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Grape seed oil: obtaining and enhancing its antioxidant function by addition of dried vegetables

Mariana-Atena Poiana*, Cristina Gaita, Diana Baltatu, Diana Moigradean

Banat`s University of Agricultural Sciences and Veterinary Medicine "King Mihai I of Romania" from Timisoara, Faculty of Food Processing, Calea Aradului 119, Timisoara 300645, Romania

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Abstract

This study describes a way to valorize the grape pomace coming out as a waste from wine industry for obtaining of grape seed oil (GSO) and further, to enhance the antioxidant function of crude oil by addition of dried vegetables. GSO was obtained using the pomace recovered from Italian Riesling (*Vitis vinifera* L.) wine processing. Crude GSO was obtained by Soxhlet extraction from grape seeds picked from pressed wine pomace, previously dried for 15 h at 60°C. In order to prepare function-enhanced GSO, different mixtures of dried vegetables (turnips, ginger, Jerusalem artichokes, red onion, chilies, bell pepper, asparagus and turmeric) have been added to GSO in a proportion of 3% (w/v). Prior using in this purpose, the vegetables were dried at 60°C for 20 h in a home-scale dehydrator. After 4 weeks, the function-enhanced oil samples were analyzed in terms of total phenolics content and antioxidant activity. Our results highlight that the grape pomace can be successfully used for recovery of high quality edible oil. Also, the addition of dried vegetables has improved the antioxidant properties of GSO and it is expected to increase its shelf life.

Keywords: grape pomace, grape seed oil, dried vegetables, function-enhanced oil, antioxidant properties

1. Introduction

Every year, on an average of 20% by weight of the grapes used in wine industry ends up as by-products [1]. Grape pomace, consisting of seeds, skins and stems, represents an important underused winemaking by-product, every year generated in huge amounts [2].

This by-product can be used in various food applications because it contains some valuable substances such as polyunsaturated essential fatty acids (eg linoleic and linolenic), polyphenols and tocopherols [3]. The use of grape pomace in the food industry represents an opportunity to create with low production costs, new food ingredients with added value [2,4,5]. The grape seeds represent a considerable proportion of the pomace, amounting to 35–50% on a dry matter basis. The grape seeds can be used to produce GSO with many potential benefits for human health. The reported data show that the GSO is rich in polyunsaturated fatty acid and the main fatty acids are present in the following proportion: linoleic acid (67–74%), oleic acid (18–27%), palmitic acid (6–8%) and stearic acid (4–5%), respectively [6-8]. The antioxidant properties and fatty acid compositions of GSO may be significantly affected by the grape variety, growing conditions, the methods applied for oil extraction as well as the degree of refining [9].

Currently, there are some data about designing of function-enhanced edible oils by addition of functionally effective antioxidant components coming from various plant sources [10-12]. In this purpose can be used some dried vegetable waste

Corresponding author: *e-mail:* atenapoiana@yahoo.com

resulted from food processing [13], or even the wild edible plants can be used as potential antioxidants in edible oils [14]. Also, the various dried vegetables rich in bioactive compounds have the potential to be used to enhance the antioxidant function of edible oils. The vegetables are seasonal and highly perishable due to their high water content. Thus, dehydration seems to be the simplest way to preserve the bioactive compounds from vegetables. The bioactive compounds from plant used for culinary purposes are very susceptible to drying and choosing the right temperatures of this parameter represents an important input for a successful operation [15]. The antioxidant components of dried vegetables could improve the nutritional quality of edible oils. Also, is expected an improving of oxidative stabilities and shelf life of this oils.

The purpose of this work is to valorize the grape seeds resulted from wine pomace to obtain GSO and further, to report a practical procedure to fortify the functionality of this oil using various dried vegetables.

