

Nutritional value and antioxidant activities in fruit of some cultivars of pepper (*Capsicum annuum* L.)

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Abstract

The purpose of the study was to determine the nutritional value and antioxidant activity in an assortment of six pepper genotypes, depending on the variety (bell and sweet) and the color of the fruits (green, yellow and red). In this way, the content of dry matter, soluble substance, carbohydrates, acidity, vitamin C, antioxidant activities, total polyphenols and total flavonoids from fresh fruit have been investigated. In addition, were also studied the correlation coefficients between the quality parameters by Pearson Correlation. The obtained results indicate that the red sweet pepper genotypes recorded significant differences for most of the analyzes, highlighting the Slonovo Uvo cultivar with a content in polyphenols of 202.6 mg GAE/100g fw in vitamin C of 204 mg/100g fw and antioxidant activity of 1376 μ M TE/100g fw. Significant positive correlations have been identified between soluble substance and carbohydrate content and between vitamin C and total phenol content, also in sweet pepper with red fruit.

Keywords: quality, variety, antioxidant

1. Introduction

Pepper is an important horticultural crop in many regions of the world [1]. Pepper (*Capsicum annuum* L.) belongs to the family Solanaceae, genus *Capsicum*, and is a vegetable appreciated by consumers because of its pleasant, refreshing taste, attractive color and special biochemical composition. Reports of the last ten years show that some types of food and spices included in the human diet, such as pepper can have a positive effect on human health [2].

Freshly consumed peppers, as well as foods supplementing the human diet, have nutraceutical potential due to the high phytochemical content (carotenoids, flavonoids, ascorbic acid, phenolic

compounds, capsaicin), which are powerful antioxidants [3]. The trend among consumers to eat food with high nutritional value is growing, even if it is not very popular [4].

For human nutrition, pepper is especially valuable for its high vitamin C content [5-6]. The *Capsicum* fruit are an excellent source of natural, micronutrient antioxidants (vitamins C and E and carotenoids) which appear to be critically important in preventing or reducing chronic and age-related diseases [7]. Also pepper fruits can be used raw or processed into various kinds of products, so it is valuable material for frozen and processing industry [5-6].

Nowadays, chilli peppers fruits are used in modern herbology and conventional drugs due to its high content of capsaicin [7].

Vegetables grown in the field, industrial greenhouses, greenhouses-solar and other shelters present food, industrial and economic importance and are a factor of intensification by using land and labor resources [8].

Pepper is one of the main species grown in protected areas. Very favorable conditions for the cultivation of this species in Romania are in south and west [9]. For pepper culture, hybrids are increasingly recommended because they have genetic resistance to pathogens, adaptability, precocity and high productivity.

Currently, people have interest in maintaining good health and they are more careful to the food they choose to consume. They choose food with a high nutritional value, bioactive compounds and antioxidant capacity, such as fruits and vegetables [10].

Consumption of foods rich in carotenoids reduces the risk of cardiovascular and carcinogenic diseases [11]. Pepper fruits contain a wide variety of carotenoids, flavonoids, phenols, ascorbic acid, capsaicin and other compounds that cause great variability in the flavor and taste of the fruit, thus influencing consumer preference [2]. However, the composition of the fruit changes depending on the

maturation stage, the environmental conditions, the cultivar and the culture management. Also, the fruit color changes during maturation and can become from greenish to yellow, orange, violet, red and even brownish-chocolate [6].

Therefore, the purpose of this study was to evaluate the variation of the phytochemical composition according to the color of the fruits and the variety of peppers cultivated in southern Romania.

2. Materials and Method

2.1. Materials

The culture was founded in southern Romania, in the Izbiceni locality, Olt County, in 2015, under solar conditions. The biological material was represented by the cultivation of sweet and bell peppers, with fruits of different colors: Blondy F1, Cecil F1, Figaro F1, Kaptur F1, Slonovo Uvo and a local population. Some morphological characteristics of genotypes are shown in Table 1.

The culture was established by seedling produced in alveolar pallets, filled with peat. At planting, the seedlings were aged 55 days. Planting seedlings was solar in third decade of March. The distance between the rows was 80 cm and 30 cm between the plants per row. The technology applied in the culture was the classic one, paying attention to the aeration of the greenhouse, combating diseases and pests, ensuring the necessity of nutrients, irrigation, defoliation and palladium of 2 arms/plant.

