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Production and quality properties of red vermouth wines

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Abstract

The goal of our study was to prepare and characterize four types of red vermouth obtained from Cabernet Sauvignon as basic wine by addition of various additives: plants alcoholic macerate, alcohol, sugar and citric acid. The alcoholic macerate containing a mixture of plants was used for basic red wine flavoring. The obtained vermouth wines differ in sugar content (60, 80, 100 and 120 g/L) as well as regarding the total dry extract values that range from 78.60 to139.65 g/L. The alcohol content was 18% (v/v), total acidity 4 g/L H_2SO_4; no significant differences were observed in the non-reducing dry extract values. Also, the red vermouth wines were analyzed in terms of total antioxidant capacity and total polyphenolic compounds after 45 days of storage at room temperature. Alcoholic macerate have given the antioxidant characteristic to red vermouth samples by the addition of phenolic compounds from plants. After 45 days of storage, the highest losses (4.5%) of total antioxidant capacity were recorded in red vermouth sample with a sugar content of 60 g/L. It can be say that polyphenolic compounds play a significant role on antioxidant function of vermouth wine.

Keywords: red vermouth, alcoholic macerates, sugar, polyphenolic compounds

1. Introduction

The word "vermouth" derives from "wormwood" – infused wines of the same name. Modern vermouth, as a commercial product, originated from the region around Turin, Italy in the late 18th Century as a moderately sweet, herbaceous, compounded bottled beverage [1].

Traditionally, vermouth and aperitif wines are prepared from grape-based wine, with the addition of an herb and spice mixture or their extracts [2]. These herbs, including coriander, nutmeg, marjoram and cinnamon, were considered to be medicinal themselves, so the sweet drinks were often sold as a tonic. The best way to describe vermouth is to call it an aromatized wine. What that means is that sugar, herbs, roots, flowers and spices have been added to give it the flavor we all know and love without changing its alcohol content, which usually falls between 15 and 19 percent [3].

The herbal infusion gives vermouth its unique flavor and aroma [2]. The wine used in the production of vermouth must account for at least 75% of the finished product so inevitably the quality of that wine will greatly impact the quality of the vermouth. Alcohol is used in vermouth to both fortify the wine and as a solvent to extract and harness the flavoring substances of botanicals. Sugar is crucial to balance various bitter botanicals used to flavor vermouth and adds body and mouth feel. Sweet vermouth contains about 150 g/L of sugar while dry vermouth have less than 50 g/L [4]. Polyphenols compounds are reported to play a substantial role in protection against oxidative stress. Consumption of one unit (100 mL) of vermouth provided 220 mg polyphenols, whereas wine in the same quality was reported to have 35 mg [5].

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2. Materials and Method

Production of red vermouth wines. The red basic wine was made from the Cabernet Sauvignon (*Vitis vinifera* L. cv. Cabernet Sauvignon) grapes variety, harvested in 2014 year; it comes from the Recas wineries. Various plant parts (seeds, leaves, roots), dried fruit, citrus peels and spaces - in dry form and different amounts - were used in flavoring (Table 1).

Table 1. The mixture of plants used in the production of vermouth

Plants	Name	Weight (g)
Herbs	Rosemary *(Rosmarinus officinals L.)*	3.00
	St. John's Wort (*Hypericum perforatum L.*)	6.00
	Sweet cherry (*Prunus avium L.*) -tails	10.00
	Yarrow (*Achillea millefolium L.*)	3.50
	Hyssop (*Hyssopus officinalis L.*)	10.00
	Cranberry (*Vaccinium vitis idaea L.*) - leaves	5.00
	Wormwood (*Artemisia absinthium L.)*	15.00
	Melilot (*Melilotus officinalis L.*)	6.00
	Lemon Balm (*Melissa officinalis L.*)	6.00
	Wild thyme (*Thymus serpyllum L.)*	5.00
	Artichoke (*Cynara scolymus L.*)	4.00
	Milk thistle (*Silybum marianum L.*)	5.00
	Chamomile (*Matricaria chamomilla L.)*	6.00
	Mint (*Mentha piperita L.*)	4.00
Dried fruits	Sea buckthorn (*Hippophae thamnoides L.*)	15.00
	Rose hips (*Rosa canina L.)*	15.00
	Mixture of wood fruits:	
	Raspberries (*Rubus idaeus L.)*	5.00
	Bilberries (*Vaccinium myrtillus L.*)	5.00
	Blueberries (*Vaccinium corymbosum L.)*	5.00
	Blackberries (*Rubus fruticosus L.*)	5.00
Citrus	Orange - peels	109.00
	Lemon - peels	102.00
Spices	Cinnamon (*Cinnamomum cinnamomum L.)*	10.00
	Cloves (*Syzygium aromaticum L.)*	10.00
	Coriander (*Coriandrum sativum L.)*	15.00
	Marjoram (*Majorana hortensis L.*)	8.00
	Thyme (*Thymus vulgaris L.*)	8.00
	Caraway (*Carum cavi L.)*	5.00
Total mixture		**405.5**

