Bulgarian Chemical Communications, Volume 52, Special Issue D (pp. 30-32) 2020

Quantitative determination of ascorbic acid in *Callisia fragrans* under open-air hydroponic conditions

A. S. Karapetyan*, S. Kh. Mairapetyan

Laboratory of Plant Nutrition and Productivity, G.S. Davtyan Institute of Hydroponics Problems, NAS RA, 108 Noragyugh, 0082 Yerevan, Republic of Armenia

Received January 24, 2020; Revised February 28, 2020

The influence of growing media on the accumulation of ascorbic acid (AsA) in the medicinal raw material of *Callisia fragrans* (*C. fragrans*) was investigated for the first time. The plants were cultivated in open-air hydroponic conditions of Ararat Valley. Soil culture was used as a control. As a result of the experiments it was found that soilless culture had positive impact on the biosynthesis of AsA in the medicinal raw material: the content of AsA in the leaves and lateral sprouts of hydroponic plants was 20.3 and 29.4 mg/100 g, respectively, which, compared to the control was higher by about 40 and 30%, respectively.

Keywords*: C. fragrans*, ascorbic acid, hydroponics, soil culture, medicinal raw material.

INTRODUCTION

Growth, development and reproductive success of plants depend on numerous factors of environment such as temperature, amount of sunlight, water (humidity), nutrition, radiation, *etc*. These factors affect the intensity of physiological (photosynthesis, transpiration, respiration, *etc*.) and biochemical processes that occur in plants and sometimes are considered to be the limiting. That is why, plants cultivated under various growing conditions are differed with regularities of growth, development and metabolism. Having an opportunity to control the main factors in the root zone, it is possible to activate and/or direct the most important physiological and biochemical processes in plants.

Hydroponics (soilless culture) as an alternative way of plant production is becoming more and more popular in the modern world. As the construction of hydroponic stations is quite expensive, it is advisable to grow rare, endangered, expensive, valuable, small-tonnage plants, like medicinal plants [1].

C. fragrans (*Callisia fragrans* (Lindl.) Woodson) is a valuable medicinal plant of *Commelinaceae* family. The plant contains a number of bioactive substances such as phenolic compounds, amino acids, carbohydrates, flavonoids, coumarins, vitamins, *etc*. Due to its rich chemical composition, the medicinal plant has antioxidative, antiradical, stress-protective, immunomodulating, antiherpetic and other medical activities [2-5].

Years ago, *C. fragrans* (Fig. 1) was introduced into open-air hydroponic conditions of Ararat Valley for the first time by us.

According to the results of our experiments, in hydroponic conditions the plants were distinguished with high productivity of medicinal raw material. Due to the high yield of biomass, the output of bioactive substances from the medicinal raw material of hydroponic plants was also higher compared with the output from the soil plants. Moreover, the experiments also showed that hydroponic conditions had positive impact on the physiological activity of the leaves and the content of photosynthetic pigments in the leaves [6-8]. According to the literature review, the intensity of photosynthesis in plants is largely due to the presence of AsA (vitamin C), which is considered to be a cofactor of enzymes which are involved in the regulation of photosynthesis [9].

Fig. 1. *C. fragrans*

Based on the above, in the frame of this work the influence of growing soilless conditions (open-air hydroponics) of Ararat Valley on the content of AsA in the medicinal raw material of *C. fragrans* was studied.

* To whom all correspondence should be sent:
E-mail: astghik84k@rambler.ru

The present work is very important for understanding *C. fragrans* physiology and how the plants adapt to the growing conditions.

EXPERIMENTAL

The experiments were carried out at the vegetational experimental station of G. S. Davtyan Institute of Hydroponics Problems (National Academy of Sciences, Republic of Armenia).

Planting

For hydroponic growing of the plants special hydroponic vegetational pots (with 0.16 m^2 nutrient surface) were used. A mixture of gravel and volcanic red slag (1:1 volumetric ratio), with 3-15 mm diameter of particles, was used as a growing substrate, which was previously disinfected with 0.05% solution of $KMnO_4$. 12 plants were planted on 1 m^2 of nutrient surface. During the vegetation the plants were nourished twice a day with 0.5 N nutrient solution elaborated by academician G. S. Davtyan [10]. Soil culture was used as a control, where all the accepted agrotechnical rules (fertilization, weed cleaning, irrigation, *etc*.) were followed [1]. Both in hydroponics and in soil the plants were cultivated in open-air conditions of Ararat Valley and subjected to the influence of the same climatic factors.

Sampling

As an object of investigations fresh leaves (an average sample was taken from the top of the plant and its lateral sprouts) and lateral sprouts (with 9 and more brownish-purple interjointal spaces) of the plant were used, which were picked from the plant immediately before performing the analysis.

Determination of AsA

Quantitative determination of AsA in the leaves and sprouts was done by titration. The analytical sample (5 g) was homogenized in 20 mL of 1% solution of HCl, the obtained homogeneous mass was moved into a 100 mL volumetric flask and filled up with oxalic acid, then the solution was filtered and the content of AsA was determined in the filtrate [11].

