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Review Article

# An Insight into Endangered Himalayan Paeony (*Paeonia emodi* Royle): Ethnobotany, Phytochemistry and Pharmacology

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**ABSTRACT**

*Paeonia emodi* Royle is an endangered herb native to Himalayan region with diverse traditional therapeutic uses. It is categorized as critically endangered plant species. Traditionally plant parts are used for nervous diseases, uterine diseases, dysentery, colic, backache, hypertension, and piles. The medicinal activity is the result of presence of various important phytochemicals triterpenes, monoterpenes, phenolics, lipooxygenases, Nortriprenoids, steroids and aldehydes. *P. emodi* has many biological activities including antimicrobial, antifungal, anti-toxicity, and spasmolytic activity. Due to remarkable medicinal potential, this species is facing extremely high risk of extinction. This article briefly reviews botanical, medicinal, phytochemical, pharmacological and molecular attributes of this plant species along with its conservation strategies.

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## INTRODUCTION

The biological diversity is concerned with the species diversity, ecosystem diversity and genetic diversity. (Ahmad and Ismail, 2003). It is essential for human survival and economic wellbeing and for the ecosystem function and stability. Plants play an important part of ecosystem and should be prior to be conserved. (Ellstrand and Elam, 1993). These plant species, having slow growth rate, low population density and narrow geographic ranges are more prone to extinction due to overutilization (Jablonski, 2004; Dhyani and Kala 2005). Biodiversity is the life that flourishes on the earth surface. (Rahman *et al.,* 2018) Floristic inventory and biodiversity is important for the present diversity status and conservation of the plant species diversity. It is important for the ecosystem function and stability (Jayakumar *et al.,* 2011). These provide useful information on the distribution and abundance of species and insights into processes that control diversity (Davidar *et al.,* 2007).

*Paeonia emodi* Royle (Paeoniaceae) is endemic to Himalayan region and distributed in the northern areas of Pakistan, Northern west India and northern Nepal and Afghanistan (Khan *et al.,* 2005; Khan and Ahmad, 2007; Riaz *et al.,* 2004; Tantry *et al.,* 2012). It is commonly called as Mamekh and Himalayan Paeony rose (Haq *et al.,* 2012; Khan *et al.,* 2008) and also called as king of flower (Tantry *et al.,* 2012). It is perennial herb, 50-70cm long with glabrous ex-stipulated leaves and axillary solitary flower. Carpels are densely pubescent and 3 flowers in a stem. Plant paeonia is known as 'Queen of herbs' due to its medicinal importance and beauty of flower (Ahmad *et al.,* 2018; Haq *et al.,* 2012; Khan *et al.,* 2005). Phylogeny of Paeonia species based on previous phylogenetic reconstruction using multiple gene showed that *Paeonia emodi* is presumably a hybrid between *P. veitchii* and *P. lactiflora* (Zand and Sang, 1999).

Figure 1. Flower and Root of *Paeonia emodi.*

The plant is critically endangered under category A with population reduction of 81% (Haq, 2011). People use local plants for their multidimensional purposes (Hamayun *et al.,* 2003). According to World Health Organization report, 80% of the world population depends on medicinal plants and thus it increased the threat to the natural population of medicinal plants (Kandari *et al.,* 2012). Many plant species are threatened with extinction because of the gradual disappearance of the terrestrial natural ecosystems for various human activities and small patches are extremely valuable for maintain regional plant diversity (ARROYO-RODRÍGUEZ *et al.,* 2008). Often, this is due to the clearing of indigenous vegetation for agriculture and the resulting erosion, salinization, and invasion of alien species, but more recently climate change is looming as a significant new threat (Reed *et al.,* 2011; Wang *et al.,* 2017). The causes of loss of species are numerous but fragmentation and loss of natural habitats are major. (Jayakumar *et al.,* 2011). *Paeonia emodi* is highly medicinal plant and found several applications in indigenous medicinal system as well. The rhizomes of plant are used to make tonic for backbone (Hamayun *et al*., 2004). Roots are used for headache, to cure vomiting and as aid for pregnancy (Khan *et al*., 2005). The seeds are purgative and emetic (Riaz *et al.,* 2004). *Paeonia emodi* shows antifungal, antibacterial, phytotoxic, cytotoxic, and insecticidal activity (Mufti *et al.,* 2012; Ismail *et al.,* 2003; Khan *et al.,* 2005). It is highly useful medicinally and it is dire need to conserve this plant species. It is reported critically endangered in Pakistan. Its conservation should be the prior concern. In view of biodiversity, Pakistan is under the great threat of extinction. Managing of the disturbance regime of the landscapes is one of the foundations for the biodiversity conservation. (Jayakumar *et al.,* 2011).

