Impact of Climatic Changes on Indian Medicinal Plants

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Abstract - Animal survival depends completely on plant existence. Plants act as fundamental components that power the activities of human society. Medicinal herbs served practical purpose in India during the Vedic period. Ayurvedic and herbal medicinal formulations use medicinal plants as their primary building elements. The quick pace of climate change leads to changes in the wild availability of useful medicinal plants. The specific habitats of medicinal plants sustain their growth but climate changes disrupt these areas thereby lowering both growth and medicinal activity. Climate change describes extended patterns of temperature and weather variation that originate mainly from human activities including fossil fuel combustion.Human activities including deforestation alongside wildfires and wild resource consumption and industrial development and both natural disasters flood and drought have endangered Indian medicinal plants by creating drastic biodiversity and climate transformations.lity of medicinal plants in wild. The medicinal plants have their particular habitat in which they grows but due the climate changes the habitat is disturbed and affecting the growth and potency of the medicinal plants. Climate change refers to long-term shifts in temperatures and weather patterns, mainly caused by human activities, especially the burning of fossil fuels. The other human activities such as deforestation, wild fire, over exploitation from the nature, industrialization and natural disasters like flood and draught are also a major cause for biodiversity changes and climate changes which in turn putting the Indian medicinal plants in the list of endangered species. International Union for Conservation of Nature (Encyclopedia of Life) organized the classification of endangered species including those that might soon become extinct. Human health faces significant challenges because rural Indians compose 80% of the population yet depend on traditional herbal medicines for primary healthcare.

Keywords: Climate change. Biodiversity, Medicinal plants, Endangered species.

1. Introduction :

More societies now acknowledge that changes in Earth's climate represent an unparalleled threat to human existence and life across all creation. The value of medicinal plants serves critically important purposes for human survival. World

Health Organization predicts traditional medicine which relies on plant drugs serves as the main health care system for 60 percent of global people and 80 percent of residents in developing nations. Most medicinal plant collections occur in unmanaged habitats presenting major conservation issues under climate change conditions[1]. Scientists predict the Earth's temperature will rise between 1.40 C and 5.80 C during the next century. Climate changes will create extreme damage to biodiversity levels. Greenhouse gas emissions that primarily raise levels of CO2 and methane together with ozone create the dominant drivers behind contemporary climatic transformations. Plants produce their medicinal compounds through secondary metabolisms although temperature changes from these stressors can disrupt both these metabolisms and plant compounds examined for medical effects. Bio diversity and ecosystem face pressure from present conditions which requires the adoption of new habitats plus life cycle adaptations and development of physical traits. Endemic plant organisms situated in high climate vulnerability areas could experience significant threats in future time frames[2].

2. **Materials and methods:** The impact of climate change on medicinal plants has been analyzed through recent literature along with journals and personal observations.
3. **Results:** Various aspects of climate change impacts on medicinal plants receive discussion under these headings:
    - Loss of habitat causing extinction of some medicinal plants.
    - Shifting ranges.
    - Phenological changes.
    - Effect of elevated ozone levels.
    - Effect of Ultraviolet radiation.
    - Changes in the Phyto-chemical due adaptive process of plants.

3.1 Loss of habitat causing extinction of some medicinal plants

The factors such as increase in population, wildfire, deforestation for construction of roads, highways and expansion of agriculture land, severe droughts, flood and climatic changes like increase in temperature, excessive O2 emission is causing loss of habitat for some of Indian medicinal plants. They are likely to be extinct and named as endangered species[3].

