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ORIGINAL ARTICLE

Use of introduced low-wide fruit plants as a paradigm of functional nutrition: Psychological attractiveness for consumers

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Assessment of the resistance of the genus Chaenomeles and the genus Berberis, the implementation of the genetically determined antioxidant potential, and the content of secondary metabolites in the fruits in the arid climate of the Steppe Dnieper has been found. Analysis of fruits and berries products has shown that Chaenomeles and barberry were not found in any of the analyzed products, including products positioned as functional products, in both supermarkets and public catering in the city of Dnipro. The fruits of chaenomeles and barberries growing in the steppe Dnieper have a high content of phenols and flavonoids as natural antioxidants, good technological properties, good preservation, differ in taste, which makes it possible to add fruits and semi-finished products based on them to various products to increase their biological and functional value. Resistance to arid growth conditions, undemanding to agricultural measures, the possibility of use in the food industry and restaurant service in the growing region, lack of processing of raw materials for long-term transportation and storage can reduce the cost of functional products containing phenols and flavonoids derived from exotic fruits. An opportunity to expand the network of "niche" restaurants and catering services, which offer organic dishes with diverse and attractive to consumer tastes, functional antioxidant properties, and prices are proven.
Keywords: Representatives of Chaenomeles and Berberis, resistance, antioxidant potential, functional products, and psychological attractiveness for consumers.

Introduction

Presently, the food sector is considered one of the most important in the current global economy. Nevertheless, the food industry or food service companies, particularly restaurant businesses and public catering, still face many challenges in managing their products and competing in the market. The food manufacturing industry has been recognized as an area with high degrees of new product failure (Guiné et al., 2020). The consumption of nutritious foods largely dictates the health and wellness of human beings. Functional foods are those food products that provide essential nutrients needed for good health and potentially positively impact human health besides providing the necessary nutritional requirements. Consumers demand food that helps prevent disease, boost mental health, and improve quality of life (Shikha et al., 2014; Lykholat et al., 2016; Akhter et al., 2019; Khalaf et al., 2021).
Any natural beneficial compounds for both therapy and health involved dietary fibers, polyphenols, antioxidants, spices, flavonoids, vitamins, probiotics, and polyunsaturated fatty acids (Das et al., 2012). Vitamins, fiber, omega-3 fatty acids, minerals, bacterial cultures, and flavonoids can add functionality to any food produced (Day et al., 2009). The major challenge for functional foods is to ensure that the bioactive constituents remain stable during processing and storage (Khalaf et al., 2021). For the successful introduction of innovations in traditional food products, it is also important to have a good understanding of consumers' perceptions and attitudes towards traditional food products and of consumers' needs and preferences when applying even small innovations to traditional food products (Linnemann et al., 2006; Vanhonacker et al., 2013). Although communication and information do not

change the characteristics of the products, they can shape consumers' attitudes and influence their choices and behaviors (Guiné et al., 2020; Verbeke and Liu, 2014).

In this sense, consumers' acceptance and improvement of traditional foods are related to product quality, innovations oriented toward safer and healthier products that do not compromise their sensory properties, labels with the guarantee of origin, and more product variety and convenience-oriented innovations (Gellynck & Kühne, 2008). Many consumers place greater importance on sustainably produced food such as organic food Nielsen (Akhter & Dil, 2019; Jin et al., 2019). In the last few years, the market of organically grown products (OGPs) has continued to grow due to speculated concerns for the environment, food safety, and health issues (Wekeza & Sibanda, 2019).

Owning to the increase in the world population and the consumer's awareness of the health benefits of consumption of fruits, the demand for both fresh and processed fruits has been increased. So, valorizwithing plant fruit processing by-products to high-value added compounds constitutes a promising alternative for addressing fruit residue management issues and leading to the production of functional food products of high nutritional value, with several potential benefit health effects (Dimou et al., 2019). Consumption of biologically active ingredients in fruits and vegetables has been linked to helping combat diseases such as cancer, cardiovascular diseases, obesity, gastrointestinal tract, and nervous system disorders (Gul et al., 2016).

