agronomy

Article

Variability of Bioactive Substances in Potatoes (*Solanum tuberosum* L.) Depending on Variety and Maturity

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Abstract: Potatoes (*Solanum tuberosum* L.) are an essential food for the human diet and thus represent an important source of biologically active substances. This study aimed at investigating the content of bioactive substances (total anthocyanin and polyphenol contents and chlorogenic acid) in seven potato varieties (Belana, Cecile, Magenta Love, Mozart, Talentine, Toscana, and Violet Queen) with various flesh and skin colors. To evaluate the impact of potato maturity on the analyzed parameters, potato samples were harvested in two different periods (1st harvest—July and 2nd harvest—September). Total anthocyanin and polyphenol contents were determined spectrophotometrically, and chlorogenic acid by the HPLC-DAD method. Varieties with a colored flesh (Magenta Love and Violet Queen) showed the highest content of bioactive substances. The maturity level significantly ($p < 0.05$) affected the total content of anthocyanins and polyphenols in potatoes. Early to medium early varieties (Belana and Magenta Love) showed an increase in chlorogenic acid content during maturation, while in other varieties, chlorogenic acid decreased due to higher maturity. In terms of the content of bioactive substances with a possible positive effect on human health, the consumption of potatoes with colored flesh could be recommended.

Keywords: potatoes; bioactive substances; polyphenols; anthocyanins; chlorogenic acid; maturity

Citation: Franková, H.; Musilová, J.; Árvay, J.; Harangozo, Ľ.; Šnirc, M.; Vollmannová, A.; Lidiková, J.; Hegedűsová, A.; Jaško, E. Variability of Bioactive Substances in Potatoes (*Solanum tuberosum* L.) Depending on Variety and Maturity. *Agronomy* **2022**, *12*, 1454. https://doi.org/10.3390/agronomy12061454

Academic Editor: Konstantinos M. Kasiotis

Received: 25 May 2022
Accepted: 16 June 2022
Published: 17 June 2022

1. Introduction

Potatoes (*Solanum tuberosum* L.) are one of the most widely available agricultural plants in the world and, after wheat, rice, and maize, also an important crop worldwide [1]. Concurrently, they represent one of the staple foods of the human diet [2], with global production in 2020 of more than 359 million tons [3]. Potatoes are considered an excellent source of energy due to their carbohydrate content [4]. From a nutritional perspective, they are also a rich source of proteins, minerals (K, P, Mg, Ca, Na, Mn) [1,4,5], and vitamins (B1, B2, B3, B5, B6, B9, C, E, K), while the concentration of vitamins is higher in the flesh than in the potato tuber skin. Due to their high potassium content and low sodium levels, potatoes are best suited for patients with high blood pressure [6]. The protein content of potatoes is comparable to the protein content of cereals (such as wheat and rice), but, nutritionally, potato protein is similar to whole egg protein [1,7]. Significant differences between potato varieties are mainly in the content of macronutrients such as proteins, fats, and micronutrients—Cu, P, and K [5,8]. In terms of the daily requirement, potatoes are an important source of vitamin C [9].

In addition to essential macronutrients, potatoes also contain many phytonutrients such as polyphenols, anthocyanins, flavonoids, and carotenoids [1,10]. In plants, polyphenols play many endogenous roles, including plant growth and development, cell wall synthesis, and pigmentation, and have a protective effect, defending plants from biotic stress (insects, bacteria, viruses) and abiotic stress (UV radiation, free radicals) [2,11,12]. An important group of phenolic compounds are phenolic acids (hydroxycinnamic acids), which are mainly represented by chlorogenic acid (CGA) [12]. Foods such as potatoes with these biologically active substances are very interesting for human consumption due to their health benefits [1]. Many studies have reported a positive effect of polyphenols and other antioxidants in the prevention of many diseases (cancer, cardiovascular diseases, allergic and neurodegenerative diseases, etc.) [13–18]. CGA was reported to decrease the risk of diabetes (type two) and slow down the entry of glucose into the blood circulation [12]. Polyphenols, vitamin C, and carotenoids contribute to the antioxidant activity of potatoes [11]. Moreover, due to the content of a wide range of phytonutrients and bioactive ingredients, potatoes play an important role in improving intestinal microflora and helping maintain intestinal health [1]. Not only nutritional content but also the content of biologically active substances depends on the potato variety [8]. Environmental factors (e.g., soil, sunlight, precipitation) and the degree of maturity of plants also have a significant effect on the polyphenol content, with the polyphenol content decreasing during maturation [19]. Polyphenols affect the color and sensory profile of foods, and their antioxidant activity decelerates lipid degradation, and thus improves the quality and nutritional value of foods [2].

Potatoes are considered worldwide as a source of various phytochemicals with health benefits. The ever-increasing demand for healthy foods, especially purple-fleshed potatoes, is attracting the attention of not only researchers but also consumers [20]. These potato varieties represent a natural source of anthocyanins affecting the specific flesh color while helping to reduce the risk of chronic diseases [21]. Currently, anthocyanins are considered to be one of the most effective antioxidants, help prevent cancer and cardiovascular disease, slow down aging, and strengthen immunity [1,22,23]. A recent study also reported a positive effect of anthocyanins from purple-fleshed potatoes in the treatment of alcohol-induced damaged liver [24].

