ejpmr, 2024, 11(3), 260-271

SJIF Impact Factor 6.222

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Review Article

ISSN 2394-3211

EJPMR

SOME ENDANGERED MEDICINAL PLANTS OF TERAI REGION OF GORAKHPUR DIVISION

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Article Received on 17/01/2024 **Article Revised on 07/02/2024** **Article Accepted on 27/02/2024**

ABSTRACT

India has a very rich plant biodiversity, many of which are medicinally useful. The rich resource is disappearing at an alarming rate due to over-exploitation, habitat destruction, climate change and migratory challenges. The management of medicinal plant resources has become a matter of urgency due to great demand of the pharmaceutical industry and lesser supplies of the medicinal species. The existing legislative mechanisms and policy parameters are not sufficient to overcome the challenges of conservation of the endangered and rare plants which have grave danger of extinction in the near future. Intervention of biotechnological tools like micropropagation, bioinformatics and metabolomics offer great help for research in conservation of rare medicinal plant. Some endangered medicinal plants of Gorakhpur Division are *Rauvolfia serentina* Benth.ex Kurz, *Withania somnifera* (L.)Dunal, *Gloriosa superba* L., *Flacourtia jangomas* (Lour.) Raeusch and *Saraca asoca* (Roxb.)W.J.de Wilde, *Bacopa monnieri* (L.) Pennell. Current Review is done regarding some endangered plants of Terai Region of Gorakhpur division.

KEYWORDS: Endangered plants, Medicinal, Gorakhpur.

INTRODUCTION

Biodiversity conservation is a demanding task that includes scientific, social, and political challenges.[1] Given the enormous diversity of species and limited resources available to undertake these conservation programs, prioritization of species for conservation, assessment of threat status and the most suitable strategy to be adopted become the basic pre-requisites. On global basis, total number of threatened plant species with varying degree of threats are 24,9149 (IUCN, 2022). Many plants species are extinct, critically endangered (5,232), endangered (9,996), and vulnerable (9,221) due to various reason like population loss, loss of pollinators, loss of reproduction or seed germination capacity, habitat destruction, over exploitation and loss of genetic variability. India has 2.4% of world's area with 8% of global biodiversity and it is one of the 12 mega diversity countries of the world.[2, 3] Among the world's 35 global biodiversity hotspots (GBH), four (Himalayas, Indo-Burma, Sunderland and Western Ghats) fall in the Indian geopolitical territory.[4] This richness of phyto-diversity in India is owing to existence of 15 agro-climatic zones with varied ecological habitats. India has ~ 10.45% of global floral diversity. In India about 11.53% of vascular plants (18,532), totaling about 2,142 species are red listed. Out of these 8 are extinct, 432 species are threatened (CR, EN and VU) and nearly 54 species are grouped under near threatened (IUCN 2020). In India 48,655 plant species documented (including virus, bacteria, algae, fungi and lichens) 9,500 species have ethno-botanical importance and 7,500 species are in medicinal use for indigenous health practices as well as modern system of medicines.[5.6] From ancient period medicinal plants have been used in all cultures as a source of medicine and its use as herbal medicine is described in numerous ancient texts. Besides being a major source of raw material for the traditional healthcare practices (Ayurveda, Siddha, Unani, Homeopathy, Naturopathy, Sowa-Rigpa and diverse area and community-specific folk medicine) and pharmaceutical industry, also provide livelihood to a large Indian population.[7] Indigenous and traditional systems of medicine using plants have shown potential (direct or indirect as immune- boosters) against many dreaded ailments including the recent global pandemic of COVID-19. For example Ayurveda preparations ('rasayana') with 'Ashwagandha' (*Withania somnifera* Dunal) can be a potential candidate for management of COVID-19, as also 'Shatavari' (*Asparagus racemosus* Willd.), 'Amala' (*Phyllanthus emblica* L. syn *Embelica officinalis*), 'Guduchi'(*Tinospora cordifolia* (Willd.) Miers), as these have immune modulatory properties, and

may have the potential to boost health and immunity to fight against SARS CoV-2 infection.[8]

In India more than 90% of medicinal plants are facing threat due to excessive and unsustainable collection, utilization, overexploitation or un-skilled harvesting.[9] Based on global rates of plant species threatened with extinction, it is estimated that around 1,000 medicinal plant species may be under threat. This Review paper attempts to review the existing information and have made list of some threatened medicinal plants of India and also of our locality Gorakhpur, situated in northern part of Uttar Pradesh.