The introduction of fruit plants enriches the diversity of species composition of the regional flora and at the same time, creates an opportunity to expand the range of plant raw materials to meet the needs of industry, medicine, and nutrition. If there are more than 400 species of fruit and berry plants in different regions of Ukraine, their number is negligible in the Dnipro region. Adverse regional climatic conditions, with a particular deficit of soil moisture and high content of pollutants (Andrusevich et al., 2018; Dilur et al., 2019; Savosko et al., 2019, 2020), have a significant impact on the distribution of taxa of ornamentals (Alexeyeva et al., 2016; Klymenko et al., 2017; Savosko et al., 2018; Nazarenko & Lykholat, 2018) and fruit plants (Shcherbyna et al., 2017; Lykholat et al., 2019b, 2019c).

In the steppe nontraditional rawphenolicszone of Ukraine, the introduction of plants from remote geographical areas, including natural and hybrid species of the genus Chaenomeles Lindl. In the steppe Dnieper region, among the introduced species, many fruit plants are receiving increasing attention every year. In particular, these are uncommon non-traditional fruit specфies in which fruits, leaves, stems, and other parts have a high biological value and are a source of physiologically active compounds that can contribute to the prevention and treatment of many diseases, be raw materials for the food industry (Mezhens'kij, 2004). Among this plant group, a significant place is occupied by representatives of the genera Chaenomeles Lindl., and Berberis L. Due to the ability to biosynthesis and accumulation of components with antioxidant properties, the fruits can prevent many diseases caused by oxidative stress (Choudhury et al., 2017; Dimitrijević et al., 2019; Guo et al., 2018; Dulić et al., 2019). Such state indicators are the content of total phenolic (the total phenolic content), the total content of flavonoids (the content of flavonoids), and the total reducing power (total reducing power) (Hassanpour & Alizadeh, 2016; Elkhalki et al., 2018). Moreover, *Berberis* took place at the Botanical Garden of Oles Honchar Dnipro National University (city of Dnipro) for many years.

The purpose of this work was to assess the resistance of the genus Chaenomeles (Ch.) and the genus Berberis (B.), study the implementation of the genetically determined antioxidant potential and the content of secondary metabolites in fruits in the arid climate of the Steppe Dnieper for using by regional food industry or food service companies.

Materials and Methods

The research was conducted in Dnipro city (steppe zone of Ukraine) in the Botanical Garden of Oles Honchar Dnipro National University. The region's climate has distinct continental features, including seasonal droughts with high temperatures and dry, hot winds. The low average amount of precipitation (472 mm) decreases in arid years to 250 mm, and the total evaporation for a year exceeds the amount of precipitation by 2–3 times. During the period of research, the weather conditions were characterized by abnormal features, particularly the precipitation of 4 cm of snow in the winter, temperature fluctuations in the spring, and the heat and droughts observed during summer.

The objects of the study are the fruits of *Ch. cathayensis* (Hemsl.) CK Schneid., *Ch. japonica* (Thunb.) Lindl. Ex Spach.), *Ch. × californica* W. Clarke ex C. Weber), *Ch. lush* (*Ch. × superba* (Frahm) Rehd.), *Ch. japanese* var. mauleia (*Ch. japonica* var. Maulei (Mast.) Lavallee), *Ch. beautiful* (*Ch. speciosa* (Sweet.) Nakai), and *B. vulgaris*, *B. amurensis*, *B. canadensis*, *B. koreana*, *B. x declinata* as a hybridogenic species, which is a spontaneous hybrid of *B. canadensis* and *B. vulgaris*.

The Folin–Ciocalteau method (Singleton et al., 1999) with modification (Nwanna et al., 2013) was used for the total phenolic content measurement. The total phenolic content was calculated using a calibration graph prepared on Gallic acid (GA) solutions and expressed as mg GA equivalents per 100 g of wet weight (mg GAE/100 g WW).

The aluminum chloride spectrophotometric method (Pękal & Pyrzynska, 2014) was used for the measurement of total flavonoids content. The content of flavonoids was calculated using a calibration graph prepared from rutin solutions, and the result was expressed as mg rutin equivalents per 100 g of fruit wet weight (mg RE/100 g WW).