List of some endangered species with their habitat -

Latin Name	Common name	Habitat
1. Swertia chirayita	Chirayita	Himalaya
2. Carum carvi	Kala jeera	Kashmir
3. Betula utilis	Bhojpatra	Himalaya
4. Atropa acuminate	Belladona	Himalaya
5. Ceropegia odorata	Jimikand	Gujrat
6. Jurinea macrocephala	Dhoop	Himalaya
7. Abutilon indicum	Indian mallow	Tamil nadu
8. Lotus corniculatus	Bird's foot	Gujrat

3.2 Shifting ranges

Climate change creates conditions which force plants to extend their distributions into different ecological domains. The species are moving northward and upward into new growing areas to reclaim lost territories. Endemic species will face extinction across the planet because of climate change and habitat destruction along with migration barriers. Research on the Eastern Himalayas biodiversity hotspot which focuses on Sikkim reveals that most medicinal plant species occur between 300 meters up to 2000 meters in elevation across the tropical and subtropical regions of the Sikkim Himalayas. Future climate projections suggest these plant populations will relocate to higher elevation areas

moving northward. A study published in Ecological Informatics demonstrates that targeted species zones will transition upward by 200 meters in 2050 and 400 meters in 2070. By 2050 and 2070 the region faces alarming habitat loss of 13-16% of its medicinal plant species. A study warns that species which reside only in particular regions with limited height variation will likely disappear because of Himalayan climate change[4].

3.3 Phenological changes

Plants base their life cycle patterns on seasonal indications yet global temperature changes threaten both species and their ecosystems and put endangered medicinal plant populations in greater danger. These important plant life events helping their survival and reproduction suffer disruption through changing climate conditions. Climate change affects medicinal plants through critical phenological cycles where breaks between significant events occur at bud burst and leaf unfolding and during flowering and fruit setting as well as during fall leaf shedding and throughout the cycles of winter hardening and breaking. The anticipated delay of spring and lengthening growing season caused by global warming could create ecological mismatches that endanger vulnerable medical plant species unable to adjust to rapid environmental changes[5].

3.4 Effect of elevated ozone levels

Plants modify their secondary chemical production in response to concentrations shifts in O3 air. Plant stress induced by elevated O3 exposure drives the activation of secondary compound synthesis pathways including salicylic acid and jasmonic acid pathways in plants[6].

3.5 Effect of Ultraviolet radiation

These radiations can cause molecular and cellular damage; for example, it can damage proteins, DNA and other biopolymers. Furthermore, this type of radiation can affect plant

growth and development and result in changes in vegetative or reproductive biomass, height, leaf characteristics, and flowering time[7].

3.6 Changes in the Phyto-chemical due adaptive process of plants

Climate change: Climate change generates observable alterations in the life phases and distribution together with phyto-chemical compounds of all planet vegetation particularly medicinal and aromatic plants. Plant architecture experiences changes because of climate-driven temperature shifts and wind patterns that modify both precipitation amounts and the timing of flower production and fruit development while affecting chemical composition and natural plant competition. The annual monsoon system which controls India's climate appears to face mounting difficulties in managing both rainfall intensity and precipitation patterns. The understanding of temperature elevation together with multiple precipitation levels alongside various soil conditions demands study through cultivation experiments to investigate sequenced phenological transformations and nutritional variations along with antioxidant and secondary metabolite profiles[8].

Protective mechanisms known as antioxidative functions operate as primary physiological functions to shield living organisms against oxidative damage generated by reactive oxygen species. Our cells accumulate both free radicals and oxidative substances throughout both everyday routines and as we age leading to systemwide organ damage. Normal aerobic cellular metabolic processes create reactive oxygen and nitrogen species which function as free radicals. Antioxidants serve as countermeasures when dealing with free radical effects[9].

Aloe vera contains over 200 natural elements composed of water soluble and fat soluble vitamins alongside enzymes and polysaccharides and phenolic compounds and organic acids and minerals[10]. Secondary metabolites from *A. vera* provide several advantages including anti-inflammatory features with antibacterial properties and the ability to reduce free radicals and enhance immune responses as well as deliver sunburn relief and

anticancer actions[11, 12]. Traditional usage studies documented *Aloe vera* applications for treating burns along with treating eczema problems and cosmetic usage and controlling inflammation and reducing fever. The bioscientists from the Genetics department at M.D. University assessed the antioxidantcapacity of 12 *A. vera* extract samples through different analytical methods revealing their antioxidant characteristics. The antioxidant potential measured from 56 to 80% across different extracts while different climate zones indicate climate changes substantially impact the plant species antioxidant capacities[10, 13].