Potatoes are one of the essential and most consumed foods in Slovakia. In order to provide a comprehensive overview of the content of healthy substances in potatoes, this study is focused on the determination of chlorogenic acid content, and total anthocyanin and polyphenol contents in seven potato varieties with different flesh colors and, therefore, an evaluation of the impact of variety on the selected parameters. Since the samples were harvested at two different stages of maturity, the influence of the harvest period on the selected parameters was also evaluated.

2. Material and Methodology

2.1. Plant Material

Seven potato varieties with different flesh colors were used for analysis (Table 1).

Table 1. Characteristics of potato varieties.

Variety	Description		
	Maturity	**Skin**	**Flesh**
Belana	Early to medium early	Pure yellow	Yellow
Cecile	Medium early to late	Red	Yellow
Magenta Love	Early	Pink	Pink
Mozart	Medium early	Red	Pale yellow
Talentine	Early	Light yellow	Yellow
Toscana	Medium early	Yellow	Deep yellow
Violet Queen	Early	Purple	Deep purple

Potato samples were grown in the cadastral area of Majcichov, Slovakia (48°17′00′′ N 17°38′00′′ E). The soil in the investigated locality is chernozem with a low P content

(32.75 mg kg^{-1}), a good K content (269.7 mg kg^{-1}), a middle Ca content (3923 mg kg^{-1}), a good Mg content (187.9 mg kg^{-1}), and a middle humus content (2.26%). The soil shows a neutral to weakly alkaline reaction (pH/KCl 7.04). The soil parameters were evaluated according to Bielek [25]. The altitude is 149 m a.s.l., with an average annual rainfall of 560 mm and an average annual temperature of 9–10 °C.

Approximately 2 kg of potatoes were taken for each variety, and extracts of flesh were prepared for analysis. To evaluate the effect of potato maturity on selected parameters, the harvest of plant material took place in July (1st harvest) and in September (2nd harvest), with a time interval between individual harvests of 8 weeks.

2.2. Extract Preparation

To prepare the extract, 25 g of homogenized potato sample (flesh) was poured with aqueous methanol (80%). The samples thus prepared were extracted by horizontal shaker (Heidolph Promax 1020, Heidolph Instruments GmbH, Schwabach, Germany) for 12 h. Subsequently, the extracts were filtered (Munktell No. 392 paper; Munktell & Filtrak GmbH, Bärenstein, Germany) and stored at 4 °C in closed 50 mL tubes until analysis. Concurrently, the dry matter content was determined in each sample using moisture analyzer (Kern DLB; KERN & SOHN GmbH, Ballingen, Germany).

2.3. Total Anthocyanin Content

Total anthocyanin content was determined by the method according to Lapornik et al. [26] with slight modifications. Extract (1 mL) and HCl (1 mL, 0.01% in 80% methanol) were pipetted into two tubes. To the first tube, 10 mL of 2% aqueous HCl solution was added and, to the second, 10 mL of McIlvaine buffer with pH 3.5 (0.1 mol L^{-1} citric acid with 0.2 mol L^{-1} Na_2HPO_4) was added. The absorbance of both prepared solutions was measured at 520 nm (spectrophotometer Shimadzu UV-1800, Kyoto, Japan). A blank was prepared by the same procedure. The total anthocyanin content was expressed as cyanidin equivalent (CyE) in mg CyE kg^{-1} of fresh weight (FW).

2.4. Total Polyphenol Content

The colorimetric method by Lachman et al. [27] was used to determine the total polyphenol content (TPC). Due to the presence of a wide range of phenolic compounds in crops, gallic acid was used as a standard. Based on the obtained absorbances of the sample solutions and the calibration curve, the total polyphenol content was expressed as gallic acid equivalent (GAE) in mg GAE g^{-1} of dry weight (DW).

An extract (0.1 mL) was pipetted into 50 mL volumetric flask and diluted with dH_2O. Subsequently, Folin–Ciocalteu reagent (2.5 mL) and, after 3 min, Na_2CO_3 (5 mL, 20% aqueous solution) were added. After 2 h, the absorbance of the prepared solutions of gallic acid and samples was measured at 765 nm (spectrophotometer Shimadzu UV-1800, Kyoto, Japan).

2.5. HPLC-DAD Determination of Chlorogenic Acid

For analysis of chlorogenic acid content by HPLC, the prepared extracts were filtered through a Q-Max syringe filter (0.22 µm, 25 mm, PVDF) (Frisenette ApS, Knebel, Denmark). Chlorogenic acid content was determined using Agilent 1260 Infinity HPLC (Agilent Technologies GmbH, Waldbronn, Germany) according to method by Vollmannová et al. [28]. The quantification wavelength of chlorogenic acid was set up to 320 nm. The limits of detection and quantification for chlorogenic acid were 0.22 and 0.67 µg mL^{-1}, respectively. Qualitative and quantitative data on the content of chlorogenic acid were collected and processed using Agilent Open Lab Chem Station software for LC 3D systems (Agilent Technologies).

