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Original Article

Extracts of Cherry and Sweet Cherry Fruit as Active Ingredients of Body Wash Formulations

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Abstract

As a response to the growing demand of consumers for active, natural ingredients of cosmetic preparations, manufacturers are looking for new raw materials, rich in compounds with high antioxidative activity. In this research an attempt were made to evaluate the content of phenolic compounds, L-ascorbic acid and the antioxidant potential (DPPH$^{\bullet}$, ABTS$^{\bullet+}$ method) of aqueous and aqueous-glycerine extracts from cherry (*Prunus avium* L), and sweet cherry (*Prunus cerasus* L.). The next stage of this work was the application of analysed extracts to cleaning preparations. The best antioxidant properties were demonstrated for the aqueous-glycerine extract of sweet cherry fruit, which also was exhibit the highest phenol and L-ascorbic acid content. After application of analysed extract aqueous-glycerine extract of sweet cherry fruit to the gel, it was showed high foam stability. The model formulations enriched with the aqueous extracts of cherries and sweet cherries had a higher foaming ability, compared to the formulations containing the aqueous-glycerine extracts. The addition of both cherry and sweet cherry fruit extracts to the formulations resulted in a decrease in viscosity, in comparison with the baseline sample. The highest decline in viscosity (15% in relation to the baseline sample) was noted for the aqueous extract of sweet cherry fruit. None of model formulations, containing analysed extracts, did not induce skin lesions in the epidermal patch tests. The results indicate that the extracts can be used as a valuable cosmetic raw material, which have strong antioxidant ability and at the same time did not adversely affecting the usable properties of the washing gel.

Keywords: antioxidant activity; cherry; phenol content; shower gel; sweet cherry

Abbreviations: W+ cherry: aqueous extract of *Prunus avium* fruit; W+ G+ cherry: aqueous- glycerine extract of *Prunus avium* fruit: W+ sweet cherry: aqueous extract of *Prunus cerasus* fruit: W+ G+ sweet cherry: aqueous- glycerine extract of *Prunus cerasus* fruit

Introduction

The growing demand for cosmetics, where the natural components plays the major role, has become stimulus for searching a new plant extracts, which contains extra ordinary rich source of bioactive compounds (Jackson *et al*., 2014; Kelley *et al*., 2018). For many years, the cosmetic industry notes a growing demand for raw materials of natural origin with potential wide-ranging benefits for the skin, including medicinal, embellish and skin care effects. This type products are perceived as healthy as well as ecological (Butler, 2000; Elser and Maibach, 2000; Jabłońska-Trypuć and Czerpak, 2008).

In recent years, particular attention has been paid on natural cosmetics (organic or biocosmetics) in which plant extracts are an essential elements. The composition and its features might depend on many different factors, including time and extraction methods (Kim *et al*., 2007). The most common method used to obtain plant extracts is a single-stage solvent extraction, using mixtures of various solvents, including water, glycerine, glycols or ethyl alcohol (Brud and Glinka, 2001).

The current trend observed in the cosmetics industry, is to develop cosmetics with a multifaceted action, where plant origin substances can be applied as multi-functional cosmetic ingredients (Chanchal and Swarnlata, 2008). Numerous scientific studies confirm the anti-inflammatory, antibacterial, antiviral and antifungal properties of plant derived materials (Miliauskas *et al*., 2004). Furthermore, they also might slow down skin aging processes and contribute to the inhibition of some skin enzymes i.e. elastase or collagenase, which are responsible for the degradation of structural proteins (Zillich *et al*., 2002). Plant substances also can improve the functional values of formulation, give the right consistency or smell (Sultana *et al*., 2009).

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Variety and abundance of plants, gives a high opportunities for the selection of plant materials used for production of various cosmetic formulations. Extracts obtained from herbs belong to the most popular plant raw materials used in preparations (Saraf and Kaur, 2010). Recently, we also can observe the use of fruits and vegetables extracts in cosmetic preparations. It is commonly know that they are a valuable source of active compounds (Mambro and Fonseca, 2005; Nizioł-Łukaszewska *et al*., 2017). Cherry and sweet cherry fruits can be included in this type of plant substances.