Figure 2. Distribution map of *Paeonia emodi* on world map.

**Phytochemicals**

Lipoxygenases constitute a family of non-haem iron containing dioxygenases and antioxidant compounds are present in the paeonia emodi. These compounds are found useful in the asthma, cancer, aging, and angiogenesis (Riaz *et al.,* 2004). Along with these oleanolic acid, phenolic compounds, betulinic acid, ethyl gallate, methyl grevillate, emodinol, benzoic acid, 3-hydroxybenzoic acid, paeonin A and B, steroids, aldehydes (Ahmad *et al.,* 2018) 1, 5-dihydroxy-3-methylanthraquinone have been isolated from P. emodi (Khan *et al.,* 2005; Khan and Ahmad, 2007). Nortriprenoids were also extracted from the roots of *Paeonia emodi (*Tantry *et al.,* 2012).

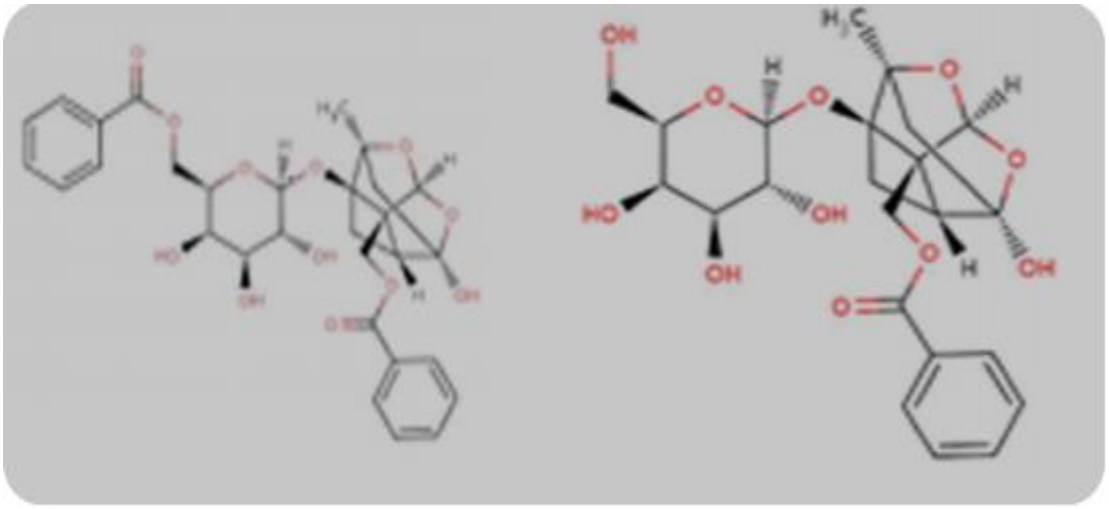

Figure 3. Active Phytochemical structure: Paeonin A (left) and Paeonin B (right).


Figure 4. Chemical constituent in *Paeonia emodi* (Zargar *et al.,* 2013).

**Ethnopharmacology**

The folk recipes are prepared either from the whole plant or from their different organs, like leaves, stem, bark, root, flower, seed, prop roots etc and from their secondary product such as gum, resins, and latex (Haq *et al.,* 2012). The root of *Paeonia emodi* is crushed and mixed with milk, sugar and is used in backache and internal body pains. *et al.,* 2006) Rhizome is used to increase milk production in livestock, also used as tonic (Haq *et al.,* 2012). The dried leaves are used as a vegetable, which helps to purify the blood. The dried leaves are fried with ghee and use to cure dysentery and colic (Negi and Maikhuri *et al.,* 2017). The infusion of dried flower is used in diarrhea (Haq *et al.,* 2012). The underground tubers are used in nervous diseases, uterine diseases, colic, bilious obstructions, dropsy, epilepsy, convulsions, and hysteria (Riaz *et al.,* 2003; Zargar *et al.,* 2013). Plant is medicinally important, and its conservation is the major issue. Due to lack of knowledge, people indigenously use this to cure diseases and it leads to threatening of species.