Study area

Gorakhpur division is the study area taken in present situated in northern part of Uttar Pradesh, which lies between 26*46'N latitude and 83*2'E longitude. The Gorakhpur division is a terai region has dense forest covers close to foothills of Himalayas. It is situated on banks of Rapti river. All the forest of Gorakhpur divison including Achalgarh, Banki, Campiergang, Chowk, Kushmahawa, Kushmahi, Lehradevi, Madhualia, Nichlawl, Pakari, Tehrighat and Tilkonia are rich in species composition of higher plants. The vegetation of forest consists of herbs, shrubs, trees and climbers. Trees, shrubs and climbers occur throughout the year and form permanent vegetation, while herbaceous plants mostly appearing during rainy season, decreasing during winter and finally become depleted in peak summer. The soil of this area is gangatic alluvial brought down by rivers like Ghaghara, Rapti, Rohin and Gandak from the Himalayas. The rainfall varies considerably from year to year. The monsoon rains commence during June and come to an end in September but may persist till October. The minimum temperature goes down to 6ºC in the month of January & maximum up to 43ºC in the month of June.

Figure: Map of study area (Gorakhpur a district of Uttar Pradesh).

REVIEW OF LITERATURE

India has a very rich plant biodiversity, many of which are medicinally useful. The rich resource is disappearing at an alarming rate as a result of over-exploitation. Therefore, the management of traditional medicinal plant resources has become a matter of urgency. An ever-increasing demand of uniform medicinal plants-based medicines warrants their mass propagation through plant tissue culture strategy. Tissue culture technology is potent and has opened extensive areas of research for biodiversity conservation. Plant *in vitro* regeneration is a biotechnological tool that offers a tremendous potential solution for the propagation of endangered and superior genotypes of medicinal plants which could be released to their natural habitat or cultivated on a large scale for the pharmaceutical product of interest. Tissue culture protocols have been developed for a wide range of medicinal plants, which includes endangered, rare and threatened plant species. The conventional means of propagation takes a long time for multiplication and also clonal non uniform. Conventionally, there are two methods of conservation*: in situ* and *ex situ* conservation, both are complementary to each other. In situ methods allow conservation to occur with ongoing natural evolutionary processes ex situ conservation via in vitro propagation also acts as a viable alternative for increase and conservation of populations of existing bioresources in the wild and to meet the commercial requirements. A review highlighting various in vitro protocols developed for selected rare and threatened plant species of India has been done to highlight the significance of *ex situ* conservation in cases where regeneration through conventional methods is difficult to undertake and species are left with low population in the wild. Thus *in vitro* cell and tissue culture methodology is envisaged as a mean for germplasm conservation to ensure the survival of endangered plant species, rapid mass propagation for large scale revegetation and for genetic manipulation studies.

Endangered medicinal plants

Due exploitation and habitat loss, a large number of rare and endangered species are on verge of extinction; frequent multiplication and organized cultivation will

help ensure the sustained availability of these species. Collection of following Indian species from wild sources should be banned: Bankakri (*Podophyllum hexandrum*), chirayata *(Swertia chirayata*), gaozahan *(Anchusa strigosa*), glory lily, agnisikha (*Gloriosa superba*), halad-vachnag, mamira (*Coptis teeta*), henbane (*Hyoscryamus niger*), Indian belladonna *(Atropa acominata*), Indian barberry, daru haridra*(Berberis aristata*), Indian gentian, pashanbheda *(Gentiana kurroa*), Indian ginseng (*Panaax pseudo-ginsengvar. himalaicus*)Indian hing(*Ferula jaeskaena*), Indian rhubarb, ghandini (*Rheum emodi*), Indian yew (*Taxus wallichiana*), jata mansi *(Nardostachys grandiglora*), jeevaka (*Microstylis nucifera*), jeevanti *(Leptadenia reticulata*), kababchini (*Piper cubeba*), kadu bonsha *(Gynacardia odorata*), kala zeera (*Brunium persicum*), kali musli *(Cuculigo orchiodes*), kshira kankoli *(Lilium polyphyllum*), kutki (*Picrorhiza kurroa*) bachang (*Acontum sp*.), safed musli(*Chlorophytum* spp.), sarpagandha *(Rauvolfia serpentina*), sweet flag (Acorus spp.), golden collyrium *(Colchicum luteum)*, yogispada *(Saussurea sacra*).[10]

