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CONTENT OF PHENOLIC ACIDS IN EDIBLE PARTS OF SOME ALLIUMS SPECIES GROWN FOR THE GREEN BUNCHING

Barbara Mysiak, Maria Tendaj
University of Life Sciences in Lublin

Abstract. Studies carried out in 2003–2005 included determinations of free phenolic acids content in edible parts (shoots, pseudostem) of onion, shallot, and Welsh onion grown for green bunching in the field and forced in the greenhouse. Plants for phenolic acids contents analyses were achieved from setting the small bulbs (common onion, shallot) or annual plants from the seedling setting in the case of Welsh onion. In the field cultivation, plants were grown under short-term covers made of perforated PE film and non-woven PP, while forcing was realized in heated and unheated greenhouse. Free phenolic acids contents were determined after plant harvest, when plants reached the size useful for trading in bunches. Phenolic acids contents were determined in shoots and pseudostem by means of spectrometric Arnova method with recalculation onto caffeic acid. Performed study revealed that shoots contained significantly more free phenolic acids as compared to the pseudostem. Referring to the field cultivation, the component concentration in shoots was 0.23 mg·100 g^{-1} FW, whereas due to forcing 0.135 mg·100 g^{-1} FW, on average. Contents of phenolic acids at pseudostems of studied plants from the field cultivation were 0.05 mg·100 g^{-1} FW, while at forced plants 0.04 mg·100 g^{-1} FW. No significant differences related to the level of phenolic acids between common onion and shallot were found, both in shoots and pseudostem. However, shoots of Welsh onion contained significantly less phenolic acids, regardless the cultivation place and cover application. The accelerated field cultivation resulted in shoots of Welsh onion was 0.19 mg·100 g^{-1} FW phenolic acids in FW, whereas the greenhouse forcing 0.11 mg·100 g^{-1} FW. Regardless the species, forced plants contained considerably less phenolic acids (namely in shoots) as compared to plants grown in the field.

Keywords: phenolic acids, onion, shallot, Welsh onion, shoots, pseudostem

Corresponding author – Adres do korespondencji: Barbara Mysiak, Maria Tendaj, University of Life Sciences in Lublin, 58 Leszczyńskiego Street, 20-068 Lublin, e-mail: maria.tendaj@up.lublin.pl

INTRODUCTION

Onion and other vegetable *Alliums* are characterized by large amounts of polyphenols – mainly flavonoids and phenolic acids, which are biological compounds improving the food quality and intensifying the taste and flavor [Kroon and Williamson 1999].

Among phenolic acids, benzoic and cynnamic acids derivatives are the most important [Manach et al. 2004, Pellegrini et al. 2006]. Content of benzoic acid and its derivatives (e.g. gallic acid) in edible plants is very low, although they are compounds with very strong anti-oxidation properties [Tomas-Barberan and Clifford 2000]. The cinnamic acid derivatives occur more often at plants, usually as glycosides or esters, among which the most important are: caffeic, p-coumaric, ferrulic, and sinapic acids. Caffeic acid when reacts with quinic acid, forms chlorogenic acid – very strong anti-oxidation activity agent [Tanaka et al. 1993].

Vanilic and p-hydroxybenzoic acids in fleshy scales onion's layers as well as protocatechuic and vanilinic acids in dry scales layers appeared to dominate among all phenolic acids studied [Ng et al. 2000].

The study was aimed at evaluating the free phenolic acids contents in edible parts (pseudostem, shoots) of common onion, shallot, and Welsh onion grown for the green bunching.

MATERIAL AND METHODS

The experiment was carried out in 2003–2005 in The Experimental Farm Felin owned by The University of Life Sciences in Lublin. The study material consisted of edible parts (pseudostem and shoots) of common onion (Rawska cv.), shallot (local population from Lublin neighborhood), and Welsh onion (with no cultivar name). In the first experiment, plants were cultivated in the field for early green bunching using short-term covers made of perforated PE film (100 holes per 1 m^2) and non-woven PP (weight of 1 m^2 – 17 g). The yielding characteristics was previously presented [Tendaj and Mysiak 2006], while similar samples were subjected to chemical analyses, including phenolic acids determination.

In the second experiment, free phenolic acids contents were determined for the same species forced since the beginning of March till the end of April 2003-2005 in heated and unheated greenhouse. Results on these plants' yields are published [Tendaj and Mysiak 2006, 2007]. Free phenolic acids concentrations were determined by means of spectrometric Arnova method described in Framakopea Polska [1999], and recalculated onto caffeic acid.

All results were statistically processed applying variance analysis, while difference significance was estimated on a base of T-Tukey's confidence intervals at the significance level of $p = 0.05$.

RESULTS AND DISCUSSION

Level of phenolic acids in plant-origin products depends not only on the species and variety, but also the maturity, the usable part, as well as storage conditions and duration [Ng et al. 2000, Yang et al. 2004, Brat et al. 2006]. *Alliums* vegetables are considered as extremely abundant in polyphenols from phenolic acids group [Chu et al. 2002, Yang et al. 2004]. According to Yang et al. [2004], shallot is a species with particular high content of polyphenols, hence its anti-oxidation activity, as compared to other 10 studied onion cultivars, appears to be the highest. Brat et al. [2006] also confirmed such studies by finding that shallot is a vegetable (besides artichoke, parsley, and Brussels sprouts) the most abundant in polyphenols.