The total reducing power (TRP) was determined following Pulido et al. (2000). The calibration graph was constructed by solution of ascorbic acid (AA). The total reduction power of the extracts was expressed as AA equivalents per g of wet plant weight (mg AAE/g WW) under Augustus et al. (2015).

Data obtained were expressed as mean ± standard deviation (X ± SD) of three measurements. Statistical analyses were performed with ANOVA. Correlation analysis examined the interrelations between the study indexes of the metabolite's content and the reducing power ($P<0.05$). Tukey's criterion of honestly significant difference (HSD) in group mean was used to distinguish between samples of mean values. This criterion makes it possible to conduct multiple pair comparisons of mean values. Differences were considered statistically significant at P<0.05.

Results

The healthy abilities of fruit plants largely determine the high antioxidant capacity of plant metabolites, which can be realized as an activity that reduces free radicals and the reduction or chelating of metals in living organizations (Costa et al., 2009; Du et al., 2013). The use of natural antioxidants in living organisms increases the nutritional and biological value of the product (Lykholat et al., 2019a).

In our study, the total phenolic content in the Chaenomeles fruits isopropanol extracts was the lowest in *Ch. speciosa* (1784 mg GAE/100 g WW), the average in *Ch. japonica* and *Ch. japonica* var. maulei (2869 and 2783 mg GAE/100 g), and the highest (3332 mg GAE/100 g) in *Ch. cathayensis* fruits (Fig. 1). As for the hybridogenous species *Ch. × californica* and *Ch. × superba*, the content of phenols in their fruits, reached an average level relative to the parent plants. The results obtained differ from the data on the phenol content in the acetone extracts from the fruits of *Ch. speciosa* (46.92 mg GAE/g) and *Ch. japonica* (19.35 mg GAE/g) collected in the Botanical Garden of Beijing in China (Du et al., 2013). It was evident that the differences in the accumulation of antioxidant metabolites in the fruits of the same plant species are due to the influence of environmental conditions, which vary widely in these two regions. The study results also suggest that the adaptation of Japanese and Chinese species to the soil and semiarid climatic conditions of the Steppe Dnieper was accompanied by a more significant accumulation of antioxidant compounds in the fruits of *Ch. japonica* plants than *Ch. species*. This assumption agrees with the data of Nichols et al. (2015) found that the high level of phenolic compounds accumulation positively correlated with the improvement of the stability of clover plants to drought. In general, the content of phenolic compounds in the Chaenomeles fruits significantly exceeded that for some other fruit crops, including peach (0.69–4.00 mg GAE/g), nectarine (0.93–1.83 mg GAE/g), and plum (3.91–13.53 mg GAE/g), reported by Mitic et al. (2016). In the fruits of different apple varieties cultivated in Italy, the mean content of total polyphenols lay between 66.2 and 211.9 mg/100 g of FW (Vrhovsek et al., 2004), while other data (Wojdyło et al., 2008) showed the variation in the range from 523 to 2,724 mg GAE/100 g DW in a group of 67 different apple varieties.

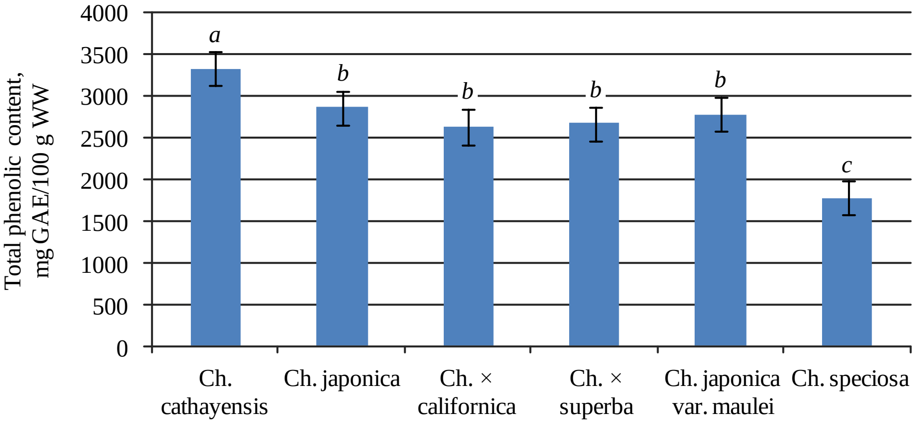

Fig. 1. Total phenolic content in the fruits of different *Chaenomeles* species. The different letters indicate statistically significant differences (P<0.05) in the means of the compared pair according to the Tukey criterion.