2. Materials and Methods

GSO extraction

The seeds from grapes Italian Riesling (*Vitis vinifera L.*) were picked from pressed grape pomace resulted as a winemaking by-product in Recas winery, vintage 2015. The grape seeds were subjected to drying for 15 h at 60°C in a Binder (Germany) oven. The dried grape seeds were ground using a Grindomix Retsch GM 2000 grinder and then, were extracted in a Soxhlet extractor for 5 h with hexane (1:5, w/v) at 60°C. The crude GSO was subjected to analytical constants evaluation.

Drying of vegetables and preparation of function-fortified GSO

Fresh vegetables such as red chili peppers (1), turnips (2), turmeric (3), Jerusalem artichokes (4), green chili peppers (5), red onion (6), red bell pepper (7), asparagus (8) and ginger (9) were subjected to drying in a Heinner (Germany) dehydrator at 60°C for 20 h. The green and red chili peppers were dried whole, and the other vegetables were thinly sliced.

After drying, the vegetables were cooled at room temperature over night and further, each dried vegetable was added to 250 ml of oil in a proportion of 3% (w/v). Also, five mixtures (M1-5) of dried vegetables were prepared as follows: M1 - red chili peppers, turnips and turmeric; M2 - Jerusalem artichokes, green chili peppers and red onion; M3 - red onion, red bell pepper and asparagus; M4 - asparagus, green chili peppers and turnips; M5 - red chili peppers, ginger and turmeric. Each mixture, consists of equal amounts of above mentioned dried vegetables was added to 250 ml of oil in a proportion of 3% (w/v). All oil samples were prepared in triplicate. Prior analysis, all oil samples were kept closed, at room temperature in dark for 4 weeks. Crude GSO was used as control.

Evaluation of analytical parameters of GSO

Crude GSO was investigated in terms of free fatty acids value, unsaponifiable matter, peroxide value, iodine value, saponification value and relative density according to standard methods for oils analysis [16]. All determinations were done in triplicate and the results were reported as average value ± standard deviation (SD).

FRAP assay

The antioxidant activity of dried vegetables as well as of oil samples with addition of dried vegetables was evaluated by ferric reducing antioxidant power (FRAP assay) according to method described by Benzie and Strain [17]. For this purpose, 2 mL of sample (dried vegetables, respectively oil) were treated with 20 mL ethyl alcohol 70% (v/v) by sonication at room temperature for 60 min. The mixture was filtered and the filtrate was used for analysis. The FRAP values were expressed as mM Fe^{2+}/100 g d.s. for vegetable samples, and mM Fe^{2+}/L for oil samples, respectively. All determinations were done in triplicate.

Total phenolics content

Total phenolic content was measured following the Folin-Ciocalteu colorimetric method described by Singleton *et al.* [18] and the results were expressed as mM gallic acid equivalents (GAE)/100g d.s for vegetable samples, and mM GAE/L for oil samples, respectively. All determinations were done in triplicate.

3. Results and discussion

According to our results, the yield of the grape seed oil was found to be about 14.17% (w/w). Our data are compatible to those obtained by Göktürk Baydar and Akkurt [7] and Lachman [19]. They reported that the oil content depend on both grapes variety and maturity stage, ranged of 10-20%. Also, the grape seeds are composed of fiber, protein, as well as other components, including phenolic antioxidants.

The crude GSO was evaluated in terms of chemical quality assurance criteria, including the free fatty acids content, iodine value, saponification value, peroxide value, unsaponifiables content, Table 1. Also, relative density at 20°C was determined.

Table 1. Analytical parameters of GSO

Analytical parameters	Value
Free fatty acids (% oleic acid)	1.19±0.05
Iodine value (g I_2/100g)	134.46±1.23
Saponification value (mg KOH/g)	190.31±1.28
Relative density (20°C)	0.9244±0.001
Unsaponifiable matter (%)	1.82±0.08
Peroxide value (meq O_2 /kg)	1.32±0.05

From the data shown in Table 1 it can be seen that GSO is a high quality culinary oil and the obtained values are consistent to those reported by other authors [8,9,20]. The peroxide value is a very useful criterion for highlighting the deterioration of oils in response to primary oxidation processes of lipids. The low value of this parameters (<10.00 meq O_2/kg oil) indicates that the GSO is stable and recommended for food applications.