Table 1. Traditional uses of plant parts of *Paeonia emodi.*

| S.no | Part used | Traditional uses | References |
|---|---|---|---|
| 1 | Roots | It is crushed with milk and sugar and used for backache and internal body pains. | (Gilani *et al.,* 2006) |
| | | Root decoction taken orally is for treatment of intestinal pain, dysentery and piles. | (Bisht *et al.,* 2013) |
| 2 | Rhizome | It is used traditionally for production of milk in livestock. | (Haq *et al.,* 2012) |
| | | Powder and decoction of rhizomes are used for 12–15 days for curing a hypertension. | (Ahmad *et al.,* 2015) |
| 3 | Leaves | Dried leaves are used to purify blood and often mixed with ghee to cure dysentery and colic | (Negi and Maikhuri, 2017; Haq *et al.,* 2012) |
| 4 | Tubers | It is used for nervous disorder and uterine diseases | (Riaz *et al.,* 2003; Zargar *et al.,* 2013) |

**Pharmacological properties**

**Antifungal activity**

Air dried and aerial and ground plant material are used against fungal growth (Mufti *et al.,* 2012; Ismail *et al.,* 2003; Khan *et al.,* 2005). Fungi can cause infection of blood, liver, lungs, and mouth etc. The crude extract of *P. emodi* is used against *Trichophyton longifusus, Candida albicans, Aspergilus flavus, Microsporum canis* and *Fusarium solani.* This in-vitro study shows no growth of fungi (Khan *et al.,* 2005). Because of this activity people locally use this plant and lead to the threatning of species and there is need to conserve the plant.

**Antimicrobial activity**

The crude extract of plant is also potent against many pathogenic bacteria and show antimicrobial activity (Ismail *et al.,* 2003; Mufti *et al.,* 2012; Khan *et al.,* 2005*). E. coli, P. aeruginosa, S. Aureus*, *Pseudomonas aeruginosa* and *Salmonella typhi* were potently killed by this extract (Mufti *et al.,* 2012). This plant could be used as pharmaceutical industry and need to preserve this.

**Free radical scavenging activity**

The potential antioxidant activity of the plant extracts was assessed on the basis of the scavenging activity of free radical (Zargar *et al.,* 2014) and enzyme inhibition activities against jack bean and *Bacillus pasteurii* urease. (Khan *et al.,* 2005b) Plant show potent activities against them. (Riaz *et al.,* 2004).

**Insecticidal activity**

Insecticidal activity of extract of paeonia was also observed against *Tribolium castaneum, Bruchus pisorum and Rhyzopartha dominica. Permethrin.* It is medicinally important plant and show the activity by killing them (Khan *et al.,* 2005; Ismail *et al.,* 2003).

**Brine shrimp toxicity**

*Artemia salina* (brine-shrimp eggs) was used to determine the cytotoxicity of the extract. This exract is shows the activity against cytotoxicity of brine shrimp (Khan *et al.,* 2005; Ismail *et al.,* 2003).

**Spasmolytic activity**

The crude extract and subsequent fractions from the aerial parts of *P. emodi* were studied for their effects on the isolated rabbit jejunum. The crude extract displayed significant spasmolytic activity in a dose-dependent manner and inhibited the spontaneous motility of the rabbit jejunum by 76% (Khan and Ahmad, 2007).

**Threats towards its extinction**

Over exploitation, loss of habitat, attack of pathogens, effect of introduced taxa and change in environments were responsible for making these species either endangered or critically endangered species. Extensive grazing and deforestation which have led to forest fragmentation and degradation of the habitat are the primary causes of species

extinction in the area (Haq, 2011) Indiginously, it is being over exploited which has contributed in being critically endangered. Excessive harvesting and large-scale developmental activities have resulted in fragmentation and reduced population size (Ravikanth *et al.,* 2018).

**Conservation strategies**

The destruction of biological diversity has reached to the proportions of a global crisis in its magnitude, severity, and urgency. Effective conservation of biological diversity requires a sound basis in scientific understanding of the entities being protected and this is a fundamental need of conservation biology (Schemske *et al.,* 1994).