They exhibit rich content of antioxidants, mainly phenolic compounds such as phenolic acids, flavonoids or anthocyanins such as chiefly cyanidin which are a pigments responsible for producing a range of colours including orange, red and even black (Piccolella *et al*., 2009). The main phenolic acid, present in cherry and sweet cherry fruits is hydroxycinnamic acid (Kelley *et al*., 2018). Both, flavonoids as well as phenolic acids are characterized by a wide range of bioactivity, due to their complex chemical structure. Hence, they are very valuable product that can be used in the pharmaceutical and cosmetics industries (Butler, 2000; Zhao *et al*., 2013).

Other ingredients which were found in the fruit of cherries, include malic and citric acids. It was showed that sweet cherry fruit has a lower content of organic acids and a higher content of simple sugars, compared to the cheery fruit (Kevers *et al*., 2007). Cherry and sweet cherry fruits also contains vitamins A, C and B, particularly vitamin B 5, and a number of micro- and macroelements, including calcium, iron, phosphorus or potassium (Serrano *et al*., 2005; Fuzzari *et al*., 2008; Kelley *et al*., 2018).

The aim of this paper was to compare the content of antioxidant compounds in different varieties of fruits of cherry and sweet cherry and to create a model washing formulation with the tested extracts. Article was attempt to indicate which type of extract will allow for create a cosmetic with a broad spectrum of activity.

The influence of cherry and sweet cherry fruits extract on selected physicochemical and functional properties of model formulations was evaluated (antioxidant activity, content of phenolic compounds, L-ascorbic acid, viscosity, foam ability, foam stability).

Materials and Methods

A. Extract

Biological material

The research was carried out on the fruits of cherry and sweet cherry grown in Southern Poland. The trees were in a period of full productivity. During the experiment, the trees were not fertilized, and the only means of protection was Decis 2.5 EC. Recommendations have been introduced according to the Plant Protection Program. The harvest took place in July.

The sweet cherry 'Burlat' and cherry 'Łutówka' varieties were used for analysis. 'Burlat' variety is moderately sensitive to cracking, the fruits of which are well tolerated by transport. Variety 'Łutówka' is characterized by large fruits. Both varieties are recommended for industrial production.

The harvested fruits were transferred to the laboratory. The fruits were washed, cleaned and prepared directly for further testing; 30 representative samples of fruit of each variety were collected for laboratory tests. The analysis was carried out in triplicate.

Technology of extract production

The plant material was dried at 40 °C until constant weight was achieved. The extracts were obtained using the method of solvent-based extraction. The extracts were prepared from 15 g of ground dried cherry and sweet cherry fruit. Distilled water and distilled water with glycerine at a weight ratio of 80:20 were used as extraction solvents. In the next step, the extracts thus obtained were passed through filters made of Whatman filter paper grade The finished extracts were stored in the refrigerator at a temperature of 4 °C.

Determination of total phenolic content

The determination of total phenolic content in extracts was evaluated spectrophotometrically by the Folin-Ciocalteu method. Respectively, 300 µL of analysed extracts or solvents were mixed with 1500 µL of 1:10 Folin-Ciocalteu reagent and after 6 min in the dark 1200 µL of sodium carbonate (7.5%) was added and samples were incubated in the dark for 2 h. After incubation absorbance at 725 nm was measured. The total phenolic concentration was calculated from a chlorogenic acid.

Determination of L- ascorbic acid

From the blended average sample, triplicate 10.0 g have been weighted and transferred quantitatively with use of 2% oxalic acid to 100 cm^3 volumetric flasks. Then supplemented with an extraction solution to the mark, mixed and allowed to stand for 50 minutes. After the time elapsed, seeped via filters into beakers. After filtration, the acetate buffer was added. It was then titrated with a solution of 2,6 dichlorophenylindophenol to a slightly pink colour.

Antioxidant potential of the extract

DPPH$^{\bullet}$

The ability of extracts to neutralize the free radical DPPH$^{\bullet}$ (1,1-diphenyl-2-picrylhydrazyl) (Sigma-Aldrich) was determined with the method described by Brand-Williamis *et al*. (1995). A 50 µM solution of DPPH was mixed with the test sample of the extract or solvent at the ratio of 1:1. The reaction mixture was incubated in the dark at room temperature for approximately 30 minutes. As the next step, absorbance was measured at the wavelength of 517 nm on an AquaMate spectrophotometer (Thermo Scientific). 96% ethyl alcohol was used as a blank sample, whereas control sample contained solution of DPPH with ethanol instead of extract. The antiradical activity was calculated from the below formula:

$$\% \text{ Inhibition of DPPH radical} = \left(1 - \frac{A_s}{A_c}\right) \cdot 100\%$$

where: As – absorption of test sample; Ac – absorption of control sample

ABTS$^{\bullet+}$

An analysis of scavenging of the ABTS$^{\bullet+}$ radical cation (2,2-azino-bis(3-ethylbenzothiazoline-6-sulphonate) was performed according to the method proposed by Re *et al*. (1999), ABTS (Sigma-Aldrich) was dissolved in phosphate

buffer with pH = 7.4 and incubated in the dark for 16 hours. Prior to the measurement the $ABTS^{\bullet+}$ solution was diluted so that the absorbance at the wavelength λ = 414 nm was approximately 1. Next, a 0.02 ml portion of diluted extracts (1.50-25 mg ml^{-1}) was added to 0.98 ml of the $ABTS^{\bullet+}$ solution. After incubating the mixture at room temperature for 10 minutes absorbance was measured at the wavelength λ=414 nm. The extent of radical cation reduction (in %) was calculated from the formula below:

% inhibition of $ABTS^{\bullet+}$ radical = $(1 - A_s / A_c) \times 100$ %

where: As – absorption of test sample; Ac – absorption of control sample

B. Model cosmetic preparation

Preparation of prototypical shower gels

A prototypical shower gel containing cherry and sweet cherry fruit extracts was designed and prepared (Table 1). The body wash formulations were prepared according to the standard procedure. Sodium Benzoate and Potassium Sorbate were used as preservatives. The pH level was adjusted to 5.5.

A total of 5 body wash formulations were prepared: an extract-free baseline sample, samples containing aqueous and aqueous-glycerine sweet cherry extracts, and samples with aqueous and aqueous-glycerine cherry extracts.

Viscosity test

Viscosity was measured at a temperature of 25 °C by means of a rotary viscometer (FungiLab Expert). The measurement was performed with the spindle rotating at 10 and 100 rpm. The measurement was repeated five times for each test sample.

Foaming ability and foam stability

Foaming power was assessed according to the modified Ross-Miles method (PN-ISO 696:1994P). Briefly, 500 mL of 1% solution of cleaning formulation was placed in separatory funnel of Ross-Miles apparatus and 50 mL of same solution was placed in receiving chamber located 30 cm below the vent of separatory funnel. The liquid from separatory funnel was released with the uniform flow to receiving chamber, what resulted in foam formulation. The volume of foam was measured immediately after total evacuation of solution from separatory funnel. Each test was performed in three replicates. The test also involved the determination of foam stability which was calculated from the formula below:

$Sp = v_t / v_o \cdot 100\%$

where:

Sp – foam stability [%],

V_t – foam volume after time t = 10 minutes [cm^3],

V_0 – foam volume after time t = 1 minute [cm^3].

Patch tests

The products were evaluated for safety in a group of 30 testers, using IQ Ultra patch test chambers. The evaluation was performed in a group of 30 healthy individuals (20 women and 10 men) aged between 30 and 50 years. Information on the health status of the subjects was obtained by taking their medical history before the tests and by subjecting the testers to diagnostic skin tests performed by a cosmetologist.

The epidermal patch tests were carried out using IQ Ultra test chambers from Chemotechnique Diagnostics. A patch test unit consists of two rows of five chambers (10 test chambers in total) mounted on adhesive carrier tape. A 30 µl portion of the test material were placed in each chamber in accordance with the manufacturer's instructions. First, the test chambers were filled with the test formulations and then the patches were applied onto the skin on the testers' backs and left for 48 hours. The assessment of skin reaction was performed immediately after patch removal and afterwards at defined time points (after 72, 96 and 168 hours). The epidermal patch tests were conducted in line with the guidelines issued by the International Contact Dermatitis Research Group (Draelos and Dover, 2011).

C. Statistical analysis

The points in the charts represent mean values from a series of three or five independent measurements. The t-test was used to calculate confidence limits for the mean values. Confidence intervals, which constitute a measuring error were determined for the confidence level 0.90. Software used was Statistica 9.0 from StatSoft. Error values are presented in the figures.

