Research Article Open Access

BCHD Bioactive Compounds in Health and Disease

A preliminary study of the domestication of *Falcaria vulgaris* Bernh. in the Ararat Valley of Armenia

Mahsa Daryadar[1], Anna Tadevosyan[1*], Hamid Reza Roosta[2], Mansour Ghorbanpour[3], Aristakes Ghahramanyan[1], Anjelika Stepanyan[1], Artur Matevosyan[1]

[1]Laboratory of Plant Nourishment and Productivity, G.S. Davtyan Institute of Hydroponics Problems, NAS RA, Republic of Armenia; [2]Department of Horticultural Sciences, Faculty of Agriculture and Natural Resources, Arak University, Arak, Republic of Iran; [3]Department of Medicinal Plants, Faculty of Agriculture and Natural Resources, Arak University, Arak, Republic of Iran.

***Corresponding Author: Anna Tadevosyan,** Ph.D., Laboratory of Plant Nourishment and Productivity, G.S. Davtyan Institute of Hydroponics Problems, National Academy of Sciences, Noragyugh 108, Yerevan 0082, Armenia

Submission Date: March 13th, 2025; **Acceptance Date:** April 11th,2025; **Publication Date:** April 15th, 2025

Please cite this article as: Daryadar M., Tadevosyan A., Roosta H. R., Ghorbanpour M., Ghahramanyan A., Stepanyan A., Matevosyan A. A preliminary study of the domestication of Falcaria vulgaris Bernh. in the Ararat Valley of Armenia. *Bioactive Compounds in Health and Disease* 2025; 8(4): 144 – 155. DOI: https://www.doi.org/10.31989/bchd.8i4.1613

ABSTRACT

Background: *Falcaria vulgaris* Bernh. (sickleweed) holds great potential as a food and medicinal plant. Its bioactive compounds (BAC) offer potential health benefits, including antimicrobial, anti-inflammatory, antioxidant, and anticancer effects. Its rich nutritional profile makes it a valuable functional food source. By studying the domestication possibilities of this plant, there is a potential to further enhance its properties without harming the environment and biodiversity. Research into its BAC content can unlock its full potential as a functional food and therapeutic herb.

Objective: To investigate the possibility of domesticating the wild edible plant sickle weed in the Ararat Valley of Armenia in hydroponic and soil conditions.

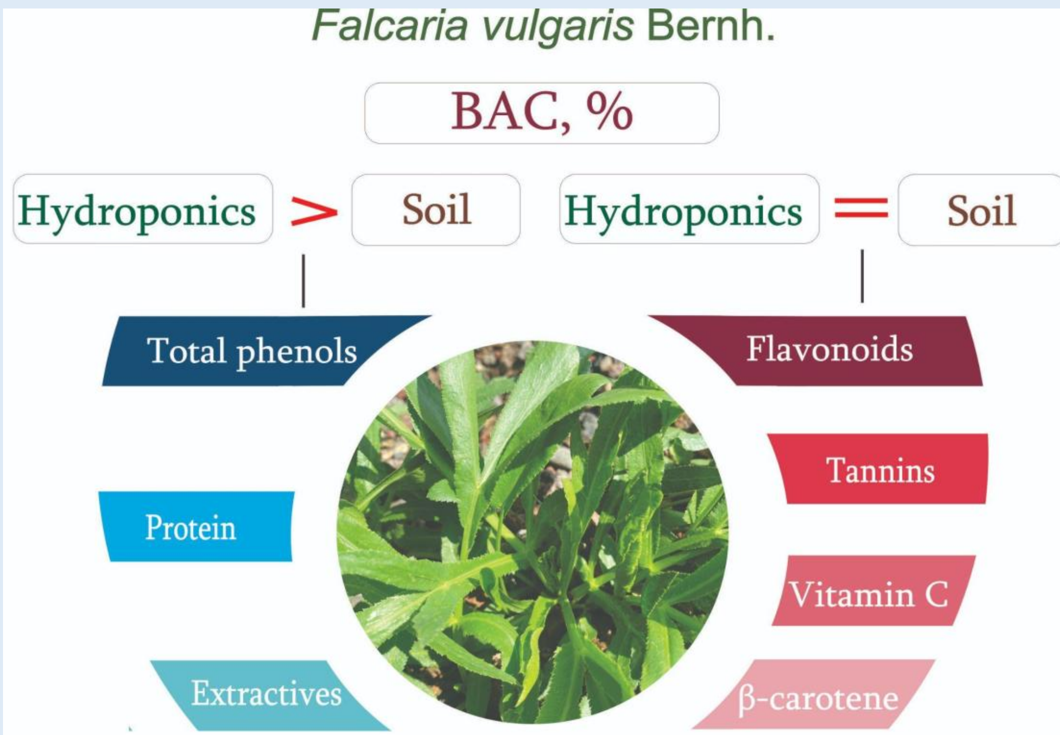
Methods: The plants' Vitamin C, β-carotene, and tannin content were determined using a titrimetric method. The total flavonoid and phenol content was quantified using a spectrophotometric method. Total protein content was assessed using the Kjeldahl method.