Conservation strategies for medicinal plants

There are basically three scientific strategies for conserving medicinal plant's genetic diversity.

- Legislation
- Conservation *in situ*
- Conservation *ex situ*

Legislation

There is no specific legislation or regulation in place in India to protect medicinal plants that thrive in forests. The following regulation concerning forestry also covers conservation of plants.

a. 1927 The Forest Act.
b. 1972 The wildlife (Protection)Act amended in 1991 as the Wildlife (Protection) Amendment
c. Act.
d. 1980 Forest Conservation Act.
e. 1986 Environment Protection Act.
f. 1988 National Forest Policy.
g. 2002 National Biodiversity Act.

To preserve Indigenous tribes and other traditional forest dwellers, the Scheduled Tribes and other Traditional Forest Dwellers Act was passed in 2006, which included;

a. The protection of wild life in its native surrounding, or the site where the develops, known as *in situ* conservation.
b. Establishment of gene libraries genome reserves and ecological reserves, nature reserves, sacred sites, and sacred groves.
c. Vegetation diversification is kept in the environment throughout time, whether it is genetic variation, life forms, or environments.
d. In discrete, relevant, biologically diverse zones, it is vital to preserve intra- specific heritable variation.

***In situ* or On–site Conservation**

This arises when a particular species or community of an ecological system is protected and conserved in its native habitat, and it is considered to be one of the most cost-effective strategies for maintaining biological and genetic variation.

National parks, Wildlife reserves, Holy groves, and other protected zones are example of *in situ* conservation initiatives.[10]

***Ex situ or* Off-site conservation**

Ex –situ conservation, taking place outside the nature niche of the plant, involves conservation of indigenous herbs carried out in botanical gardens, parks, and other appropriate locations, as well as through lengthy collection of vegetation propagules in gene banks (grain banks, spore banks, DNA Libraries, etc.) and by means of tissue culture as well as cryogenics.[10]

Table 1: Some threatened medicinal plants of india.

SR. No.	Scientific name	Family	Red list category	Reference
	Angiosperms			
1.	*Aldrovanda vesiculosa L.*	Droseraceae	Endangered	IUCN Red List version 3.1
2.	*Magonolia pealiana* King	Magnoliaceae	Critically endangered	IUCN Red List version 3.1
3.	*Paphipedilum Charlesworthii (*Rolfe*)* Pfitzer	Orchidaceae	Endangered	IUCN Red List version 3.1
4.	*Dipterocarpus hasseltii* Blume	Dipterocarpaceae	Critically endangered	IUCN Red List version 3.1
5.	*Santalum album* L.	Santalaceae	Vulnerable	IUCN Red List version 3.1
6.	*Aquilaria malaccensis* Lam.	Thymelaceae	Critically endangered	IUCN Red List version 3.1
7.	*Dipterocarpus restus* Blume	Dipterocarpeaceae	Endangered	IUCN Red List version 3.1
8.	*Hopea helferi* Brandis	Dipterocarpeaceae	Endangered	IUCN Red List version 3.1

