WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.453
Volume 14, Issue 15, 1286-1294. Review Article ISSN 2277–7105

POTENTIAL CONSEQUENCES OF CLIMATE CHANGE ON MEDICINAL PLANTS AND AYURVEDIC TECHNIQUES TO COMBAT POLLUTION-A REVIEW

Dr. Nikita Sharma[1]*, Dr. Chandan Singh[2], Dr. Rajendra Prasad Purvia[3] and Dr. Manoj Adlakha[4]

[1]Assistant Professor of Department of Dravyaguna Vigyan, Jayoti Vidyapeeth Women's University, Jaipur(Rajasthan), 303122, India.

[2]Professor & HOD of Department of Dravyaguna Vigyan, Dr. Sarvepalli Radhakrishnan Ayurved University, Jodhpur (Rajasthan), 342037, India.

[3,4]Associate Professor of Department of Dravyaguna Vigyan, Dr. Sarvepalli Radhakrishnan Ayurved University, Jodhpur(Rajasthan), 342037, India.

Article Received on
19 June 2025,

Revised on 09 July 2025,
Accepted on 29 July 2025

DOI: 10.20959/wjpr202515-37534

***Corresponding Author**
Nikita Sharma
Assistant Professor of Department of Dravyaguna Vigyan, Jayoti Vidyapeeth Women's University, Jaipur(Rajasthan), 303122, India.

ABSTRACT

One of the biggest challenges to ecosystem health and biodiversity is climate change. In this context, climate change also has an impact on key secondary metabolites produced by medicinal plants. Major abiotic elements that have an impact on changing climatic conditions and factors that either directly or indirectly affect the development, synthesis, and production of secondary metabolites in plants include elevated levels of CO_2, ozone, drought, and cold temperatures. The secondary metabolites of medicinal plants are being employed as a safe alternative to allopathic therapy, which has adverse effects and diseases associated with multidrug resistance. Since ancient times, herbal plants and their products have been widely utilised to cure common illnesses including diabetes, cancer, cholera, diarrhoea, asthma, and pyrexia.

KEYWORDS: Secondary metabolites, Plant, *Ashtawarga* plants.

1. INTRODUCTION

Medicinal plants are extremely important to human survival, and India is known for its medicinal plant prosperity. The use of phytonutrients and herbal medicines, often known as

nutraceuticals, is growing quickly all over the world as more individuals turn to these products to treat a variety of health issues in various national healthcare systems (WHO, 2004). There has been a clear increase in public interest and acceptance of natural medicines over the past ten years, both in developed and developing nations, as seen by the availability of herbal remedies not just in drugstores but also in supermarkets and grocery shops. Due to their importance in conventional medical practises and as productive plants, studies on the potential consequences of climate change on medicinal plants are particularly important. There is evidence that the distribution and life cycles of plant species are being significantly impacted by climate change. But it's questionable how a changing climate would affect plants' secondary metabolites.

2. MATERIALS AND METHODS

There are following elements-

1. Impact of Climate change on Medicinal plant productivity and quality

Decreases in availability, most visibly in the loss of species, may be detrimental impacts of climate change on medicinal plants and the people who utilise them. It should be noted that some human populations will also be denied access to medicinal plants through displacement from their traditional homelands as a result of climate change, despite the fact that the concern that access to plants will be lost through the reduction or loss of plant populations is highlighted here. The availability and productivity of medicinal plants may be impacted by climate change, but it may also have an impact on the phytochemical composition of surviving populations, particularly of alpine plants, which might have an impact on their pharmacological characteristics.

There are following impact of climate change on traditional medicinal plants-

(A). Loss of traditional Knowledge-Changes in the availability and distribution of these plants can make it harder for communities to access them, leading to a decline in the use of traditional medicine practices.

(B) Decreased availability of medicinal plants-Changes in temperatures and precipitation patterns can disrupt the natural habitats of these plants, making it harder for them to grow and thrive.

(C) Loss of Biodiversity-Many traditional medicine practices rely on a diverse range of medicinal plants and a decline in biodiversity can limit the availability of these plants.

(D) Increased vulnerability to climate sensitive diseases-Climate change can increase the prevalence of climate sensitive diseases, making communities more vulnerable, results increase demand for traditional medicines.

