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Study of the agrobiological characterization and dynamics of vitamin C and anthocyanins in the landraces from the National Sweet Pepper Collection of Armenia

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ABSTRACT

Sweet pepper is cultivated in almost all countries of the world, in open and protected soils. In the Republic of Armenia, landrace forms of sweet pepper have been cultivated for more than 100 years. The fruits of local landrace forms of sweet pepper are used for fresh consumption, canning, drying (paprika) and are rich in various vitamins, mineral salts, micro and macroelements, carbohydrates, organic acids, pectin substances, and antioxidant properties.

Objective: We have researched dynamics of vitamin C and anthocyanins content in their fresh and dried (in the form of paprika) fruits in the landraces Sweet Pepper.

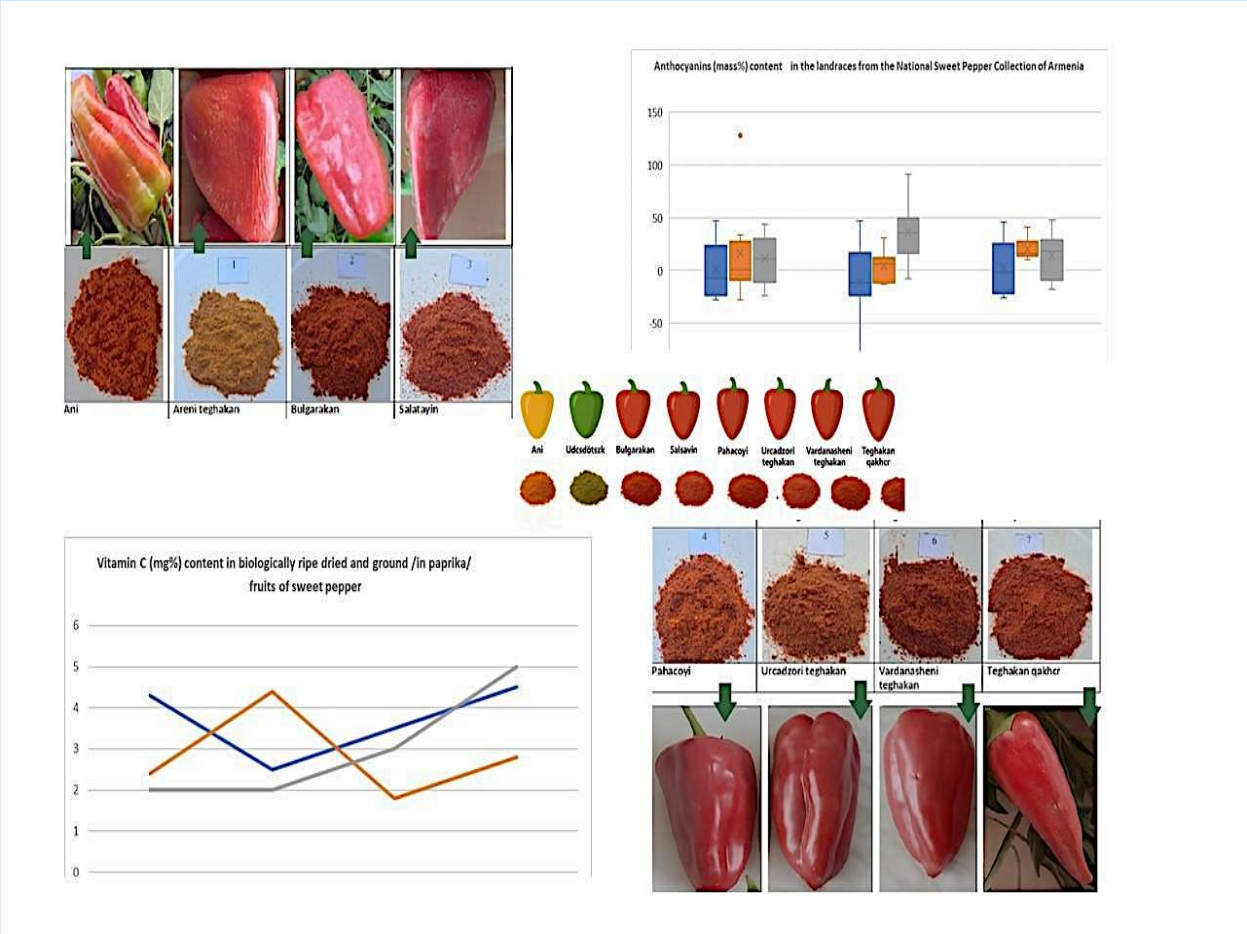
Methods: The experimental work of the research, the climatic conditions of the field, and the methods of biochemical and statistical analysis.

