content of 0.761 mM GAE. Similar, 1 ml of macerate is responsible for an FRAP value of 0.994 mM Fe^{2+}.

The innovative character of the obtained product is supported by the combination of herbs, spices, fruits and citrus peels, as well as the long-term maceration technique applied, which ensures the production of an extract with a high content of bioactive compounds from the polyphenol class. Aromatization of wine with botanical substances could strengthen the effect of the phenolic matrix due to the abundance of phenolic substances in most plant materials used in their production [20, 21].

The organoleptic quality of the aromatized wine is associated with the volatility and solubility of the substances responsible for the aromatic profile that can be affected by the non-volatile matrix of the wine, consisting of compounds such as phenolics, proteins and polysaccharides, being known as the matrix effect [22].

The interaction between phenolic and aromatic compounds in aromatized wines could manipulate organoleptic characteristics, in particular, the aroma and taste of wine, which opens new directions of study. Thus, the design of new aromatized wines is an area of research that can be extended by investigating

the interaction between specific phenolic compounds derived from herbs/fruits/spices and the specific compounds responsible for the aroma of the base wine. These studies are needed to expand the flavored wine market by developing new types of flavored wines with distinctive profile and health benefits.

4. Conclusion

The designed red Bitter assortment belongs to the class of special aromatized wines. Its manufacture involved two main stages consisting of the preparation of the base wine and the secondary ingredients and obtaining the technological mixture. The production of the Bitter-type aromatized red wine assortment is distinguished by several aspects that support technological innovation, such as the combination of medicinal plants and fruits, as well as the long-term maceration technique applied, which ensures obtaining a macerate rich in bioactive compounds from the class of polyphenols. The techniques accessed for the preparation of Bitter are relatively simple, with a high application potential in winemaking sector. The development of the range of flavored wines with natural extracts brings added value both to producers by diversifying production and to consumers, offering new options of flavored wines, with a distinct overall profile and improved bioactivity. The designing of new varieties of wines flavored with plant/fruit/spice macerates represents a new potential market for wine producers.

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human or animal subjects (if exist) respect the specific regulation and standards.

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References

1. Tonutti, I.; Liddle, P., Aromatic plants in alcoholic beverages. A review. *Flavour and Fragrance Journal* **2010**, *25*(5), 341–350. https://doi.org/10.1002/ffj.2001
2. Liang, Z.; Zhang, P.; Zeng, X.A.; Fang, Z., The art of flavored wine: Tradition and future, *Trends in Food Science & Technology* **2021**, *116*, 130–145.
3. Pereira, V.; Pereira, A.C.; Marques, J.C. Emerging trends in fortified wines: A scientific perspective, *Alcoholic beverages* **2019**, 419–470.
4. Joshi, V.K.; Sharma, S.; Thakur, A.D., 13 - wines: White, red, sparkling, fortified, and cider. In A. Pandey, M.A. ´ Sanrom´ an, G. Du, C. R. Soccol, & C.- G. Dussap (Eds.), Current developments in biotechnology and bioengineering, Elsevier, **2017**, pp. 353–406. https://doi.org/10.1016/B978-0-444-63666-9.00013-3.
5. Saltman, Y.; Culbert, J A.; Johnson, T.E.; Ristic, R.; Wilkinson, K.L., Bastian, S.E., Impact of bottle aging on the composition and sensory properties of flavored Chardonnay and Shiraz wines, *Foods* **2020**, *9*(9), 1208. https://doi.org/10.3390/ foods9091208
6. Morata, A.; Vaquero, C.; Palomero, F.; Loira, I.; Bañuelos, M.A.; Suárez-Lepe, J.A., 2-Technology of Vermouth Wines. In: Grumezescu A.M., Holban A.M., editors. Alcoholic Beverages. Woodhead Publishing; Cambridge, UK, **2019**, pp. 35–63.
7. Lakićević, S.H.; Karabegović, I.T.; Cvetković, D.J.; Lazić, M.L.; Jančić, R.; Popović-Djordjević, J.B., Insight into the aroma profile and sensory characteristics of 'Prokupac'red wine aromatised with medicinal herbs, *Horticulturae* **2022**, *8*(4), 277.
8. Martinez-Frances, V.; Rivera, D.; Obon, C.; Alcaraz, F.; Ríos, S., Medicinal plants in traditional herbal wines and liquors in the east of Spain and the Balearic Islands, *Frontiers in Pharmacology* **2021**, *12*, 713414.
9. Poiana M.A.; Dobrei A.; Moigradean D., Developing and quality characteristics of some white vermouth wines, *Journal of Agroalimentary Processes and Technologies* **2016**, *22*(3), 201–206, http://www.journal-of-agroalimentary.ro/admin/articole/96093ML10_722Manuscript_Poiana_M.pdf
10. The European Parliament and The Council of The European Union. In Regulation (EU) No 251/2014 of the European Parliament and of the Council of 26 February 2014 on the efinition, description, presentation, labelling and the protection of geographical indications of aromatised wine products and repealing Council Regulation (EEC) No 1601/91, **2014**, https://eur-lex.europa.eu/legal-content/en/TXT/?qid=1466610281663&uri=CELEX% 3A32014R0251.
11. Order No. 142 from February 29, 2008, published in *The Official Gazette of Romania* No. 565 from July 28, **2008**, http://old.madr.ro/pages/inspectii/ordin-142-din-2008.pdf.