Table 1. Content of free phenolic acids (mg·100 g^{-1} FW recalculated onto caffeic acid) in shoots and pseudostems of common onion, shallot, and Welsh onion grown in the field (mean for 2003–2005)

Tabela 1. Zawartość wolnych kwasów fenolowych (mg·100 g^{-1}św.m. w przeliczeniu na kwas kawowy) w szczypiorze i łodydze rzekomej cebuli zwyczajnej, szalotki i siedmiolatki z uprawy w polu (średnio z lat 2003–2005)

Species Gatunek	Part of plants Część rośliny	Kind of cover – Rodzaj osłony			Mean Średnio
		perforated PE film folia perforowana	non-woven PP włóknina	Control kontrola	
Onion Cebula	shoots – szczypior	0.34	0.22	0.23	0.26
	pseudostem – łodyga rzekoma	0.04	0.06	0.04	0.05
	mean – średnio	0.19	0.14	0.13	0.15
Shallot Szalotka	shoots – szczypior	0.17	0.35	0.27	0.26
	pseudostem – łodyga rzekoma	0.05	0.06	0.05	0.05
	mean – średnio	0.11	0.20	0.16	0.15
Welsh onion Siedmiolatka	shoots – szczypior	0.19	0.20	0.18	0.19
	pseudostem – łodyga rzekoma	0.05	0.06	0.03	0.04
	mean – średnio	0.12	0.13	0.10	0.11
Mean Średnio	shoots – szczypior	0.23	0.26	0.22	0.23
	pseudostem – łodyga rzekoma	0.05	0.06	0.04	0.05
	mean – średnio	0.14	0.16	0.13	0.14
$LSD_{0.05}$ $NIR_{0,05}$	species – gatunek				0.037
	kind of cover – rodzaj osłony				n.s. ni.
	part of plants – część rośliny				0.058

Own examinations revealed that content of free phenolic acids in common onion, shallot, and Welsh onion plants at the early growth stage was not high. At plants grown in the field, it amounted to 0.23 mg·100 g^{-1} FW in shoots and 0.05 mg·100 g^{-1} FW in pseudostem. However, regardless the edible part and the type of cover, Welsh onion contained significantly less free phenolic acids as compared to common onion, and shallot. Applying the covers in a form of non-woven PP or perforated PE film had not significant influence on the level of phenolic acids in edible parts of studied species (tab. 1).

The studied species plants forced under greenhouse conditions contained much less phenolic acids as compared to those from the field cultivation: plants forced in heated greenhouse contained 0.09 mg·100 g^{-1} FW, while in unheated one 0.08 mg·100 g^{-1} FW. As similar as at field grown plants, shoots of the forced plants contained significantly more phenolic acids (0.135 mg·100 g^{-1} FW, on average).

No considerable differences in phenolic acids contents between studied species and depending on the forcing place were observed; however, similarly as at field grown plants, shoots and pseudostem of the Welsh onion contained slightly lower level of phenolic acids as compared to common onion and shallot (tab. 2).

Table 2. Free phenolic acids contents (mg·100 g^{-1} FW recalculated onto caffeic acid) in shoots and pseudostem of common onion, shallot, and Welsh onion forced under greenhouse conditions (mean for 2003–2005)

Tabela 2. Zawartość wolnych kwasów fenolowych (mg·100 g^{-1}św.m. w przeliczeniu na kwas kawowy) w szczypiorze i łodydze rzekomej cebuli zwyczajnej, szalotki i siedmiolatki z pędzenia w warunkach szklarniowych (średnio z lat 2003–2005)

Species Gatunek	Part of plants Część rośliny	Conditions of forcing (place of forcing) Warunki pędzenia (miejsce pędzenia)		Mean Średnio
		heated greenhouse szklarnia ogrzewana	unheated greenhouse szklarnia nieogrzewana	
Onion Cebula	shoots – szczypior	0.13	0.17	0.150
	pseudostem – łodyga rzekoma	0.05	0.04	0.045
	mean – średnio	0.09	0.105	0.097
Shallot Szalotka	shoots – szczypior	0.12	0.17	0.145
	pseudostem – łodyga rzekoma	0.06	0.03	0.045
	mean – średnio	0.08	0.10	0.095
Welsh onion Siedmiolatka	shoots – szczypior	0.14	0.08	0.110
	pseudostem – łodyga rzekoma	0.04	0.02	0.030
	mean – średnio	0.09	0.05	0.070
Mean Średnio	shoots – szczypior	0.13	0.14	0.135
	pseudostem – łodyga rzekoma	0.05	0.03	0.040
	mean – średnio	0.09	0.08	0.087
$LSD_{0.05}$ $NIR_{0,05}$	species – gatunek			n.s. ni.
	place of forcing – miejsce pędzenia			n.s. ni.
	part of plants – część rośliny			0.0341