Results: Results of the dynamics of vitamin C accumulation in sweet pepper fruits at the beginning of the fruit harvest stage - at the time of technical ripeness- 75,25 – 87,35 mg%, at the stage of mass fruit harvest stage - at the time of

technical ripeness –92,65 – 125,45 mg%, at the end of the fruit harvest stage - at the time of technical ripeness- 81,25 – 93,85 mg%. The results of the anthocyanin content In biologically ripe fresh fruits of sweet pepper, at the beginning of the fruit harvest stage - at the time of biological ripeness– 0,62 – 0,85 (mass%), at the stage of mass fruit harvest stage - at the time of biological ripeness– 0,81 – 0,98 (mass%), at the end of the fruit harvest stage - at the time of biological ripeness – 0,71 – 0,89 (mass%). The following Sweet Pepper landraces provided the best results in content of vitamin C and anthocyanins: Bulgarakan, Salatayin, Pahacoyi, Urcadzori teghakan, Vardanasheni teghakan.

Conclusion: Several genetic resources of from the the landraces Sweet Pepper collection such as Bulgarakan, Salatayin, Pahacoyi, Urcadzori teghakan, Vardanasheni teghakan with a high content of bioactive compounds studied. Selected landraces can be used in breeding programs and used to prepare new functional food recipes to address human health problems.

Keywords: sweet pepper, landraces, vitamin C, anthocyanins.



Graphical Abstract: Study of the agrobiological characterization and dynamics of vitamin C and anthocyanins in the landraces from the National Sweet Pepper Collection of Armenia

INTRODUCTION

Currently, the science of preparing and using functional foods is rapidly developing in the world. Anthocyanins, which are present in plant foods, both dried and ground in the form of powder, such as paprika, are of great importance for the prevention of a number of diseases [1-6]. Pepper belongs to the *Solanaceae* family, Genus – *Capsicum*, to the cultured species. *Capsicum annuum L. var. annuum.* Currently, *C. annuum* is a widespread species, the most important as a vegetable culture. The sweet form of *C. annuum* has become widespread in our country, and therefore this cultural type of pepper has become almost the only object of genetic selection research. An indicator of the growing popularity of the culture is also its wider spread on garden and home plots [7].

Currently, our population widely uses hot powder made from local landrace forms of Sweet Pepper, paprika, which is prepared mainly by drying and grinding biological or red ripe fruits. The high content of biological substances in the fruits of sweet pepper plants is due to agroclimatic factors, species and varietal composition [8-10], organic and chemical fertilizers used during their cultivation, micro- and macroelements [11-12]. Sweet pepper (*C. annuum*) is widely cultivated worldwide in open and protected ground conditions. Pepper fruits contain as much vitamin C as lemon fruits [13-15]. It is necessary to note that, for the first time, vitamin C was synthesized from hot pepper by the Hungarian scientist Szent-Dépdi, for which he was nominated for the Nobel Prize [16]. Taking into account the fact that local landrace forms of sweet pepper are used in large quantities by our population, we set ourselves the task of studying the dynamics of vitamin C and anthocyanins content in their fresh and dried (in the form of paprika) fruits at the early, mass, and late harvest periods. These studies made it possible to obtain functional food with a high content of antioxidants from local, best landrace forms of sweet pepper.

According to economic importance, sweet peppers are divided into two types: salad peppers and pepper-fried peppers. Salad peppers have large fruits (50-200 g and more), which are of different colors and shapes. The flesh is thick (4-7 mm) and sweet. This type of product is used to produce canned food and for fresh consumption. Pepper-fried peppers have oblong-conical fruits, bright red in color, weighing up to 12-15 g, with a thin (1.5-2 mm), easily drying core [17-18]. It is used for grinding, to produce pepper powder (sweet paprika), which is highly valued in medicine, and is used as a seasoning for various dishes. Paprika powder is a rich multivitamin concentrate, the ascorbic acid content of which exceeds 1000 mg per 100 grams. It is used in the food and canning industry and at home for the preparation of various semi-finished products, such as sauces, jams, soups, and garnishes. The pepper fruits used to make paprika have different properties, according to our national characteristics and the requirements of the final product [19-22].

The practical value of our scientific works in Armenian conditions, the dynamics of vitamin C accumulation and anthocyanin content in fresh and dried fruits of sweet pepper landrace forms have been comprehensively studied. The technical and biological ripening dates of sweet pepper fruits, early, mass and late yield dates have been studied.

Considering the above circumstances, we conducted scientific research on the fresh use of local landrace forms of sweet pepper and the determination of the dynamics of vitamin C and anthocyanins in dried, ground fruits, to determine and use their functional food value.

The scientific research “The first detailed comparative study of vitamin C and anthocyanins in local, landrace forms of Armenian pepper” we conducted is carried out for the first time in the soil and climatic conditions of the Ararat Plain of Armenia. Until now, we have lacked similar written research, thanks to which the importance of fresh and dried and ground pepper,

paprika, for their use in functional food has been revealed.