Statistical analysis

The experiments were performed in 4-6 replications. For the statistical analysis of the obtained data GraphPad Prism 6 (GraphPad Software, Inc.) software package was used.

RESULTS AND DISCUSSION

It was found that the growing conditions had significant impact on the biosynthesis of AsA in the medicinal raw material of *C. fragrans*. According to the results of the biochemical analysis, the hydroponic conditions had positive influence on the accumulation of vitamin C. The content of AsA in the leaves and sprouts of hydroponic plants was 20.3 and 29.4 mg/100 g, respectively, which, compared to the soil ones was higher by about 40 and 30%, respectively. Making parallels between different upground parts of the plant, it is obvious, that regardless of the cultivation conditions the content of AsA in the sprouts was higher than in the leaves. The content of AsA in the sprouts of both soil and hydroponic plants exceeded that in the leaves 1.6 and 1.4 times, correspondingly (Figs. 2, 3).

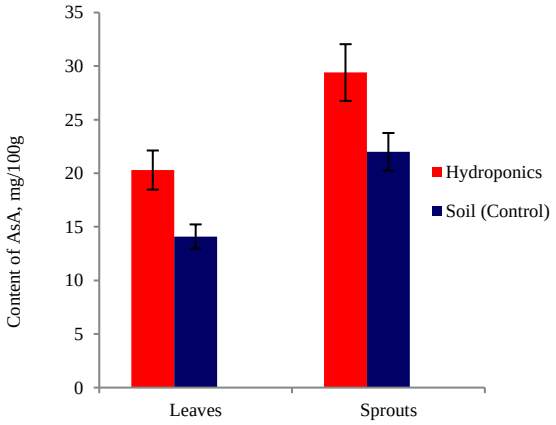

Fig. 2. Content of AsA in the medicinal raw material of *C. fragrans* depending on cultivation conditions.

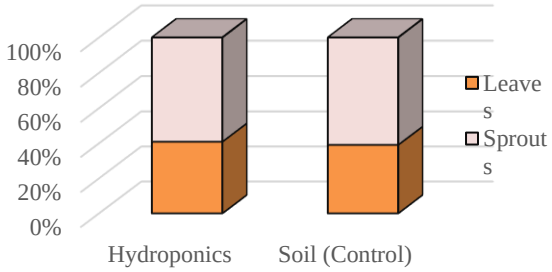

Fig. 3. Proportion of AsA in various upground parts of *C. fragrans* under hydroponic and soil culture conditions.

As a result of our experiments it is shown, that the medicinal raw material of *C. fragrans* obtained in soilless culture conditions is distinguished with high content of AsA compared to the soil ones. This can be explained by the fact that in soilless culture optimal air-water-nutrition conditions are created at the same time almost during the whole vegetation, which provides intensive physiological processes, while in soil culture the plants use the above

mentioned optimal factors only for a short-time period [1].

REFERENCES

1. S. Kh. Mairapetyan, Essential oil-bearing plants culture in open-air hydroponics, AS of ASSR Publ., Yerevan, 1989. [in Russian].
2. T. Chernenko, N. Ul'chenko, A. Glushenkova, D. Redzhepov, *Chem. Nat. Compd*., **43,** 253 (2007).
3. D. N. Olennikov, I. I. Zilfikarov, A. A. Toropova, T. A. Ibragimov, *Himija rastitel'nogo syr'ja*, **4,** 95 (2008). [in Russian].
4. L. N. Shantanova, E. A. Alekseeva, V. B. Khobrakova, D. B. Radnaeva, *Sibirskij medicinskij zhurnal*, **3**, 126 (2009). [in Russian].
5. L. Yarmolinsky, M. Zaccai, Sh. Ben-Shabat, M. Huleihel, *The Open Virology Journal.*, **4**, 57 (2010).
6. A. S. Karapetyan, *Biolog. Journ. Armenia*, **66**, 124 (2014). [in Armenian].
7. S. Kh. Mairapetyan, A. S. Karapetyan, J. S. Alexanyan, H. M. Galstyan, B. T. Stepanyan, *Biolog. Journ. Armenia*, **66**, 65 (2014).
8. S. Kh. Mairapetyan, A. S. Karapetyan, J. S. Aleksanyan, B. T. Stepanyan, H. M. Galstyan, V. G. Takushyan, *Biolog. Journ. Armenia*, **66**, 27 (2015). [in Armenian].
9. N. Smirnoff, G. Wheeler, *Crit. Rev. Biochem. Mol. Biol.*, **35**, 291 (2000).
10. G. S. Davtyan, S. Kh. Mairapetyan, Soilless production of Rose Geranium, AS of ASSR Publ., Yerevan, 1976. [in Armenian].
11. Methods of biochemical studies of plants, A. I. Ermakov (ed.), Kolos, Leningrad, 1972. [in Russian].