Biological and Clinical Sciences Research Journal
ISSN: 2708-2261
www.bcsrj.com
DOI: https://doi.org/10.54112/bcsrj.v2021i1.64
*Biol. Clin. Sci. Res. J., Volume, **2020**: 64*
Mini Review Article

BIOSYNTHESIS OF POLYPHENOLS IN SALVIA SPECIES

***SHEIKH KA, MAQSOOD M, REHMAN MU, SARWAR S, QAYYUM AA, Ali Q**

Institute of Molecular Biology and Biotechnology, The University of Lahore, Lahore, Pakistan
Corresponding author email: loinsgate12@gmail.com

(Received, 20th January 2021, Revised 8th May 2021, Published 14th May 2021)

Abstract: *Chinese Salvia Species also called as "sages" are known as full of polyphenols that are rich source of natural antioxidants which are used to decrease levels of free radicals. Caffeic acid is an antioxidant present in Salvia as a secondary metabolite in plant metabolism. Many species of this plant are used in the treatment of degenerative disorders like cancer due to its anti-inflammatory, anti-oxygenation, anti-tumor and cytotoxic properties. Because of these specific properties of salvia species it is used in food, cosmetics and pharmaceutical industries.*

Keywords: salvia, caffeic acid, cytotoxic, cancer, anti-inflammatory

Introduction

Salvia officinalis (Salvia), also known as Chinese Salvia is one of the largest species which belongs to the Lamiaceae family with over 1000 species distributed worldwide out of which 84 species are found within China (Min-hui et al., 2008). It is a perennial plant belongs to the genus Salvia which is highly valued for its roots in traditional Chinese medicine. It has been used as a beneficial drug for certain cardiac diseases particularly in China and other countries in Asia (Wang et al., 2017). Salvia species contain high content of polyphenols particularly Flavonoids and Phenolic acids due to which they are widely used in food and pharmaceutical products. Due to the high level of polyphenols these species exhibit certain anti-oxidant, anti-cancer and other therapeutic effects. Moreover, they also have applications in cosmetic industries due to being high in nutritional values (Wang et al., 2019a). Polyphenols are the micronutrients that can be obtained through certain plant-based foods. They are compounds which are highly rich with antioxidants and potential health benefits. Polyphenols are one of the most abundant antioxidants and provide a positive source of nutrition in diet mainly due to their wide distribution within the plants (Scalbert et al., 2005). Fruits and vegetables being a rich source of polyphenols are considered as the best products of secondary metabolism and also functions to decrease the risk of degenerative diseases such as cancer and arthrosclerosis (Chiva-Blanch and Visioli, 2012). It is necessary to improve the production of polyphenols because of their high antioxidants, anti-cancer and anti-inflammatory capacities. Furthermore, to understand their biosynthetic pathway and regulatory mechanisms (Shi et al., 2019). These polyphenols or secondary metabolites release certain enzymes during their biosynthetic pathways which then can be metabolically engineered to improve the production of these compounds in plants or microorganisms (Ma et al., 2015). Salvia species are used in traditional medicines worldwide as they are high in flavonoids and polyphenols like components (Wang et al., 2019c). The phenolic compounds are rich in their ability of antioxidant production as they can transfer electron to free radicals (Lopresti, 2017). Antioxidants are substances that remove free radicals and can provide to body by artificially or natural means. Natural source of antioxidants are salvia species. As salvia has Antioxidant, anti-inflammatory, cytotoxic activities, of the different types which includes Salvia discolor, *S. officinalis* and *S. sclarea* etc. MIT assay showed to elevate cytotoxic effect of salvia species for human tumor cell lines which suggest that the cytotoxicity of Salvia extracts is affiliated to ortho-dihydroxyl polyphenols groups, especially the rosmarinic acid is a major component of the extracts (Sharopov et al., 2018). Monomers of caffeic acid are frequently present in Salvia, and have antioxidant activity. Caffeic acid play main role and act as a dimer form for rosmarinic acid. And it is the main component of salvia species, as of that plant metabolites from simple to multiple products and give rise to a variety of different oligomers. It has been reported that metabolite biosynthesis appears to be in close association with cultural growth and higher production occurs after reaching a stable stage. This has always been the case with modified roots of