2.6. Statistical Analysis

All analyzes were performed in 4 replicates. Results are reported as average ± standard deviation (SD). The Kruskal–Wallis test was used to determine the statistical differences between the individual potato varieties, and the difference between harvest periods was evaluated using the Wilcoxon test. Differences between potato varieties and harvest periods were considered significant at $p < 0.05$. Statistical analysis and all graphical illustrations were performed using Jamovi software [29] and R Core Team [30] according to methods by Wickham et al. [31] and Patil [32].

3. Results and Discussion

3.1. Total Anthocyanin Content

Anthocyanins are among the many flavonoids that may be found in potato tubers. The average anthocyanin content in potatoes is reported to be from 55 to 350 mg kg^{-1} FW; some authors report the range to be from 20 to 400 mg kg^{-1} FW. The content of anthocyanins depends on the potato variety. In addition to the total amount of anthocyanins, the individual varieties also differ in the composition of anthocyanins [33]. Brown [33] and Lachman et al. [34] reported peonidin as one of the major anthocyanins in purple-fleshed potatoes. In potatoes, anthocyanins are predominantly acylated glucosides of pelargonidin in the red-fleshed potato, and acylated glucosides of predominantly petunidin and peonidin with smaller amounts of delphinidin and malvidin in the purple-fleshed potato [33,35]. The total anthocyanin content in seven potato varieties differing in flesh color harvested in two different periods was determined (Table 2).

Table 2. Total anthocyanin contents in seven potato varieties depending on variety and harvesting period.

Variety	**Anthocyanins (mg CyE kg^{-1} FW ± SD)**	
	1st Harvest July	**2nd Harvest September**
Belana	45.7 ± 2.54	58.3 ± 10.35
Cecile	41.8 ± 5.27	58.4 ± 5.81
Magenta Love	91.6 ± 2.27	216 ± 20.3
Mozart	61.1 ± 5.58	89.0 ± 19.26
Talentine	52.2 ± 6.70	58.2 ± 7.60
Toscana	58.9 ± 8.41	53.4 ± 5.03
Violet Queen	116 ± 5.02	176 ± 4.25

Notes: CyE—cyanidin equivalents; FW—fresh weight; SD—standard deviation.

The total anthocyanin content in potatoes harvested in July (1st harvest) varied from 41.8 (Cecile—yellow-fleshed) to 116 mg CyE kg^{-1} FW (Violet Queen—purple-fleshed) and in September from 53.2 (Toscana—yellow-fleshed) to 216 mg kg^{-1} FW (Magenta Love—pink-fleshed). In the case of the Toscana variety, the anthocyanin content decreased between the individual harvest periods. Conversely, the content of anthocyanins in the Magenta Love variety (2nd harvest) was more than two times higher than in the 1st harvest (July). A comparable anthocyanin content (9–38 mg CyE 100 g^{-1} FW) was reported by Brown [33] in red and purple potatoes with solidly pigmented flesh. The lowest anthocyanin contents were determined in varieties with light flesh (Cecile, Belana, Talentine) compared to other varieties. Conversely, several authors did not detect anthocyanins in potatoes with yellow and white flesh [35–37]. These compounds were identified only in potatoes with red and purple flesh.

However, few authors reported higher anthocyanin contents in potatoes. Hamouz et al. [38] determined the total anthocyanins in the Violette variety (purple) to be 527.4 mg CyE kg^{-1} FW, which was approximately twice as high as in the Magenta Love variety (216 mg CyE kg^{-1} FW—2nd harvest), which had the highest anthocyanin content among the seven studied potato varieties. Similarly, Dalamu et al. [39] reported several times higher values of total anthocyanins in potatoes (80.9–269.67 mg CyE 100 g^{-1} FW). On the other hand, a comparable anthocyanin content with the Magenta Love variety (2nd harvest) was detected in the Purple Majesty variety (219 mg CyE kg^{-1} FW) [40].

Differences between each variety in samples harvested in July and September were statistically significant ($p < 0.05$) (Figure 1). Statistical differences (1st harvest July) were found between the purple variety Violet Queen and the two yellow varieties (Cecile and Belana) and between the Magenta Love and Cecile varieties. In the samples harvested in September (2nd harvest), a statistically significant difference was found between the pink-fleshed variety Magenta Love and the yellow-fleshed varieties (Mozart and Toscana).