Table 1. Morphological characteristics of the genotypes studied

| Cultivar | Variety | Maturity | Fruit shape | Fruit colour |
|------------------|---------|----------|-------------|--------------|
| Local population | sweet | early | elongated | red |
| Kaptur F1 | sweet | early | elongated | red |
| Slonovo Uvo | sweet | early | elongated | red |
| Cecil F1 | bell | early | conical | green-yellow |
| Blondy F1 | bell | early | blocky | green-yellow |
| Figaro F1 | bell | early | blocky | green |

To determine the nutritional value and the antioxidant activity of the six sweet pepper cultivars, biochemical analyzes were performed on dry matter, total soluble solids, vitamin C, titratable acidity, reducing sugars, total phenolic compounds, antioxidant activity and total flavonoids. In order to perform the analyses, fruit samples were taken from the cultivar and brought to the biochemistry laboratory of the Faculty of Agronomy, performing average tests.

Pericarp of washed pepper fruit was grounded in a blender. Biochemical determinations were performed at consumption maturity.

2.2. Chemical analysis

2.2.1. Dry matter content (%) was determined gravimetrically by drying 5g pepper homogenate to a constant weight at 105°C.

2.2.2. The total soluble solids content (TSS) was determined using a digital refractometer (%).

2.2.3. The titratable acid (%) content was determined by titration with 0.1N sodium hydroxide (NaOH), using phenolphthalein as indicator and expressed as % citric acid.

2.2.4. Reducing sugars (%) were extracted in distilled water (1:50w/v) and assayed colorimetric with 3.5 dinitrosalicylic.

2.2.5. Ascorbic acid was extracted in 2% hydrochloric acid (HCl) (1:50 w/v) and determined by iodometric redox titration. Ascorbic acid content was expressed as mg/100g fw. Extracts for the determination of phenols and antioxidant activity were prepared into 80% aqueous methanol (1:10 w/v) at 24°C for 16 h. The resulting slurries were centrifuged at 4000g for 5 min and the supernatants were analysed.

2.2.6. Total phenolic content (TPC): were determined colorimetric by using the Folin-Ciocalteu method [12]. The absorbance was recorded at 765 nm using a Thermo Scientific Evolution 600 UV-Vis spectrophotometer. The total phenolic content (TPC) was calculated using a standard curve prepared using gallic acid and expressed as mg of gallic acid equivalents GAE/100 g fw.

2.2.7. Determination of total flavonoids content (TF): was quantitatively determined by using colorimetric methods at 500 nm with chromogenic system of NaNO_2 -Al (NO_3)₃-NaOH according to [13]. 0.5 ml of the sample extract was transferred into a 10ml volumetric flask. Furthermore, a 0.6 mL of 5% sodium nitrite (NaNO_2) was added and the mixture was shaken and left for 6 min. Secondly, 0.5 mL of 10% Al(NO_3)₃ was added to the volumetric flask, shaken, and was left to stand for 6 min. Finally, 3.0 mL of the 4.3% NaOH was added to the volumetric flask. Subsequently, water was added up to the scale. The mixture was then shaken and left to stand for 15 min before determination.

The total flavonoid concentration in methanol extract was calculated from quercetin (Q) calibration curve and expressed as quercetin equivalents (Q)/100g .

2.2.8. Antioxidant activity (AO): DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging assay: The capacity of tomato extracts to reduce the radical 2,2-diphenyl-1-picrylhydrazyl was assessed using the method of [14] with some modification.

A 0.075 mM (final concentration) DPPH solution in ethanol was mixed with sample extracts and vortexed thoroughly. The absorbance of the mixtures at ambient temperature was recorded for 20 min at 2 min intervals. The absorbance of the remaining DPPH radicals was measured at 519 nm. A blank reagent was used to study stability of DPPH over the test time. The scavenging activity of extracts was evaluated as a percentage of DPPH discoloration using the formula: % scavenging = $[\text{A}_0 - (\text{A}_1 - \text{A}_S)] / \text{A}_0 \cdot 100$, where A_0 is the absorbance of DPPH alone, A_1 is the absorbance of DPPH + extract and A_S is the absorbance of the extract only. The Trolox calibration curve was plotted as a function of the percentage of DPPH radical scavenging activity. The final results were expressed as $\mu\text{mol Trolox (TE)} / 100 \text{ g fw}$.