Results: The study on sickleweed under hydroponics and soil cultivation observed significant differences in biometric parameters such as leaf number, leaf length, and root thickness in June: hydroponic plants had 1.3 times more leaves and thicker roots, whereas soil-grown plants developed leaves that were 3.5 cm longer on average. Hydroponic plants also exhibited significantly higher yields of BAC: 1.5 times more extractives, 1.2 times more flavonoids, 1.5 times more phenols, 1.3 times more tannins, and 1.7 times more protein. However, vitamin C and β-carotene levels remained in the same range for both growing conditions.

Novelty of the Study: This study pioneers the domestication of *Falcaria vulgaris* in Armenia's Ararat Valley, comparing hydroponic and soil cultivation. Hydroponic methods significantly increased yields of flavonoids, phenols, tannins, and protein versus soil cultivation. This research uniquely establishes domestication feasibility and optimizes functional food potential via controlled hydroponics, providing regional growth and biochemical data.

Conclusion: The study confirmed the possibility of domesticating sickle weed in the conditions of the Ararat Valley. Hydroponic cultivation generally provides a higher concentration of specific BAC, which can enhance the plant's medicinal properties as a functional food.

Keywords: sickle weed, hydroponics, soil, flavonoids, total phenols, tannins, protein, vitamin C



Graphical Abstract: A preliminary study of the domestication of Falcaria vulgaris Bernh. in the Ararat Valley of Armenia

INTRODUCTION

Vegetarian cuisine, centered around plant-based ingredients, has become a popular dietary choice globally due to its potential health benefits and environmental sustainability. As awareness grows about the impact of animal agriculture on the planet and human health, more people are turning to vegetables, fruits, grains, and legumes as the cornerstone of their diets. Beyond simply providing nourishment, many plant-based foods are recognized for their functional properties, offering additional health benefits such as antioxidant, anti-inflammatory, and antimicrobial effects [1-3]. One such plant that has garnered attention for its potential nutritional and medicinal properties is *Falcaria vulgaris* Bernh. (FV). The local name in Armenia is Sibekh sovorakan. According to Batsatsashvili K. et al. [4], it is distributed in all floristic regions of Armenia at altitudes of 700–2000 meters. This plant, rich in bioactive compounds, exemplifies the growing trend of using wild plants in vegetarian and vegan diets as a food source and a natural remedy for various health conditions [5-6]. FV is a wild plant part of the Apiaceae family, commonly found in regions with temperate climates. While it is not as widely cultivated as other plants, it grows naturally in various parts of the world, particularly in Europe, Asia, and North America [7].

FV holds great promise both as a food and medicinal plant. It's BAC offers potential health benefits, including antimicrobial, anti-inflammatory, antioxidant, and anticancer effects. Additionally, its rich nutritional profile makes it a valuable food source. By studying its genetic profile, there is potential to enhance its properties through breeding programs, ensuring that FV continues to serve as a significant plant in human health and nutrition. Research into its organic and mineral content will also help unlock its full potential as a functional food and therapeutic herb [8-9].

The leaves of FV contain a variety of BAC that contribute to their medicinal and biochemical effects. These compounds are primarily involved in antioxidant, anti-inflammatory, and antimicrobial activities, which may have health benefits. FV contains phenolic compounds, which are known for their antioxidant properties. These compounds can help neutralize free radicals, potentially reducing oxidative stress and lowering the risk of chronic diseases such as heart disease and cancer [10-11]. The leaves of this plant contain essential nutrients, such as vitamin C, which is vital for maintaining immune function, skin health, and collagen production [12].

The tannins in FV play a role in its antioxidant activity, which helps neutralize harmful free radicals and protect cells from oxidative damage. This antioxidant effect is beneficial in preventing chronic diseases like cardiovascular diseases, diabetes, and cancer. Moreover, the anti-inflammatory properties of tannins contribute to alleviating symptoms of inflammatory conditions such as arthritis and digestive tract disorders [13].

The protein content in FV provides an essential source of amino acids that help support general health. Consuming FV as a vegetable may help meet daily protein requirements, especially in diets that are plant-based or lacking in other protein-rich food sources [14]

The study aims to investigate the possibility of domesticating the wild edible plant Falcaria vulgaris Bernh in the Ararat Valley of Armenia, using hydroponic and soil cultivation. The research identifies the key quality indicators in FV leaves for food and their biochemical components: flavonoids, total phenols, tannins, protein, and vitamin C.