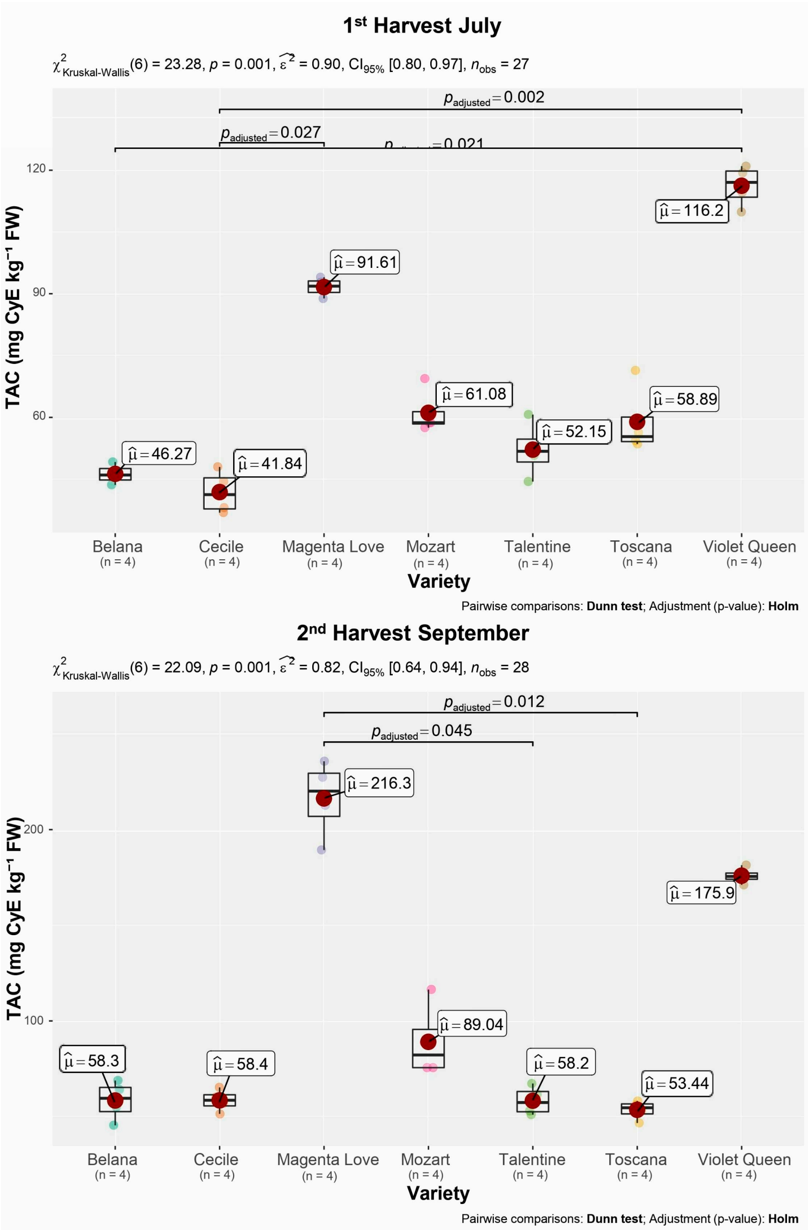

Figure 1. Statistical differences in total anthocyanin content (TAC) between individual potato varieties harvested in July (1st harvest) and September (2nd harvest).

Based on our results, the harvest period significantly ($p < 0.05$) influenced the total anthocyanin content (Figure 2). Although the impact of environmental factors has not been investigated in this study, previous studies suggest that higher anthocyanins may be associated with many stress factors affecting the plant during growth (e.g., drought) [38,41,42].

Although in the long term total solar radiation could affect the anthocyanin content of potatoes, Šulc et al. [43] found that increased sunlight does not directly affect the concentration of anthocyanins. Some authors [43,44] reported a decrease in total anthocyanins. Šulc et al. [43] detected anthocyanin contents of up to 780 mg CyE kg^{-1} FW in red- and purple-fleshed potatoes harvested during growth, but fully ripened potatoes contained only 100–390 mg CyE kg^{-1} FW.

