THE EFFECT OF MARMALADE TYPES ON BIOACTIVE PROPERTIES, PHENOLIC COMPOUNDS AND MINERAL CONTENTS

ВЛИЯНИЕ ТИПА МАРМЕЛАДА НА БИОАКТИВНЫЕ СВОЙСТВА, ФЕНОЛЬНЫЕ СОЕДИНЕНИЯ И МИНЕРАЛЬНЫЙ СОСТАВ

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Antioxidant activities of samples varied between 99,6 % (Mahaleb) and 117,2 % (Cornus). Also, total phenolics of marmalades changed between 103,52 (Mahaleb) and 126,63 mgGAE/100 g (Cornus). While gallic acid contents of extracts range from 0,91 (Mahaleb) to 6,27 mg/100 g (Cornus), (+)-Catechin contents of samples were varied between 3,29 (Mahaleb) and 9,61 mg/100 g (Cornus). The highest syringic acid was found in rosa marmalade sample (3,81 mg/100 g). The highest rutin trihydrate was determined in cornus marmalade (3,37 mg/100 g). K and P contents of marmalades were found between 271,37 mg/Kg (Rosa) and 8004,00 mg/kg (Mahaleb) to 55,12 (Cornus) and 415,12 (Mahaleb) mg/kg, respectively. Fe contents of marmalades changed between 12,97 (Rosa) and 16,92 mg/kg (Cornus). According to results, marmalade samples are rich in Ca, K, Mg, Na and P elements.

Антиоксидантная активность образцов варьировала между 99,6 % (вишня) и 117,2 % (кизил). Кроме того, общие фенолы мармеладов изменились между 103,52 (вишня) и 126,63 мгГЭ / 100 г (кизил) В то время как содержание галловой кислоты в экстрактах варьируется от 0,91 (вишня) до 6,27 мг / 100 г (кизил), (+) − содержание катехинов в образцах изменялось от 3,29 (вишня) до 9,61 мг / 100 г (кизил). Самый высокий уровень сиринговой кислоты был обнаружен в образце розмаринового мармелада (3,81 мг / 100 г). Наивысшее содержание тригидрат рутина определяли в мармеладе кукурузы (3,37 мг / 100 г). Концентрация K и P в мармеладах была установлена между 271,37 мг / кг (шиповник) и 8004,00 мг / кг (вишня) до 55,12 (кизил) и 415,12 (вишня) мг / кг соответственно. Содержание железа в мармеладах изменилось между 12,97 (шиповник) и 16,92 мг / кг (кизил). Согласно результатам, образцы мармелада богаты элементами Ca, K, Mg, Na и P.

Keywords: marmalade, antioxidant activity, anthocyanins, phenolic compounds, minerals, ICP-AES.

Ключевые слова: мармелад, антиоксидантная активность, антоцианы, фенольные соединения, минеральные вещества, ICP-AES.

Introduction. The fruit are rarely eaten directly as fresh and dried product. There are several conservation foods used predominantly in the manufacture of canning such as rosehip pulp [Nowak, 2005]. *Cornus* and Cornelian cherry fruits have significant amounts of bioactive substances including anthocyanins [Tural and Koca, 2008]. Among medicinal plants in Turkey, *Prunus mahaleb* L. is commonly known as mahlep, mehlep, idris agac, in Turkey and its kernels are used for medicinal and nutritional purposes. Hawthorn (*Crataegus* spp) is an endemic member of the Rosaceae family, and its fruit possesses potent antioxidant and free radical scavenging activities, due to the presence of different, bioactive compounds, such as epicatechin, hyperoside, and chlorogenic acid [Nabavi et al., 2015]. Marmalade is very important energy and functional food and is used as an ingredient in cereal based products for sweetness, color and flavor [Nowak, 2005]. The current study was to determine the effect of marmalade types on bioactive properties, phenolic compounds and mineral contents.

Material and methods. The marmalade samples of *Rosa canina* (rose hip), *Cornus mas* (Cornus), *Mahaleb cerasus* (Mahaleb), and *Crataegus* spp (hawtorn) were provided in Tokat province, Turkey.

Total phenolic content and Antioxidant activity. Total phenol contents and the free radical scavenging activity values of marmalade extracts were determined by using Folin-Ciacueltau (FC) reagent as described by Yoo et al. (2004). and using DPPH (1,1-diphenyl-2-picrylhydrazyl) according to Lee et al. (1998), respectively.