MATERIALS AND METHODS

Plant growth and sample collection: This study in Armenia's Ararat Valley compared plant growth in hydroponic and soil conditions using FV. In hydroponics, the EBB and Flow method with automatic nourishment was used [15]. The experiment utilized self-seeding seedlings of FV, which is known for its well-expressed self-seeding property. In the spring of 2023, wild plants growing in the Institute of Hydroponics Problems territory were replanted into hydroponic vessels. These plants were adapted into soilless culture and have flowered since August. Self-seeding of the hydroponic mother plants occurs from the end of August through early September. By the middle of September, the self-seeding seeds began to germinate uniformly, and by the end of October, viable seedlings suitable for transplanting had formed. Ten plants were randomly selected from the seedlings, and biometric measurements were taken. The seedlings overwintered in hydroponic containers. In early April 2024, on April 3rd, the self-seeding seedlings of the hydroponic mother plants were transplanted into permanent hydroponic and soil-growing media. Ten plants were randomly selected from the seedlings, carefully removed from the substrate, and their aerial and underground parts were separated. The roots were washed carefully to remove substrate particles, and biometric measurements were recorded. During the growing season, four biometric measurements were made: in April, May, June, and July. The lengths of the roots and aerial organs were measured using a ruler, and the root collar thickness was measured using an electronic caliper. Volcanic slag and gravel were hydroponic substrates [16-17]. The hydroponic plants were nourished 1-2 times daily with a specific nutrient solution developed by Davtyan [18]. In contrast, the FV grown in soil was irrigated every 3-4 days.

Determination of vitamin C content: A 5-gram sample of fresh leaves was ground in a mortar with 20 mL of 1% hydrochloric acid solution to achieve a uniform mixture. The resulting leaf paste was then transferred to a volumetric flask containing 80 mL of 1% oxalic acid solution. From this mixture, two 10 mL aliquots were precisely measured and titrated with a 0.001 N solution of 2,6-dichlorophenolindophenol dye using a micro burette [19].

Determination of β-carotene: A 0.5-gram sample of fresh leaf material was carefully crushed in a mortar with sodium bicarbonate ($NaHCO_3$) to neutralize organic acids and with sodium sulfate (Na_2SO_4) for dehydration. Once the mixture was thoroughly ground, hexane was added to the mortar. The mixture was then filtered by suction, and the mortar was rinsed with additional hexane. The residue on the filter paper was washed with small portions of hexane until the color of the eluate was no longer visible. The resulting hexane extract was transferred to a 25 mL volumetric flask and diluted to the mark with hexane. The final extract was analyzed using a UV spectrophotometer at a wavelength of 445 nm. [20].

Determination of extractives, flavonoids, and total phenols: A 1-gram sample of dried and finely ground leaves of the plant material was mixed with 100 ml of 70% ethanol and extracted by a reflux extraction method for 60 minutes. After cooling, the extract was filtered into a 100 mL volumetric flask, and the flask and filter paper were rinsed with additional ethanol to ensure complete transfer. The volume was then brought to the mark with 70% ethanol to prepare Solution A. For analysis, 2 mL of Solution A was transferred to a 25 mL volumetric flask, diluted with ethanol, and the absorbance was measured at 370 nm for flavonoids and 277 nm for total phenols using a UV-Vis spectrophotometer [20].

Determination of tannins: 2 grams of crushed dry plant material were accurately weighed and transferred to a 250 mL conical flask, adding 50 mL of boiling water. The mixture was heated in a water bath for 30 minutes with constant stirring. The hot extract was then filtered through cotton wool into a 250 mL volumetric flask, and this extraction process was repeated four more times. The filtrates were collected in the same volumetric flask, and the final volume was adjusted to the mark with distilled water, resulting in Solution A. For titration, 25 mL of Solution A was transferred to a 1 L conical flask, followed by the addition of 750 mL of distilled water and 25 mL of indigo carmine (or indigo sulfonic acid) solution. The solution was titrated with 0.1 N $KMnO_4$ while stirring continuously until the color changed from blue to golden yellow. The volume of $KMnO_4$ used was recorded as V_1. A blank solution was prepared similarly, and the volume of $KMnO_4$ used was recorded as V_2. The tannin content **(**X**)** was calculated using the formula [21]:

$$X = ((V_1 - V_2) * D * V * 100) / (m * V_3)$$

Determination of proteins: Protein content in dry leaves was estimated by determining the nitrogen content and applying a nitrogen conversion factor of 6.25. The nitrogen content was measured using the modified micro-Kjeldahl method. [22].

Statistical Analysis: The obtained data were analyzed using Microsoft Excel and GraphPad Prism 8.

RESULTS AND DISCUSSION:

FV's productivity and biometric indicators were studied under hydroponic and soil cultivation conditions. The data revealed that by the end of October, the average root length of the self-seeding seedlings was 15.9 cm, the leaf length was 14.9 cm, the number of leaves was 5.4, and the root collar thickness was 2.6 mm. In the following April, the root length of the transplanted seedlings ranged from 36 to 55 cm, with an average of 44.4 cm. The leaf length ranged from 18 to 20 cm, averaging 19 cm. The number of leaves ranged from 4 to 6, with an average of 5. The root collar thickness ranged from 3.7 to 4.7 mm, averaging 3.9 mm. The fresh weight (FW) of the aerial and underground organs of the seedlings was also determined. The FW of the leaves ranged from 1.4 to 6.0 g, while the root weight ranged from 2.0 to 3.9 g.

