Journal of Microbiology, Biotechnology and Food Sciences

Ivanišová et al. 2013 : 2 (Special issue 1) 1692-1703

REGULAR ARTICLE

ANTIOXIDANT ACTIVITY OF SELECTED PLANT PRODUCTS

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ABSTRACT

Plants and plants products have been claimed to have health-promoting effects, which may be related to the antioxidant activity *in vivo*. The aim of this study was to determine antioxidant activity of selected plant products – wine, apples and spices. We found that these products are very good source of antioxidant compounds. The aim of this study was also to mention the potential use of biologically active component of plant product - substances from these products can be isolated and after treatment, which causes their efficiently usable for human body, they can be used for fortification of wide range of food products.

Keywords: antioxidant, wine, apple, spices

INTRODUCTION

Numerous physiological and biochemical processes in the human body may produce oxygen-centered free radicals and other reactive oxygen species as by products. Over production of such free radicals can cause oxidative damage to biomolecules (e.g. lipids, proteins, DNA), eventually leading to many chronic diseases, such as atherosclerosis, cancer, diabetes, aging, and other degenerative diseases in humans **(Halliwell, 1994; Niki, 1997;**

Poulson *et al.*, 1998). Plants (fruits, vegetables, medicinal herbs, etc.) and products made from plants may contain a wide variety of free radical scavenging molecules, such as phenolic compounds (e.g. phenolic acids, flavonoids, quinones, coumarins, lignans, stilbenes, tannins), nitrogen compounds (alkaloids, amines, betalains), vitamins, terpenoids (including carotenoids), and some other endogenous metabolites, which are rich in antioxidant activity **(Shahidi and Naczk, 1995; Cotelle *et al.*, 1996; Velioglu *et al.*, 1998; Zheng and Wang, 2001; Cai *et al.*, 2003)**. Epidemiological studies have shown that many of these antioxidant compounds possess antiinflammatory, antiatherosclerotic, antitumor, antimutagenic, anticarcinogenic, antibacterial, or antiviral activities to a greater or lesser extent **(Owen *et al.*, 2000; Sala *et al.*, 2002)**. The intake of natural antioxidants has been associated with reduced risks of cancer, cardiovascular disease, diabetes, and other diseases associated with ageing, but there is still considerable controversy in this area **(Mclarty, 1997; Yang *et al.*, 2001; Sun *et al.*, 2002)** chemical spoilage and its products are potentially toxic.

Antioxidants are very important also in many foods to prevent fat rancidity (**Jadhav *et al.*, 1996**). Synthetic antioxidants such as butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT) are widely used because they are effective and cheaper than natural ones (**Pokorny, 2007**). However, the safety and toxicity of synthetic antioxidants have raised important concerns. Hence, considerable interest has been given to the use of natural antioxidants which may also have nutritional properties (**Jadhav *et al.*, 1996**).

The main objective of the present work was to evaluate of antioxidant potential of selected wines, apples and spices by free radical scavenging activity (DPPH); in addition the total phenolic content in apples and spices was also determined. The aim of this study was also to refer the possibility use of biologically active components from these products in food industry.

MATERIAL AND METHODS

Wines

Six widely consumed, commercially produced Slovakia wines, made from red and white grape varieties (*Vitis vinifera* L.) grown in four different wine-producing regions of Slovakia, were chosen as follows: red wines – Frankovka modrá (region Levice), Cabernet Sauvignon (region Topoľčianky), Rulandské modré (region Modra); white wines – Rízling vlašský (region Levice), Veltlínske zelené (region Toplčianky), Rulandské biele (Modra). The wines, packed in glass bottles and made in the vintage year 2010, were purchased from local supermarkets and stored at room temperature until analysed.

Apple cultivars

Four apple cultivars grown in Slovakia (1 kilogram each), Golden Delicious (region Nové Zámky), Gloster (region Nové Zámky), Jonagold (region Nitra), Idared (region Nitra) were purchased from local supermarkets. Before the measurement samples were shredded and from each variety was prepared apple juice.

Spices

The seven commercial dry spices including cinnamon (*Cinnamonum zeylanicum* L), ginger (*Zingiber officinale* Rosc), cumin (*Carum carvi* L), rosemary (*Rosmarinus officinalis* L), oregano (*Origanum vulgare* L), thyme (*Thymus vulgaris* L) and basil (*Ocimum basilicum* L) were purchased from supermarket in Slovakia. Before the measurement samples (2 g each) were extracted with 200 ml of hot (100 ° C) distilled water for 5 minute, and after filtration extracts were used for measurement.