Our research will have a great impact on producers and users of fresh sweet pepper fruits and paprika. All this will become possible in the future for their application and use as functional foods to reach a greater extent.

MATERIAL AND METODS

In our scientific work we have used the sweet pepper landraces from Areni teghakan, Bulgarakan, Salatayin, Pahacoyi, Urcadzori teghakan, Vardanasheni teghakan, and Teghakan qakhcr. The local Ani variety served as a tester.

Ani

Areni teghakan

Bulgarakan

Salatayin

Pahacoyi

Urcadzori teghakan

Vardanasheni teghakan

Teghakan qakhcr

Figure 1. The color of sweet pepper fruits at the stage of technical ripeness

Ani

Areni teghakan

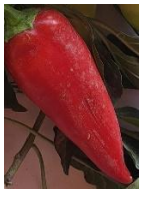
Bulgarakan

Salatayin

Pahacoyi

Urcadzori teghakan

Vardanasheni teghakan



Teghakan qakhcr

Figure 2. The color of sweet pepper fruits at the stage of biological maturity.


Ani


Areni teghakan


Bulgarakan


Salatayin


Pahacoyi


Urcadzori teghakan


Vardanasheni teghakan


Teghakan qakhcr

Figure 3. The color of biologically ripe dried and ground /paprika/ sweet pepper fruits.

Seed Germination, Transplanting, and Plant Growth: For the cultivation of marigold in the open field, seeds of different samples were sown in the second decade of March 2025 under greenhouse conditions. The seeds germinated en masse after 5 days. All agrotechnical measures were taken to obtain healthy and high-quality seedlings. The 55-day-old seedlings were planted in the field with a 70x30 sm. planting scheme. The seedlings were cultivated in the field under irrigation and fertilization conditions. Phenological observations were made during the vegetation period [23-24].

We conducted the experimental work in the natural climatic conditions of the Ararat Plain in 2025, in an open field, with 4 replications. We collected experimental samples from each replication, and the methods of AVRDC [25-26].

Fruit quality: Vitamin C was measured in pepper fruits and paprika at both technical and biological maturity by titration method. A Cary 60 UV-Vis spectrophotometer (Agilent Technologies, USA) was used. This technique involved measuring reduced and oxidized riboflavin at a wavelength of 445 nm against 0.1N HCl solvent [27].

Determination of Anthocyanin Content: The total anthocyanin content was determined by pH differential spectrophotometry. Buffers were prepared. A buffer containing 1.86 g of potassium chloride was dissolved in approximately 980 ml of distilled water, concentrated hydrochloric acid was added, and the pH was adjusted to 1. The optical density of the solutions was measured at wavelengths of 510 and 700 nm. The experiments were repeated three times for statistical purposes. The total anthocyanin content was calculated in terms of cyanidin-3-glucoside using the following formula: $C = (A \times 449.5 \times F \times V \times 100\%) / (26900 \times l \times m)$, where C is the total anthocyanin content calculated for cyanidin-3-glucoside in mass %. Optical density of A-cyanidin-3-glucoside: 449.5 molecular weight, g/mol. F-dilution factor, V-volume of extract, ml; molecular absorption coefficient of cyanidin-3-glucoside: 26900; 1-length of cuvette, cm; m-mass of sample, g. [27]

The obtained indicators were subjected to statistical analysis by Analysis of Variance (ANOVA)

RESULTS AND DISCUSSION

Agrobiological Characterization: For pepper, the correct determination of the technical and biological ripening

dates of fruits is important. The determination of bioactive indicators of plants at the early, mass and end of vegetation stages during these ripening periods can play a decisive role in using fresh and dried and ground (made into paprika) fruits as functional foods. Some authors have noted similar characteristics of agricultural plants in their studies [28-29].

Table 1. Agrobiological characterization in the landraces Sweet Pepper.

Sweet pepper LD	From seed germination to mass					
	At the beginning of the fruit harvest stage - at the time of technical ripeness days	At the stage of mass fruit harvest stage - at the time of technical ripeness days	At the end of the fruit harvest stage - at the time of technical ripeness days	At the beginning of the fruit harvest stage - at the time of biological ripeness days	At the stage of mass fruit harvest stage - at the time of biological ripeness days	At the end of the fruit harvest stage - at the time of biological ripeness days
Ani, control	116	122	136	129	137	143
Areni teghakan	108	115	125	118	125	136
Bulgarakan	110	119	126	119	127	137
Salatayin	109	115	124	119	126	136
Pahacoyi	111	118	126	118	125	137
Urcadzori teghakan	112	119	126	124	129	137
Vardanasheni teghakan	110	118	125	122	126	138
Teghakan qakhcr	115	121	135	128	135	140

The results of the research (Table 1) showed that the beginning harvest stage, at the time of technical ripeness, is 108-116 days. The stage of mass fruit harvest, at the time of technical ripeness, is 115-122 days. The end of the fruit harvest stage, at the time of technical ripeness, is 125-136 days. At the beginning of the fruit harvest stage, at the time of biological ripeness, is 118-129 days. The stage of mass fruit harvest, at the time of biological ripeness, is 125-137 days. At the end of the fruit harvest stage, at the time of biological ripeness, is 136-143 days.The following sweet pepper landraces provided the best results in terms of agrobiological properties: Areni teghakan, Bulgarakan, Salatayin, Pahacoyi, Urcadzori teghakan, Vardanasheni teghakan. These forms outperformed the control variety Ani, ($P < 0.05$).