**Ex-situ conservation**

Ex situ conservation methods sample genetic diversity of species using certain criteria and store/propagate the collected material outside its native habitat (Volis and Blecher, 2010). RAPD PCR amplification is one of method to conserve plant species. The ex-situ conserved population ML holds an intermediate level of genetic diversity compared with three natural populations and conserved 88.31% of the total genetic variation of the species (Li *et al.,* 2002) The restored environments will undoubtedly differ from the original habitats and communities (Schemske er al. 1994) It is therefore critical that the released populations have sufficient genetic variability to provide adaptive flexibility in an uncertain future (Li *et al.,* 2002).

Botanical Gardens have played important role in ex situ conservation of rare and endangered plants (Li *et al.,* 2002; Volis and Blecher, 2010) They also focus on wild plants and non-economic plants. But plants could only be genetically conserved due to lack of available space to grow them (Li *et al.,* 2002).

In conservation, the inter-situ approach proposed an off-site collection maintained within the natural habitat. This approach was treated as potentially very promising. It can be applied to the lands of low economic value such as abandoned agricultural lands and allows simultaneous reintroduction of large number of species (Volis and Blecher, 2010). Therefore, another method to conserve is planting of sampled germplasm as live gene banks and creation of living collection.

**In-situ conservation**

For speies threatened with extinction, in situ conservation may be the best option. The use of in vitro-propagated plants for reintroduction or restoration of rare species is also finding application, and this relies on the development of successful methods for acclimatizing plants from culture to in situ conditions (Reed *et al.,* 2011) when several species within an ecosystem are endangered, sampling and planting can be done in parallel for several coexisting species. In this case the only factor limiting number of species to be preserved in living collections is available space. In general, multi-species living collections should be viewed as a preferred option. (Volis, 2010). Another promising approach is to identify `hotspots', or areas featuring exceptional concentrations of endemic species and experiencing exceptional loss of habitat (Myers *et al.,* 2000).

**CONCLUSIONS**

The medicinal properties of *Paeonia emodi* discussed in this review have highlighted significant traditional and pharmacological activities of this plant. It is reported as critically endangered species. It is highly medicinal, and it is used by indigenous people for treatment. This excessive use and exploitation lead to the threatening of this species from its habitat. Different efficient, wise, and sustainable conservation strategies could be applied to protect this plant. The integrated approach is to match the biological subject of concern with the most suitable conservation method.

**REFERENCES**

Ahmad, F.B., and G. Ismail. 2003. Medicinal plants used by Kadazandusun communities around Crocker Range. ASEAN Review of Biodiversity and Environmental Conservation (ARBEC), 1: 1-10.

Ahmad, L., A. Semotiuk, M. Zafar, M. Ahmad, S. Sultana, Q.R. Liu and G. Yaseen. 2015. Ethnopharmacological documentation of medicinal plants used for hypertension among the local communities of DIR Lower, Pakistan. Journal of ethnopharmacology, 175, 138-146.

Ahmad, M., K. Malik, A. Tariq, G. Zhang, G. Yaseen, N. Rashid and M.P.Z. Khan. 2018. Botany, ethnomedicines, phytochemistry and pharmacology of Himalayan Paeony (*Paeonia emodi* Royle.). Journal of ethnopharmacology, 220: 197-219.

Arroyo-Rodríguez, V. Í. C. T. O. R., E. Pineda, F. Escobar and J.U.L.I.E.T.A. Benítez-Malvido. 2009. Value of small patches in the conservation of plant-species

diversity in highly fragmented rainforest. Conservation Biology, 23(3), 729-739.

Bisht, V.K., J.S. Negi, A.K. Bh and R.C. Sundriyal. 2013. Traditional use of medicinal plants in district Chamoli, Uttarakhand, India. Journal of Medicinal Plants Research, 7(15): 918-929.

Davidar, P., D.M. Dass and S.L. Vijayan. 2007. Floristic inventory of woody plants in a tropical montane (shola) forest in the Palni hills of the Western Ghats, India. Tropical Ecology, 48(1): 15-26.

Dhyani, P.P. and C.P. Kala. 2005. Current research on medicinal plants: Five lesser known but valuable aspects. Current science, 88(3): 335-335.