Over herbs mixture was added 1.45 L alcohol 45% (v/v), at dried fruits mixture - 0.55 L, at citrus peels 1L and at spices mixture 0.55 L. During maceration, the plants are placed in four tanks, covered with aqueous alcohol and agitated periodically [4], at room temperature (20°C) during 21 days. After this time, the four alcoholic macerates were filtered and were added in the red wine in rate of 20/13.33/40/26.67% (v/v/v/v) - herbs, dried fruits, citrus peels and spices.

Analytical methods of red vermouth wine

All chemicals and reagents were analytical grade or purest quality purchased from Merck, Fluka, Sigma. Was used bidistilled water.

The following chemical analyses were carried out according to the methods described in the OIV [6]: total acidity, alcohol and sugar contents, total dry extract and non-reducing dry extract. Sugar content was determined using DR 301-95 Digital Handheld Refractometer by A. Krüss Optronic–Germany.

Also, have been carried out and other determinations: total antioxidant capacity and total polyphenolic compounds content. This is it carried after keeping the vermouth 45 days at room temperature, packed in the brown bottles.

Determination of total antioxidant capacity (TAC) by FRAP method: FRAP method depend upon the reduction of ferric tripyridyltriazine complex to the ferrous tripyridyltriazine by a reductant at low pH. This ferrous tripyridyltriazine complex has an intensive blue color and can be monitored at 593 nm. For TAC determination were using diluted samples of 1/50 (v/v) in deionized water. TAC in vermouth in mM Fe^{+2}/L was calculated [7,8]. Correlation coefficient (r^2) for calibration curve was 0.9991.

The content of total polyphenolic compounds in red vermouth wine diluted 1/100 (v/v) was determined by Singleton *et al* [9]. The absorbance of blue-colored complex solution was then read at 725 nm using Spectrophotometer UV-VIS SPECORD 205 by Analytik Jena. Gallic acid was used as a standard, and results were calculated in mM gallic acid equivalents (GAE)/L. Correlation coefficient (r^2) for calibration curve was 0.9980.

All tests were performed in triplicate.

3. Results and Discussions

Cabernet Sauvignon is naturally acid, lower in pH and has less sugar than other wines. Acidity in a wine is paramount. Acidity makes the wine feel fresh, refreshing and alive on your palate. Too much acidity and the wine will feel sharp [10].

Table 2 shows some of the physicochemical characteristics of a base wine Cabernet Sauvignon; it is a dry wine with sugar content less than 4 g/L [4].

Table 2. The physicochemical characteristics of Cabernet Sauvignon

Physicochemical characteristics	Values
Total acidity (g/L H_2SO_4)	3.28
Alcohol (%, v/v)	12.50
Sugar (g/L)	3.70
Total dry extract (g/L)	24.57
Non-reducing dry extract (g/L)	26.50

The additives we need for preparing one liter of red vermouth (RV), on the base of material balance (total and partial in alcohol and sugar), are presented in Table 3. Depending on sugar content, the four types of red vermouth wines we have noted: RV1 – red vermouth with 60 g/L sugar, RV2 – red vermouth with 80 g/L sugar, RV3 – red vermouth with 100 g/L sugar, RV4 – red vermouth with 120 g/L sugar. The alcoholic macerate represented 2% (v/v) of the final red vermouth.