(E) Extinctions of plant species-An overall temperature rise of 2 to 3degree centigrade amplies the risk of extinction for 20-30 percent of species. By 2080, it is assumed that the niche of about 58 percent of plants will be lost depending on their immediate dispersal rates.

2. Impact of climate change on Secondary metabolites

Atmospheric carbon dioxide (CO_2) concentration has reached record highs since the industrial revolution, with an annual mean concentration of 416.45 µmol mol^{-1} in 2021, and an anticipated increase to 700 µmol mol^{-1} by 2100. Increases in CO_2, along with other greenhouse gases, have led to temperature increases of 1.59 °C and 0.88 °C, over land and ocean, respectively, with a further increase of up to 5.7 °C, as projected under the very high greenhouse gas emission scenario, by the end of this century. Generally when plants are stressed, secondary metabolite production may increase because growth is often inhibited more than photosynthesis, and the carbon fixed not allocated to growth is instead allocated to secondary metabolites. The availability of menthol crystals was affected by heavy monsoon rainfall, which occurred earlier than usual in Northern India and reportedly damaged field mint crops in 2008 . Stress factors that are both biotic and abiotic alter the metabolism of plants shows the conditions necessary for the emergence of plant secondary metabolites. Secondary compound formation in plants is influenced by genetic, ontogenetic, environmental, and morphogenetic variables. Inducing secondary stressors in plants that function as catalysts for PSM production include a number of harmful abiotic conditions that are present in the environment, including low and high temperatures, high light intensity, drought, flood, and the presence of numerous hazardous compounds in the soil. The findings of the experiments demonstrate that temperature stress causes the production of PSMs to start.

3. Effect on threats of medicinal plant species due to climate change -Climate change will affect plant species and medicinal plants in many ways. While remaining in their current habitat, certain species will evolve to accommodate altered climatic circumstances. Other species will move to higher latitudes or altitudes. Some plant species that are used medicinally might go extinct. According to the Karnataka State action plan on climate change, the Western Ghats, one of the world's bio-diversity hot spots, is in danger of going

extinct due to the indiscriminate harvesting of NTFP (Non timber forest products) like *Machilus macarantha*, which has significantly reduced its population.

(A) Medicinal plants in Alpine and Arctic regions-In comparison to other parts of the planet, warming is occuring more rapidly in Arctic.

- The distribution of certain Arctic flora is already being impacted by changes in snow patterns, ice cover, and temperatures. According to some researchers, climate warming may have an impact on the chemical composition and, eventually, the sustainability of some MAPs in Arctic regions.

- *Alain Cuerrier*, PhD, a botanist at the Montreal Botanical Garden and an assistant professor at the University of Montreal, has researched the therapeutic plants of the Canadian Arctic. In the Canadian Arctic, aerial images show that tree and shrub boundaries have changed over the past few decades, according to Dr. Cuerrier. According to Dr. Cuerrier, the dry Arctic snow has historically stripped or negatively affected tall trees or bushes in a way similar to sandblasting. Some species and populations as a result have only expanded in regions that would protect them from such extreme climatic circumstances. Climate change-related temperature and wind patterns are modifying precipitation variables and enabling some plants and shrubs to develop. Climate change may also have an especially negative influence on plants that thrive in alpine regions.

- Researchers from all around the world have observed and documented the advancing tree lines and the extinction of populations of mountain plants in recent years, which have been used as indicators of the effects of climate change on alpine ecosystems.

- Researchers have discovered that some cold-adapted plant species have started to gradually climb higher up mountain peaks in alpine environments—a behaviour linked to increasing temperatures. These plants may be threatened with extinction if they continue to travel upward to the point where there are no higher regions left for them to occupy. Additionally, as a result of increasing competition for resources and space brought on by plant species' upward migration, alpine plant populations may experience additional stress.

- Alpine areas are very important for Tibetan doctors' use," explained Dr. Salick. "They traditionally spend a month each year going into the mountains to collect plants. A lot of their medicines come from the mountains." Snow lotus (*Saussurea laniceps*, *Asteraceae*) is one of

the medicinal plant species that Dr. Salick and her former graduate student Wayne Law, PhD, have studied in particular. Snow lotus has historically been used in Tibetan medicine to treat high blood pressure, heart conditions, and women's conditions (such as childbirth, dysmenorrhea). Although this herb has not yet been formally listed as "threatened" by any governmental body or reputable nongovernmental organisation (NGO), such as the International Union for Conservation of Nature (IUCN), local experts currently believe that snow lotus, an endemic to the Eastern Himalayas, is in danger from both over-harvesting and adverse effects of climate change. Numerous attempts have been undertaken to grow snow lotus in response to these alleged dangers, often without success.