Flavonoids are a subclass of polyphenols, and they form a large group of food constituents, many of which alter metabolic processes and positively impact health (Beecher, 2003), possess preventive and therapeutic potential (Owczarek et al., 2017). As for the plant fruits, the highest flavonoids accumulation was revealed in *Ch. cathayensis* and *Ch. japonica* var. maulei (66.5 and 62.6 mg RE/100 g WW, respectively), while the lowest level (29.8 mg RE/100 g WW) was in the fruits of Ch. speciosa (Fig. 2). The fruits of Japanese quince and the hybrid species *Ch. × superba* and *Ch. × californica* had an intermediate flavonoid content, respectively, 56.8 and 41.9 mg RE/100 g WW. The results obtained are consistent with the data (Hafez-Taghva et al., 2016) on the accumulation of flavonoids in the range 0.091–0.618 mg RE/g in *Ch. japonica* fruits. Dissimilar levels of flavonoid accumulation in fruits of different species can be attributed to the general diversity of the phenolic compounds found within the genus Chaenomeles (Watychowicz et al., 2017; Miao et al., 2016; Lewandowska et al., 2013).

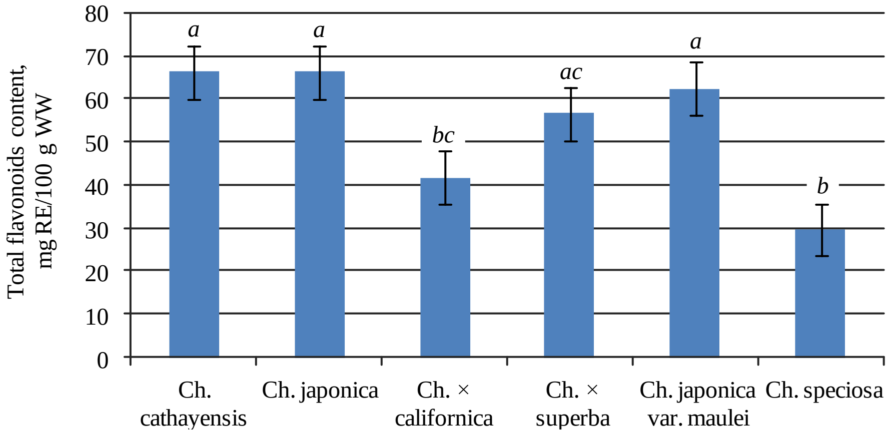

Fig. 2. Total flavonoids content in the fruits of different *Chaenomeles* species. The different letters indicate statistically significant differences (P<0.05) in the means of the compared pair according to the Tukey criterion.

Ch. cathayensis fruits showed the maximal level of total reducing power while *Ch. speciosa* minimal, respectively, 11.22 and 5.66 mg AAE/g WW (Fig. 3). The antioxidant capacity of *Ch. japonica* and *Ch. japonica* var. maulei fruits occupied the middle position between the TRP of the hybridogenic species *Ch. × superba* and *Ch. × californica* (7.84 and 9.38 mg AAE/g, respectively). In total, the antioxidant potential of Chaenomeles fruits is comparable to the level shown by Mitic et al. (2016) for other fruit crops, including nectarine (14.36–17.58 mg AAE/g), plum (32.43–58.30 mg AAE/g), and peach (12.31–24.55 mg AAE/g) as well as to the reducing power of Berberis fruits defined in the range 5.0–9.6 mg AAE/g WW (Khromykh et al., 2018).