Table 1. The formulations of model wash gels

Ingredient name according INCI	Ingredient content in formulation [%]				
	Base (product without extract)	W+ cherry	W+ G+ cherry	W+ sweet cherry	W+ G+ sweet cherry
Lauryl Glucoside	10.0	10.0	10.0	10.0	10.0
Cocamidopropyl Betaine	3.0	1.5	1.5	1.5	1.5
Cocamide DEA	1.5	1.5	1.5	1.5	1.5
Xnathan Gum	0.9	0.9	0.9	0.9	0.9
W+ cherry	0.0	5.0	0.0	0.0	0.0
W+ G+ cherry	0.0	0.0	5.0	0.0	0.0
W+ sweet cherry	0.0	0.0	0.0	5.0	0.0
W+ G+ sweet cherry	0.0	0.0	0.0	0.0	5.0
Citric Acid	0.5	0.5	0.5	0.5	0.5
Sodium Benzoate, Potassium Sorbate	0.5	0.5	0.5	0.5	0.5
Aqua	up to 100				

Results and Discussion

Physicochemical properties of cherry and sweet cherry fruit extracts

The purpose of the performed experiment was to compare the different content of antioxidant compounds in cherry and sweet cherry fruits extracts and then their application in model cosmetic formulations. Following the changing needs and requirements of consumers, there are research carring, which the main aim is to better understand the cosmetic properties of plant extracts (Jackson *et al.*, 2014). The current tendency is to make that cosmetic formulation apart from the care function also contain a number of active substances, which will increase effectiveness of its action (Butler, 2000). This type of ingredients includes the fruits of cherries and sweet cherries, which exhibit a rich amount of antioxidant substances, which function is to neutralize free radicals, to prevent lipids peroxidation and DNA damage or to counteract the degradation of collagen and elastin structures (Lupo, 2001; Evans *et al.*, 2004; Katsube *et al.*, 2004). Polyphenols could has to be seen as the one of the most important functional antioxidant compounds, present in cherry and sweet cherry (Lee *et al.*, 2004).

The content of phenolic compounds has been determined in the extracts analysed. The highest concentration were recorded for the water-glycerine extract acquired from sweet cherry fruit (W + G + sweet cherry) and they are 350 mg 100 g^{-1} f.m. Significantly lower values can be seen in cases of extracts with addition of cherry fruits (Fig. 1.).

Cherries fruits are characterized by higher levels of phenols comparing to sweet cherry fruits, mainly because of higher phenolic acids concentration. Similar conclusions were drawn by Ferretti *et al.* (2010) where sum of phenols in cherry fruits was 228.8 mg 100 g^{-1} f.m., while for sweet cherry fruits it was lower equalling 109.8 mg 100 g^{-1} f.m. Also according to Vangdal and Slimestad (2006) sum of phenols in nine varieties of sweet cherry was lower and it was in the range from 23 to 168 mg·100 g^{-1}. According to Gonçalves *et al.* (2004) the content of phenols in sweet cherry fruit is in the range of 124 to 227 mg 100 g^{-1} f.m. It is possible that this tendency is observed because cherries fruits are characterized by higher levels of phenols comparing to sweet cherry fruits, mainly because of higher phenolic acids concentration. The lowest values were observed for water extract of cherries (W + cherry) content of phenolic acids was among analysed samples equaling 150 mg 100 g^{-1} f.m. This trend is in line with Draelos and Dover (2011), Jackson *et al.* (2014) where it has been shown that extraction with water results in the lowest efficiency of extracting active substances. The addition of glycerine in the extract increased the efficiency of isolation of active compounds from extracts (Dragovic-Uzelac *et al.*, 2007; Kirakosyan *et al.*, 2009; Ayuso and Rodriguez, 2010; Mielichàčovà *et al.*, 2010; Usenik *et al.*, 2008).

Analogous situations were observed during analyzing the content of L -ascorbic acid in the extracts tested, the highest value was observed in case of water-glycerine extract from sweet cherry fruit (W + G + sweet cherry), which equalled 12 mg 100 g^{-1} f.m. (Fig. 2). Similar conclusions from their research have been obtained by Usenik *et al.* (2008) where the content of vitamin C in the tested cherry varieties ranged from 8.0 mg 100 g^{-1} f.m. to 17.2 mg 100 g^{-1} f.m. In water extracts from cherry and sweet cherry fruits, the content of compounds of antioxidant character was lower comparing to water-glycerine extracts. Extracts with addition of cherry fruit were characterized by a higher content of L-ascorbic acid (Dragovic-Uzelac *et al.*, 2007; Kirakosyan *et al.*, 2009; Ayuso and Rodriguez, 2010). Similar conclusions have been derived by Serrano *et al.* (2005) and Ferretti *et al.* (2010), where sweet cherries fruits are characterized by lower content of ascorbic acid equalling about 7% comparing to higher content in case of sweet cherries exceeding 10%.