(B) Endangered medicinal plant species in Ayurveda

The extinction of medicinal plant species due to climate change may have adverse impacts on traditional practises. Some plant species could no longer be able to live in their native environments if temperatures increase and rainfall patterns change.

- Some of Endangered plant species are following-

1. *Aconitum deinorhizzum*
2. *Angelica glauca*
3. *Betula utilis*
4. *Dioscorea deltoidae*
5. *Ephedra gerardiana*
6. *Habeneria intermedia*
7. *Hyoscyamus niger*
8. *Juniperus polycarpos*
9. *Nordostachys grandiflora*
10. *Podophylum hexandrum*
11. *Rheum emodi*
12. *Taxus wallichiana*
13. *Zanthoxylum armatum*

(C) Ashtawarga- threatened medicinal plant species

Ashtawarga plants are among the 560 plants that are listed as endangered on the red list. The Department of AYUSH of the Indian government has given permission for the replacement of rare herbal medicines with readily available alternatives in order to address the issue of the non-availability of endangered species. Ayurvedic products are currently dealing with a

serious problem of adulteration due to the addition of low grade, spoiled, inferior, spurious drugs, useless parts of the same or different plants, harmful substances, or entirely different drugs that are either free from or have inferior therapeutic and chemical properties to the original drugs and are used to increase profits. *Ashtavarga* means group of eight rare and threatened species of medicinal value plants. The eight members of *Ashtavarga* group commonly occur in Himalayan region. Plants of *Ashtavarga* group make important ingredient of various classical Ayurvedic formulations, Like ***Chyawanprash*** because these plants have health promoting and immense cell regeneration properties which work as antioxidants in the body and strengthen the immune system. There have been many changes in the environment and soil through decades, which could be a reason that original plant species may not able to survive in such environment.

Drugs	**Botanical Name**	**Substitute Used**	**Botanical Name**
Jeevaka *Rishabhaka*	*Microstylis wallichi* *Microstylis mucifera*	*Vidarikand*	*Peuraria tuberosa*
Meda *Mahameda*	*Polygonum verticillatum* *Polygonum cirrhifolium*	*Shatavari*	*Asparagus racemosus*
Kakoli *Ksheerkakoli*	*Rosea procera* *Lilium polyphyllum*	*Ashwagandha*	*Withania somnifera*
Riddhi *Siddhi*	*Habenaria edgewrthii* *Habenaria intermedia*	*Varahikand*	*Dioscorea bulbifera*

4. Demand trends in Trade

(A) Global Ayurvedic Market- In current scenario, there is a increasing demand of Ayurveda**.** According to estimates, the worldwide Ayurveda market was worth US$ 4.5 billion in 2019 and is projected to grow to US$ 14.9 billion by 2026 at a CAGR of 16.14 percent. Ayurveda is becoming growing global demand in the world due to a number of factors, including its extensive knowledge base, which is enabling modernizations of ancient practices, trust built up over many years of use, an advanced educational system, and large institutional structure. Nutraceuticals (products derived from food sources but which provide extra health benefits) and personal care products like lotions, oils and medicinal formulations are the niche segments of the Ayurveda market. According to research and Markets, the domestic market for Ayurveda in India is expected to be around US$ 4 billion. This represents around 89 of the world market. The market is anticipated to expand at a CAGR of 16 in the upcoming years supported by large pool of qualified labor and a sizable and expanding middle class. Top export destinations from India are USA, Nepal, UAE, Netherland, Italy, Russia and France.

(B) Domestic Market- According to estimates, 70% of Indians utilize traditional medicine (ITCOT 1999). The rural poor, notably tribal and other people who depend on the forest, have little to no access to alternative medical practices. The popularity of Dabur, Baidyanath, Himalaya Drugs, and Zandu is evidence of the rise in ayurvedic drug demand. Over the past two decades, the ayurvedic business has steadily increased its market share. The constant consumption by the steadily growing population and, to some extent, a rebirth of confidence in traditional and natural ayurveda beliefs are the main drivers of the local market's growth.