12. Moigradean D.; Poiana M.A.; Alda L.M.; Gogoasa I., Production and quality properties of red vermouth wines, *Journal of Agroalimentary Processes and Technologies* **2016**, *22*(4), 236–240.
13. Abreu, T.; Perestrelo, R.; Bordiga, M.; Locatelli, M.; Daniel Coïsson, J.; Câmara, J.S., The flavor chemistry of fortified wines—A comprehensive approach *Foods*, **2021**, *10*(6), 1239. https:// doi.org/10.3390/foods10061239
14. Gorjanović, S.Ž.; Pastor, F.T.; Loupassaki, S.; Veljović, M.; Vukosavljević, P.' Zlatanović, S.; Pezo, L., Serbian aromatized wine "Bermet": Electrochemical, chemiluminescent and spectrophotometric determination of antioxidant activity, *Journal of the Serbian Chemical Society*, **2020**, *85*(4), 517–529. https://doi.org/10.2298/JSC190404139G
15. Saltman, Y.; Johnson, T.E.; Wilkinson, K.L.; Ristic, R.; Norris, L.M., Bastian, S.E., Natural flavor additives influence the sensory perception and consumer liking of Australian Chardonnay and Shiraz wines, *American Journal of Enology and Viticulture* **2017**, *68*(2), 243–251. https://doi.org/10.5344/ ajev.2016.16057
16. OIV – Compendium of international methods of wine and must analysis, Office International de la Vigne et du Vin, Paris, **2006**.
17. Singleton, V.L.; Orthofer, R.; Lamuela-Raventos, R.M., Analysis of total phenols and other oxidation substrates and antioxidants by means of FolinCiocalteu reagent, *Methods in Enzymology* **1999**, *299*, 152–178.
18. Benzie, I.F.F.; Strain, L., Ferric reducing ability of plasma (FRAP) as a measure of antioxidant power: The FRAP assay, *Analytical Biochemistry* **1996**, *239*, 70–76.
19. Lakićević, S.H.; Karabegović, I.T.; Nikolić, N.Č.; Petrović, GM.; Đorđević, A.S.;, Lazić M., The kinetics of alcoholic fermentation, phenolic content, antioxidant and antimicrobial activity of the wine obtained from Plovdina grape with the addition of aromatic herbs, *Advanced Technologies* **2018**, *7*(2), 11–18. https://doi. org/10.5937/SavTeh1802011L
20. Saltman, Y.; Johnson, T.; Wilkinson, K.; Bastian, S., Australian wine consumers' acceptance of and attitudes toward the use of additives in wine and food production, *International Journal of Wine Research* **2015**, *7*, 83–92. https://doi.org/10.2147/IJWR. S90802
21. Brglez Mojzer, E.; Knez Hrnčič, M.; Škerget, M.; Knez, Ž.; Bren, U., Polyphenols: Extraction methods, antioxidative action, bioavailability and anticarcinogenic effects, *Molecules* **2016**, *21*(7)**,** 901. https://doi.org/10.3390/molecules21070901
22. Wang, X.-J.; Li, Y.-K.; Song, H.-C.; Tao, Y.-S.; Russo, N., Phenolic matrix effect on aroma formation of terpenes during simulated wine fermentation – Part I: Phenolic acids. *Food Chemistry* **2021**, *341*, 128288. https://doi.org/10.1016/j. foodchem.2020.128288