Determination of Anthocyanins. For anthocyanin analysis, about 0.5 g fresh weight (FW) were homogenized in a solution containing propanol, chlorhydric acid, and water (18:1:81). After the homogenates were boiled in a water bath for 3 min and then left in darkness for 24 h at room temperature. About 3 mL of the supernatants centrifuged at 6500 rpm for 40 min. was measured at 535 and 650 nm, and The absorbance value was calculated and corrected by the following formula [Ticconi et al. 2001]:

$$A = A_{535} - A_{650}.$$

Determinetion of flavonoid. Total flavonoids contents of marmalade samples were estimated according to Dewanto et al. (2002). The flavonoid content was expressed as mg Catechol equivalents (CE) per g of dry weight (mg CE/g DW).

Determination of phenolic compounds. Phenolic compounds were extracted according to Ivanova et al. (2005). The dried extracts were dissolved in 2 ml of methanol, and filtered. The it was injected for analyses. Phenolic compounds were performed using a Shimadzu-HPLC equipped with a PDA detector and an Inertsil ODS-3 (5 µm; 4,6 × 250 mm) column. The mobile phase was a mixture of 0,05% acetic acid in water (A) and acetonitrile (B).

Mineral Analyses. Mineral contents were determined by Inductively Coupled Plasma Atomic Emission Spectrometry (Varian-Vista, Australia) [Skujins, 1998]. All analyses were carried out three times and the results are mean±standard deviation (MSTAT C) of marmalade samples.

Results and discussion. Moisture contents of samples changed between 86,3 % (Rosa) and 89,5 % (Hawtorn). While antioxidant activity values of marmalades vary between 99,6 % (mahaleb) and 117,2 % (Cornus), total phenol contents of marmalades changed between 103,52 (Mahaleb) and 126,63 mgGAE/100 g (Cornus). In addition, flavonoid contents of marmalade samples were determined between 13.4 mgCE/g (Hawtorn) and 28,3 mg CE/g (Cornus). In previous study, Pirone et al. (2007) determined 31 mg/kg total anthocyanin and carotene 42,6 mg/kg in rose hip nectars. Total phenolic contents of marmalades was found considerably higher compared to black currant (3,61–4,35 mg/g), blueberry (2,70–3,48 mg/g), strawberry (1,61–2,94 mg/g) and raspberry (2,7–3,03 mg/g) [Heinonen et al., 1998]. Guerrero et al. (2010) found that the total anthocyanin content in rosehip fruits was 0,38 mg/100 g, and the total phenolic content was 145,7 mg/100 g. Present results showed partly differences with literature value. These differences can be probably due to different fruit species, heating and processing conditions.

Generally, gallic acid, (+)-catechin, syringic acid, caffeic acid, rutin trihydrate, quercetin and kaempferol contents were major phenolics in marmalade samples. While gallic acid contents vary between 0,91 mg/100 g (Mahaleb) and 6,27 mg/100g (Cornus), (+)-Catechin contents of marmalades were determined between 3,29 mg/100g (Mahaleb) and 9,61 mg/100 g (Cornus). The highest syringic acid was found in rosa marmalade sample (3,81 mg/100g). Geographic location and soil affect to the contents of phenolic compound in fruits [Dimitrijevic et al., 2014].

K contents of marmalades changed between 271,37 mg/Kg (rosa) and 8004,00 mg/Kg (Mahaleb). P contents (415,12 mg/Kg) of mahaleb marmalade was found higher than those of results of other marmalade samples. The highest Ca (175,13 mg/Kg) was determined in rose marmalade sample. Fe contents of marmalades were found between 12,97 mg/Kg (Rosa) and 16,92 mg/Kg (Cornus). The highest Cu and Zn was found in mahaleb marmalade (1,75 mg/kg and 7,62 mg/kg), respectively.

Topçu et al. (1997) established 369.46 Ca, 89,0 P, 12,78 Mg, 7,31 Fe, 18,67 Na and 1369,40 mg/100 g K in boiled grape juice. Mineral contents varied depending on the different types of fruits. According to results, marmalade samples are rich in Ca, K, Mg, Na and P elements.

In conclusions, the chemical composition, and antioxidant activities, nutritional values showed significant differences depending on the marmalade types. The *Cornus* and *Rosa* marmalades showed considerable high nutritional value and antioxidant activity which could be chosen for functional food development that benefits human health.

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