It is also worth noting that the discrepancies in the content of polyphenolic compounds and vitamin C can be significantly affected by numerous environmental and varietal factors. Among that, degree of fruit maturity or storage conditions also may affect to the amount and proportions of polyphenols (Robards *et al.*, 1999; Dai and Mumper, 2010). The content of polyphenolic compounds and vitamin C was correlated with the antioxidant properties of the examined extracts. It was observed an tendency, that the the more polyphenol compounds, the more potent antioxidant properties were found. Other authors also reported a correlation between these components (Gąstoł *et al.*, 2013; Martini *et al.*, 2017).

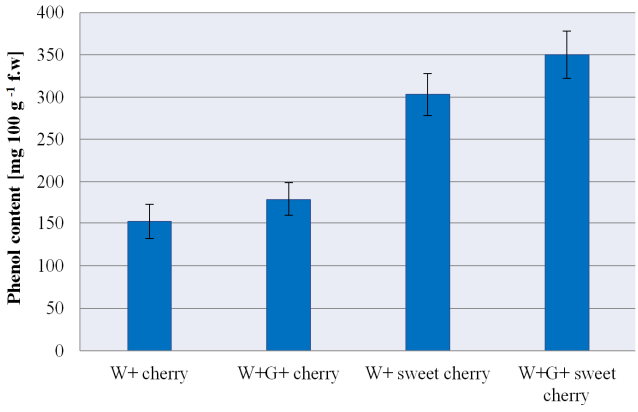

Fig. 1. Total phenolic content in extracts: W+ cherry, W+ G+ cherry, W+ sweet cherry, W+ G+ sweet cherry

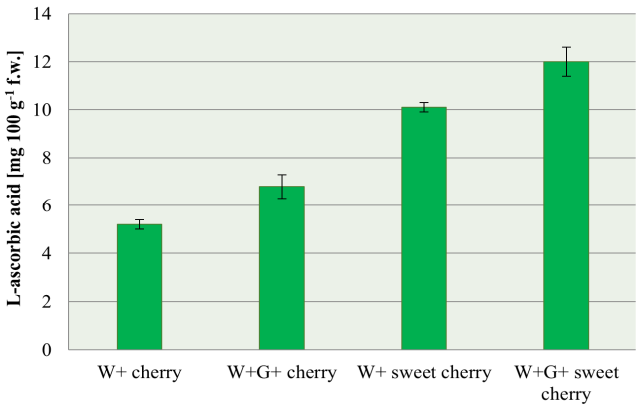

Fig. 2. L- ascorbic acid content in extracts: W+ cherry, W+ G+ cherry, W+ sweet cherry, W+ G+ sweet cherry

Gonzáles-Gómez *et al.* (2010) pointed out that the content of flavonoidswas correlated with the antioxidant capacity. Vangdal and Slimestad (2006) also found a correlation between the antioxidant capacity of sweet cherry fruits and the content of phenolic compounds and anthocyanins present in these fruits (Lima *et al.*, 2002). To analyse antioxidant ability of tested extract the DPPH free radical and ABTS assay were conducted. The best antioxidant properties were showed in the aqueous-glycerine of sweet cherry fruit extract (W+ G+ sweet cherry). At concentration of extract, the free radicals scavenging ability was on level 89%, whereas for the extract (W + cherry) was about 15% lower. The lowest potential to scavenge reactive oxygen species was observed in the aqueous extract of cherry fruit in concentration 0.4 mg ml^{-1} and it oscillate at 12% level (Fig. 3).