The seedlings transplanted to the permanent growing media (hydroponic substrate and soil) showed 100% adhesion. In May, hydroponic and soil plants didn't significantly differ in leaf length, leaf number per plant, and root collar thickness (Fig. 1a, b, d). The leaf length of the hydroponic plants ranged from 17.0 to 20.7 cm, with an average of 17.9 cm, while for the soil-grown plants, it ranged from 19.0 to 22.0 cm, with an average of 20.3 cm. In other words, the leaves of soil plants were 2.4 cm longer, but that difference was insignificant. The number of leaves in the hydroponic plants ranged from 6 to 8, and in the soil-grown plants it ranged from 6 to 7, with averages of 7.4 and 7 leaves, respectively. The root collar thickness ranged in the hydroponic plants from 6.0 to 7.6 mm and in the soil-grown plants from 5.9 to 7.1 mm, with averages of 6.7 and 6.5 mm, respectively. It was noted that at the beginning of the growing season, the ever-increasing medium did not significantly affect the biometric indicators of FV (Fig. 1a, 1b, 1d).

In June (Fig. 1a, 1b, 1d), the hydroponic and soil plants significantly differed in their biometric data. The hydroponic plants had a higher number of formed leaves (1.3 times more) and root collar thickness (1.1 times more), while the soil plants had longer leaves (on average, they were 3.5 cm longer). The leaf length in the hydroponic variant ranged from 19 to 21 cm, and in the soil variant, it ranged from 21 to 25 cm, with averages of 20.0 and 23.5 cm, respectively. The number of leaves per plant in the hydroponic and soil variants ranged from 8 to 11 and 7 to 8, with averages of 9.3 and 7.2, respectively. The root collar thickness ranged in the hydroponic variant from 7.3 to 7.4 mm and in the soil variant from 6.0 to 7.6 mm, with averages of 7.4 and 6.5 mm, respectively.