Biochemical Characteristics Evaluation of Fruits: The scientific research "The first detailed comparative study of vitamin C and anthocyanins in local, landrace forms of Armenian pepper" we conducted was carried out for the first time in the soil and climatic conditions of the Ararat Plain of Armenia. Until now, we have lacked similar written research, thanks to which the importance of fresh and dried and ground pepper, paprika, for their use in functional food has been revealed.

The content of vitamin C in fresh technically and biologically ripe pepper fruits and the dynamics of its accumulation at certain periods of ripening are of great importance. The importance of vitamin C in the fruits of agricultural crops has been addressed by a number of scientists [30-31]. Considering the high demand for

vitamin C for humans as an important source of functional food, we have carried out scientific research work in the landraces from the National Sweet Pepper fruits at the time of technical and biological ripeness. Studies of the dynamics of vitamin C accumulation in paprika made from dried and salted red sweet pepper fruits have also been emphasized.

Table 2. Dynamics of vitamin C (mg%) in the landraces from the National Sweet Pepper fruits at the time of technical ripeness.

Sweet pepper LD	Dynamics of Vitamin C (mg%) accumulation in sweet pepper fruits		
	At the beginning of the fruit harvest stage - at the time of technical ripeness	At the stage of mass fruit harvest stage - at the time of technical ripeness	At the end of the fruit harvest stage - at the time of technical ripeness
Ani, control	75,25	92,65	81,25
Areni teghakan	79,45	93,75	83,15
Bulgarakan	87,35	125,45	93,85
Salatayin	86,45	118,35	90,95
Pahacoyi	86,55	116,65	91,45
Urcadzori teghakan	85,25	114,15	89,65
Vardanasheni teghakan	87,15	123,65	91,75
Teghakan qakhcr	82,25	100,15	85,45

The results of the dynamics of Vitamin C accumulation in sweet pepper fruits (Table 2) at the beginning of the fruit harvest stage - at the time of technical ripeness- 75,25 – 87,35 mg%, at the stage of mass fruit harvest stage - at the time of technical ripeness –92,65 – 125,45 mg%, at the end of the fruit harvest stage - at the time of technical ripeness- 81,25 – 93,85 mg%, The following sweet pepper landraces provided the best results in the dynamics of vitamin C accumulation: Bulgarakan, Salatayin, Pahacoyi, Urcadzori teghakan, Vardanasheni teghakan, Teghakan qakhcr. These forms outperformed the control variety Ani, ($P < 0.05$).

Table 3. Dynamics of vitamin C (mg%) in the landraces from the National Sweet Pepper fruits at the time of biological ripeness.

Sweet pepper LD	Dynamics of Vitamin C (mg%) accumulation in sweet pepper fruits		
	At the beginning of the fruit harvest stage - at the time of biological ripeness	At the stage of mass fruit harvest stage - at the time of biological ripeness	At the end of the fruit harvest stage - at the time of biological ripeness
Ani, control	135,65	176,25	89,45
Areni teghakan	140,15	180,25	95,65
Bulgarakan	158,65	215,55	134,35
Salatayin	150,45	207,45	127,75
Pahacoyi	152,35	209,65	130,45
Urcadzori teghakan	155,15	212,25	129,55
Vardanasheni teghakan	156,25	213,45	130,15

Sweet pepper LD	Dynamics of Vitamin C (mg%) accumulation in sweet pepper fruits		
	At the beginning of the fruit harvest stage - at the time of biological ripeness	At the stage of mass fruit harvest stage - at the time of biological ripeness	At the end of the fruit harvest stage - at the time of biological ripeness
Teghakan qakhcr	147,75	194,65	99,25

The results of the dynamics of vitamin C (mg %) accumulation in sweet pepper fruits (Table 3) at the beginning of the fruit harvest stage - at the time of biological ripeness- 135,65 – 158,65 mg %, at the stage of mass fruit harvest stage - at the time of biological ripeness- 176,23 – 215,55 mg %, at the end of the fruit harvest stage - at the time of biological ripeness – 89,45 – 134,35 mg %. The following sweet pepper landraces provided the best results in the dynamics of Vitamin C accumulation: Bulgarakan, Salatayin, Pahacoyi, Urcadzori teghakan, Vardanasheni teghakan, Teghakan qakhcr. These forms outperformed the control variety Ani, ($P < 0.05$).