A decrease of antioxidant properties was corresponding to the increase of dilutions of tested extracts. The obtained results provide grounds to conclude, that cherry fruits contains more compounds with health-promoting effects than sweet cherry fruits (Serrano *et al.*, 2005; Ferretti *et al.*, 2010). Cherries are characterized by a higher content of antioxidants. According to Prvulovic *et al.* (2011), sweet cherry fruit extracts were characterized by lower antioxidant potential and depending on the variety. The scavenging ability of the DPPH$^{\bullet}$ radical was within the limits of 29.88% and 86.94%. According to the literature, cherry fruits are richer in flavonoids and anthocyanins than sweet cherry fruits. The cherry extracts were much darker than the extracts obtained from sweet cherry fruit. This might be an effect of higher content of anthocyanins, which have an influence on the extracts colour and giving them a dark red colour. The cherry extracts under study were much darker than the extracts obtained from sweet cherry fruit (Chaovanalikit and Wrolstad, 2004; Ferretti *et al.*, 2010; Martini *et al.*, 2017).

The study found that the analyzed cherry and sweet cherry extracts had a lower ABTS$^{\bullet+}$ radical scavenging ability (Fig. 4). Opposite conclusions was found by Dziadek *et al.* (2018) here in the case of analysis of antioxidative

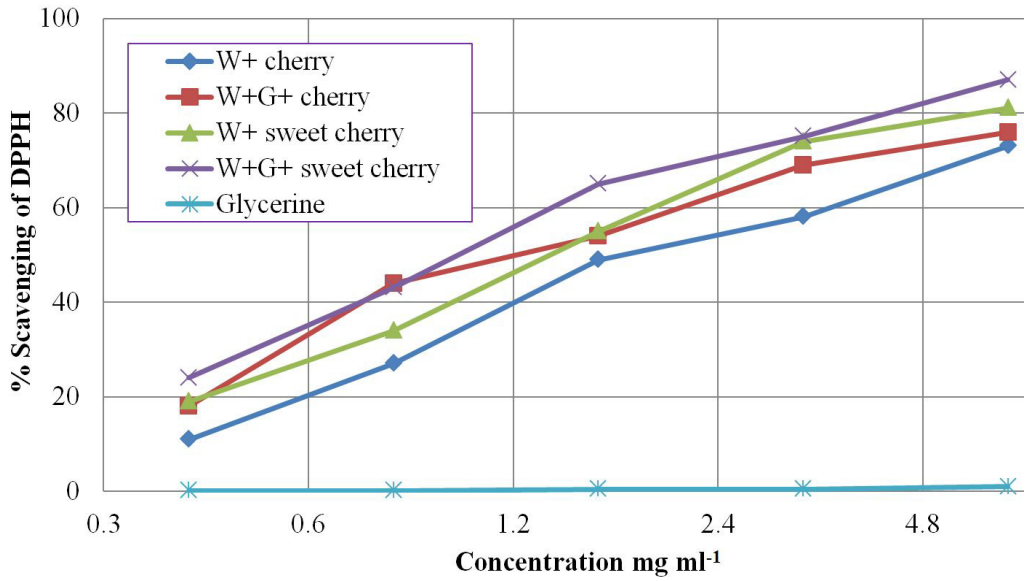

Fig. 3. % of DPPH$^{\bullet}$ scavenging in extracts: W+ cherry, W+ G+ cherry, W+ sweet cherry, W+ G+ sweet cherry