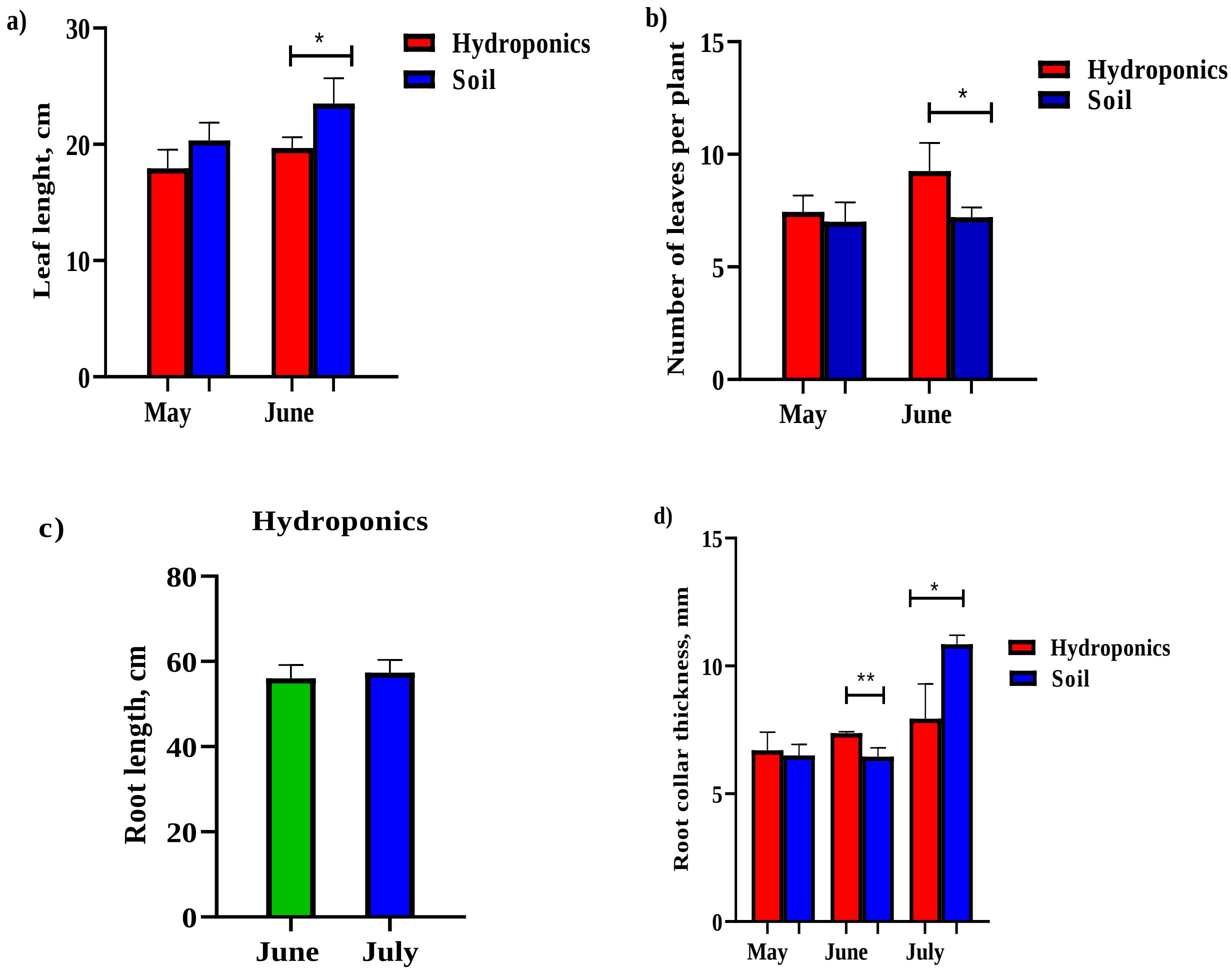


Figure 1. Biometric data: leaf length (a), number of leaves per plant (b), root length (c), and root collar thickness (d) of one-year-old FV in hydroponics and soil (* P<0.05, ** P<0.005).

In June, the root length of FV in hydroponics ranged from 53 to 60 cm, and in July, the root length of the hydroponic plants reached 54-60 cm (Fig. 1c). So, there has been no change in root length since June. The root length of the soil-grown plants was not measured, as removing the plants from the soil completely was impossible.

In July, the plants flowered, while the leaves dried out. The root collar thickness of the plants ranged from 7.0 to 9.5 mm in hydroponics and from 10.5 to 11.2 mm in soil, with averages of 7.9 mm and 10.9 mm, respectively. Thus, a significant difference was observed between the root collar thickness of the hydroponic and soil plants during the flowering phase: it was 1.4 times greater in the soil variant.

It was found (Fig. 2-3) that there was no significant difference between the hydroponic and soil FV plants regarding leaf FW, but a significant difference was observed in dry weight (DW). The hydroponic plants exceeded the soil plants in leaf DW by about 30%. The leaf FW of FV ranged in the hydroponic variant from 12.1 to 14.7 g and in the soil variant from 10.1 to 13.5 g, with averages of 14 g and 11.8 g, respectively. For DW, the hydroponic variant ranged from 2.7 to 3.4 g, and the soil variant ranged from 2.2 to 2.9 g, with averages of 3.2 g and 2.5 g, respectively.

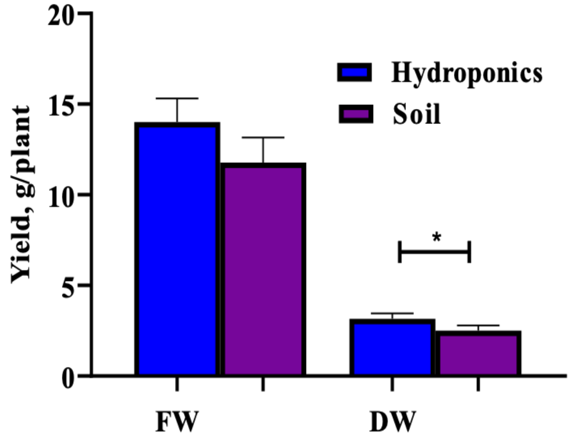


Figure 2. FW and DW of hydroponic and soil FV yield (Different letters indicate significant differences, * P< 0.02).

(a) (b)

Figure 3. Hydroponic (a) and soil (b) FV plants (07.06.2024)

For a product to be considered a functional food, it is necessary to study its BAC, thanks to which the product improves human health [3]. BACs are substances with biological activity that directly affect a living organism, either positively or negatively (23-24). According to Ozturk, FV contains a variety of phenolic components/ [25]. The results of our research show that under the conditions of the Ararat Valley in Armenia, regardless of the growing environment, the total content of flavonoids and phenols in the dry plant material of FV ranged from 2.74-2.83% and 0.46-0.55%, respectively. The recalculation of our research results shows that under soil conditions, the total phenolic content in FV leaves is 97.458 mg/100 g. Moreover, under hydroponic conditions, the total phenolic content in fresh FV plant material can reach up to 125.714 mg/100 g. Rahimi et al. [26] report that in FV fresh leaves collected from 7 different regions of Iran, the total phenolic content ranged from 52.031 to 88.149 mg/100 g, which means that FV grown in soil and hydroponic conditions of Armenia are richer in total phenols than plants grown in Iran by 11-90% and 43-142%, respectively. It is essential to mention that, according to Monfared et al. [27], the maximum concentration of phenolics in Falcaria vulgaris could reach 64.287 ± 0.32 mg GAE/g dry weight powder when exposed to microwave extraction and maceration with ethanol extracts.

Studies conducted in Iran confirm the presence of tannins in FV, but the research is purely qualitative, and no quantitative data are provided [28]. In our research, the tannin content in soil and hydroponic FV ranged on average from 4.66% to 4.69%. The biochemical analysis of the yield (Table 1) revealed that the one-year-old hydroponic and soil plants did not differ in their tannin and flavonoid content. Still, the hydroponic plants stood out with higher levels of extractives (1.2 times).

According to the data in Table 1, hydroponic plants, compared to soil plants, provided higher yields, resulting in increased levels of extractives (1.5 times), flavonoids (1.2 times), phenols (1.5 times), and tannins (1.3 times).