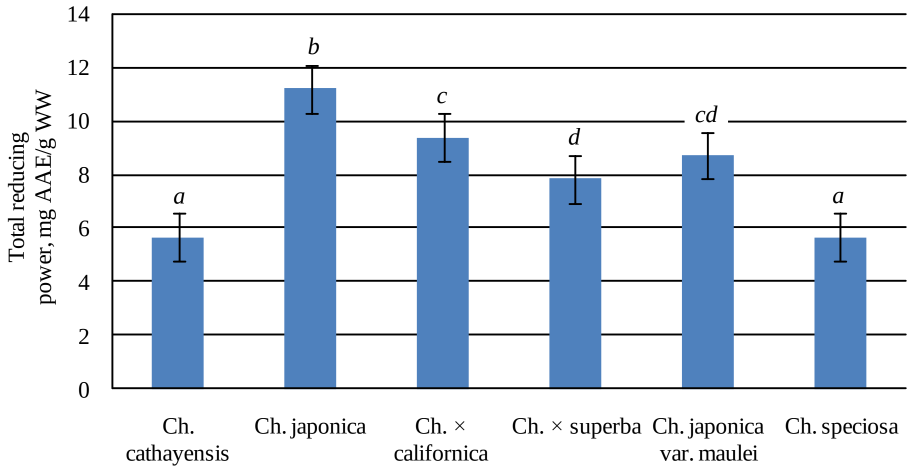

Fig. 3. Total reducing power in the fruits of different *Chaenomeles* species. The different letters indicate statistically significant differences (P<0.05) in the means of the compared pair according to the Tukey criterion.

As for the fruits of the Chaenomeles species, a strong correlation was established between the total reducing power and the total phenol content (r=0.95, P<0.05), whereas a lower correlation coefficient (r=0.66) was found between the total reducing power and total flavonoids content. The explanation for the low level of correlation may be because flavonoids are widespread but not evenly (Beecher, 2003), most likely even within the same genus of plants.

The total phenolic content of the crude extracts of the Berberis fruits varied in a relatively wide range, and the content of phenols in the *B. vulgaris* was significantly (P<0.05) different from those of all other species. The study results showed that the highest phenolics concentration was revealed in the fresh ripe fruits of *B. koreana* (1362.8 ± 66.1 mg GAE/100 g WW), followed by *B. x declinata* fruits (91% of the *B. koreana* phenolics content). The phenolics concentration in the fruits of the native species *B. vulgaris* (1052.3 ± 54.3 mg GAE/100 g WW) reached 77% of the highest content in *B. koreana* fruits (Fig. 4). Pyrkosz-Biardzka et al. (2014) found a similar content of polyphenols in the methanolic crude extracts of *B. vulgaris* fruits, where it reached 1024.3 ± 15.2 mg GAE/100 g FM. The aqueous and alcoholic extracts of *B. vulgaris* fruits contained the total phenols at 184.1 ± 5.3 and 291.2 ± 2.5 mg GAE/g of dried extract, respectively (Hoshyar et al., 2016). In total, the results obtained showed the relatively high total phenolic content in the fruits of Berberis species compared to other fruit plants. Thus, Wolfe et al. (2003) evaluated the highest total phenolic content in different varieties of apples as 589 ± 83.2 and 500 ± 13.7 mg GAE/100 g of crude mass. The smallest value of the phenolic compounds was revealed in the fresh fruits of the northern species *B. canadensis* (899.2 ± 34.0 mg GAE/100 g WW), and it was one and a half times lower than that of the southern species *B. koreana*. Significant differences in the content of phenolic compounds in the investigated fruits of Berberis species are consistent with other data on the variation of total phenolic content, depending on the genotype and plant tissues.

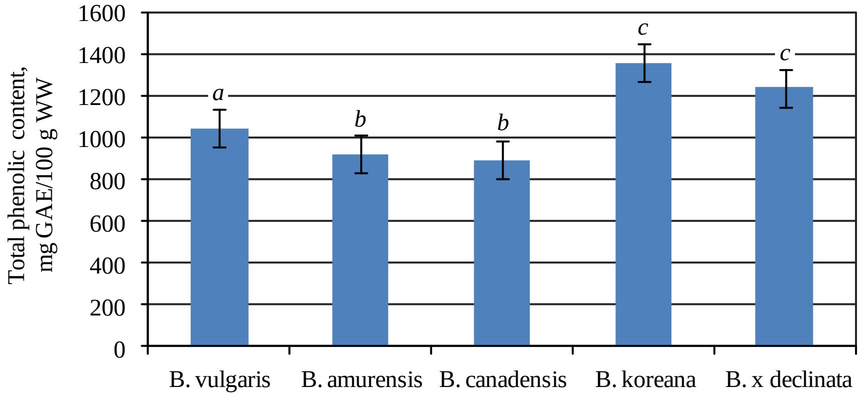

Fig. 4. Total phenolic content in the fruits of different *Berberis* species. The different letters indicate statistically significant differences (P<0.05) in the means of the compared pair according to the Tukey criterion.

