Total Polyphenols from Different Fresh and Processed Fruits and Vegetables

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Abstract. The purpose of this research was to evaluate the total polyphenols content of some fruits (sour cherry and plums) and vegetables (red cabbage and red beetroot), usually consumed in Romania, fresh or processed, using Folin Ciocalteu method. Absorbance was measured at 725 nm using UV-Visible Spectrometer and phenolic compounds were quantified based on standard calibration curve prepared from pure phenolic standard (gallic acid). After processing and storage stages, the content of polyphenols decreased significantly in all four samples taken into study. The biggest losses of polyphenols by oxidative degradation occurs for canned red cabbage (from 448.5±4.56 to 151.5±9.13 mg GAE/100g) followed closely by plum compote (from 503.4±3.04 to 266.7±6.08 mg GAE/100g).

Keywords: total phenols, antioxidant action, vegetables, fruits, health effects, spectroscopic method

INTRODUCTION

Polyphenol compounds, the most abundant antioxidants in human diet, represent a large and complex group of phytochemicals, constituents widely distributed in plants, fruits and vegetables. They are divided into several classes according to the number of phenol rings contained and to the structural elements that bind these rings to each other. The main groups of polyphenols are: flavonoids, phenolic acids, tannins (hydrolysable and condensed), stilbenes and lignans (D’Archivio et al., 2007).

Phenolic compounds are essential for the growth and reproduction of plants. They are produce as a response for defending injured plants against pathogens. The importance of antioxidant activities of phenolic compounds and their possible use in processed foods as natural antioxidants have reached a high recognition in recent years.

Polyphenols compounds are antioxidants that, when present at low concentrations compared with those of an oxidizable substrate, significantly delays or prevents oxidation of that substrate. The potential health benefits of polyphenols compounds are getting more and more recognition, as reports indicate that these compounds inhibit the harmful effects of reactive oxygen species, which act as oxidants (Halliwell, 1995), thus protecting macromolecules, such as proteins, lipids and DNA, from oxidative degradation.

Their physiological functions have a great potential on prevention of chronic diseases such as cancer and arteriosclerosis, osteoporosis, neurodegenerative diseases and diabetes mellitus (Lampe JW.,1999; Podszędek A., 2007).

In the past few years, an increasing number of epidemiological studies have shown an inverse correlation between the consumption of fruit and vegetables and the incidence of degenerative diseases (Ames et al., 1993). Epidemiological studies also revealed that whole fruit and vegetables were more efficient than its purified chemical component in reducing the risk of diseases. The difference between fresh whole fruit and vegetables and pure chemical component supplementation may be due to the interaction between bioactive components in the whole fruit and vegetables (Holick et al., 2002).
Polyphenol content can vary considerably, depending on a number of factors of which the most important are plant variety, genetics, sunlight, annual climatic variations, topography, soils, location, season, soil fertilization and maturity including organic or conventional production method, post-harvest processing and storage (Amarowicz et al., 2009; Bravo L. 1998).

Storage also may affect the content of polyphenols that will oxidize easily. Oxidation reactions result in the formation of more or less polymerized substances, which lead to changes in the quality of foods, particularly in color and organoleptic characteristics. Such changes may be beneficial (as is the case with black tea) or harmful (browning of fruit) to consumer acceptability. Industrial food processing also affects polyphenol content. As with fruit peeling, hulling of legume seeds and decorticating and bolting of cereals can result in a loss of some polyphenols (Manach et al., 2004).

Simple peeling of fruit and vegetables can eliminate a significant portion of polyphenols because these substances are often present in higher concentrations in the outer parts than in the inner parts. Cooking may also have a major effect. Onions and tomatoes lose between 75% and 80% of their initial quercetin content after boiling for 15 min, 65% after cooking in a microwave oven, and 30% after frying (Crozier et al., 1997).

Unwanted process can occur during the process of making compote or jam from fruit. Grinding of plant tissues may lead to oxidative degradation of polyphenols as a result of cellular decomposition and contact between cytoplasmic polyphenol oxidase and phenolic substrates present in the vacuoles. Polyphenols are then transformed into brown pigments that are polymerized to different degrees (Manach et al., 2004).
MATERIALS AND METHODS

Fresh and canned fruits and vegetables studied were purchased from local market in Cluj-Napoca. Gallic acid (GAE) (purity 97.5%), were obtained from Sigma-Aldrich (Darmstadt, Germany). Folin-Ciocalteu’s phenol reagent, HCl, Na₂CO₃ and MeOH were purchased from Merck (Darmstadt, Germany). All other chemicals were of analytical grade.