Table 4. Vitamin C (mg%) content in biologically ripe dried and ground /in paprika/ fruits of sweet pepper.

Sweet pepper LD	Vitamin C (mg%) content		
	In biologically ripe dried and ground /in paprika/ fruits of sweet pepper		
	At the beginning of the fruit harvest stage - at the time of biological ripeness	At the stage of mass fruit harvest stage - at the time of biological ripeness	At the end of the fruit harvest stage - at the time of biological ripeness
Ani, control	125,65	148,25	71,85
Areni teghakan	132,15	154,65	86,75
Bulgarakan	143,85	189,35	92,85
Salatayin	142,25	186,75	90,25
Pahacoyi	140,35	182,85	88,65
Urcadzori teghakan	135,65	161,15	86,55
Vardanasheni teghakan	141,15	185,25	90,75
Teghakan qakhcr	138,45	168,35	87,15

Vitamin C content in biologically ripe dried and ground /in paprika/ fruits of sweet pepper (Table 4) at the beginning of the fruit harvest stage - at the time of biological ripeness – 125,65- 143,85 mg %, at the stage of mass fruit harvest stage - at the time of biological ripeness – 148,25 – 189,35 mg %, at the end of the fruit harvest stage - at the time of biological ripeness – 71,85 - 92,85 mg %. The following sweet pepper landraces provided the best results in the dynamics of vitamin C accumulation: Bulgarakan, Salatayin, Pahacoyi, Urcadzori teghakan, Vardanasheni teghakan, Teghakan qakhcr. These forms outperformed the control variety Ani, ($P < 0.05$).

Anthocyanins play a very important role in biologically ripe fresh fruits of pepper, and their accumulation at certain periods of ripening is of great importance in antioxidant properties. Many scientists have addressed the determination of antioxidant

substances, anthocyanin content in fresh and processed fruits of agricultural crops [32-33]. Considering the demand for antioxidants in humans for the treatment of cancer, and the use of pepper as a functional food, we have carried out scientific research in the landraces from the National Sweet Pepper Collection of the fresh and paprika prepared fruits at the time of biological ripeness.

Table 5. Anthocyanins (mass %) content in the landraces from the National Sweet Pepper Collection of Armenia.

Sweet pepper LD	Anthocyanin (mass%) content					
	In biologically ripe fresh fruits of sweet pepper			In biologically ripe dried and ground /in paprika/ fruits of sweet pepper		
	At the beginning of the fruit harvest stage - at the time of biological ripeness	At the stage of mass fruit harvest stage - at the time of biological ripeness	At the end of the fruit harvest stage - at the time of biological ripeness	At the beginning of the fruit harvest stage - at the time of biological ripeness	At the stage of mass fruit harvest stage - at the time of biological ripeness	At the end of the fruit harvest stage - at the time of biological ripeness
Ani, control	0,62	0,81	0,71	0,56	0,75	0,64
Areni teghakan	0,70	0,88	0,80	0,64	0,79	0.69
Bulgarakan	0,85	0,98	0,89	0,80	0,95	0,84
Salatayin	0,81	0,96	0,85	0,77	0,89	0,80
Pahacoyi	0,84	0,95	0,86	0,79	0,92	0,81
Urcadzori teghakan	0,83	0,93	0,86	0,79	0,93	0,81
Vardanasheni teghakan	0,84	0,96	0,87	0,80	0,94	0,82
Teghakan qakhcr	0,75	0,91	0,82	0,67	0,82	0,73

The results of the anthocyanin content (Table 5) in biologically ripe fresh fruits of sweet pepper, at the beginning of the fruit harvest stage - at the time of biological ripeness– 0,62 – 0,85 (mass %), at the stage of mass fruit harvest stage - at the time of biological ripeness– 0,81 – 0,98 (mass %), at the end of the fruit harvest stage - at the time of biological ripeness – 0,71 – 0,89 (mass %). Anthocyanin content In biologically ripe dried and ground /in paprika/ fruits of sweet pepper, at the beginning of the fruit harvest stage - at the time of biological ripeness – 0,56 – 0, 80 (mass %), at the stage of mass fruit harvest stage - at the time of biological ripeness – 0,75 – 0,95 (mass %), at the end of the fruit harvest stage - at the time of biological ripeness- 0,64 – 0,84 (mass%). The following sweet pepper landraces provided the best results in content of anthocyanins: Bulgarakan, Salatayin, Pahacoyi, Urcadzori teghakan, Vardanasheni teghakan. These forms outperformed the control variety Ani, ($P < 0.05$).

This research is completely new and has several different and innovative studies compared to the previous article. The experimental work includes the study of the dynamics of vitamin C in technically and biologically ripe fruits and paprika throughout the harvest period at three different times. The dynamics of anthocyanin accumulation in biologically ripe fruits and paprika obtained from them throughout the harvest period at 3 different times has also been widely clarified.