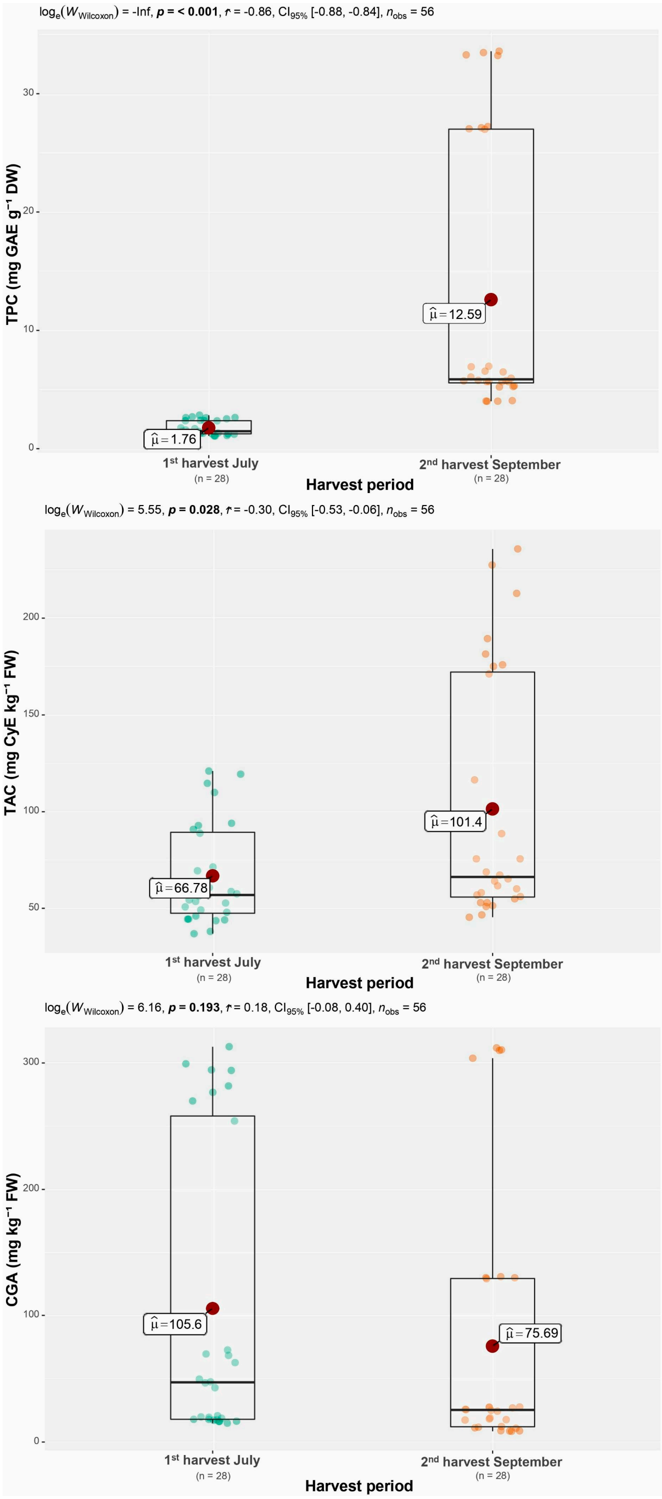

Figure 2. Statistical differences in total polyphenol content (TPC), total anthocyanin content (TAC), and chlorogenic acid content (CGA) in potatoes between two different harvest periods.

According to the presented results, the total anthocyanin content in potatoes depends not only on the variety [34,35,38,45], which was confirmed by our results, but it was demonstrated that the harvest period also has a significant impact on the content of these bioactive substances. The flesh color is a direct indicator of the total anthocyanin concentration, as purple- and pink-fleshed potatoes contain higher amounts of anthocyanins than varieties with yellow and white flesh.

3.2. Total Polyphenol Content

Polyphenols, secondary metabolites in plants, are abundant organic compounds that can have preventive and/or therapeutic effects [18,46]. In plants, polyphenols are almost widespread, commonly found in foods such as fruits, vegetables, and nuts, but also products and common beverages (coffee, tea, wine), and, therefore, they are an essential part of the human diet [47].

Regarding potatoes, purple- and red-fleshed potatoes especially are a rich source of polyphenols [48]. The total polyphenol content (TPC) varied in the studied varieties depending on the variety but also the harvest period. The TPC in potatoes harvested in July ranged between 1.14 (Mozart—pale yellow-fleshed) and 2.69 mg GAE g^{-1} DW (Violet Queen—purple-fleshed). In the samples harvested in September, the content of polyphenols was higher and ranged from 5.35 (Talentine—yellow-fleshed) to 33.4 mg GAE g^{-1} DW (Violet Queen—purple-fleshed) (Table 3).

Table 3. Total polyphenol contents in seven potato varieties depending on variety and harvesting period.

Variety	Polyphenols (mg GAE g^{-1} DW ± SD)	
	1st Harvest July	2nd Harvest September
Belana	1.21 ± 0.10	6.72 ± 0.25
Cecile	2.47 ± 0.13	5.86 ± 0.17
Magenta Love	2.04 ± 0.37	27.1 ± 0.10
Mozart	1.14 ± 0.06	5.71 ± 0.05
Talentine	1.48 ± 0.21	5.35 ± 0.21
Toscana	1.29 ± 0.05	4.02 ± 0.02
Violet Queen	2.69 ± 0.10	33.4 ± 0.17

Notes: GAE—gallic acid equivalents; DW—dry weight; SD—standard deviation.

Regarding the differences between varieties, the TPC in purple-fleshed potatoes (Violet Queen) was several times higher than in other varieties with yellow flesh, which indicates a significant effect of variety. These differences were statistically significant ($p < 0.05$) between Violet Queen and the two yellow-fleshed varieties—Belana and Mozart (1st harvest July) and between Violet Queen and Toscana and Talentine (2nd harvest September) (Figure 3). Hamouz et al. [49] reported a more than two to three times higher content of polyphenols in purple-fleshed potatoes compared to yellow-fleshed. Sun et al. [10] reported a total polyphenol content in purple-fleshed potatoes at the level of 6.50 mg GAE g^{-1} DW. Our purple-fleshed potatoes (Violet Queen) harvested in September showed a higher TPC (33.4 mg GAE g^{-1} DW). Differences in the content of polyphenols may be due to varietal diversity among cultivars. Even varieties with the same flesh color differ in polyphenol content [48]. In the case of potatoes with colored (red/purple) flesh, the content of total polyphenols was 40 to 58% higher compared to varieties with yellow flesh. The higher content of total polyphenols in varieties with colored flesh is related to the high proportion of anthocyanins, which are lacking in varieties with yellow or white flesh color [37,49–53]. Many authors reported comparable TPCs in potatoes with various flesh colors [36,37,48,49]. On the other hand, Deußer et al. [54] determined lower TPCs in potato flesh (0.4–5.4 mg GAE g^{-1} DW) compared to our results. Giusti et al. [55] determined a wide range of total polyphenol content in 20 potato varieties with different flesh colors. The TPC in investigated varieties ranged from 162.19 to 510.20 mg GAE 100 g^{-1} DW in purple-fleshed potatoes, from 152.40 to 261.49 mg GAE 100 g^{-1} DW in red-fleshed potatoes, and from 113.37 to 114.63 mg GAE 100 g^{-1} DW in yellow-fleshed potatoes.