Table 3. The additives for preparation 1 L of red vermouth wines

Additives	RV1	RV2	RV3	RV4
Red wine (L)	0.80	0.80	0.80	0.80
Alcohol 96% (v/v) (L)	0.084	0.084	0.084	0.084
Sugar (g/L)	60.00	80.00	100.00	120.00
Macerate (L)	0.02	0.02	0.02	0.02
Water (L)	0.059	0.047	0.035	0.023

Table 4. The red vermouth wines characteristics

Physicochemical characteristics	RV1	RV2	RV3	RV4
Total acidity (g/L H_2SO_4)	4.00	4.00	4.00	4.00
Alcohol content (%, v/v)	18.00	18.00	18.00	18.00
Sugar content (g/L)	60.00	80.00	100.00	120.00
Total dry extract (g/L)	78.60	98.90	120.50	139.65
Non-reducing dry extract (g/L)	19.15	19.18	19.50	19.65

The amount of water added, as a result, may not exceed 10% by volume of the vermouth [2].

The total dry extract ranges from 78.60 in RV1 to139.65 g/L in RV4 with increasing the sugar value. The results show that the total acidity and alcohol content were similar in the four red vermouths wines; no significant differences were observed in the non-reducing dry extract.

Wine acids also affect the actual color of the wine. In red wine, the color signifying the most acidity is bright red. As the color mellows to purple then bluish tones, the acidity mellows with its [4].The citric acid was added to adjuster total acidity at 4.00 g/L H_2SO_4.

The duration between herbal/spice infusion and final bottling is normally 3-5 year. Further aging can lower the quality [2].

In Figure 1 and 2 were illustrated the modification of total antioxidant capacity and polyphenolic compounds of RV with different sugar content after 45 days storage for room temperature.

Regardless of total antioxidant capacity of RV, the small value (35.40 mM Fe^{+2}/L) was present in RV1 with 60 g/L sugar content and increases up to 36 mM Fe^{+2}/L in RV4 with 120g/L.

After 45 days at room temperature, the higher losses of total antioxidant capacity were present in RV1, from 35.40 mM Fe^{+2}/L to 33.80 mM Fe^{+2}/L (Figure 1).

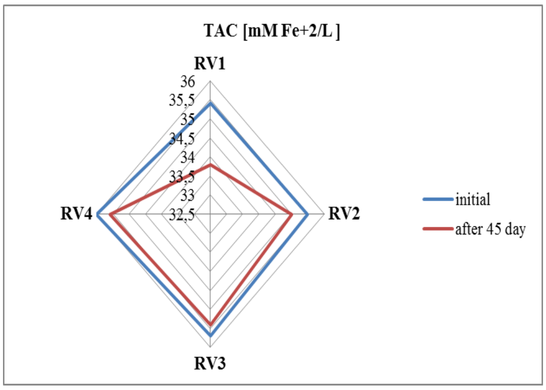

Figure 1. The evolution of total antioxidant capacity of red vermouth samples in response to storage

After storage, we observed a significant increase of polyphenols content from 19.70 mM GAE/L in RV1 to 23.60 in RV4; at initial time no significant differences were recorded. The highest losses were registered in RV1 with the lowest sugar content (Figure 2).

The herbal infusion donate antioxidant characteristic to vermouths, primary from the addition of phenolic compounds. That may provide some protection against the oxidative stress [2].

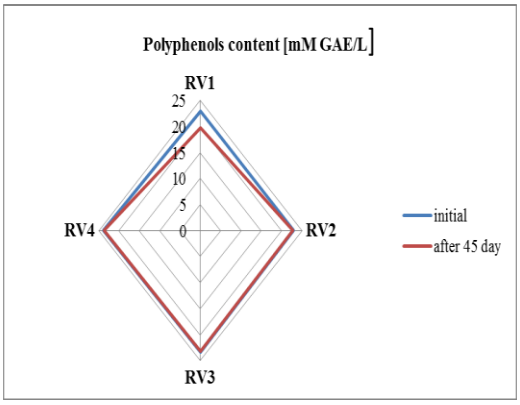

Figure 2. The evolution of polyphenolic compounds in red vermouth samples in response to storage

4. Conclusion

All types of red prepared vermouth belong to the category of special wines, dessert type, with 18% alcohol content and a sugar content range from 60 to 120 g/L. Also, no significant differences were recorded in the non-reducing dry extract values of vermouth samples. The total antioxidant capacity and the total polyphenolic compounds in red vermouth wines slightly increase by increasing of the sugar content. The polyphenolic compounds have a strong influence on the antioxidant function of red vermouth wines.

After 45 days of storage at room temperature, the highest losses in total antioxidant capacity and total polyphenolic compounds were noted in red vermouth samples with the lowest sugar level. So, we can say that the sugar content acts as a preservative, keeping unchanged the antioxidant properties of red vermouth.

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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