International Journal of Research and Review
Vol. 10; Issue: 10; October 2023
Website: www.ijrrjournal.com
Review Paper *E-ISSN: 2349-9788; P-ISSN: 2454-2237*

Cultivation of Medicinal Plants Using Hydroponic System

Jayashree Gaja.[1], Sumanji Bala[2], Sharvani Hugara[3], Tulsiram M.S.[4]

[1,2,3,4]Department of Pharmaceutics, Vivekananda College of Pharmacy, Rajajinagar, Bangalore, Karnataka, 560055

Corresponding Author: Jayashree Gaja.

DOI: https://doi.org/10.52403/ijrr.20231003

ABSTRACT

The global demand for medicinal plants is growing rapidly, and to meet this demand, commercial cultivation of the plants is needed. However, traditional cultivation methods result in varying levels of biomass production as well as active content variation. Hydroponic farming can be used to produce medicinal plants with superior quality, more biomass output, and higher concentrations of bioactive substances. This system plays an important role in improving the therapeutic value of medicinal plant species.

Keywords: Hydroponic, medicinal plants, cultivation, bioactive compounds

INTRODUCTION

Plants have long been utilized in traditional medicine systems like Ayurvedic, Siddha, Unani, Chinese, where these plant medicines still represent an important part of healthcare in developing countries. Medicinal plants also called medicinal herbs, are the natural source of potential new medicines. Several modern semi-synthetic and synthetic drugs are derived directly or indirectly from plants. Medicinal plants are the "backbone" of traditional medicine. [1, 2,3] The development and recognition of medicinal and financial aid for these plants are increasing in both industrialized and developing nations. [4] The WHO estimates that, at present, more than 80% of the world's population relies on traditional healing modalities and herbals to meet primary healthcare needs. [5]

The widespread use of herbal medicine is not only confined to developing countries but has also been widely seen in many European countries as well as in North America and Australia.[6] The traditional medicine system is gaining popularity due to the growing interest of consumers in natural products. In addition, industry demand for herbal products has also increased as new product categories such as health foods, natural cosmetics, hygiene products, and more have emerged over the past few years.[8,9]

The increasing population and the demand for natural medicines have led to the overexploitation of medicinal plant species. Habitat destruction, overharvesting, and improper farming methods have put many of these plants at risk of extinction [9, 10, 11]. Therefore, there is an urgent need to conserve them and develop sustainable cultivation techniques.[12] However, conventional cultivation practices result in large fluctuations in both the amount of biomass produced and concentrations of active constituents. Hydroponic technology may be applied to produce high-quality plant material all year round using appropriate nutrient solutions rather than soil, where essential plant nutrients are dissolved in water for growing plants. [13,14,15,16]

Advantages of hydroponic system [17,18,19,20]

This system offers several advantages as compared to conventional cultivation.

A controlled environment for growth along with proper nutrition helps to face the challenges of climate change.

Plants grow faster and healthier in hydroponics technology than they would be when grown in soil, as these systems provide a balanced supply of water and nutrients.

It reduces or eliminates the use of insecticides and herbicides, resulting in crops that are free from contamination.

There is no need for larger space for cultivation.

Plants that are grown in hydroponic systems typically have superior quality and a higher concentration of bioactive compounds than plants that are cultivated conventionally.

Disadvantages of hydroponic systems: [20, 21]

Although hydroponic systems offer many advantages over soil-based systems, some limitations must be considered.

The cost of installing a hydroponic crop system is typically higher than traditional agricultural systems.

It is necessary to constantly monitor nutrient levels, water usage, and power supply in order to maintain optimal conditions.

Microorganisms, such as bacteria and molds, can contaminate water and cause plant diseases

TYPES OF THE HYDROPONIC SYSTEM:

Wick System:

It is the simplest soil-less hydroponic system, that doesn't require pumps, electricity, or aerators. Plants are kept in an absorbent medium such as coco-peat, perlite, or vermiculite, and have a nylon wick running through their roots to provide water and nutrients. Capillary action transports water and nutrients to plants. This technique works well for small plants but can be difficult to manage as pants grows and get heavier.[22]

Ebb and Flow System:

It is also known as a flood and drain system which uses a pump that periodically floods the grow tray with nutrient solution, which, slowly drains away, ensuring uniform distribution to all plants in the system. Maintenance and set-up are relatively simple.[23]

Nutrient Film Technique:

In the Nutrient Film Technique, a nutrient solution is pumped constantly through 'V-shaped inverted channels in which plants are placed. This process allows for increased yields of produce as the nutrient solution is circulated repeatedly throughout the plant's roots. However, because plants are submerged in fluid indefinitely, they are susceptible to fungal infections. [23, 24]

Drip (or Top Feed) System:

In the drip hydroponic method, the nutrient solution is supplied to the plant roots in an appropriate amount from a reservoir through a water pump. The solution is time-regulated so, this system is expensive and difficult to set up.[24, 25]

Deep water culture System:

In deep water culture, plants are grown in nutrient-rich water and air is supplied directly to their roots via an air stone. Plants are placed in net pots and the roots are suspended within a solution containing oxygen and nutrients. Oxygen levels, nutrient concentrations, and pH balance must be monitored to prevent the growth of algae.[24]

APPLICATIONS OF HYDROPONICS FOR GROWING MEDICINAL PLANTS:

Herbal medicinal products are becoming increasingly popular around the world, so hydroponic cultivation is a good option to meet this demand. This method of growing plants uses water and nutrients in an enclosed environment instead of soil, which can overcome some of the difficulties associated with traditional herbal medicine

such as misidentification, genetic and phenotypical variability, and active substance variability. Controlled cultivation also leads to higher concentrations of bioactive compounds.[25]

The nutrient solution used in a hydroponic culture has a profound effect on the concentration of phytochemical compounds produced by plants. Accumulation of high levels of nitrates can lead to increased production of phenolic compounds and their derivatives.

Hydroponic cultivation of E. purpurea has resulted in an increase in total phenolic content and various caffeic acid derivatives concentrations, with a decrease in perlite size and an increased NO3-/NH4+ ratio.[26]

Costmary, Chrysanthemum balsamita L., Asteraceae, grown in a hydroponic production system shows higher proportions of oxygenated monoterpenes and sesquiterpene hydrocarbons. This suggests that growing conditions and environmental factors strongly affect the composition of essential oil. [27]

The study conducted by Simun Kolega et al showed that growing basil plants in fortified nutrient solutions resulted in an increase in the accumulation of biomass and nutraceutical compounds. Modulation of more than 400 secondary metabolites was observed, including phenylpropanoids, isoprenoids, alkaloids, several flavonoids, and terpenoid molecules.[28]

A study of the nutritional properties of basil (Ocimum basilicum cv. Genova) has shown that its leaves contain higher concentrations of vitamin C and Vitamin E as well as a higher antioxidant activity when grown in hydroponics than when growing in soil.[29]

Results of the Experiments conducted by A. E. Manukyan suggest that nutrient solutions can influence the concentration of pharmaceutical compounds in celandine and catmint, indicating the possibility of modulation of biosynthesis pathways for certain pharmaceuticals via optimal nutritional supplementation. [30]

CONCLUSION

A high-quality plant with improved bioactive component concentrations can be grown hydroponically. Numerous experiments have shown that this method can modify the biosynthesis of secondary metabolites. Additionally, using hydroponics for cultivating medicinal plants has significant practical implications for the pharmaceutical industry.

Declaration by Authors

Ethical Approval: Not Required
Acknowledgement: None
Source of Funding: None
Conflict of Interest: The authors declare no conflict of interest.

REFERENCES

1. Gurib-Fakim A. Medicinal plants: traditions of yesterday and drugs of tomorrow. Molecular Aspects of Medicine 2006; 27(1), 1–93. doi.org/10.1016/j.mam.2005.07.008
2. Lubbe, A., & Verpoorte, R. Cultivation of medicinal and aromatic plants for specialty industrial materials. Industrial Crops and Products 2011; 34(1), 785–801. doi.org/10.1016/j.indcrop.2011.01.019
3. Sofowora, A., Ogunbodede, E., & Onayade, A. The role and place of medicinal plants in the strategies for disease prevention. African Journal of Traditional, Complementary and Alternative Medicines 2013; 10(5), 210-229. DOI: 10.4314/ajtcam. v10i5.2
4. Dar, RA., Shahnawaz, M., & Qazi, P.H. General overview of medicinal plants: A review. The Journal of Phytopharmacology; 2017, 6(6): 349-351. DOI:10.31254/phyto.2017.6608
5. World Health Organization. WHO Traditional Medicine Strategy 2002–2005; 1-6. Geneva, Switzerland.
6. Ekor, M. The growing use of herbal medicines: issues relating to adverse reactions and challenges in monitoring safety. Frontiers in Pharmacology 2014; 4: (177). DOI:10.3389/fphar.2013.00177
7. Pal sk., Shukla Y. Herbal medicine: current status and future. Asian journal of cancer prevention; 2003, 4(4):281-88
8. Chitrarekha A. Jadhav, Dattaprasad N. Vikhe, R. S. Jadhav. Global and domestic market of herbal medicines: a review.