[Citation: Sheikh, K.A., Maqsood, M., Rehman, M.U., Sarwar, S., Qayyum, A.A. Ali, Q. (2021). Biosynthesis of polyphenols in salvia species. *Biol. Clin. Sci. Res. J.*, 2021*:* 64. doi: https://doi.org/10.54112/bcsrj.v2021i1.64]

Echinaceae purpurea, where the highest production of all polyphenolic acids derived from raw material (caffeic acid, caftaric acid, chlorogenic acid and cichoric acid) is achieved on the day of 40-45 of culture, where culture entered a standing phase.

The biosynthetic pathway of polyphenols in salvia species is shown below:

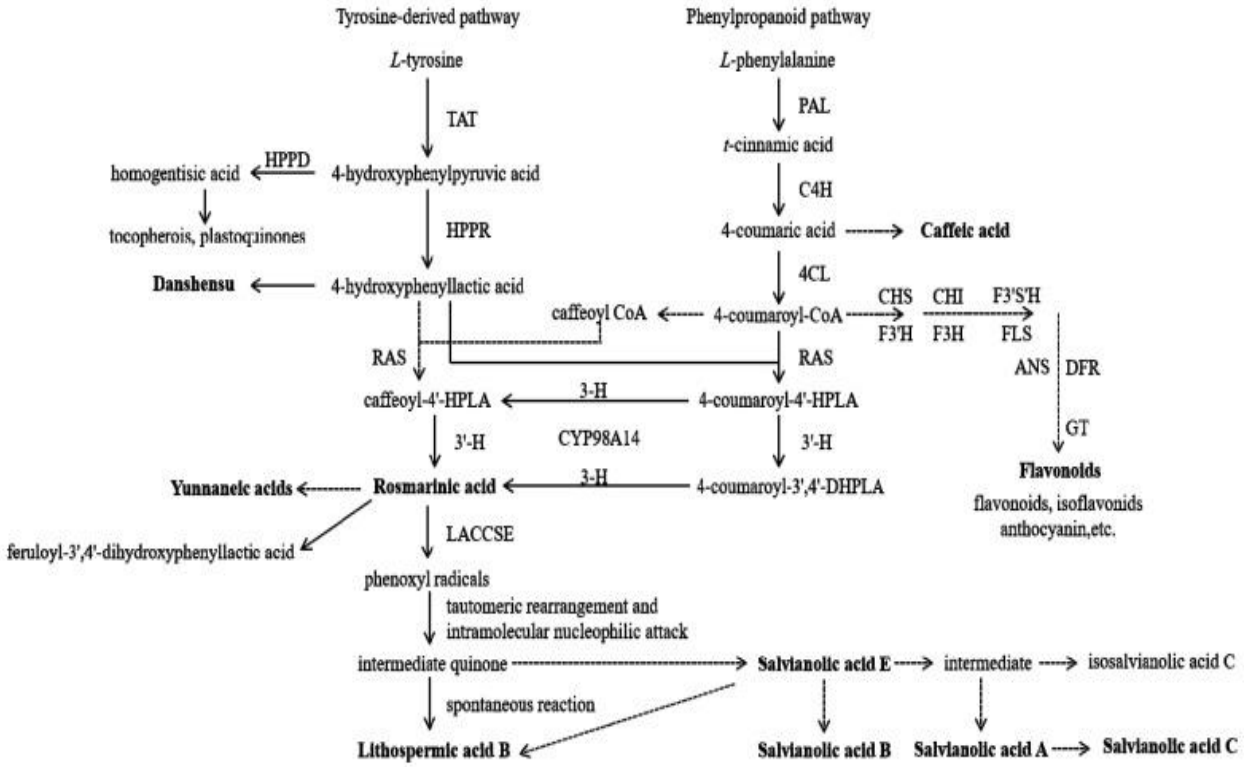

Figure 1. Biosynthetic pathway of polyphenols in salvia species (Wang et al., 2019b) HPPR: 4-hydroxyphenylpyruvate reductase; 4CL: 4-coumarate-CoA ligase; TAT: tyrosine aminotransferase; RAS: hydroxycinnamoyl-CoA: HPPD: 4-hydroxyphenylpyruvated dioxygenase; PAL: phenylalanine ammonia-lyase; hydroxyphenyllactate hydroxycinnamoyl transferase; caffeoyl-4′-HPLA: 4-coumaroyl-3′,4′-DHPLA: 4-coumaroyl-3′,4′-dihydroxyphenyllactic acid; caffeoyl-4′-hydroxyphenyllactic acid; 4-coumaroyl-4′-HPLA: 4-coumaroyl-4′-hydroxyphenyllactic acid; 3-H: hydroxycinnamoyl-hydroxyphenyllactate 3-hydroxylase, C4H: cinnamic acid 4-hydroxylase; 3′-H: hydroxycinnamoyl-hydroxyphenyllactate 3′-hydroxylase; dotted line: proposed biosynthesis processes; Solid line: the verified biosynthesis process

It is believed that the roots that are hairy, can synthesize secondary metabolites present in transformed tissues which suggested that the condition of culture or the change in the gene of transformed roots can change the biosynthesis of polyphenol's pathway. The synthesis of compounds is lower in natural root plants and higher in hairy roots which ultimately results in more stable culture process and their growth depends upon the rol gene expression (Grzegorczyk-Karolak et al., 2018). Polyphenol oxidases are present in fungi, land plants, and some bacteria, such as *P.* patens, *P.