In our study, the highest total content of flavonoid compounds revealed in fruits of *B. koreana* (210.4 ± 6.1 mg RE/100 g WW) exceeded the content in fruits of other Berberis species by 1.1–2.1 times, and the lowest value (102.8 ± 4.1 mg RE/100 g WW) was found in the fruits of *B. amurensis* (Fig. 5). The content of flavonoids determined by us in the isopropanol extracts of *B. vulgaris* fruits (142.9 ± 6.4 mg RE/100 g WW) was higher than the content in methanol extract (86.0 ± 1.8 mg RE/100 g FM), reported by Pyrkosz-Biardzka et al. (2014). The highest flavonoids share in total phenolics content was found in the fruits of *B. koreana* and *B. x declinata* (15.5% and 15.1% respectively), while it decreased to 13.6%, 12.5%, and 11.1%, respectively, in the fruits of *B. vulgaris*, *B. canadensis*, and *B. amurensis*.

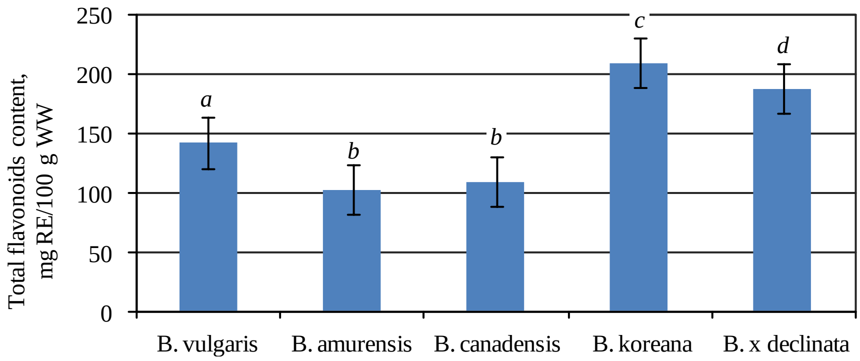

Fig. 5. Total flavonoids content in the fruits of different *Berberis* species. The different letters indicate statistically significant differences (P<0.05) in the means of the compared pair according to the Tukey criterion.

The highest level of the total reducing power (determined by RP assay) was found in the fruits of *B. koreana* and *B. x declinata* (respectively, 9.6 ± 0.6 and 8.6 ± 0.5 mg AE/g DW), exceeding the indices of other species by 1.7–1.9 times (Fig. 6). Therefore, the reducing power of the Berberis fruits defined in the range 5.0–9.6 mg AAE/ g DW may be deemed sufficiently high. Since flavonoids are the major contributors to the total reducing power in different fruit species (Borges et al., 2010), the antioxidant capacity of some Berberis fruits could be reduced due to the adverse effects of abnormal weather conditions during the growing season.

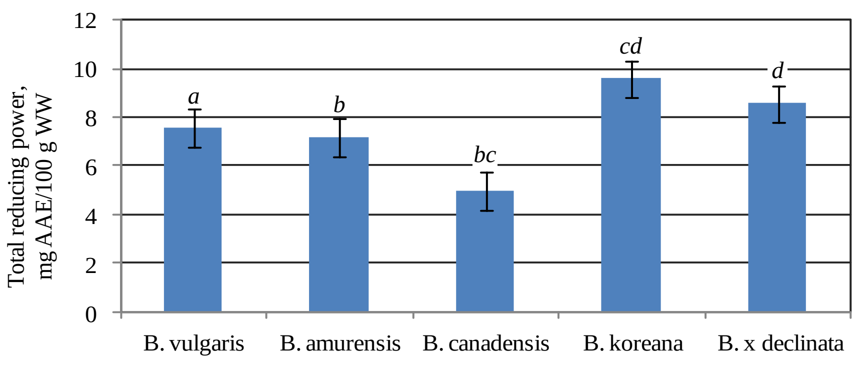

Fig. 6. Total reducing power in the fruits of different *Berberis* species. The different letters indicate statistically significant differences (P<0.05) in the means of the compared pair according to the Tukey criterion.