The practical implications of the research are promising and applicable. We recommend that to meet the daily requirement of Vitamin C and anthocyanins, we divide it into three portions per day: two green or one and a half red fruits for breakfast, lunch, and dinner. Adults are also advised to eat up to 20 grams of paprika

3 times a day, mixed with other dishes or salads, and minors up to 10 grams. People and children who have and taste these fruits and paprika in their daily diet benefit greatly in terms of improving and restoring their health. Such use increases their antioxidant properties and for a long time their body remains free from the risk of cancer [34-36].

CONCLUSION

Our research at beginning harvest stage - at the time of technical ripeness- 108-116 days, at the stage of mass fruit harvest stage - at the time of technical ripeness- 115-122 days, at the end of the fruit harvest stage - at the time of technical ripeness- 125-136 days, at the beginning of the fruit harvest stage - at the time of biological ripeness- 118-129 days, at the stage of mass fruit harvest stage - at the time of biological ripeness- 125-137 days, at the end of the fruit harvest stage - at the time of biological ripeness- 136-143 days. The following sweet pepper landraces provided the best results in terms of agrobiological properties: Areni teghakan, Bulgarakan, Salatayin, Pahacoyi, Urcadzori teghakan, Vardanasheni teghakan.

The results of the dynamics of vitamin C accumulation in sweet pepper fruits at the beginning of the fruit harvest stage - at the time of technical ripeness- 75,25 – 87,35 mg %, at the stage of mass fruit harvest stage - at the time of technical ripeness –92,65 – 125,45 mg %, at the end of the fruit harvest stage - at the time of technical ripeness- 81,25 – 93,85 mg %, at the beginning of the fruit harvest stage - at the time of biological ripeness- 135,65 – 158,65 mg %, at the stage of mass fruit harvest stage - at the time of biological ripeness- 176,23 – 215,55 mg %, at the end of the fruit harvest stage - at the time of biological ripeness – 89,45 – 134,35 mg %. Vitamin C content In biologically ripe dried and ground /in paprika/ fruits of sweet pepper at the beginning of the fruit harvest stage - at the time of biological ripeness – 125,65- 143,85 mg %, at the stage of mass fruit harvest stage - at the time of biological ripeness – 148,25 – 189,35 mg %, at the end of the fruit harvest stage - at the time of biological ripeness – 71,85 - 92,85 mg %. The following sweet pepper landraces provided the best results in the dynamics of vitamin C accumulation: Bulgarakan, Salatayin, Pahacoyi, Urcadzori teghakan, Vardanasheni teghakan, Teghakan qakhcr.

The results of the anthocyanin content in biologically ripe fresh fruits of sweet pepper, at the beginning of the fruit harvest stage - at the time of biological ripeness– 0,62 – 0,85 (mass %), at the stage of mass fruit harvest stage - at the time of biological ripeness– 0,81 – 0,98 (mass %), at the end of the fruit harvest stage - at the time of biological ripeness – 0,71 – 0,89 (mass %). Anthocyanin content in biologically ripe dried and ground /in paprika/ fruits of sweet pepper, at the beginning of the fruit harvest stage - at the time of biological ripeness – 0,56 – 0, 80 (mass %), at the stage of mass fruit harvest stage - at the time of biological ripeness – 0,75 – 0,95 (mass %), at the end of the fruit harvest stage - at the time of biological ripeness- 0,64 – 0,84 (mass %). The following sweet pepper landraces provided the best results in content of anthocyanins: Bulgarakan, Salatayin, Pahacoyi, Urcadzori teghakan, Vardanasheni teghakan.

Several genetic resources of from the landraces sweet pepper collection such as Bulgarakan, Salatayin, Pahacoyi, Urcadzori teghakan, Vardanasheni teghakan with a high content of bioactive compounds studied. Selected landraces can be used in breeding programs and used to prepare new functional food recipes to address human health problems.

Author contributions: K.S., P.T. designed the research. K.S., G.Sh., M.G., A.Z. provided fresh and dried (in the form of paprika) fruits in the landraces from the National Sweet Pepper Collection of Armenia, for research. A.Z., G.S. performed biochemical analysis. G.K., V.V. performed statistical analyses. K.S. and G.K. wrote the manuscript. K.S. edit the article. All authors read and approved the final version of the manuscript.

List of Abbreviations: C. – Capsicum.

Competing Interests: There are no conflicts of interest to declare.