2.3. Statistical Analysis

Data were elaborated using one-way ANOVA, single-factor was performed. The significance of differences was evaluated using Duncan's test, with the critical significance level of $p \leq 0.05$. Furthermore, an analysis of the correlation was made between quality parameters.

3. Results and Discussion

The quality of pepper fruits is influenced by many factors: genotype, mineral fertilization, grafting, cultivation conditions, the degree of ripeness at harvest [1-10].

In the present study all chemical indices determined varied according to variety and cultivar, as well as their color at consumption maturity (Table 2). Thus, dry matter and TSS varied from 5.66% to 9.33% and respectively from 3.5% to 7%, the highest values being recorded for long and red fruit genotypes. Also, reducing sugars recorded higher values in the elongated and red fruit cultures, up to 5.76% in the Kaptur hybrid. By [5] in their research on the nutritional value of an assortment of sweet peppers, reported a dry matter fruit weight between 7.0 and 9.0 g · 100 g⁻¹ FW and a reducing sugar content between 3.20-4.92 g · 100 g⁻¹ FW.

In this study, acidity of peppers increases and decreases depending on the variety and genotype. Total titratable acidity, recorded lower values at the bell pepper, with green and yellow fruit 0448 (Figaro F1și Cecil F1) and higher values sweet peppers with red fruits, up to 0.704% (Slonovo Uvo).

Increasing the content of vitamin C in fruits of pepper is an important breeding target for this species. In this study, it is significantly presented the content vitamin C in red sweet pepper, 204 mg/100g sp, in the Slonovo Uvo and the lowest value in the Figaro F1 cultivar, with the green fruit of 125 mg/100g sp. Similarly, [15], reported vitamin

C content values above 250 mg in 100 g⁻¹ in local hot peppers varieties and [5], found in sweet pepper fruit a content of ascorbic acid from 116.3 to 190.5 mg100 g⁻¹ FW. According to [6] red pepper had higher content of vitamin C than green and yellow peppers.

Table 2. Chemical properties of in studied papper cultivars

| Cultivar | Dry matter (%) | TSS (%) | Titratable acidity (%) | Reducing sugars (%) |
|------------------|----------------|---------|------------------------|---------------------|
| Local population | 8.66b | 6b | 0.512c | 4.96b |
| Kaptur F1 | 9.33a | 7a | 0.640b | 5.76a |
| Slonovo Uvo | 8.66b | 7a | 0.704a | 5.63a |
| Cecil F1 | 5.66d | 3.5c | 0.448d | 3.02c |
| Blondy F1 | 7c | 3.5c | 0.642b | 3.01c |
| Figaro F1 | 5.66 | 4c | 0.448d | 3.61b |
| LSD | 0.37 | 0.76 | 0.01 | 0.19 |

a,b,c,d- Different letters indicate statistical difference ($p \leq 0.05$)

Table 3. Vitamin C, Total phenolic, flavonoides, content and antioxidant activity

| Cultivar | Vitamin C (mg /100g fw) | Total phenolic (mg GAE/100g) | AO ($\mu\text{mol TE}/100\text{g fw}$) | TF (mgQ/100g) |
|------------------|-------------------------|------------------------------|--|---------------|
| Local population | 132cd | 128d | 827.2e | 255.0cd |
| Kaptur F1 | 187b | 163.b5 | 1153.28d | 480a |
| Slonovo Uvo | 204a | 202.6a | 1376a | 295.28b |
| Cecil F1 | 143.6cd | 136.42cd | 656f | 292b |
| Blondy F1 | 144c | 146.87bc | 1224c | 250d |
| Figaro F1 | 125d | 151.78bc | 1272b | 281bc |
| LSD | 18.90 | 17.06 | 32.90 | 26.87 |

a,b,c,d- Different letters indicate statistical difference ($p \leq 0.05$)