A strong positive correlation was found between the total reducing power and the total content of phenols in the fruit extracts of Berberis species (r=0.87, P<0.001), and the total content of flavonoids and the total reducing power as well (r=0.84, P<0.001).

High correlation coefficients confirm the significant contribution of phenolic compounds, including flavonoids, to the antioxidant capacity of the fruits of all examined Berberis species, which can be an easily accessible source of antioxidants.

Discussion

It is known that Chaenomeles and Barbary fruits are rich in ascorbic acids (50-200 mg/100 g), pectins (1-3%), have low contents of sugars (2-5%), and behind the vitamins, the content exceeds lemons (Mezhens'kij, 2004; Homich et al., 2014). Existence in fruits of considerable cellulose content (2-4%) testifies to a possibility of fruit use at low-calorie food production. Naturally, the fruits of various species of the Chaenomeles genus have been used for centuries in China and other Southeast Asia countries to treat cardiovascular diseases, anemia, rheumatism, diabetes, and gout (Du et al., 2013; Watychowicz et al., 2017). The vast majority of study results indicate that the biological activity of the preparations is to the greatest extent associated with the presence of polyphenols (Hamauzu et al., 2006; Brglez et al., 2016; Zakłos-Szyda & Pawlik, 2018). For instance, the antioxidant ability of the phenolic compounds contained in plants is associated with anti-carcinogenic, anti-mutagenic and anti-inflammatory, anti-diabetes effects, as well as the effect on signaling pathways of carcinogen metabolism (Huang et al., 2010), hepatic oxidative stress, idiopathic male factor infertility, brain disorder and Alzheimer's disease (Abd El-Wahab et al., 2013; Kwon et al., 2015; Kim et al., 2019). The attractiveness of functional foods and the intention to try and eventually purchase such foods vary according to the product type. Foods that the consumer perceives as healthier are judged more positively, and therefore, consumer acceptance is higher. claims,Consumers' behavior and attitudes concerning foods with health claims are also partially influenced by their own general state of health or some particular diseases, as well as the perception of how relevant the health claim might be (Guiné et al., 2020; Williams et al., 2008; Hunter et al., 2019). It is crucial to evaluate the general principles that influence consumer responses to the health-related aspects of functional foods, including the claims, much beyond the product's characteristics alone (Guiné et al., 2020).

After analyzing the range of fresh fruits and berries, frozen and dried products, canned fruits and berries (juices, purees, jams), confectionery (marmalade, marshmallows, pastilles, candies with fillings), dough products, cookies, gingerbread, croissants, cakes), pastries with and without filling (buns, pies, rings, brioche), both in supermarkets and public catering in the city of Dnipro, it is established that the offer is dominated by traditional for Ukraine seasonal crops: apples, pears, cherries, peaches, plums, apricots. Recently, blueberries, cranberries, blueberries, gooseberries, currants, currants, blackberries are offered. The range of tropical and subtropical fruits is quite comprehensive. These are lemon, mandarin, orange, kumquat, grapefruit, pomelo, banana, mango, pomegranate, pineapple, kiwi, lychee, coconut, rambutan, passion fruit, papaya, pitahaya, guava, carambola. Goji berries and chia seeds as superfoods are offered to Ukrainian consumers. Unfortunately, Chaenomeles and barberry were not found in any of the analyzed products, including products positioned as functional products, although the ones are in demand abroad. In Ukraine, there are also scientific developments in the use of Chaenomeles and barberry to improve food quality and functional value (Horobets, 2017). Nevertheless, the fruits are not given enough attention by foodservice companies, restaurant businesses, and public catering. For low-income households and individuals, the price may be a barrier to the consumption of healthy food (Akhter & Dil Bahadur, 2019). Furthermore, the costs of drying and storage of fruit processing residues are economically limiting factors hindering their further exploitation (Dimou et al., 2019). The cost of plant products is influenced by the resistance of plant organisms to climatic fluctuations, demanding soil quality, the complexity of agronomic measures, watering requirements, fertilizer application conditions and shelf life, and the ability not to lose biological value during storage and preparation.