The growing technology had the most pronounced effect on sickle weed's protein content and yield. It was found that compared to soil, protein biosynthesis in plants grown in hydroponics proceeded about 30% more intensively, and due to the high yield of hydroponic plants, 1.7 times more protein was accumulated per plant. Scientific data on the protein content in FV are scarce [29]. However, based on the research, the protein content was 21.69%, which falls within the range of our study results (17.24 - 22.82%).

Table 1. Biochemical indicators of one-year-old FV under different growing conditions (n=3)

Biochemical indices		Hydroponics	Soil
Extractives	%	39.9±0.35*	34.6±0.5
	g/plant	1.28	0.87
Flavonoids	%	2. 74±0. 01	2. 83±0.08
	mg/plant	88	71
Total phenols	%	0.55±0.003*	0.46±0.009
	mg/plant	18	12
Tannins	%	4.69±0.092	4.66±0.065
	mg/plant	150	120
Protein	%	22.82±0.10**	17.20±0.02
	mg/plant	730	431

For the use of sickle weed as a functional food product, it is important to evaluate the content of vitamin C and β-carotene in its biomass, since they have antioxidant properties and are considered a means of increasing the human body's immunity and, to some extent, neutralizing the negative effects of free radicals [30-31]. Literature data confirm the presence of vitamin C and β-carotene in FV, but quantitative data are not provided [7-8]. In June, an analysis of vitamin C and β-carotene content in the leaves of FV was conducted under different growing conditions. It was found (Fig. 4) that there was no significant difference in the vitamin C and β-carotene content between hydroponic and soil plants. Vitamin C content ranged on average from 123.8 to 133.4 mg% and β-carotene content ranged from 11.75 to 12.98 mg%, respectively.

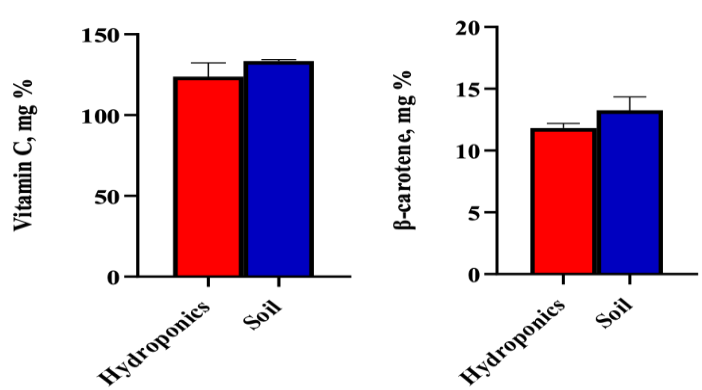


Figure 4. Vitamin C and β-carotene content in FV leaves under different growing media

The growing conditions did not significantly affect the vitamin C and β-carotene yields between the hydroponic and soil variants (Fig. 5), ranging from 14.6 to 18.4 mg/plant and 1.36 to 1.75 mg/plant, respectively.

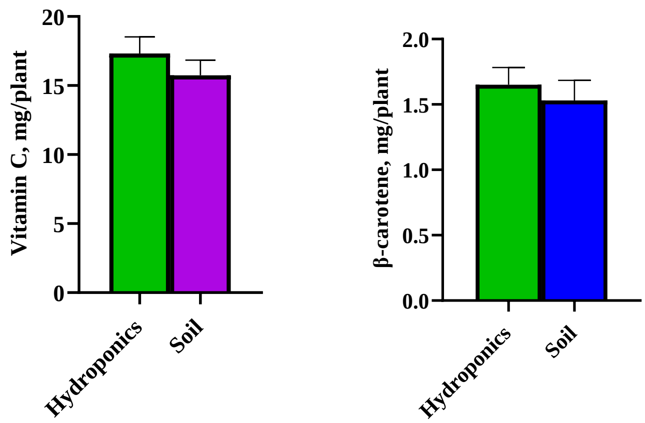


Figure 5. Vitamin C and β-carotene yield in FV leaves under different growing media. Vitamin C yielded 14.6 to 18.4 mg/plant and β-carotene yielded 1.36 to 1.75 mg/plant, respectively.

Scientific innovation and practical implications: This study provides insights into the domestication of wild edible plants, particularly *Falcaria vulgaris* Bernh, in soil and soilless conditions. It shows that high yields with high quality characteristics can be achieved under controlled hydroponic conditions. These results may serve as a background for the domestication of wild edible plants and, in the future, may contribute to biomass production as a functional food with health benefits.

CONCLUSION

The study showed the possibility of domesticating FV in the conditions of the Ararat Valley. The biometric parameters significantly differed between hydroponic and soil-grown plants, including leaf length, number, and root collar thickness. Hydroponic plants also exhibited higher yields of extractives, flavonoids, phenols, tannins, and protein than soil-grown plants. Additionally, vitamin C and β-carotene content were similar in both cultivation environments, indicating that the growing medium did not significantly affect these compounds. Overall, hydroponic cultivation offers a higher concentration of specific BAC, which may enhance the plant's nutritional and medicinal properties.