Ellstrand, N.C. and D.R. Elam. 1993. Population genetic consequences of small population size: implications for plant conservation. Annual review of Ecology and Systematics, 24(1): 217-242.

Falk, D.A. 1990. Endangered forest resources in the US: Integrated strategies for conservation of rare species and genetic diversity. Forest Ecology and Management, 35(1-2): 91-107.

Fay, M.F. 1992. Conservation of rare and endangered plants using in vitro methods. In Vitro Cellular and Developmental Biology-Plant, 28(1): 1-4.

Gilani, S.A., R.A. Qureshi and S.J. Gilani. 2006. Indigenous uses of some important ethnomedicinal herbs of Ayubia National Park, Abbottabad, Pakistan. Ethnobotanical Leaflets, 2006(1): 32.

Guerrant, E.O., K. Havens and M. Maunder. (Eds.). 2004. Ex situ plant conservation: supporting species survival in the wild (Vol. 3). Island Press.

Hamayun, M. and M.F. Chaudhary. 2004. Effect of foliar and soil application of NPK on different growth parametersand nodulation in lentil. Sarhad Journal of Agriculture (Pakistan).

Hamayun, M., A. Khan and M.A. Khan. 2003. Common medicinal folk recipes of District Buner, NWFP, Pakistan. Ethnobotanical Leaflets, 2003(1): 14.

Hamayun, M., S.A. Khan, E.Y. Sohn and I.J. Lee. 2006. Folk medicinal knowledge and conservation status of some economically valued medicinal plants of District Swat, Pakistan. Lyonia, 11(2): 101-113.

Haq, F.U. 2011. Conservation status of the critically endangered and endangered species in the Nandiar Khuwar catchment District Battagram, Pakistan. International Journal of Biodiversity and Conservation, 3(2): 27-35.

Haq, F., S. Rehman, H. Ahmad, Z. Iqbal and R. Ullah. 2012. Elemental analysis of *Paeonia emodi* and *Punica granatum* by atomic absorption spectroscopy. American Journal of Biochemistry, 2(4): 47-50. http://eol.org/data_objects/29271174

Ismail, M., Z. Iqbal, B. Ahmad, S. Zakir and U. Niaz. 2003. Biological and pharmacological properties of two indigenous medicinal plants, *Rheum emodi* and *Paeonia emodi*. Pakistan Journal of Biological Sciences, 6(9): 984-986.

Jablonski, D. 2004. Extinction: past and present. Nature, 427(6975): 589-589.

Jayakumar, S., S.S. Kim and J. Heo. 2011. Floristic inventory and diversity assessment-a critical review. Proceedings of the International Academy of Ecology and Environmental Sciences, 1(3-4): 151.

Kandari, L.S., P.C. Phondani, K.C. Payal, K.S. Rao and R.K. Maikhuri. 2012. Ethnobotanical study towards conservation of medicinal and aromatic plants in upper catchments of Dhauli Ganga in the central Himalaya. Journal of Mountain Science, 9(2): 286-296.

Khan, S.M., S. Page, H.A.B.I.B. Ahmad, H.A.M.A. Shaheen and D.M. Harper. (2012). Vegetation dynamics in the Western Himalayas, diversity indices and climate change. Sci., Tech. and Dev, 31(3), 232-243.

Khan, T., and M. Ahmad. 2007. Spasmolytic and spasmogenic activities of crude extract and subsequent fractions of Paeonia emodi. Die Pharmazie-An International Journal of Pharmaceutical Sciences, 62(6): 476-477.

Khan, T., M. Ahmad, H. Khan and M.A. Khan. 2005. Biological activities of aerial parts of *Paeonia emodi* Wall. African Journal of Biotechnology, 4(11).

Khan, T., M. Ahmad, M. Nisar, M. Ahmad, M.A. Lodhi and M.I. Choudhary. 2005b. Enzyme inhibition and radical scavenging activities of aerial parts of *Paeonia emodi* Wall. (Paeoniaceae). Journal of enzyme inhibition and medicinal chemistry, 20(3): 245-249.

Li, Q., Z. Xu and T. He. 2002. Ex situ genetic conservation of endangered *Vatica guangxiensis* (Dipterocarpaceae) in China. Biological Conservation, 106(2): 151-156.