Total phenolic contents of all plant extracts were determined using Folin-Ciocalteu colorimetric method (Singleton et al., 1999).

Stock solution of sample extracts were dissolved in methanol and further dilution were performed to obtain readings within the standard curve made with gallic acid ($R^2=0.9981$). The concentrations of gallic acid in the solution from which the curve was prepared were 1, 0.75, 0.5, 0.25, 0.125 and 0.0625 mg/ml.

The methanolic extracts of samples (50 µl) - were oxidized by the Folin-Ciocalteu reagent (240 µl) followed after 5 minutes by neutralization with Na₂CO₃ 7.5% (680 µl). After 30 minute in the dark, the absorbance of the samples was measured at 725 nm, using a Shimadzu UV-1700 PharmaSpec UV-VIS Spectrophotometer. The results were expressed as milligram of gallic acid per 100 grams ± standard deviation of duplicate analysis.

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y = 0.929x - 0.0239 \\
R^2 = 0.9981
\]

Fig. 2 Gallic acid calibration curve

RESULTS AND DISCUSSIONS

Fruits are very high in polyphenols, especially berries, blueberries (670.9 mg GAE/100g), sour cherry (429.5 mg GAE/100g) (Marinova et al., 2006) and plums (534.8 mg GAE/100g) (Imeh and Santosh Khokhar, 2002). Vegetable are generally lower in polyphenols than fruits, but red vegetables, such as red beetroot and red cabbage (439 mg GAE/100g) (Lee WY et al., 2007) are exceptions. The major components found in plums include the anthocyanins, cyanidin-3-glucoside and cyanidin-3-rutinoside, the flavonols, quercetin-3-glucoside, quercetin-3-rutinoside and quercetin-3-xylloside, and the hydroxycinnamic acids, chlorogenic and neochlorogenic acid (Nunes et al., 2008).

Over 20 compounds of quercetin and kaempferol were found in cabbage (Nielsen et al., 1998). Anthocyanin pigments found in red cabbage are acyl derivatives of cyanidin (Clifford, 2000). Brassica vegetables contain also derivatives of hydroxycinnamic acid – caffic, chlorogenic, ferulic, and synapic (Vallejo, 2003) as well as flavonols.
The major polyphenolic components found in sour cherry include quercetin, kaempferol, chlorogenic acid, p-coumaric acid, gallic acid, perillyl alcohol, D-glucaric acid (Wang et al., 1999).

The obtained results indicate diversified polyphenol content, depending on many factors, including, the raw material species, storage conditions and method of processing. The highest concentration of polyphenols, 503.4±3.04 mg GAE/100 g, was found in fresh plum and the lowest in red beetroot 305.5±6.08 mg GAE/100 g. The values obtained are in accordance with those found in literature.

Fig. 3 shows the difference in polyphenols content of fresh and processed fruits and vegetables. It can be noticed that after processing and storage stages, the content of polyphenols decreased significantly in all four samples taken into study. This stands that the biggest losses of polyphenols by oxidative degradation occurs for canned red cabbage (from 448.5±4.56 to 151.5±9.13 mg GAE/100 g) followed closely by plum compote (from 503.4±3.04 to 266.7±6.08 mg GAE/100 g). The smallest decrease in the polyphenol content was recorded in the case of red beetroot. Also, in the case of sour cherries compote the decrease in phenolic compounds wasn’t so great as for plums and red cabbage.

![Fig. 3 Total Polyphenols content in fresh and processed fruits and vegetables (mean of two replicates ± standard deviation)](image)

**CONCLUSION**

The aim of this research was to assess the loss of phenolic compounds between fresh and canned fruits and vegetables. Because during the preservation process, a significant loss in antioxidants has been noticed, we recommend, whenever possible, to consume fresh or slightly processed fruits and vegetables in order to minimize oxidative degradation.
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REFERENCES