Table 4. Values of correlations (R^2) between chemical compounds analyzed

| Chemical compound | TSS (%) | Vitamin C (mg/100 g fw) | Titratable acidity (%) | Reducing sugars (%) | Total phenolic (mg GAE/100 fw) | AO ($\mu\text{mol TE}/100\text{g fw}$) | TF (mgQ/100g fw) |
|-------------------|---------|-------------------------|------------------------|---------------------|--------------------------------|--|------------------|
| DM | 0,913** | 0,660 | 0,704 | 0,898 | 0,368 | 0,237 | 0,499 |
| TSS | - | 0,745 | 0,589 | 0,997** | 0,585 | 0,298 | 0,553 |
| Vitamin C | - | - | 0,817* | 0,718 | 0,902** | 0,448 | 0,563 |
| Aciditate | - | - | - | 0,554 | 0,723 | 0,633 | 0,305 |
| Reducing power | - | - | - | - | 0,561 | 0,311 | 0,572 |
| TPC | | | | | | 0,745 | 0,277 |
| AO | | | | | | | 0,128 |

**Correlation is significant at the 0.01 level *Correlation is significant at the 0.05 level

Phenol compounds are found in considerable quantities in many fruits and vegetables and thus form an integral part of the human diet [10].

Numerous authors have argued that there are differences in the accumulation of phenols and flavonoids depending on the variety, the stages of maturity and the types of peppers [10-12].

In the present work, phenolic compounds from sweet papper varied between 128 mg GAE/100g fresh weight (local population) and 202.6 mg GAE/100g fw (Slonovo Uvo). At pepper with green fruits, the content in phenolic compounds varied from 146.87 mg GAE/100g at Blondy to 151.78 mg GAE / 100g (Figaro F1).

The content of total flavonoids recorded values up to 480 mg Q/100g (Kaptur F1) in sweet pepper with red fruit, and in bell pepper with yellowish-green fruits up to 292 mg Q/100g (Cecil F1) (Table 3).

There are numerous studies in scientific literature that confirm the presence of phenolic compounds and flavonoids in fruit pepper. [16-17], found that red peppers generally exceeded green peppers in flavonoid content, which significantly contributes to the antioxidant power of the fruit. [10] reported a total phenol content averaging 10.54 and 9.95 mg/g of fresh tissue, and [2] have found that in some morphotypes of pepper, the total phenol and flavonoid values averaged from 113.2 to 262.9 and 9.7 to 73.7 mg 100 g-1 fresh weight, respectively.

Regarding the antioxidant activity, varied in different colored genotyps peppers (Tabelul 2.). The highest value for antioxidant activity was at sweet pepper with red fruit, 1376 $\mu\text{mol TE}/100\text{g fw}$ (Slavo Uno,) while at bell pepper, with the green-yellow fruit, the highest value was 656 $\mu\text{mol TE}/100\text{g fw}$. (Cecil F1). Some authors [16] investigated the ability to capture free radicals in sweet peppers of different colors, and found that the lowest values but insignificant were for green peppers.

Correlations between the chemical compounds analyzed for sweet pepper genotypes are shown in Table 4. Thus, the highest correlation, respectively very significant, was recorded between TSS and reducing sugars ($r= 0.997$), between TSS and DM ($r = 0.913$), between total polyphenols and Vitamin C ($r= 0.902$), between Vitamin C and titratable acidity ($r=0,817$) followed by total polyphenols and antioxidant activity (0.745). For the other characters, correlations were positive but insignificant.

4. Conclusions

In the present study, have been identified changes in the content of dry matter, soluble solides, reducing sugar, acidity, vitamin C, total polyphenols, total flavonoids and antioxidant activity.

All these phytochemicals and antioxidant activity from pepper fruits depended on the variety and color. Higher contents were found in sewet peppers with red color fruits, followed by yellow fruits.

The Slonovo Uvo cultivar recorded significant differences regarding the content in TSS (7%), in reducing sugar (5.63%), vitamin C (204 mg/100g fw), in total polyphenols (202.6 mg GAE 100g fw) and in antioxidant activity (1376 mmol TE/100g fw), and the Kaptur F1 genotype recorded significant differences regarding the the high content of flavonoids (480 mgQ/100g fw).

The local population of red pepper recorded high values for content in vitamin C (132 mg/100g sp) and antioxidant capacity (827.2 $\mu\text{mol TE}/100\text{g sp}$), surpassing some of the cultivars in the assortment studied. These values are favorable for the use of the local population as genitors for hybridization breeding programs.

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

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