Available literature on the issue of phenolic acids content in vegetables provides with the information that free and bound phenolic acids levels at onion and shallot may be much higher than those here presented. Chu et al. [2002] reported that free phenolic acids concentration at yellow onion amounted to 68.9 mg·100 g^{-1} FW (recalculated onto gallic acid), while bound phenolic acids to 3.27 mg·100 g^{-1} FW. According to Mattila and Hellström [2006], the sum of phenolic acids at onion was 0.79 mg·100 g^{-1} FW, which referred both to yellow and red onion. Horbowicz [1999], when studying flavonols contents during vegetation of two onion varieties (Sochaczewska cv. and Błońska cv.) found that these substances levels was low at the beginning with fast increase during maturation and subsequent stabilization during 3–4 months of storage.

It can be supposed that phenolic acids contents at shallot and Welsh onion can increase along with their growth and maturation process. Studies of Szaufer-Hajdrych [2004] revealed that phenolic acids concentrations (after recalculation onto caffeic acid) at leaves of ten species from *Aquilegia* genus were from 0.31% to 1.13% with dependence on a given species' properties. It can indicate a wide diversity of phenolic acids contents depending on growth stage and genetic features of a plant.

CONCLUSIONS

1. Contents of free phenolic acids (recalculated onto caffeic acid) at the early growth stage of common onion, shallot, and Welsh onion were low, although varied depending on the species, cultivation place, and edible part of a plant.

2. Common onion and shallot grown for the green bunching both from the field and forced cultivations were the most abundant in phenolic acids. Applying the perforated PE film and non-woven PP as well as forcing under various conditions (heated or unheated greenhouse) had not significant influence on phenolic acids concentration both in shoots and pseudostems.

3. Regardless the species, forced plants contained apparently less phenolic acids (namely in shoots) as compared to the field cultivated ones.

4. For all species, shoots unlike the pseudostem contained significantly more phenolic acids (about 4 times more, on average).

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ZAWARTOŚĆ KWASÓW FENOLOWYCH W CZĘŚCIACH JADALNYCH NIEKTÓRYCH WARZYW CEBULOWYCH UPRAWIANYCH NA ZBIÓR PĘCZKOWY

Streszczenie. Badania przeprowadzone w latach 2003–2005 obejmowały ocenę zawartości wolnych kwasów fenolowych w częściach jadalnych (szczypior, łodyga rzekoma) cebuli zwyczajnej, szalotki i siedmiolatki, które uprawiano na zbiór pęczkowy, w polu i z pędzenia w szklarni. Rośliny do analiz na zawartość kwasów fenolowych uzyskano z sadzenia dymki (cebula, szalotka), a w przypadku siedmiolatki były to roczne rośliny z sadzenia rozsady. W uprawie polowej rośliny uprawiano z zastosowaniem krótkotrwałych osłon z folii perforowanej i włókniny. Natomiast pędzenie przeprowadzono w szklarni ogrzewanej i nieogrzewanej. Zawartość wolnych kwasów fenolowych oznaczono po zbiorze roślin, które osiągnęły wielkość przydatną do sprzedaży w pęczkach. Zawartość kwasów fenolowych oznaczono w szczypiorze i łodydze rzekomej metodą spektrofotometryczną Arnova w przeliczeniu na kwas kawowy. Z przeprowadzonych badań wynika, że u badanych gatunków szczypior zawiera istotnie więcej wolnych kwasów fenolowych w porównaniu z łodygą rzekomą. Z uprawy polowej zawartość tego składnika w szczypiorze wynosiła średnio 0,23 mg·100 g^{-1}·św.m., a z pędzenia 0,135 mg·100 g^{-1}·św.m. Natomiast w łodydze rzekomej zawartość kwasów fenolowych u badanych roślin z uprawy w polu wynosiła średnio 0,05 mg·100 g^{-1}·św.m., a z pędzenia 0,04 mg·100 g^{-1}·św.m. Nie stwierdzono istotnych różnic w poziomie zawartości kwasów fenolowych między cebulą zwyczajną i szalotką, co odnosiło się zarówno do szczypioru, jak i łodygi rzekomej. Natomiast szczypior siedmiolatki zawierał istotnie mniej kwasów fenolowych, niezależnie od miejsca uprawy i stosowania osłon. Z przyspieszonej uprawy polowej zawartość kwasów fenolowych w szczypiorze siedmiolatki wynosiła średnio 0,19 mg·100 g^{-1}·św.m., a z pędzenia w szklarni 0,11 mg·100 g^{-1}·św.m. Niezależnie od gatunku rośliny z pędzenia w szklarni zawierały zdecydowanie mniej kwasów fenolowych (zwłaszcza w szczypiorze) w porównaniu z roślinami z uprawy w polu.

Słowa kluczowe: kwasy fenolowe, cebula, szalotka, siedmiolatka, szczypior, łodyga rzekoma

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