Abstract
Fresh fruits are rich sources of polyphenolic compounds. The polyphenolics present in plant sources are known to have beneficial effects, especially in the prevention of cardio-vascular diseases, cancer, etc. Therefore, the consumption of fresh fruits is not only associated with vitamin supplementation, but also serves as an effective preventive agent for many diseases. The polyphenolic compounds comprise a wide range of phytochemicals including tannins, flavonoids, phenolic acids, stilbenes and lignans. Tannins present in plant materials comprise two groups: hydrolysable tannins and condensed tannins (proanthocyanidins). Condensed tannins are found in abundance in fruits and fruit products. They are associated with the astringency and color of fruits. Furthermore, these compounds are known to possess functional properties such as antioxidant, antimicrobial and antiviral effects. In this study, the condensed tannin content of fruits cultivated in Ida Mountains, Çanakkale, Turkey was determined. Among the investigated fruits, sour cherry (Prunus cerasus) was found to have the highest condensed tannin content (163.4±3.21 µg CE/g), while greengage plums (Prunus domestica) type “Papaz” had the lowest condensed tannin content (20.42±0.81 µg CE/g).

Keywords: tannins, condensed tannins, fruits, Ida Mountains

Introduction
Phenolics in plants are compounds that contain one or more phenol unit in their molecules. According to their structure, the phenolics can be classified into several groups like simple phenolics, phenolic acids, coumarins, flavonoids, stilbenes, lignans, lignins, and tannins (Naczk and Shahidi, 2006). Tannins, that contain tannic acid as a building block, have relatively high molecular weight and are usually divided into two groups: hydrolysable and condensed tannins. Condensed tannins are also known as proanthocyanidins. Condensed tannins are found in abundance in fruits and fruit products. This unique group of phenolics is associated with the astringency and color of fruits (Landete, 2012; Serrano et al., 2009; Koleckar et al., 2008). Moreover, proanthocyanidins are known to possess some biological properties that are of vital importance for human health. The tannins, present in human diet, as an integral part of foods of plant origin were initially considered as anti-nutrient constituents. These compounds tend to bind to carbohydrates and proteins, thus decreasing the absorption and ingestion of these nutrients (Chung et al., 1998). On the other hand, a considerable research revealed the anticarcinogenic, antimutagenic, antimicrobial (antibacterial, antiviral) and antioxidant effects of tannins (Chung et al, 1998; Cos et al., 2004; Koleckar et al., 2008; Serrano et al., 2009). Furthermore, the proanthocyanidins were attributed to have...
cardioprotective effects, as the intake of these compounds was found to reduce the risk of heart breaks. Tannins were also found to be effective in diabetes. The intake of tannins was found to lower the glucose levels in blood by delaying the intestinal glucose absorption. Therefore, a diet rich in tannins is recommended to those suffering from diabetes. Nevertheless, tannins are found to have anti-inflammatory effects (Koleckar et al., 2008; Serrano et al., 2009). Tannins were also reported to exhibit physiological effects such as reduction in blood pressure, decrease in serum lipid level and modulation of immunoresponses (Chnug et al., 1998).

Tannins are also well-known for their antioxidant properties. The antioxidant effects of these compounds are mainly explained with respect of their mode of action like free radical scavenging, chelation of transition metals, inhibition of prooxidative enzymes and lipid peroxidation (Cos et al., 2004; Koleckar et al., 2008).

Based on the knowledge about the physiological and health effects of the condensed tannins, it is of significance to determine the relative content present in plant food products. Food products of plant origin like fruits and vegetables are known to be the best sources of phenolic compounds (Kapur and Kapoor, 2001). The condensed tannin content of fruits is mainly affected by the environmental conditions of the cultivation areas, as well as the degree of ripening of the plants. Furthermore, the tannin content might be also influenced by the storage and processing conditions of fruits (Serrano et al., 2009).

The purpose of this study was to determine the condensed tannin content of 4 ripe fruits that are grown in the Northern parts of the Ida Mountains, Canakkale, Turkey.

MATERIALS AND METHODS

Chemical reagents

All chemicals were purchased from Sigma-Aldrich (USA), SPA (Milan, Italy), Merck (Germany) and Fluka Chemie (Switzerland).

Plants materials

Fruits of sour cherry (Prunus cerasus), cherry (Prunus avium) type “Napolyon”, apricot (Prunus armeniaca), and greengage plums (Prunus domestica) type “Papaz” grown in the Northern parts of Ida Mountains (Kazdağları), in the Province of Canakkale, Turkey were collected.

Preparation of fresh fruit sample extracts

The collected fruits were stored at 4°C till analysis (not more than 12 hours) and fresh fruits were used for extraction. The fresh fruits were pitted. Each fresh fruit sample (20 g) was extracted according to Maisuthisakul et al. (2007). Briefly, a sample (20 g) was blended with 60 mL methanol (95%) in a blender for 1 minute and shaken for 4.5 h. The supernatant was filtered through Whatman filter paper (No. 4). All filtrates were evaporated under reduced pressure using a Rotary evaporator at 40°C and weighed in order to determine the yield of soluble components. Afterwards, the extracts were immediately analyzed for total condensed tannins in triplicate.

Analysis of total condensed tannins content

Condensed tannin content was evaluated using the vanillin assay (Price et al., 1978). An aliquot of 0.5 g of the fruit extracts was placed in centrifuge tubes and 20 mL of 1% HCl in methanol was added to each sample. Then, the tubes were placed in a water bath at 30°C with constant shaking for 20 min. After incubation, the samples were centrifuged. Aliquots of the supernatants were placed in two separate assay tubes, one for the sample determination and the other for blank determination. Samples and blanks were incubated for exactly 20 min after adding 5 mL of the vanillin reagent (0.5 g of reagent and 200 mL of 4% HCl methanol) to the samples and 4% HCl in methanol to the blanks. Afterwards, the absorbance was measured at 500 nm using a UV–Vis spectrophotometer (Thermo Aquamate). The results were expressed as microgram catechin equivalents per gram of fruits (µg CE/g).

Statistical analysis

The results were reported as mean ± SD (standard deviation). One-way ANOVA was applied to investigate the differences among means by using Statghaphics Centurion XV software. The values were considered to be significantly different at p<0.05.

RESULTS AND DISCUSSION

The condensed tannin content of ripe sour cherry, cherry, apricot and greengage plum is given in Table 1. The highest amount of condensed tannins was found in sour cherry, while the lowest was detected in greengage plum. In all the fruits, the condensed tannin contents were significantly different from each other (Table 1, Figure 1).
Table 1. The condensed tannin content of the fruits cultivated in Ida Mountains*

<table>
<thead>
<tr>
<th></th>
<th>Sour Cherry</th>
<th>Cherry</th>
<th>Apricot</th>
<th>Greengage Plum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condensed Tannin Content (µg CE/g)**</td>
<td>163.4±3.21a</td>
<td>113.1±5.8b</td>
<td>38.8±1.34c</td>
<td>20.42±0.81d</td>
</tr>
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</table>

*The values are given as mean ± standard deviation (n=3).
**Means with different letter within a row are significantly different at p<0.05.

The level of condensed tannins is greatly influenced and varies with respect of the type of the fruit, the environmental and cultivation conditions, the degree of ripening, as well as the storage conditions. In order to compare the condensed tannin contents of different fruits grown in the same area, all the fruits were collected at their ripe stage and were taken into analysis within 12 hours after collection.

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REFERENCES