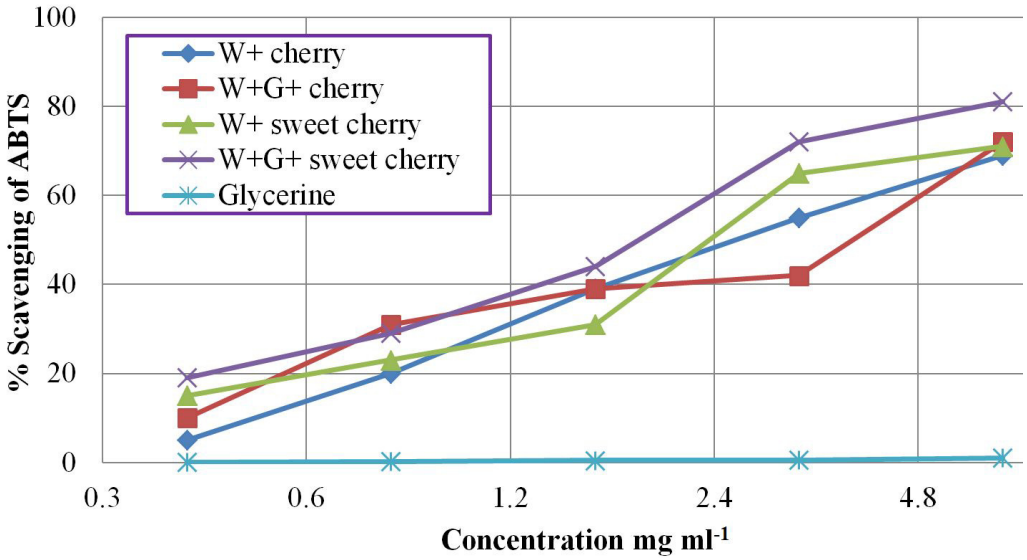

Fig. 4. % of ABTS$^{\bullet}$ scavenging in extracts: W+ cherry, W+ G+ cherry, W+ sweet cherry, W+ G+ sweet cherry

activity of cherry and sweet cherry, the higher ability to scavenge the ABTS$^{\bullet+}$ radical comparing to DPPH$^{\bullet}$ has been demonstrated. Similarly to the DPPH$^{\bullet}$ radical, the ABTS$^{\bullet+}$ method demonstrated the highest free radical scavenging ability in the aqueous-glycerine extract obtained from sweet cherry fruit (W+ G+ sweet cherry). At a concentration of 6.4 mg ml^{-1}, the ABTS$^{\bullet+}$ radical scavenging ability determined for the aqueous-glycerine extract of sweet cherry fruit (W+ G+ sweet cherry) was 81%, and for the DPPH$^{\bullet}$ radical it was 9% higher. The results were the same for the other measurement points. The remaining three extracts under study exhibited a lower antioxidant capacity. For example, at a concentration of 1.6 mg ml^{-1} the lowest ABTS$^{\bullet+}$ radical scavenging ability (31%) was determined in the aqueous extract of sweet cherry fruit (W+ sweet cherry). At a concentration of 0.4 mg ml^{-1}, the lowest parameters were found in the aqueous extract of cherry fruit (W+ cherry).

The content of antioxidant substances in formulas of cosmetic preparations is very important because these types of cosmetics are better absorbed by the human skin and cause less irritation than products based on synthetic substances (Butler, 2000). Antioxidant compounds also limit the processes of oxidation of substances contained in cosmetics which may positive affects the prolongation of cosmetic products (Jackson *et al.*, 2014; Martini *et al.*, 2017).

The influence of cherry and sweet cherry fruit extracts on the properties of model cleaning preparations

The extracts under analysis were applied in model shower gels, and the physicochemical properties of the products were assessed. One of the important parameters is the viscosity of the cosmetic product, which has a significant impact on the application properties of the cosmetic product. Too low viscosity may cause the cosmetic to spill, while too high may cause difficulties in spreading the product. In the conducted experiment dynamic viscosity measurements were performed at the viscometer spindle rotational speed of 100 rpm (Fig. 5). The addition of both cherry and sweet cherry fruit extracts to the formulations resulted in a decrease in viscosity, as compared to the baseline sample.

Similar tendencies were also observed by other researchers (Draelos and Dover, 2011, Bujak *et al.*, 2015). The highest drop in viscosity (15% in relation to the baseline sample) was noted for the aqueous extract of sweet cherry fruit (W+ sweet cherry). The addition of sweet cherry extracts, both the aqueous (W+ cherry) and aqueous-glycerine (W+ G+ cherry) types, induced a lower decrease in product viscosity compared to the baseline sample than the addition of sweet cherry extract. The above finding may be attributed to the higher sugar content in the sweet cherry extract. Sweet cherry fruit contains more sugars than the cherry fruit extract (Serrano *et al.*, 2005; Ferretti et *al.*, 2010).

The model shower gels formulated with the addition of the analyzed extracts (Figs. 6 and 7) were assessed to determine their foaming ability and foam stability. The products enriched with the aqueous extracts of cherry and sweet cherry fruit had a higher foaming ability than the products which contained the aqueous-glycerine extracts of cherry and sweet cherry fruit. The best foaming ability was determined in the aqueous sweet cherry fruit extract (W+ sweet cherry). The foam stability demonstrated in the product enriched with the sweet cherry fruit extract (W+ G+ sweet cherry) was 94 cm^3, and it was the highest value of all the products under study. The lowest foam stability was found in the product containing the aqueous extract of cherry fruit (W+ cherry). It was approximately 10% lower than in the baseline sample. These results are in line with the prevailing standards for washing preparations and do not significantly affect the rheological properties of cosmetic preparations (Elser and Maibach, 2000; Mambro and Fonseca, 2005).