9.	*Pterocarpus indicus* Wild.	Fabaceae	Endangered	IUCN Red List version 3.1
10.	*Cryptocoryne cognata* Schott	Araceae	Endangered	IUCN Red List version 3.1
11.	*Isachne meeboldii* C.E.C.Fisch	Poaceae	Critically endangered	IUCN Red List version 3.1
12.	*Farmeria indica* Willis	Podostemaceae	Endangered	IUCN Red List version 3.1
13.	*Rotala malabarica* Pradeep & K.T.Joseph & Sivar.	Lythraceae	Critically endangered	IUCN Red List version 3.1
14.	*Ammannnia nagpurensis* T.Mathew & M.P. Nayar	Lythraceae	Endangered	IUCN Red List version 3.1
15.	*Dimeria hohenackeri* Hochst. Ex Miq.	Poaceae	Endangered	IUCN Red List version 3.1
16.	*Fimbristylis dauciformis* Govind	Cyperaceae	Endangered	IUCN Red List version 3.1
17.	*Lindernia minima (*Benth.*)* Mukerjee	Linderniaceae	Endangered	IUCN Red List version 3.1
18.	*Syzygium chavaran (*Bourd.*)* Gamble	Myrtaceae	Endangered	IUCN Red List version2.3
19.	*Ixora johnsonii* Hook.f.	Rubiaceae	Critically endangered	IUCN Red List version2.13
20.	*Ixora lawsonii* Gamble	Rubiaceae	Endangered	IUCN Red List version2.3
21.	*Madhuca bourdillonii (*Gamble*)* H.J.Lam	Saptotaceae	Endangered	IUCN Red List version2.3
22.	*Pittosporum eriocarpum* Royle	Pittosporaceae	Endangered	IUCN Red List version2.3
23.	*Shorea assamica* Dyer	Dipterocarpaceae	Critically endangered	IUCN Red List version2.3
24.	*Berberis nilghiriensis* Ahrendt	Berberidaceae	Critically endangered	IUCN Red List version2.3
25.	*Dipterocarpus bourdillonii* Brandis	Dipterocarpaceae	Critically endangered	IUCN Red List version2.3
26.	*Vateria indica* L.	Dipterocarpaceae	Critically endangered	IUCN Red List version2.3
27.	*Bombax insigne* var.*polystemon* Prain	Malvaceae	Critically endangered	IUCN Red List version2.3
28.	*Garcinia cadelliana* King	Clusiaceae	Critically endangered	IUCN Red List version2.3
29.	*Drypetes andamanica* Pax & K.Hoffin	Putranjivaceae	Endangered	IUCN Red List version2.3
30.	*Ficus andamanica* Corner	Moraceae	Endangered	IUCN Red List version2.3
31.	*Aconitum heterophyllum* Wall.ex Royle	Ranunculaceae	Critically endangered	IUCN Red list version 3.1
32.	*Aconitum chasmanthum* Stapf ex Holmes	Ranunculaceae	Critically endangered	IUCN Red list version 3.1
33.	*Acorus calamus* L.	Acoraceae	Endangered	IUCN Red list version 3.1
34.	*Aegle marmelos* L.	Rutaceae	Vulnerable	IUCN Red list version 3.1
35.	*Aquilaria malaccensis* Lam	Thymelaeaceae	Critically endangered	IUCN Red list version 3.1
36.	*Cinnamomum wightii* Meisn.	Lauraceae	Vulnerable	IUCN Red list version 3.1
37.	*Nardostachys jatamansi* DC	Caprifoliaceae	Critically endangered	IUCN Red list version 3.1
38.	*Picrorhiza kurroa* Royle ex Benth.	Plantaginaceae	Endangered	IUCN Red list