Chemicals

All chemicals were analytical grade and were purchased from Reachem (Slovakia), Merck (Germany) and Sigma Aldrich (USA).

Free Radical Scavenging Activity

Free radical scavenging activity of samples was measured using the 2,2-difenyl-1-picrylhydrazyl (DPPH) according to the procedures described by **Sánchés-Moreno *et al.*, (1998)**. The sample (100 µL) was reacted with 3900 µL of DPPH solution (0.025 g DPPH in 100 mL ethanol). Absorbance of the samples was determined using spectrophotometer Jenway 6405 UV/Vis (Keison, England) at 515 nm. Free radical scavenging activity of the samples was expressed according equation:

$$\%\ Inhibition = \frac{A_0 - A}{A_0} x\, 100$$

where A_0 is the absorbance of DPPH$^•$ in solution without an antioxidant, and A is the absorbance of DPPH$^•$ in the presence of an antioxidant. All analyses were performed in triplicates.

Total phenolic content

Total phenolic content of samples was measured spectrophotometrically, using the modified Folin-Ciocalteu method as described by **Singleton and Rossi, (1965)**. 0.5 mL of each sample was mixed with 0.5 mL of the Folin-Ciocalteau reagent and 5 mL of 20 % sodium carbonate. The distilled water was added to the mixtures (to the mark – 50 mL) in volumetric flask. The mixture was allowed to stand at room temperature for 30 min. in the dark. The absorbance was read at 700 nm using spectrophotometer Jenway 6405 UV/Vis (Keison, England). The total phenolics content was expressed as mg tannin equivalent (TE) per kg of matter. All analyses were performed in triplicates.

RESULTS AND DISCUSSION

Free Radical Scavenging Activity

Wine

DPPH$^•$ is a stable free radical and accepts an electron or hydrogen radical to become a stable diamagnetic molecule. The reductions capability of DPPH$^•$ is determined by the decrease in its absorbance induced by antioxidant **(Liu and Yao, 2007)**. The scavenging effect of red wines (Fig. 1) on DPPH radical expressed as % inhibition decreased in this order: Rulandské modré > Cabernet Sauvignon > Frankovka modrá; and in white wines exhibited the following order: Veltlínske zelené > Rulandské biele > Rízling vlašský. These results indicated that all the samples had a noticeable effect on scavenging free radical. The higher activities were measured in red wines. Similar results also found **Struck *et al*., (1994); Beer *et al*., (2005); Roussis *et al*., (2008)** which reported that red wine compare to white wine has higher antioxidant activity. It is not surprising because is well known, that wine, especially red wine, is a very rich source of polyphenols, such as flavanols (catechin, epicatechin, etc.), flavonols (quercetin, rutin, myricetin, etc.), anthocyanins (the most abundant is malvidin-3-O-glucoside), oligomeric and polymeric proanthocyanidins, phenolic acids (gallic acid, caffeic acid, p-coumaric acid, etc.), stilbenes (trans-resveratrol) and many others polyphenols. Many of these compounds (e.g. resveratrol, quercetin, rutin, catechin and their oligomers and polymers proanthocyanidins) have been reported to have multiple biological activities, including cardioprotective, antiinflammatory, anticarcinogenic, antiviral and antibacterial properties **(Santos-Buelga and Scalbert, 2000; King *et al.*, 2006)**. These biological properties are attributed mainly to their powerful antioxidant and antiradical activity. It has been suggested that the antioxidant activity of wine is more related to the kind of phenolic compounds present in the wines than their global content **(Rice-Evans and Miller, 1996)**. Recent studies have disclosed that the antioxidant activity of wines, mainly red wines can be strongly affected both quantitatively and qualitatively by the grape varietal, environmental factors, grape ripeness, pressing regimen, the extent and temperature of maceration, the temperature of fermentation, the use of enzymes, the type of oak used during ageing and the extent to which the wine was aged **(Granato *et al.*, 2011)**.