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REFERENCES:

1. Martirosyan DM, Lampert T, Ekblad M. Classification and regulation of functional food proposed by the functional food center. *Functional Food Science.* 2022; 2(2): 25–46. DOI: https://doi.org/10.31989/ffs.v2i2.890
2. Granato D, Barba FJ, Bursać Kovačević D, Lorenzo JM, Cruz AG, Putnik P. Functional foods: product development, technological trends, efficacy testing, and safety. *Annual Review of Food Science and Technology.* 2020; 11: 93–118. DOI: https://doi.org/10.1146/annurev-food-032519-051708
3. Martirosyan D, Kanya H, Nadalet C. Can functional foods reduce the risk of disease? Advancement of functional food definition and steps to create functional food products. *Functional Foods in Health and Disease.* 2021; 11(5): 213–221. DOI: https://doi.org/10.31989/ffhd.v11i5.788
4. Gur J, Mawuntu M, Martirosyan D. FFC's advancement of functional food definition. *Functional Foods in Health and Disease.* 2018; 8(7): 385–397. DOI: https://doi.org/10.31989/ffhd.v8i7.531
5. Martirosyan DM, Stratton S. Quantum and tempus theories of functional food science in practice. *Functional Food Science.* 2023; 3(5): 55–62. DOI: https://doi.org/10.31989/ffs.v3i5.1122
6. Martirosyan DM, Ekblad M. Functional foods classification system: exemplifying through analysis of bioactive compounds. *Functional Food Science.* 2022; 2(4): 94–123. DOI: https://doi.org/10.31989/ffs.v2i4.919
7. Pishnaya ON, Mamedov MI, Pivavarov VF. *Pepper breeding.* VNIISSOK Publishing; 2012. 248 p.
8. Sarikyan KM, Hovhannisyan FA, Kirakosyan GV, Hakobyan AH, Shaboyan GG, Hovhannisyan AA. Study of the fertilizer "Multibar" for the productivity and characterization of eggplant varieties. *BIO Web of Conferences.* 2023; 71: 01008. DOI: https://doi.org/10.1051/bioconf/20237101008
9. Hovsepyan A, Petrosyan T, Saghatelyan L, Tsaturyan A, Paronyan M, Koloyan H, Hovhannisyan S, Abrahamyan M, Avetisyan S. Safety evaluation of bacterial melanin as a plant growth stimulant for agricultural and food industry applications. *Functional Food Science.* 2025; 5(9): 450–461. DOI: https://doi.org/10.31989/ffs.v5i9.1734
10. Yeritsyan S, Yeritsyan L, Jhangiryan T, Barseghyan M, Grigoryan K, Gasparyan G. Enhancing wheat yield and nutritional quality through organo-mineral fertilizer applications. *Functional Food Science.* 2025; 5(5): 146–159. DOI: https://doi.org/10.31989/ffs.v5i5.1604
11. Kirakosyan G, Melyan G, Vardanyan V, Sarikyan K. Effect of biofertilizers on the content of bioactive components of common bean under open field and greenhouse cultivation conditions. *Bioactive Compounds in Health and Disease.*2024; 7(12): 669–680. DOI: https://doi.org/10.31989/bchd.v7i12.1519
12. Rosa-Martínez E, García-Martínez MD, Adalid AM, Pereira-Dias L, Casanova C, Soler E, Figàs MR, et al. Differences in fruit composition among varieties of pepper, tomato, and eggplant grown under uniform conditions. *Food Research International.* 2021; 147. DOI: https://doi.org/10.1016/j.foodres.2021.110531
13. Tripodi P, Rabanus-Wallace MT, Barchi L, Kale S, Esposito S, et al. *Pepper and eggplant genetic resources.* Springer; 2021. DOI: https://doi.org/10.1007/978-3-030-30343-3
14. Rosa-Martínez E, García-Martínez MD, Adalid AM, Pereira-Dias L, Casanova C, Soler E, Figàs MR, et al. Differences in fruit composition among varieties of pepper, tomato, and eggplant grown under uniform conditions. *Food Research International.* 2021; 147. DOI: https://doi.org/10.1016/j.foodres.2021.110531
15. Lahbib K, Bnejdi F, Pandino G, Lombardo S, El-Gazzah M, El-Bok S, Dabbou S. Yield-related traits, phytochemical

composition, and antioxidant activity of pepper (*Capsicum annuum*) depending on variety, fruit position, and ripening stage. *Foods.* 2023; 12(21): 3948.
DOI: https://doi.org/10.3390/foods12213948