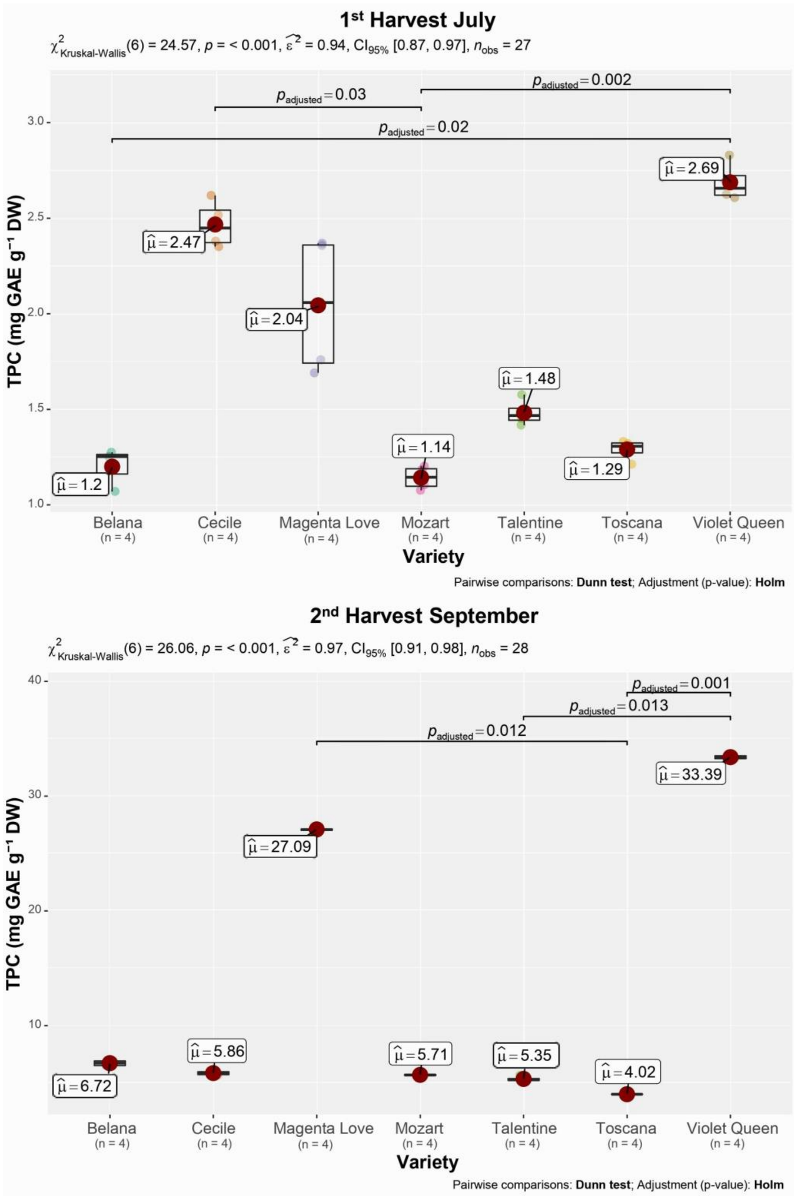

Figure 3. Statistical differences in total polyphenol content (TPC) between individual potato varieties harvested in July (1st harvest) and September (2nd harvest).

Several authors attribute the differences in the content and accumulation of polyphenols in potatoes to different environmental growth conditions in individual growing localities (e.g., altitude, the average temperature during the growing season) and the type of cultivation, as well as the harvest period [34,35,42,45,48,49,56]. Lachman et al. [34] found that there is a higher TPC in potatoes grown at higher altitudes, where annual temperatures are lower and annual rainfall is higher, and in soils with low fertility. Moreover, a higher biochemical composition was reported in potatoes cultivated organically and biodynamically than conventionally [35].

Therefore, we also focused on comparing the contents of selected bioactive substances in the monitored potato varieties harvested at two different stages of maturity (July and September). According to available sources, the concentration of phytonutrients and total nutritional content are higher in unripe potatoes and, resp., in potatoes in earlier development stages (also known as baby potatoes). In addition, although yields are significantly lower than when harvested at maturity, such potatoes are considered a premium product [12], mainly due to their high nutritional value and phytonutrient content. Based on our results, it can be stated that the harvest period has a significant impact on the content of bioactive substances in potatoes. These observations were also confirmed by statistical analysis (Figure 2). During potato maturation and growth, the total polyphenol content increased in all varieties. The highest increase was detected in the varieties Violet Queen (12.4 times) and Magenta Love (13.3 times). As there was also detected an increase in total anthocyanins in these two varieties during maturation (the highest content of anthocyanins), this could have resulted in this significant increase in total polyphenols compared to other varieties.