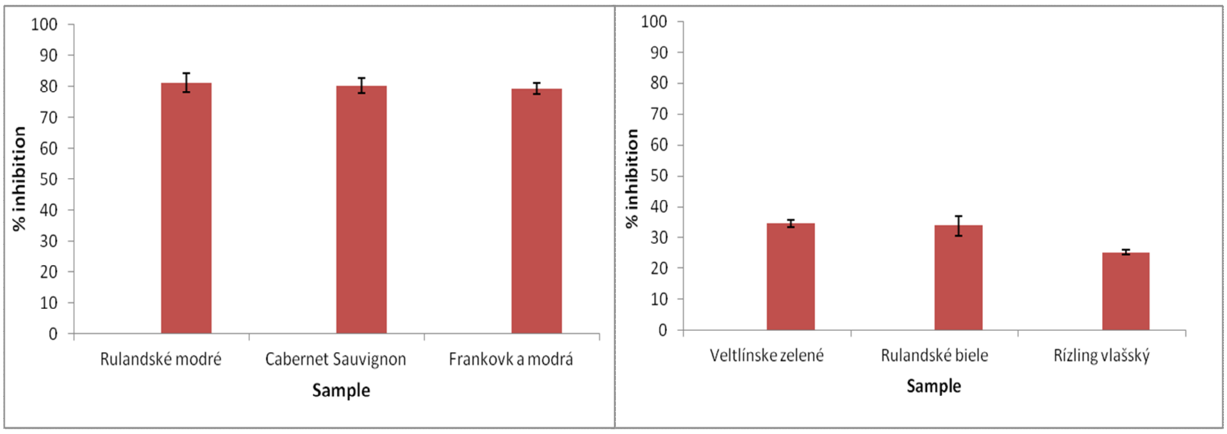

Figure 1 Antioxidant activity of red and white wines expressed as % inhibition of DPPH$^{\bullet}$

Apple cultivars

The scavenging effect of apple cultivars (Fig. 2) on DPPH radical expressed as % inhibition decreased in this order: Jonagold > Idared > Gloster > Golden Delicious. The highest antioxidant activity was detected in variety Jonagold. Apples are an excellent source of several compounds which possess high total antioxidant capacity. **Sun *et al.*, (2002)** found that apples had the highest soluble free phenolics when compared to 10 other commonly consumed fruits. **Vinson *et al.*, (2001)** measured the antioxidant capacity of 20 fruits using the oxygen radical absorbance capacity assay (ORAC), and ranked apples 8 out of 20. **Bončíková *et al.*, (2011)** determined antioxidant activity of selected apple varieties and found that Idared variety had strong antioxidant activity (82.5 %), but variety Golden Delicious had lower antioxidant activity (45.18 %). Antioxidant activity of apples is regulated by environmental and post-harvest factors, including fruit season, fruit maturity, light exposure, storage and processing. On the other hand, it is well established that genetics play a major role in controlling the antioxidant composition of apples **(Khanizadeh *et al*., 2007)** and other fruits.

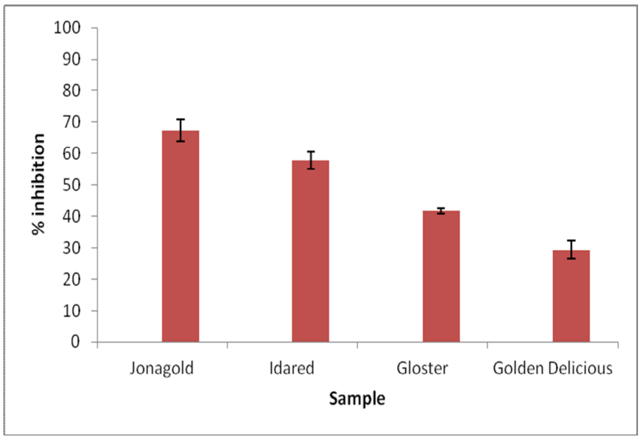

Figure 2 Antioxidant activity of apple varieties expressed as % inhibition of DPPH$^{\bullet}$

Spices

Spices – the natural food additives contribute immensely to the taste and flavour of our foods. These esoteric food adjuncts have been in use for thousands of years. Spices have also been recognized to possess several medicinal properties and have been effectively used in the indigenous systems of medicine in many countries **(Srinivasan, 2005)**.

The scavenging effect of spices (Fig. 3) on DPPH radical expressed as % inhibition decreased in this order: cinnamon > rosemary > basil > thyme > oregano > ginger > cumin. These results showed that medicinal herbs and spices are very important source of antioxidant compounds for human health and also for food industry. **Su *et al*., (2010)** detected antioxidant activity of cinnamon and oregano and reported high antioxidant activity, and also shown that extraction solvent may significantly alter the antioxidant activity. They used 80 % methanol and 50 % acetone extracts and found that 50 % acetone solvent is better for extraction antioxidant compounds; in our study was used water extraction. Very strong antioxidant was determined in rosemary extracts. **Petrová *et al*., (2008)** tested extract from rosemary to protect meat before fat oxidation and reported that rosemary seems as very good food additive with antioxidant effect for foods mainly meat products. The lower antioxidant activity was found in ginger and cumin. **Stoilova *et al*., (2007)** determined antioxidant activity of ginger extract and found strong activity comparable with BHT, they used deoxiribose test and linoleic acid model. In our work we used only DPPH method, it is necessary to use more methods for determine antioxidant activity of spices in future.