Impact of ozone stress on secondary metabolites: The dominant greenhouse gasses include CO2, methane and nitrous oxide while causing climatic effects that extend beyond plant-related sectors. Secondary metabolites undergo changes due to ozone stress[14]. Ansari et al. (2021) found that exposing Costus pictus leaves and rhizome to ozone results in elevated levels of tannins and lignin and saponins and alkaloids. The plants of Sida cordifolia exhibit elevated levels of alkaloids alongside flavonoids terpenes glycosides and saponins according to Ansari et al. 2020. Han et al. (2020) discovered that natural cross-pollination in Brassica compestris suffers from ozone exposure[15].

Climate warming vs. secondary metabolite production

The responses of secondary chemicals to increased temperature are less understood, although, an increase in volatile organic compounds has been generally detected[16].

4. Conclusion:

The Indian medicinal plants maintain great value for human societies along with a reputation for extensive medicinal diversity. Scientific investigations focusing on effects from climate change become especially critical because medicinal plants hold both medicinal value in traditional systems and economic importance. Medical plants demonstrate that climate change impacts their natural life patterns and habitat distribution operations. Current understanding about how climate change alters secondary metabolite

production in plants remains minimal. Research studies under the climate change scenario should focus on threatened medicinal plants because they provide essential information for both conservation strategies and local community farming programs which protect against climate change effects.

Reference:

1. Kumar, S., Saha, S., Singh, K., Singh, T., Mishra, A. K., Dubey, B. N., & Singh, S. (2024). Beneficial effects of spirulina on brain health: A systematic review. *Current Functional Foods*, *3*(1), Article e120124225622. https://doi.org/10.2174/0126668629269256231222092721
2. RaviKKumar VR, Rathi S, Singh S, Patel B, Singh S, Chaturvedi K, Sharma B. A Comprehensive Review on Ulcer and Their Treatment. Zhongguo Ying Yong Sheng Li Xue Za Zhi. 2023 Dec 21;39:e20230006. doi: 10.62958/j.cjap.2023.006. PMID: 38755116.
3. Singh, V., Arora, S., Akram, W., Alam, S., Kumari, L., Kumar, N., Kumar, B., Kumar, S., Agrawal, M., Singhal, M., Kumar, S., Singh, S., Singh, K., Saha, S., & Dwivedi, V. (2024). Involvement of molecular mechanism and biological activities of Pemirolast: A therapeutic review. *New Emirates Medical Journal*, *5*, Article e02506882308410. https://doi.org/10.2174/0102506882308410240607053814
4. Rajput DS, Gupta N, Singh S, Sharma B. A Comprehensive Review: Personalized Medicine for Rare Disease Cancer Treatment. Zhongguo Ying Yong Sheng Li Xue Za Zhi. 2023 Dec 23;39:e20230008. doi: 10.62958/j.cjap.2023.008. PMID: 38830754.
5. Singh S, Chaurasia A, Rajput DS, Gupta N. Mucoadhesive Drug Delivery System and There Future Prospective: Are a Promising Approach for Effective Treatment? Zhongguo Ying Yong Sheng Li Xue Za Zhi. 2023 Dec 20;39:e20230005. doi: 10.62958/j.cjap.2023.005. PMID: 38751344.
6. Kumar, S., Saha, S., Sharma, B., Singh, S., Shukla, P., Mukherjee, S., Agrawal, M., Singh, K., & Singh, T. (2023). The role of resveratrol in Alzheimer's disease: A comprehensive review of current research. *Current Functional Foods*, *2*(2), Article e121223224364, 13 pages. https://doi.org/10.2174/0126668629269244231127071411
7. Patel S, Ismail Y, Singh S, Rathi S, Shakya S, Patil SS, Bumrela S, Jain PC, Goswami P, Singh S. Recent Innovations and Future Perspectives in Transferosomes for Transdermal Drug Delivery in Therapeutic and Pharmacological Applications. Zhongguo Ying Yong Sheng Li Xue Za Zhi. 2024 Oct 24;40:e20240031. doi: 10.62958/j.cjap.2024.031. PMID: 39442957.
8. Vaghela MC, Rathi S, Shirole RL, Verma J, Shaheen, Panigrahi S, Singh S. Leveraging AI and Machine Learning in Six-Sigma Documentation for Pharmaceutical Quality Assurance. Zhongguo Ying Yong Sheng Li Xue Za Zhi. 2024 Jul 18;40:e20240005. doi: 10.62958/j.cjap.2024.005. PMID: 39019923.
9. Patel S, Ismail Y, Singh S, Rathi S, Shakya S, Patil SS, Bumrela S, Jain PC, Goswami P, Singh S. Recent Innovations and Future Perspectives in Transferosomes for Transdermal Drug Delivery in Therapeutic and Pharmacological Applications. Zhongguo Ying Yong Sheng Li Xue Za Zhi. 2024 Oct 24;40:e20240031. doi: 10.62958/j.cjap.2024.031. PMID: 39442957.