3.3. Chlorogenic Acid

Among phenolic acids, chlorogenic acid (CGA) is found in potatoes in high concentrations [1,57]. Chlorogenic acid has been found to account for up to 43–87% of the total polyphenol content of potatoes [55,58]. Concurrently, CGA is one of the most abundant phenolic substances and an effective antioxidant [57]. In the investigated potato varieties, a wide range of chlorogenic acid contents was found (Table 4). The chlorogenic acid content in samples harvested in July (1st harvest) ranged from 16.2 (Mozart—pale yellow-fleshed) to 294 mg kg^{-1} FW (Magenta Love—pink-fleshed). The chlorogenic acid content in potatoes from the 2nd harvest (September) varied from 8.70 (Toscana—deep yellow-fleshed) to 309 mg kg^{-1} FW (Magenta Love—pink-fleshed).

Table 4. The content of chlorogenic acid in seven potato varieties depending on variety and harvesting period.

Variety	CGA (mg kg^{-1} FW $\pm$ SD)	
	1st Harvest July	**2nd Harvest September**
Belana	17.6 ± 1.07	18.0 ± 0.71
Cecile	46.7 ± 2.84	25.1 ± 0.65
Magenta Love	294 ± 17.92	309 ± 3.60
Mozart	16.2 ± 0.99	11.5 ± 0.61
Talentine	68.3 ± 4.16	27.4 ± 0.31
Toscana	19.5 ± 1.19	8.70 ± 0.20
Violet Queen	277 ± 19.87	130 ± 0.69

Notes: CGA—chlorogenic acid; FW—fresh weight; SD—standard deviation.

As in the case of TAC and TPC, the CGA content of potatoes varied depending on the variety. Among the investigated varieties, the varieties Magenta Love and Violet Queen, which are the varieties with colored flesh (pink and deep purple, respectively), had the highest CGA content, while Magenta Love showed the highest CGA content overall in both harvest periods. Lachman et al. [59] also reported a higher CGA content in purple-fleshed and red-fleshed potatoes compared to yellow varieties. A statistically significant effect of potato genotype on the CGA content was detected by Hamouz et al. [60]. They also reported a demonstrable effect of flesh color on the CGA content. The content and profile of phenolic compounds reflect the genetic diversity of individual potato varieties and their ability to synthesize these compounds [12]. In varieties with pale yellow–deep yellow flesh, the content of CGA (1st harvest) decreased in the order of Talentine > Cecile > Toscana > Belana > Mozart, and, in samples harvested in September (2nd harvest), the CGA content decreased in the order of Talentine > Cecile > Belana > Mozart > Toscana. Hamouz et al. [60] detected higher CGA contents in 14 potato cultivars, where the average CGA concentration ranged from 53.1 (cultivar Lady Balfour—white-fleshed) to 1157 mg kg^{-1} FW (Violette—purple-fleshed). Moser et al. [61] reported a high CGA concentration in potatoes, while in individual varieties, the concentration of phenolic acids decreased in the order purple > red > white. Moreover, Brazinskiene et al. [58] detected chlorogenic and caffeic acid as the major acids present in potato tubers.

One of the other factors influencing the CGA content of potatoes is the growing locality, as pointed out by Hamouz et al. [60]. They found that higher CGA values were recorded in potatoes grown in warm locations with frequent periods of drought than in potatoes grown in locations with high altitude climatic conditions that are beneficial for growing potatoes.

Although no statistical difference in CGA content was observed between harvest periods (July and September) (Figure 2), differences ($p < 0.05$) between individual varieties were detected in samples from both harvests (Figure 4). In potatoes harvested in July, there was a statistical difference between pink variety Magenta Love and Belana (yellow-fleshed), and Mozart (pale yellow-fleshed), and between purple variety Violet Queen and Mozart. In September (2nd harvest), there was a statistically significant difference between Violet Queen and Toscana and also between the Magenta Love variety and varieties Mozart and Toscana (Figure 4).