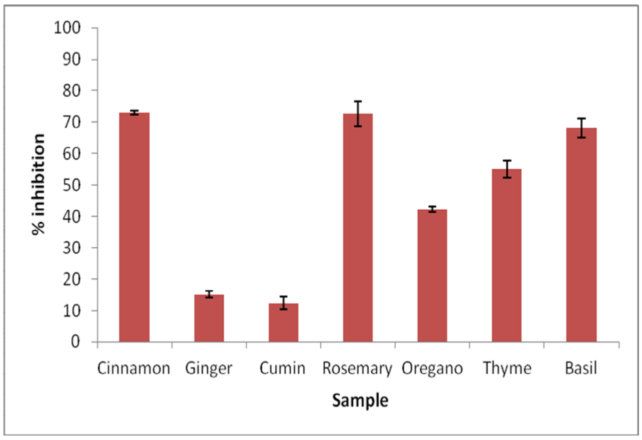

Figure 3 Antioxidant activity of spices expressed as % inhibition of DPPH$^{\bullet}$

Total phenolic content

Apple cultivars

Polyphenols are widely common secondary metabolites of plants, the content of which varies greatly between different species, and cultivars, and with maturity, season, region and yield. Polyphenols are classified according to their structure as phenolic acids derivatives, flavonoids, stilbenes or lignans. Phenolics are compounds with one or more aromatic ring and one or more hydroxyl groups **(Liu, 2003)**. The total phenolic content was determined by the Folin-Ciocalteau assay. The results are presented in Tab. 1. Total phenolic content of apple cultivars expressed as mg TE/ kg of matter decreased in this order: Gloster > Jonagold > Golden Delicious > Idared. In apple cultivar Gloster was detected the highest total phenolic content. Similar results also reported **Lachman *et al.*, (2006**) which detected high amount of polyphenol in apple variety Gloster. Apples contain many types of phenolic acid derivatives and flavonoids (flavan-3-ols, flavonols, procyanidins, chalcones, and anthocyanins) **(Shoji *et al.*, 2000)**. The lowest total phenolic content was found in apple variety Idared. **Kolodziejczyk *et al.*, (2010)** determined similar results in apple variety Idared.

Table 1 Total phenolic content of apple varieties expressed as mg TE/kg of matter

Sample	Total phenolic content mg TE/kg
Jonagold	565.81 ±1.25
Idared	507.38 ±0.56
Gloster	575.92 ±5.63
Golden Delicious	541.09 ±2.22

Spices

Spices have shown to contain a number of phenolic compounds, which were shown to have antioxidant antiinflammatory, antimutagenic and anticarcinogenic activities **(Prasad *et al.*, 2004)**. Total phenolic content of spices (Tab. 2) expressed as mg TE/ kg of matter decreased in this order: thyme > oregano > cinnamon > basil > rosemary > ginger > cumin. These results demonstrate the presence of natural antioxidant phenolic compounds in all tested sample. The high value was detected in thyme, oregano, basil and rosemary which belong to *Lamiacea* species. *Lamiaceae* species are known to contain a range of secondary metabolites, such phenolic compounds. The value obtained for extracts of thyme is similar to that reported **Roby *et al.*, (2013)**. **Su *et al.*, (2010)** determined total phenolic content and reported that cinnamon and oregano content high amount of these compounds. Our results indicated that spices is very good sources of antioxidant phenolic compounds and can be used after isolation as food additives in lipids and lipid containing foods to minimize rancidity, retard the formation of toxic oxidation products, maintain nutritional quality and increase the shelf life of food products.

Table 2 Total phenolic content of spices expressed as mg TE/kg of matter

Sample	Total phenolic content mg TE/kg
Cinnamon	448.97 ±2.36
Ginger	139.97 ±0.96
Cumin	87.16 ±1.23
Rosemary	329.85 ±3.09
Oregano	547.83 ±0.21
Thyme	656.82 ±3.33
Basil	356.82 ±1.36

CONCLUSIONS

In this study, we prepared and evaluated antioxidant activity of selected plant products. Our results showed that tested plant products had noticeably antioxidant effect and total phenolic content. Antioxidant compounds from these products with preventive and treatment effect on various diseases can be used for improving the shelf life of food products.

Acknowledgments: This work was supported by the grant KEGA 015SPU-4/2011.

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