10. Kumar, S., Saha, S., Pathak, D., Singh, T., Kumar, A., Singh, K., Mishra, A. K., Singh, S., & Singh, S. (2024). Cholesterol absorption inhibition by some nutraceuticals. *Recent Advances in Food, Nutrition & Agriculture*, *16*(1), 2–11. https://doi.org/10.2174/012772574X285280240220065812
11. Singh, S., Chaurasia, A., Rajput, D. S., & Gupta, N. (2024). An overview on mucoadhesive buccal drug delivery systems & approaches: A comprehensive review. *African Journal of Biological Sciences (South Africa)*, *6*(5), 522–541, DOI: 10.33472/AFJBS.6.5.2024.522-541
12. Kumar, S., Singh, S., Rajput, D., Sharma, B., Chaturvedi, K., Singh, N., Saha, S., Singh, K., & Mukherjee, S. (2024). Pharmacological approaches and herbal interventions for Alzheimer's disease. *The Natural Products Journal*, *14*(8), Article e220124225945. https://doi.org/10.2174/0122103155275266231123090138
13. Ravikkumar VR, Patel BD, Rathi S, Parthiban S, Upadhye MC, Shah AM, Rehan SSA, Samanta S, Singh S. Formulation and Evaluation of Drumstick Leaves Tablet as An Immunomodulator. Zhongguo Ying Yong Sheng Li Xue Za Zhi. 2024 Jun 21;40:e20240004. doi: 10.62958/j.cjap.2024.004. PMID: 38902996.
14. Sharma, A., Bara, G., Keshamma, E., Sharma, B., Singh, S., Singh, S. P., Parashar, T., Rathore, H. S., Sarma, S. K., & Rawat, S. (2023). Cancer biology and therapeutics: A contemporary review. *Journal of Cardiovascular Disease Research*, *14*(10), 1229-1247.
15. Dewangan, H. K., Singh, S., Mishra, R., & Dubey, R. K. (2020). A review on application of nanoadjuvant as delivery system. *International Journal of Applied Pharmaceutics*, *12*(4), 24–33. https://doi.org/10.22159/ijap.2020v12i4.36856
16. Singh S, Chaurasia A, Gupta N, Rajput DS. Effect of Formulation Parameters on Enalapril Maleate Mucoadhesive Buccal Tablet Using Quality by Design (QbD) Approach. Zhongguo Ying Yong Sheng Li Xue Za Zhi. 2024 Jun 27;40:e20240003. doi: 10.62958/j.cjap.2024.003. PMID: 38925868.