Table 2. The humidity of fresh and dried vegetables

Vegetables	humidity(%)	
	fresh	dried
Red chili peppers (1)	89.31	5.82
Turnips (2)	81.30	6.23
Turmeric (3)	79.32	6.52
Jerusalem artichokes (4)	75.63	7.28
Green chili peppers (5)	90.17	5.91
Red onion (6)	89.85	5.12
Red bell pepper (7)	91.71	6.94
Asparagus (8)	92.54	6.17
Ginger (9)	93.07	7.53

Table 2 shows the humidity of vegetables fresh and after drying for 20 h at 60°C. It can be noticed a massive decreasing in water content by dehydration. This, the humidity of vegetables decreased from initial values located in the range 75-93% till the values ranged of 5-7.5%.

The loss of antioxidants compounds during heat treatment might be due to the temperature and duration because polyphenolic compounds are sensitive to heat and oxygen [21]. Previous studies have evaluated the effects of drying conditions on the changes recorded in bioactive compounds of plant materials [22]. The minimum losses in bioactive compounds were noticed at drying temperature around 50°C [23]. For fully benefit in terms of bioactive compounds retention and also in order to remain economically feasible, in our study the drying of vegetables was done at 60°C for 20 h.

In Table 3 are shown the antioxidant properties of dried vegetables added to GSO samples, expressed by total phenolics content and antioxidant activity (FRAP values).

Table 3. Total phenolics content and FRAP value of dried vegetables

Vegetables	FRAP (mM Fe^{2+}/100 g d.s)	Total Phenolics (mM GAE/100 g d.s)
Red chili peppers (1)	2.41±0.15	6.21±0.38
Turnips (2)	1.55±0.09	1.75±0.06
Turmeric (3)	16.91±0.97	29.64±1.38
Jerusalem artichokes (4)	15.71±0.89	27.2±1.23
Green chili peppers (5)	9.54±0.46	2.23±0.11
Red onion (6)	11.78±0.61	20.05±1.04
Red bell pepper (7)	0.94±0.04	3.80±0.21
Asparagus (8)	9.52±0.41	12.94±0.78
Ginger (9)	20.38±1.03	45.22±2.19

It can be seen that, the highest values of antioxidant characteristics are revealed in ginger, turmeric, Jerusalem artichokes and red onion. At the opposite pole are the samples of red bell pepper and turnips for FRAP values and turnips and green chili peppers as regards the total phenolics content.

Figures 1 and 2 show the total phenols content of GSO samples supplemented with each dried vegetable (Figure 1) and also with different mixtures of dehydrated vegetables (Figure 2).

Properly, Figures 3 and 4 are reported the FRAP values of GSO samples with addition of each dried vegetable (Figure 3) and with different mixtures of vegetables (Figure 4).

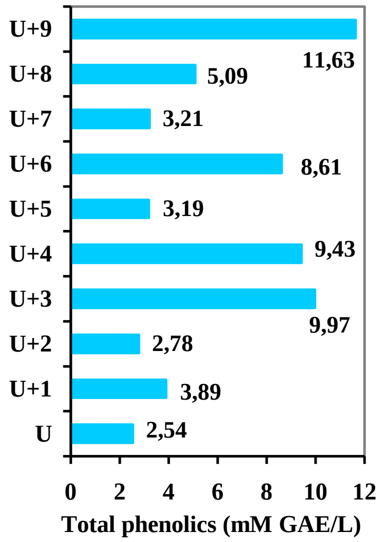

Figure 1. Total phenolic content of GSO samples supplemented with dried vegetables