Chaenomeles belong to early-growing crops. The first harvest can be expected 3–4 years after planting in the ground. It is covered with a thick grayish "waxy" coating. It protects quince from spoilage and cold weather. Even in winters with little snow, Chaenomeles can withstand temperatures as low as –30 °C. Chaenomeles is not picky about soils, tolerates slight salinity, and can grow in areas with a close groundwater occurrence. Due to the peculiarities of the structure of the root system, Chaenomeles is highly drought-resistant. In most cases, it can get by with natural precipitation. A very high immunity distinguishes the plant; the high content of tannins in the tissues of Chaenomeles repels almost all garden pests (Sorokopudov et al., 2017).

If lemon can be grown up only in the closed soil trees in the conditions of the steppe of Ukraine, then plants of Chaenomeles can transfer the climatic features of this zone.

Due to the unpretentiousness of the barberry, it can grow in open areas since it is not afraid of drafts and strong winds, as well as in part shade. It is unnecessary to water the barberry with normal rainfall, and only in extreme heat and drought, the soil in the area with barberry is still needed to moisturize weekly. The fertilizers introduced during planting into the ground will be enough for the barberry for a year.

Unripe Ch. ripens well in the refrigerator at a temperature of 3–5°C. During heat treatment and storage, it inevitably collapses, but its concentration is that spring quince blanks contain more of it than in store-bought lemons. In the same conditions, fresh fruits can be kept until the end of winter. Due to the record high vitamin C content, the Chaenomeles fruits have earned the nickname "northern lemon".

Both Ch. and B. have a significant amount of pectins (up to 12 %) favorable for obtaining various processed products. It can also recommend preparing a semifinished product in the form of natural juice, sugar extract, mashed potatoes, dried, and frozen fruits, which can be stored for a long time and used to prepare various dishes (Sorokopudov et al., 2017).

Studies show that the content of total phenols and flavonoids fluctuations, depending on the type of Chaenomeles and Berberis, and the peculiarities of seasonal climatic fluctuations (temperature, humidity). However, despite the observed phenomena, the content of total phenols and flavonoids can be assessed as high. At the same time, the total phenol level in all samples of Chaenomeles (1784.4–3331.7 mg GAE/100 g WW) on average is almost several times higher than in barberry samples (899.2–1362.8 mg

GAE/100 g WW). Concerning the total flavonoid content, barberry samples contain this antioxidant in an amount (102.8–210.4 mg RE/100 g WW), three times higher than its concentration in Chaenomeles samples (29.8–66.5 mg RE/100 g WW).

Total reducing power is comparable to that of chenomeles 5.7–11.2 and mg AAE/g WW, for barberries from 5.0–9.6 mg AAE/g WW. Higher values in the Chaenomeles samples can be explained by the "champion" content of ascorbic acid, which enhances the antioxidant capacity of the Chaenomeles fruits. Expensive functional products containing exotic ingredients can be successfully replaced by the products to which nutrients derived from raw materials of little introduced species introduced in Ukraine are added.

Conclusion

Thus, the fruits of chaenomeles and barberries growing in the steppe Dnieper have a high content of phenols and flavonoids as natural antioxidants, good technological properties, good preservation, differ in taste, which makes it possible to add fruits and semi-finished products based on them to various products to increase their biological and functional value. Resistance to arid growth conditions, undemanding to agricultural measures, the possibility of use in the food industry and restaurant service in the growing region, lack of processing of raw materials for long-term transportation and storage can reduce the cost of functional products containing phenols and flavonoids derived from exotic fruits. There is an opportunity to expand the network of "niche" restaurants and catering services, which offer organic dishes with diverse and attractive to consumer tastes, functional antioxidant properties, and prices.

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