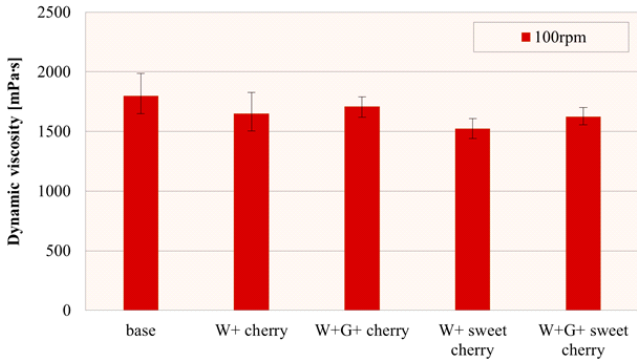

Fig. 5. Viscosity of model wash gels with extracts: W+ cherry, W+ G+ cherry, W+ sweet cherry, W+ G+ sweet cherry

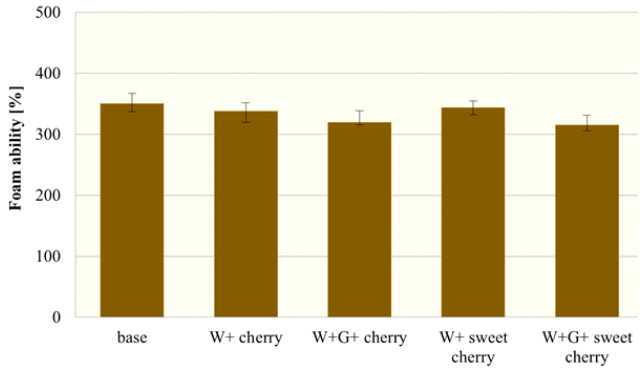

Fig. 6. Foam ability of model wash gels with extracts: W+ cherry, W+ G+ cherry, W+ sweet cherry, W+ G+ sweet cherry

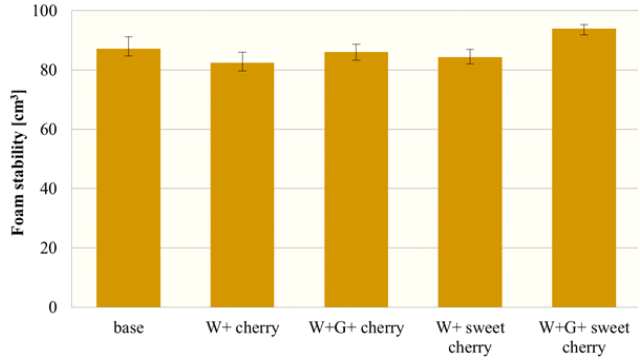

Fig. 7. Foam stability of model wash gels with extracts: W+ cherry, W+ G+ cherry, W+ sweet cherry, W+ G+ sweet cherry

Epidermal patch tests showed that the model formulations with cherry and sweet cherry extracts triggered no allergic skin reactions and exhibited no skin irritation effect.

Conclusions

Both aqueous and aqueous-glycerine extracts obtained from cherry and sweet cherry fruit are characterized by potent antioxidant properties. Analyses performed with use of the $DPPH^{\bullet}$, $ABTS^{\bullet+}$ methods and total phenolic and L-ascorbic acid content revealed the best antioxidant properties in the case of aqueous-glycerine extract of sweet cherry fruit (W+ G+ sweet cherry). The addition of extracts to cosmetic formulations was shown to have an impact on the foaming ability and foam stability. The model formulations enriched with the aqueous extracts of cherries and sweet cherries had a higher foaming ability compared to the formulations containing the aqueous-glycerine extracts. The best foaming ability was shown in the aqueous sweet cherry fruit extract (W+ sweet cherry), and the highest foam stability was found in the sweet cherry extract (W+ G+ sweet cherry). The epidermal patch tests results showed that all the model cosmetic formulations containing the studied extracts were safe to use and had no skin irritation properties. The obtained results indicates that the extracts from cherry and sweet cherry fruit can be a valuable cosmetic raw material having a strong antioxidant ability and at the same time not having adverse effect on the usable properties of the washing gel.

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