Abbreviations: Bioactive compounds -BAC; Falcaria vulgaris - FV; Fresh Weight - FW; Dry Weight – DW

Authors' Contribution: All authors contributed to this study.

Competing interests: The authors declare no conflict of interest.

Acknowledgement/Funding: The RA Science Committee supported the work in the research project № 22RL-028 framework.

REFERENCES

1. Sevoyan G, Ghazaryan K, Yesayan T, Hayrapetyan A, Minasyan S, Babayan B, Gabrielyan I, Esoyan S, Chakhmakhchyan A, Grigoryan A, Melkumyan M: Traditional vegetarian food products in villages of Syunik, Armenia: Technogenic contamination risks assessment. Functional Food Science 2024, 4(10):380-9. DOI: https://doi.org/10.31989/ffs.v4i10.1463

2. Dhont K, Ioannidou M: Similarities and differences between vegetarians and vegans in motives for meat-free and plantbased diets. Appetite 2024, 195:107232.
DOI: https://doi.org/10.1016/j.appet.2024.107232
3. Martirosyan D, Stratton S: Quantum and tempus theories of function food science in practice. Functional Food Science 2023, 3(5):55-62.
DOI: https://doi.org/10.31989/ffs.v3i5.1122
4. Batsatsashvili, K. et al. (2017). Falcaria vulgaris Bernh. APIACEAE. In: Bussmann, R. (eds) Ethnobotany of the Caucasus. European Ethnobotany. Springer, Cham.
DOI: https://doi.org/10.1007/978-3-319-49412-8_36.
5. Baghdasaryan A, Martirosyan D: Economic implications of functional foods. Functional Food Science 2024, 4(6):216-27.
DOI: https://doi.org/10.31989/ffs.v4i6.1379
6. Durán-Lara EF, Valderrama A, Marican A: Natural organic compounds for application in organic farming. Agriculture 2020, 10(2):41.
DOI: https://doi.org/10.3390/agriculture10020041
7. Davoodi F, Raisi A, Farjanikish G, Abdollahzadeh H, Kamalpour M: A review on wound healing with Iranian medicinal plants and microbial flora in veterinary medicine. Iranian Journal of Veterinary Surgery 2022, 17(2):146-59.
DOI: https://doi.org/10.30500/ivsa.2022.345708.1304
8. Rahimi M, AhmadiAfzadi M, Kordrostami M: Genetic diversity in Sickleweed (*Falcaria vulgaris*) and using stepwise regression to identify marker associated with traits. Scientific Reports 2023, 13(1):12142.
DOI: https://doi.org/10.1038/s41598-023-39419-5
9. Mandal U, Jyotirmayee B, Mahalik G: Traditional plants utilized for the viral disease treatment. Plant Science Today 2022, 9(2):386-98.
DOI: https://doi.org/10.14719/pst.1491
10. Shahsavari S, Sarkar S, Sen DJ, Mandal SK: Determination of the total antioxidant activity of methanolic extract of *Falcaria vulgaris*. Journal of Biochemicals and Phytomedicine 2022, 1(1):8-12.
DOI: https://doi.org/10.34172/jbp.2022.3
11. Hosseini, K., Jasori, S., Delazar, A. *et al.* Phytochemical analysis and anticancer activity of *Falcaria vulgaris* Bernh growing in Moghan plain, northwest of Iran. *BMC Complement Med Ther* 21, 294 (2021).
DOI: https://doi.org/10.1186/s12906-021-03464-2
12. Khazaei F, Yadegari M, Ghanbari E, Heydari M, Khazaei M: Therapeutic applications and characteristics of *Falcaria vulgaris* in traditional medicine and experimental studies. Avicenna Journal of Phytomedicine 2022, 12(2):116.
DOI: https://doi.org/10.22038/AJP.2021.18488
13. Jafari Z, Farzaei MH, Foroughini A: Potential therapeutic effects of *Falcaria vulgaris* Bernh: A systematic review. Journal of Reports in Pharmaceutical Sciences 2022, 11(1):18-27.
DOI: https://doi.org/10.4103/jrptps.JRPTPS_160_21
14. Salahshoor MR, Mohammadi MM, Roshankhah S, Jalili C: Effect of *Falcaria vulgaris* on milk production parameters in female rats' mammary glands. Journal of family & reproductive health 2018, 12(4):177.
15. Tadevosyan A, Daryadar M, Tovmasyan A, Asatryan A, Roosta HR, Hakobjanyan A: Comparison of Growth, Antioxidant, and Antibacterial Activities in Hydroponic and Soil-grown Moringa oleifera in Armenia. International Journal of Horticultural Science and Technology 2024, 11(2):217-28.
DOI: https://doi.org/10.22059/ijhst.2023.362559.669
16. Daryadar M, Alexanyan J, Mayrapetyan S, Mayrapetyan K, Tovmasyan A, Tadevosyan A: Estimating peppermint essential oil levels: water-stream and classical hydroponic systems. Functional Foods in Health and Disease 2023, 13(7):361-71.
DOI: https://doi.org/10.31989/ffhd.v13i7.1123
17. Tadevosyan A, Hakobjanyan A, Tovmasyan A, Asatryan A, Roosta HR, Daryadar M: Hypoglycemic and hypolipidemic activity of moringa grown in hydroponics and soil in Ararat Valley. Functional Foods in Health and Disease 2023, 13(8):398-408.
DOI: https://doi.org/10.31989/ffhd.v13i8.1158
18. Ghalachyan L, Mairapetyan S, Vardanyan A, Hovhannisyan L, Daryadar M, Mairapetyan K, Tadevosyan A: The study of gross beta-radioactivity of some medicinal plants in conditions of outdoor hydroponics and soil culture in Ararat Valley. Bioactive Compounds in Health and Disease 2023, 6(10):243-258.
DOI: https://doi.org/10.31989/bchd.v6i10.1174
19. Daryadar M, Matevosyan A, Roosta H, Ghorbanpour M, Stepanyan A, Ghahramanyan A, Tadevosyan A: Some parameters of hydroponic and soil Rhubarb cultivated in the Ararat Valley of Armenia. Functional Foods in Health and Disease 2024, 14(8):564-73.
DOI: https://doi.org/10.31989/ffhd.v14i8.1401
20. Vardanyan A, Ghalachyan L, Tadevosyan A, Baghdasaryan V, Stepanyan A, Daryadar M: The phytochemical study of Eleutherococcus senticosus (Rupr. & Maxim) leaves in hydroponics and soil culture. Functional Foods in Health and Disease 2023, 13(11):574-83.