(C) The Crisis in Supply- The present resource base is under a lot of pressure because of the growing local and worldwide demand for ayurvedic formulations. Several studies have suggested that the industrial demand may lead to the extinction of important species. Jain (1987). 120 medicinal plants are listed as being endangered or uncommon. FRLHT 1997 has compiled a priority list of 285 South American medicinal plant species. A prime example is the north-western Himalayas, which serve as a significant supply of medicinal plants but are currently experiencing significant strain from the high demand. Many species in this region have gone extinct, including Arnebia benthamii and Aconitum violaceum, and one of the main causes given is commercial exploitation.

5. Strategies for Climate change-Numerous climate change solutions can enhance our quality of life, save the environment, and yield financial gains. We also have international frameworks and aggrements, including the Paris Agreement, the UN Framework Convention on Climate Change, and the Sustainable Development Goals, to direct our development. Cutting emissions, preparing for climate consequences, and funding necessary adaptations are the three major areas of action. Even while more nations are pledging to have net-zero emissions by 2050, emissions must be cut in half by 2030 to maintain global warming to 1.5°C or less. In order to achieve this, significant reductions in the use of coal, oil, and gas must be made; by 2050, more than two-thirds of the world's confirmed fossil fuel reserves must remain underground. Protecting people, homes, companies, livelihoods, infrastructure, and natural ecosystems against the effects of climate change.

(A) Techniques to combat pollution using ayurveda-Some formulation and some traditional way of conserving our nature is discussed here.

(1) *Dava aswakrnadi yoga* for water pollution. (explain prepration and use)

(2) *Ananta (durva*) mixed the *sarvaganda* (aromatic drug) and sweets like honey etc and mixed with the alcoholic prepration like sura or water and sprinkled over the land for land or soil pollution.

(3) Paste of some anti poisonous drug has to be made and smeared over the drum or other instruments and should play that so that it will spread over the small plants over the land it can also give as a remedy of soil pollution.

(4) The drug like *laksha*, *haridra*, *ativisa* etc. has to be fired that resulting smoke will purifies the air.

6. CONCLUSION

In compared to other commercial crops, research on medicinal plants and climate change is extremely rare and minor. Since these MAPs (medicinal and aromatic plant) species are essential sources of key biomolecules and nutraceuticals, it is of utmost importance that they not be abandoned. There is a wide variety of medicinal plant species that produce secondary metabolites that are extremely beneficial for treating acute human illnesses as cancer, TB, HIV, ulcers, etc. The medicinal plants growing in various Indian geographic regions, such as the Himalayas and Western Ghats, are severely impacted by the changing climate background. The normal physiology and functioning of medicinal plants have been altered as a result of changes in temperature, CO2 level, oxygen concentration, and other abiotic stressors like salinity stress. This has an impact on the production of biologically active compounds like phenolics, terpenoids, alkaloids, saponins, etc. Collectively, weather changes have both beneficial and negative consequences, although the latter are more thought-provoking. The best way to approach this issue and the approaches we ought to take are still up for debate. As a result, scientists must concentrate on maximizing plant growth and development under abiotic challenges. Various conventional and unconventional methods must be used to increase plant tolerance to biotic and abiotic stressors.

REFFERENCES

1. Bidart-Bouzat MG, Imeh-Nathaniel A Global change effects on plant chemical defenses against insect herbivores. J. Integr. Plant. Biol., 2008; 50(11): 1339-1354.
2. Salick J, Zhendong F, Byg A. Eastern Himalayan alpine plant ecology, Tibetan ethnobotany, and climate change.
3. Yoon CK. Warming moves plants up peaks, threatening extinction. June 21, 1994: C4.

4. Niraj subrat, Meera iyer, Ram prasad, The Ayurvedic medicine industry: Current status and sustainability, A collaboration between Ecotech services private limited and International institute of Environment and development, 2002.
5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8371220/
6. Acharya Balkrishna, 2012 Secrets of Ashtawarga plants (For vitality and Anti-ageing), Divya prakashan, patanajali yogpeeth, Uttrakhand, Haridwar
7. Badola H.K. pal, M Endangered medicinal plant in Himachal Pradesh, Current science, 2002; 83(7).
8. Walther, G.R., et al., Ecological responses to recent climate change. Nature, 2002; 416(6879).
9. Bhandari C. R. Vanaushadhi Chandrodaya, Chsndra raj bhandari, Bhanpura, Indore, 1985; 1-9.