* trichocarpa, eggplant, tomato, sugarcane, vicia faba, walnut, and grapevine. PPOs has great variation members encoded by the gene family (Li et al., 2017) . These genes have been originated in bacteria and the transferred PPO gene expands through gene duplication or deletion of fragments during plant evolution which is why there is variation in PPO gene. The cell cultures of salvia can be brought by different part of plants such as roots, anthers, leaves, seeds, petioles and stems. The accumulation of these metabolites shall remain high in the tissues of plants for a higher production of bioactive compounds (D'Amelia et al., 2017). The presences of polyphenols in acids such as salvianolic, luteiolic gluciside and rosemarinic acid present in ethanolic extract helps in stabilizing and reducing the gold salts that produce nanoparticles of AuNPs and thus these plant extracts act as great agents for reducing and stabilizing (Oueslati et al., 2020). The polyphenols extracted from various fruits and plants have the ability of reducing and stabilizing AgNPs, it also

requires little maintenance and are low on budget. In biotechnology and several industries related to microbial production, AgNPs are used as antibacterial agent to prevent the replication of certain fungi and bacteria, this property acts against both gram negative and positive bacteria (Hernández-Morales et al., 2019)

Conclusion

Different sorts of polyphenols were explored inside and out. A few elements are engaged with the system of polyphenol action against neurodegenerative illnesses. Diverse polyphenols have fluctuating potencies of decrease. Another significant factor included is the bioavailability of polyphenols. It is vital to know that the polyphenols have a higher bioavailability and could help forestall illnesses proficiently. Polyphenols could show supportive of oxidant properties that could endanger the job of polyphenols and deteriorate oxidative pressure. Subsequently, a superior comprehension of their central decrease component would help in creating novel treatments for diseases.

Conflict of interest

The authors declared absence of conflict of interest.

References

Chiva-Blanch, G., and Visioli, F. (2012). Polyphenols and health: Moving beyond antioxidants. *Journal of Berry Research* **2**, 63-71.

D'Amelia, V., Ruggiero, A., Tranchida-Lombardo, V., Leone, A., Tucci, M., and Docimo, T. (2017). Biosynthesis of salvia specialized metabolites and biotechnological approaches to increase their production. *In* "Salvia Biotechnology", pp. 241-270. Springer.