Research Journal of Science and Technology. 2020; 12(4):327-330. DOI: 10.5958/2349-2988.2020.00049.2.
9. Dzoyem JP, Tshikalange E, Kuete V, 24 - Medicinal Plants Market and Industry in Africa,
10. Medicinal Plant Research in Africa, Pharmacology and Chemistry, Elsevier. 2013, 859-890. DOI:10.1016/B978-0-12-405927-6.00024-2
11. Chen, SL., Yu, H., Luo, HM. Luo, Wu Q, Li CF, Steinmetz A. Conservation and sustainable use of medicinal plants: problems, progress, and prospects. Chinese Medicine 2016; 11(1):37. Chen, SL., Yu, H., Luo, HM. Luo, Wu Q, Li CF, Steinmetz A. Conservation and sustainable use of medicinal plants: problems, progress, and prospects. Chinese Medicine 2016; 11(1):37
12. Gupta, R., Nigam, A. & Kapila, R. Cultivation and conservation of underutilized medicinal and agricultural plants in India. Proceedings of the National Academy of Sciences, India Section B: Biological Sciences 2022; 92, 741–745. DOI:10.1007/s40011-022-01405-8
13. Sharma ML. Need for cultivation to enrich Ayurvedic materia medica. Ayu. 2012; 33(1):1-2. DOI:10.4103/0974-8520.100282
14. Maggini, R., Kiefer, C., Guidi, L., Pardossi, A. and Raffaelli, A. Growing medical plants in hydroponic culture. Acta Horticulture. 2012; 952, 697-704
15. Shrestha A, Dunn B. Hydroponics, Oklahoma state university Extension: Division of agricultural sciences and natural resources 2017.
16. Harris, D. Hydroponics: Growing plants without soil, Sphere Books Ltd. London 1978; 192-39
17. Khan, F. A. A review on hydroponic greenhouse cultivation for sustainable agriculture. International Journal of Agriculture Environment and Food Sciences 2018; 2 (2) :59-66
18. Malik A, Kaiser I, Showkat A, Prasanto M, Negi A. A review on the science of growing crops without soil (soilless culture) – a novel alternative for growing crops. International Journal of Agriculture and Crop Sciences 2014; 7: 833-842.
19. Wootton-Beard, P. Growing without soil: An overview of hydroponics. Farming Connect 2019.
20. Umapriya M, Subikshaa. M, Ilakiya Suruthi. V, Jayaprabhakaran. M, Sankarganash A. Hydroponics for the cultivation of medicinal herbs. International Journal of Recent Technology and Engineering 2019; 8(4S2): 655-658. doi.org/10.3390/agriculture12050646
21. Maitreya, A., & Mankad, A.U. A review on study of plant species grown by methods of hydroponics. International Journal of Creative Research Thoughts 2021;9(5), a91-a96
22. Nguyen NT, McInturf SA, Mendoza-Cózatl DG. Hydroponics: A versatile system to study nutrient allocation and plant responses to nutrient availability and exposure to toxic elements. Journal of Visualized Experiments: Jove 2016; (113):1-9. doi: 10.3791/54317
23. George D., & George N. Hydroponics-(soilless cultivation of plants) for biodiversity conservation. 2016;3(6): 97-104. Corpus ID: 220923236
24. Sharma N., Acharya S., Kumar K., Singh NP., & Chaurasia, OP. Hydroponics as an advanced technique for vegetable production: An overview. Journal of Soil and Water Conservation 2018; 17: 364-371. DOI:10.5958/2455-7145.2018.00056.5
25. Kumar S., Singh M., Yadav K., Singh, P. Opportunities and constraints in hydroponic crop production systems: A review. Environment Conservation Journal 2021;22(3), 401–408. doi.org/10.36953/ECJ.2021.22346
26. Maggini R., Kiferle C., Guidi L., Pardossi A. and Raffaelli, A. Growing medicinal plants in hydroponic culture. Acta Horticulture.2012; 952, 697-704. doi.org/10.17660/ActaHortic.2012.952.88
27. Ahmadi F., Samadi, A., Sepehr E. & Rahimi A., Shabala S. Increasing medicinal and phytochemical compounds of coneflower (Echinacea purpurea L.) medicinal plant using new hydroponic culture media and nutrition pattern. Research Square 2021; 1-18. doi.org/10.21203/rs.3.rs-452779/v1
28. Hassanpouraghdam MB, Tabatabaie SJ, Nazemiyeh H, Vojodi L, Aazami MA. Essential Oil Composition of Hydroponically Grown Chrysanthemum balsamita L, Journal of Essential Oil-Bearing Plants 2008; 11(6):649-654. doi.org/10.1080/0972060X.2008.10643682

29. Kolega S., Miras-Moreno B., Buffagni V., Lucini L., Valentinuzzi F., Maver M., Mimmo T., Trevisan M., Pii Y., & Cesco S. Nutraceutical profiles of two hydroponically grown sweet basil cultivars as affected by the composition of the nutrient solution and the inoculation with azospirillum brasilense. Frontiers in Plant Science 2020;11: 596000. 10.3389/fpls.2020.596000. eCollection 2020.
30. Sgherri C., Cecconami S., Pinzino C., Navari-Izzo F., Izzo R., Levels of antioxidants and nutraceuticals in basil grown in hydroponics and soil, Food Chemistry 2010; 123(2),416-422. doi.org/10.1016/j.foodchem.2010.04.058
31. Manukyan AE Optimum nutrition for biosynthesis of pharmaceutical compounds in celandtheine and catmint under outside hydroponic conditions, Journal of Plant Nutrition 2005; 28:5, 751-761. DOI:10.1081/PLN-200055526

How to cite this article: Jayashree Gaja., Sumanji Bala, Sharvani Hugara, Tulsiram M.S. Cultivation of medicinal plants using hydroponic system. *International Journal of Research and Review*. 2023; 10(10): 17-21. DOI: *https://doi.org/10.52403/ijrr.20231003*

******