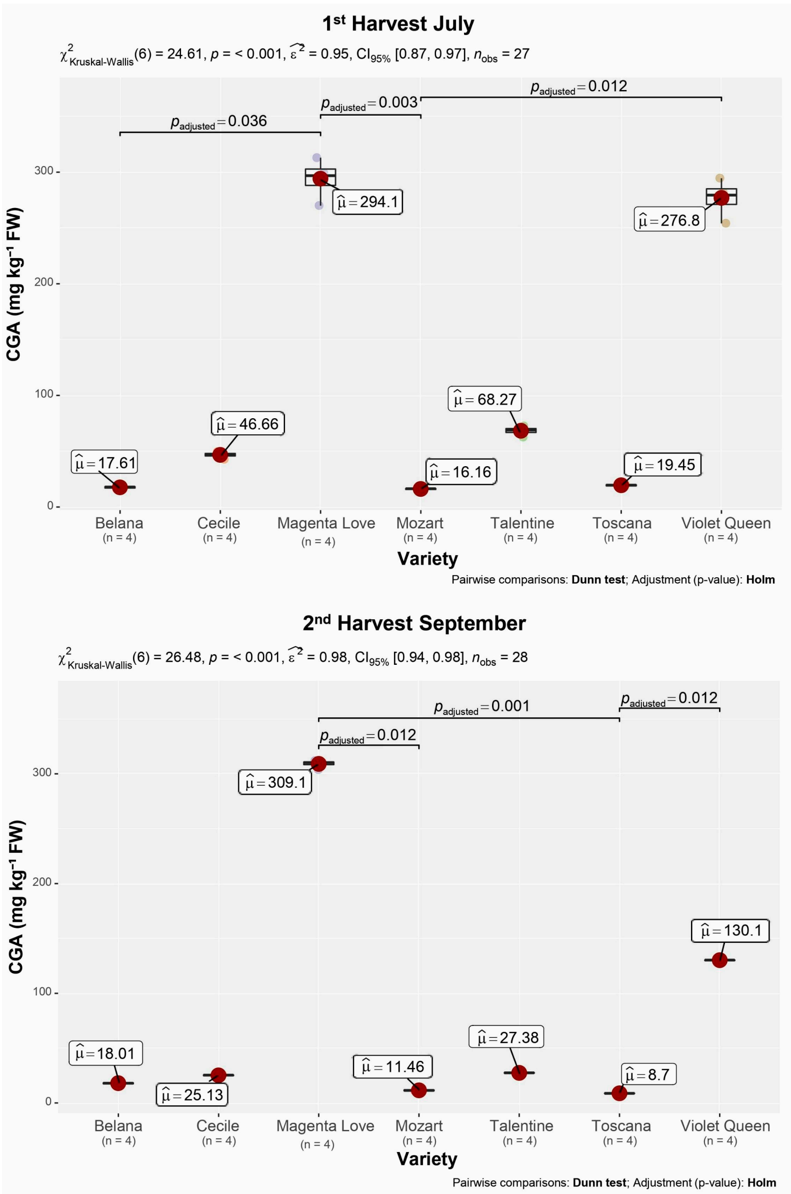

Figure 4. Statistical differences in chlorogenic acid content (CGA) between individual potato varieties harvested in July (1st harvest) and September (2nd harvest).

The CGA content in samples from September was not higher in all potato varieties compared to July. Although the total anthocyanin and polyphenol contents increased significantly in all varieties (Tables 2 and 3), indicating a positive effect of the degree of maturity on the monitored bioactive substances, in the varieties Cecile, Mozart, Talentine, Toscana, and Violet Queen the CGA content decreased. The most significant decrease in CGA was recorded in the Talentine variety (by approx. 59.9%). A similar decrease during potato growth was reported by Payyavula et al. [44], by 39–72% (depending on the variety). The increase in CGA content occurred only in the case of the Belana and Magenta Love varieties. Brazinskiene et al. [58] also reported a declining trend in the content of phenolic compounds (including CGA) due to increasing maturity. They also reported that very early potato varieties accumulate higher concentrations of biologically active compounds than the other varieties (early, medium, and late varieties). This assumption is also confirmed by the fact that both varieties (Belana and Magenta Love), in which an increase in CGA was found during ripening, belong to the early to medium early varieties. It can be concluded that not only the color of the flesh but also the type of variety significantly influenced the CGA content in the seven potato varieties monitored, which was also confirmed by statistical analysis.

4. Conclusions

Many potential health effects are attributed to potatoes mainly due to the content of a wide range of biologically active substances such as phenolic compounds. A wide variation range of bioactive substances can be found in potatoes due to differently colored potato flesh and/or skin. Varieties Magenta Love (pink-fleshed) and Violet Queen (deep purple flesh) showed the highest content of total anthocyanins and polyphenols, and chlorogenic acid. Therefore, potato varieties with colored flesh can be identified as major sources of these biologically active substances compared with varieties with white or yellow flesh. Although some previous studies indicate a decrease in bioactive substances with increasing levels of maturity, our results suggest the opposite. The content of monitored compounds (anthocyanins, polyphenols) was higher in potatoes harvested in September (2nd harvest) than in samples from July (1st harvest), which indicates that a higher level of maturity (later harvest) has a positive effect on the content of beneficial substances in potatoes. However, in the case of CGA, its content decreased during maturation in several varieties. For further studies, it would be appropriate to focus on, e.g., pedological and climatic factors, which would help to better and more comprehensively assess the behavior of beneficial substances in potatoes. This study provides comprehensive information on the content of bioactive substances in potatoes, which can be further used both in agriculture (improvement of growing conditions, selection of a suitable variety) and in the food industry (development of functional potato-based foods).

Author Contributions: Conceptualization, H.F. and J.M.; validation, J.L. and Ľ.H.; formal analysis, M.Š.; investigation, H.F. and J.Á.; data curation, Ľ.H. and M.Š.; writing—original draft preparation, H.F.; writing—review and editing, A.H., E.J., and J.M.; visualization, M.Š.; funding acquisition, A.V. All authors have read and agreed to the published version of the manuscript.

Funding: This work was financially supported by project VEGA 1/0113/21.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The datasets generated for this study are available on request to the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

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