DOI: https://doi.org/10.31989/ffhd.v13i11.1183

21. Atanassova M and Christova-Bagdassarian V: Determination of tannins content by titrimetric method for comparison of different plant species. J. Univ. Chem. Technol. Metallurgy 2009, 44(4), 413-415.
22. Matevosyan A, Tadevosyan A, Tovmasyan A, Asatryan A, Mairapetyan S: Nutritional Value of Soybean under Outdoor Hydroponics and Soil Conditions of the Ararat Valley. Functional Foods in Health and Disease 2023, 13(10):533-46. DOI: https://doi.org/10.31989/ffhd.v13i10.1208
23. Martirosyan D., Miller E., Bioactive Compounds: The Key to Functional Foods. Bioactive Compounds in Health and Disease 2018, 1(3): 36-39. DOI: https://doi.org/10.31989/bchd.v1i3.539
24. V. Santé-Lhoutellier, V. Ferraro: Contribution of bioactive compounds from meat, Editor(s): Michael Dikeman, Encyclopedia of Meat Sciences (Third Edition), 2024, 750-756. DOI: https://doi.org/10.1016/B978-0-323-85125-1.00189-7.
25. Ozturk HI, Nas H, Ekinci M, Turan M, Ercisli S, Narmanlioglu HK, and Peluso I: Antioxidant Activity, Phenolic Composition, and Hormone Content of Wild Edible Vegetables. Horticulturae 2022, 8(5), 427. DOI: https://doi.org/10.3390/horticulturae8050427
26. Rahimi M, Kordrostami M, Nasiri J: Evaluation of biochemical, physiological traits and percentage of essential oil of sickleweed (*Falcaria vulgaris*) population in different geographical and climatic regions. Plos one 2023, 18(6), e0287480. DOI: https://doi.org/10.1371/journal.pone.0287480
27. Monfared, K. E., Rafiee, Z., and Jafari, S. M. Phenolic Content and Antioxidant Activity of Falcaria vulgaris Extracts. Analytical Chemistry Letters, (2012)., 2(3), 159–170. DOI: https://doi.org/10.1080/22297928.2000.10648264
28. Fazly Bazza, BS, Haririzadeh G, Imami SA, and Rashed MH: Survey of Iranian plants for alkaloids, flavonoids, saponins, and tannins [Khorasan Province]. International journal of pharmacognosy 1997, 35(1), 17-30. DOI: https://doi.org/10.1076/phbi.35.1.17.13275
29. Tunçtürk M, Tunçtürk R, Eryiğit T, & Kaya AR: Mineral and heavy metal constituents of three edible wild plants growing in Van province. Iğdır Üniversitesi Fen Bilimleri Enstitüsü Dergisi 2018, 8(2), 293-298. DOI: https://doi.org/10.21597/jist.429008
30. Agwu E, Ezihe C, Kaigama G. Antioxidant Roles/Functions of Ascorbic Acid (Vitamin C). IntechOpen. 2024, DOI: https://doi.org/10.5772/intechopen.110589
31. Tufail T, Bader Ul Ain H, Noreen S, Ikram A, Arshad MT, Abdullahi MA: Nutritional Benefits of Lycopene and Beta-Carotene: A Comprehensive Overview. Food Sci Nutr. 2024, 12(11):8715-8741. DOI: https://doi.org/10.1002/fsn3.4502.