Maikhuri, R.K., S. Nautiyal, K.S. Rao and R.L. Semwal. 2000. Indigenous knowledge of medicinal plants and wild edibles among three tribal sub communities of the central Himalayas, India. Indigenous Knowledge and Development Monitor, 8(2): 7-13.

Mufti, F.U.D., H. Ullah, A. Bangash, N. Khan, S. Hussain, F. Ullah and M. Jabeen. 2012. Antimicrobial activities of *Aerva javanica* and *Paeonia emodi* plants. Pakistan Journal of Pharmaceutical Sciences, 25(3): 565-569.

Myers, N., R.A. Mittermeier, C.G. Mittermeier, G.A. Da Fonseca and J. Kent. 2000. Biodiversity hotspots for conservation priorities. Nature, 403(6772): 853-858

Negi, V.S. and R.K. Maikhuri. 2017. Forest resources consumption pattern in Govind wildlife sanctuary, western Himalaya, India. Journal of Environmental Planning and Management, 60(7): 1235-1252.

Rahman, I.U., A.F.T.A.B. Afzal, Z. Iqbal, F. Ijaz, N. Ali, M. Asif and R.W. Bussmann. 2018. First insights into the floristic diversity, biological spectra and phenology of Manoor Valley, Pakistan. Pakistan Journal of Botany, 50(3): 1113-1124.

Ravikanth, G., M.R. Jagadish, R. Vasudeva, R.U. Shaanker, and N.A. Aravind. 2018. Recovery of critically endangered plant species in India: need for a comprehensive approach. Current Science, 114(3): 504.

Reed, B.M., Sarasan, V., Kane, M., Bunn, E., & Pence, V. C. 2011. Biodiversity conservation and conservation biotechnology tools. In Vitro Cellular and Developmental Biology-Plant, 47(1): 1-4.

Riaz, N., Anis, I., Malik, A., Ahmed, Z., Muhammad, P., Nawaz, S. A., & Choudhary, M. I. 2003. Paeonins A and B, lipoxygenase inhibiting monoterpene galactosides from *Paeonia emodi*. Chemical and pharmaceutical bulletin, 51(3): 252-254.

Riaz, N., A. Malik, A.U. Rehman, Z. Ahmed, P. Muhammad, S.A. Nawaz and M.I. Choudhary. 2004. Lipoxygenase inhibiting and antioxidant oligostilbene and monoterpene galactoside from *Paeonia emodi*. Phytochemistry, 65(8): 1129-1135.

Schemske, D.W., B.C. Husband, M.H. Ruckelshaus, C. Goodwillie, I.M. Parker and J.G. Bishop. 1994. Evaluating approaches to the conservation of rare and endangered plants. Ecology, 75(3): 584-606.

Tantry, M.A., J.A. Dar, M.A. Khuroo and A.S. Shawl. 2012. Nortriterpenoids from the roots of Paeonia emodi. Phytochemistry Letters, 5(2): 253-257.

Volis, S. and M. Blecher. 2010. Quasi in situ: a bridge between ex situ and in situ conservation of plants. Biodiversity and Conservation, 19(9): 2441-2454.

Wang, C.J., J.Z. Wan, Z.X. Zhang and L.C. Zhao. 2017. Integrating climate change into conservation planning for *Taxus chinensis*, an endangered endemic tree plant in China. JAPS, Journal of Animal and Plant Sciences, 27(1): 219-226.

Zargar, B.A., M.H. Masoodi, B. Ahmed and S.A. Ganie. 2014. Antihyperlipidemic and antioxidant potential of Paeonia emodi Royle against high-fat diet induced oxidative stress. ISRN pharmacology, 2014.

Zargar, B.A., M.H. Masoodi, B.A. Khan and S. Akbar. 2013. Paeonia emodi Royle: ethnomedicinal uses, phytochemistry and pharmacology. Phytochemistry letters, 6(2): 261-266.

Zhang, D. and T. Sang. 1999. Physical mapping of ribosomal RNA genes in peonies (Paeonia, Paeoniaceae) by fluorescent in situ hybridization: implications for phylogeny and concerted evolution. American Journal of Botany, 86(5): 735-740.

**CONFLICT OF INTEREST**

The authors declare that they have no conflicts of interest.

**AUTHORS CONTRIBUTIONS**

All the authors contributed equally to this work.

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