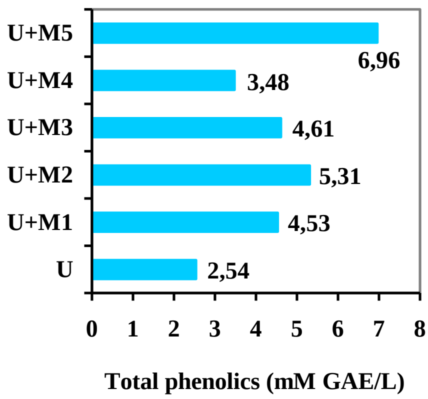

Figure 2. Total phenolic content of GSO samples supplemented with mixtures of dried vegetables

At a closer look to the antioxidant properties of GSO with addition of each dried vegetable, it can be noticed that the FRAP values and total phenolics content of oil samples are enhanced according to the antioxidant potential of the native dried vegetables, Figures 1 and 3.

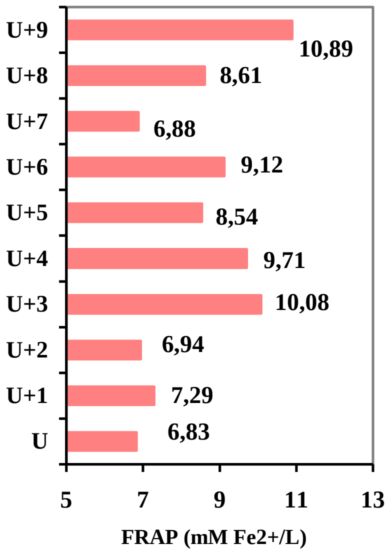

Figure 3. FRAP values of GSO samples supplemented with dried vegetables

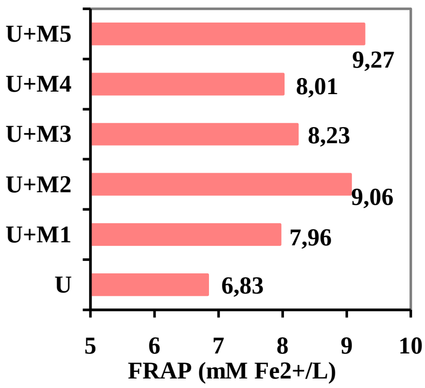

Figure 4. FRAP values of GSO samples supplemented with mixtures of dried vegetables

Regarding the oil samples obtained by addition of five mixtures of dehydrated vegetables, our results reveal that, the highest content of total phenolics was registered in the oil sample with M5, followed by oil samples with addition of M2, M3, M1 and M4. In terms of FRAP values, on the top three positions are located oil samples with addition of M5, M2 and M3.

This finding shows a strong correlation between total phenolic content and antioxidant capacity. Thus, the phenolic compounds are powerful antioxidants and have enhanced the antioxidant function of GSO. For all GSO samples supplemented with dried vegetables the antioxidant characteristics were higher than in the control sample. Based on the theoretical value of the total phenolics content and FRAP values of oil samples with addition of dried vegetables (taking into account the FRAP values and total phenolics content of GSO and dried vegetable used in the recipe) and practical values of these parameters obtained after analyses, it can be observed an extraction yield of antioxidant compounds of about 67-71%. This finding recommends the use of dried vegetables for enhancing the antioxidant function of edible oils.

4. Conclusions

Our data reveals that the grape seeds derived from wine pomace represents a valuable source for GSO obtaining. The dehydration of vegetables at 60°C has the potential to preserve the bioactive compounds from the raw material. Therefore, the GSO and the dried vegetables have the potential to serve as ingredients for functional food products development. The supplementation of GSO with some mixtures of dried vegetables resulted in obtaining of oils with an improved antioxidant function. The antioxidant characteristics of prepared oil samples are influenced by the vegetables type as well as the selected vegetables used to compose the vegetable mixtures. The addition of dehydrated vegetables in the form of various mixtures represents an accessible way to design function-enhanced edible oil. Additionally, on this way is increased the shelf life of oils as a result of a better protection against oxidative damage.

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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