Grzegorczyk-Karolak, I., Kuźma, Ł., Skała, E., and Kiss, A. K. (2018). Hairy root cultures of Salvia viridis L. for production of polyphenolic compounds. *Industrial crops and products* **117**, 235-244.

Hernández-Morales, L., Espinoza-Gómez, H., Flores-López, L. Z., Sotelo-Barrera, E. L., Núñez-Rivera, A., Cadena-Nava, R. D., Alonso-Núñez, G., and Espinoza, K. A. (2019). Study of the green synthesis of silver nanoparticles using a natural extract of dark or white Salvia hispanica L. seeds and their antibacterial application. *Applied Surface Science* **489**, 952-961.

Li, C., Li, D., Li, J., Shao, F., and Lu, S. (2017). Characterization of the polyphenol oxidase gene family reveals a novel microRNA involved in posttranscriptional regulation of PPOs in Salvia miltiorrhiza. *Scientific reports* **7**, 1-15.

Lopresti, A. L. J. D. i. R. (2017). Salvia (sage): a review of its potential cognitive-enhancing and protective effects. **17**, 53-64.

Ma, X.-H., Ma, Y., Tang, J.-F., He, Y.-L., Liu, Y.-C., Ma, X.-J., Shen, Y., Cui, G.-H., Lin, H.-X., and Rong, Q.-X. (2015). The biosynthetic pathways of tanshinones and phenolic acids in Salvia miltiorrhiza. *Molecules* **20**, 16235-16254.

Min-hui, L., Jian-min, C., Yong, P., and Pei-gen, X. (2008). Distribution of phenolic acids in Chinese Salvia plants. *World Science and Technology* **10**, 46-52.

Oueslati, M. H., Ben Tahar, L., and Harrath, A. H. (2020). Synthesis of ultra-small gold nanoparticles by polyphenol extracted from Salvia officinalis and efficiency for catalytic reduction of p-nitrophenol and methylene blue. *Green Chemistry Letters and Reviews* **13**, 18-26.

Scalbert, A., Johnson, I. T., and Saltmarsh, M. (2005). Polyphenols: antioxidants and beyond. *The American journal of clinical nutrition* **81**, 215S-217S.

Sharopov, F., Valiev, A., Sobeh, M., Arnold, E., and Winka, M. J. P. C. J. (2018). Bioactivity of three Salvia species in relation to their total phenolic and flavonoid contents. **52**, 596-600.

Shi, M., Huang, F., Deng, C., Wang, Y., and Kai, G. (2019). Bioactivities, biosynthesis and biotechnological production of phenolic acids in Salvia miltiorrhiza. *Critical reviews in food science and nutrition* **59**, 953-964.

Wang, J., Xu, J., Gong, X., Yang, M., Zhang, C., and Li, M. (2019a). Biosynthesis, chemistry, and pharmacology of polyphenols from Chinese Salvia species: A review. *Molecules* **24**, 155.

Wang, J., Xu, J., Gong, X., Yang, M., Zhang, C., and Li, M. (2019b). Biosynthesis, Chemistry, and Pharmacology of Polyphenols from Chinese Salvia Species: A Review. *Molecules* **24**.

Wang, J., Xu, J., Gong, X., Yang, M., Zhang, C., and Li, M. J. M. (2019c). Biosynthesis, chemistry, and pharmacology of polyphenols from Chinese Salvia species: A review. **24**, 155.

Wang, L., Ma, R., Liu, C., Liu, H., Zhu, R., Guo, S., Tang, M., Li, Y., Niu, J., Fu, M., Gao, S., and Zhang, D. (2017). Salvia miltiorrhiza: A Potential Red Light to the Development of Cardiovascular Diseases. *Curr Pharm Des* **23**, 1077-1097.

[Citation: Sheikh, K.A., Maqsood, M., Rehman, M.U., Sarwar, S., Qayyum, A.A. Ali, Q. (2021). Biosynthesis of polyphenols in salvia species. *Biol. Clin. Sci. Res. J.*, 2021*:* 64. doi: https://doi.org/10.54112/bcsrj.v2021i1.64]