16. Pivovarov VF, Mamedov MI, Bocharnikova NI. *Solanaceae crops: tomato, pepper, eggplant, physalis.* Moscow; 1998.
17. Baskovtceva A, Barakova N, Samodelkin E, Kiprushkina E, Alkhateeb R, Tochilnikov G. Unlocking the potential of carrot pomace: enzymatic and impact-disintegrator-activator processing for elevated beta-carotene concentration in carrot powder. *Functional Foods in Health and Disease.* 2023; 13(10): 505–519.
DOI: https://doi.org/10.31989/ffhd.v13i10.1184
18. Martirosyan DM, Stratton S. Functional food regulation. *Bioactive Compounds in Health and Disease.* 2023; 6(7): 166.
DOI: https://doi.org/10.31989/bchd.v6i7.1178
19. Santos VA, Santos RA, Da Silva ES, Alves AS, et al. Chemical composition and biological activities of *Capsicum frutescens* L.: a literature review. 2023.
DOI: https://doi.org/10.56238/alookdevelopv1-167
20. Tripodi P, Rabanus-Wallace MT, Barchi L, Kale S, Esposito S, et al. Global range expansion history of pepper (*Capsicum* spp.) revealed by over 10,000 genebank accessions. *PNAS.* 2021; 118(34): e2104315118.
DOI: https://doi.org/10.1073/pnas.2104315118
21. García-Vásquez R, Vera-Guzmán AM, Carrillo-Rodríguez JC, et al. Bioactive and nutritional compounds in fruits of pepper landraces conserved among indigenous communities from Mexico. *AIMS Agriculture and Food.* 2023; 8: 832–850.
DOI: https://doi.org/10.3934/agrfood.202304
22. Liu F, Zhao J, Sun H, Xiong C, Sun X, Wang X, et al. Genomes of cultivated and wild *Capsicum* species provide insights into pepper domestication. *Nature Communications.* 2023; 14: 5487. DOI: https://doi.org/10.1038/s41467-023-41251-4
23. Parisi M, Alioto D, Tripodi P. Overview of biotic stresses in pepper (*Capsicum* spp.): sources of genetic resistance, molecular breeding, and genomics. *International Journal of Molecular Sciences.* 2020; 21(7): 2587.
DOI: https://doi.org/10.3390/ijms21072587
24. Ledesma DR. *Experimental design, analysis of variance IRRISTAT.* AVRDC; Taiwan; 2006. p. 15.
25. IPGRI, AVRDC, CATIE. *Descriptors for Capsicum (Capsicum spp.).* 1995.
26. Kirakosyan G, Martirosyan G, Tseretely I, Shaboyan G, Vardanyan V, Sahradyan G, Ghazaryan D, Zhamharyan A, Sarikyan K. Study of anthocyanins and biochemical properties in *Capsicum chinense* chili pepper genetic resources in Armenia. *Bioactive Compounds in Health and Disease.* 2025; 8(4): 130–143.
DOI: https://doi.org/10.31989/bchd.v8i4.1588
27. Borovsky Y, Raz A, Faigenboim A, Zemach H, Karavani E, Paran I. Pepper fruit elongation is controlled by *Capsicum annuum* Ovate Family Protein 20. *Frontiers in Plant Science.* 2022.
DOI: https://doi.org/10.3389/fpls.2021.815589
28. Shaboyan G, Mayrapetyan K, Martirosyan G, Sarikyan K, Matevosyan A, Gasparyan A, Mayrapetyan S. Comparative study of qualitative traits of lentil accessions grown in hydroponic and soil conditions in Armenia. *Functional Food Science.* 2025; 5(6): 249–259.
DOI: https://doi.org/10.31989/ffs.v5i6.1632
29. Martirosyan D. Vitamin C: optimal dosages, supplementation, and use in disease prevention. *Functional Foods in Health and Disease.* 2015.
DOI: https://doi.org/10.31989/ffhd.v5i3.174
30. Martirosyan G, Avagyan A, Pahlevanyan A, et al. Biochemical composition of Armenian chili pepper varieties: insights for functional food applications. *Functional Food Science.* 2024; 4(11): 443–451.
DOI: https://doi.org/10.31989/ffs.v4i11.1495
31. Vardanian I, Sargsyan G, Martirosyan G, et al. Comprehensive agrobiological and biochemical study of sweet pepper varieties. *Functional Food Science.* 2025; 5(6): 205–222. DOI: https://doi.org/10.31989/ffs.v5i6.1640
32. Zhou K, Yu L. Total phenolic contents and antioxidant properties of commonly consumed vegetables grown in Colorado. *LWT – Food Science and Technology.* 2006; 39: 1155–1162. DOI: https://doi.org/10.1016/j.lwt.2005.07.015
33. Giusti MM, Wrolstad RE. Characterization and measurement of anthocyanins by UV-visible spectroscopy. *Current Protocols in Food Analytical Chemistry.* 2001; F1.2.1–F1.2.13.
DOI: https://doi.org/10.1002/0471142913.faf0102s00
34. Priya G, Garg AP. Biomedical applications of black pepper: a review. *Biomedical Journal of Scientific & Technical Research.* 2023; 53(1).
DOI: https://doi.org/10.26717/BJSTR.2023.53.008353
35. Sarikyan K, Kirakosyan G, Grigoryan M, et al. Study of anthocyanins in genetic resources from the national eggplant collection of Armenia. *Bioactive Compounds in Health and Disease.* 2024; 7(12): 636–648.
DOI: https://doi.org/10.31989/bchd.v7i12.1518