				version 3.1
39.	*Taxus wallichiana* Zucc.	Taxaceae	Critically endangered	IUCN Red list version 3.1
40.	*Berberis affinis* G.Don	Begoniaceae	Rare	IUCN Red list version 3.1
41.	*Berberis lambertii* Parker	Begoniaceae	Endangered	IUCN Red list version 3.1
42.	*Allium stracheyi* Baker	Alliaceae	Endangered	IUCN Red list version 3.1
43.	*Cymbidium hookeianum* Reicbb.f	Orchidaceae	Rare	IUCN Red list version 3.1
44.	*Celastrus paniculatus* Willd	Celastraceae	Endangered	IUCN Red list version 3.1
45.	*Saraca asoca* (Roxb.)W.J.de Wilde	Fabaceae	Vulnerable	IUCN Red list version 3.1
46.	*Mangifera nicobarica* Kosterm	Anacardiaceae	Endangered	IUCN Red list version 3.1
47.	*Euphorbia epiphylloides* Kurz	Euphorbiaceae	Endangered	IUCN Red list version 3.1
48.	*Euphorbia santapaui* A.N.Henry	Euphorbiaceae	Endangered	IUCN Red list version 3.1
49.	*Atuna indica* (Bedd.) Kosterm.	Chrysobalanaceae	Endangered	IUCN Red list version 3.1
50.	*Lilium polyphyllum* Don	Liliaceae	Critically endangered	IUCN Red list version 3.1
51.	*Ceropagia odorata* Nimmo ex J.Graham	Apocynaceae	Critically endangered	IUCN Red list version 3.1
52.	*Paphiopedilum druryi (Bedd.)* Stein	Orchidaceae	Critically endangered	IUCN Red list version 3.1
53.	*Sussurea costus* Lipsch	Asteraceae	Critically endangered	IUCN Red list version 3.1
54.	*Tribulus rajasthanensis* Bhandari & Sharma	Zygophyllaceae	Critically endangered	IUCN Red list version 3.1
55.	*Symplocos oligandra* Bedd.	Symplocaceae	Critically endangered	IUCN Red list version 3.1
56.	*Syzygium microphyllum* Gamble	Myrtaceae	Endangered	IUCN Red list version 2.3
57.	*Bentinckia nicobarica (*Kurz*)* Becc.	Arecaceae	Endangered	IUCN Red list version 2.3
58.	*Cleistanthus travancorensis* Jabl.	Phyllanthaceae	Endangered	IUCN Red list version 2.3
59.	*Croton lawianus* Nimmo	Euphorbiaceae	Endangered	IUCN Red list version 2.3
60.	*Dimorphocalyx beddomei* Airy Shaw	Euphorbiaceae	Endangered	IUCN Red list version 2.3
61.	*Drypetes travancorica* (Bourd.*)*	Putranjivaceae	Endangered	IUCN Red list version 2.3
62.	*Homalium travancorium* Bedd.	Chrysobalanaceae	Endangered	IUCN Red list version 2.3
63.	*Glochidion sisparense* Gamble	Phyllanthaceae	Endangered	IUCN Red list version 2.3
64.	*Sophora wightii* Baker	Fabaceae	Endangered	IUCN Red list version 2.3
65.	*Ficus angladei* C.E.C.Fisch	Moraceae	Endangered	IUCN Red list version 2.3
66.	*Eugenia indica(*Wight*)* Chithra	Myrtaceae	Endangered	IUCN Red list version 2.3
67.	*Ardiscia sonchifolia* Mez	Myrsinaceae	Endangered	IUCN Red list version 2.3

68.	*Chionanthus linocieroides* Bennet &Raizada	Oleaceae	Endangered	IUCN Red list version 2.3
69.	*Photinia serratifolia*Vivek var. *tomentosa* (Gamble)& B.V. Shetty	Rosaceae	Endangered	IUCN Red list version 2.3
70.	*Psydrax ficiformis* (Hook.f.)Bridson	Rubiaceae	Endangered	IUCN Red list version 2.3
71.	*Ixora malabarica* (Dennst.) Mabb.	Rubiaceae	Endangered	IUCN Red list version 2.3
72.	*Coffea neobridsoniae* A.P. Davis	Rubiaceae	Endangered	IUCN Red list version 3.1
73.	*Coffea arabica* L.	Rubiaceae	Endangered	IUCN Red list version 3.1
74.	*Dalbergia congesta* Wight & Arn.	Fabaceae	Endangered	IUCN Red list version 3.1
75.	*Cypripedium elegans* Rchb.f.	Orchidaceae	Endangered	IUCN Red list version 3.1
76.	*Kyllinga pluristaminea* Govind &Ramani	Cyperaceae	Endangered	IUCN Red list version 3.1
77.	*Curcuma coriaceae* Mangaly &M.Sabu	Zingiberaceae	Endangered	IUCN Red list version 3.1
78.	*Curcuma caulina* J.Graham	Zingiberaceae	Endangered	IUCN Red list version 3.1
79.	*Shorea tumbuggaia* Roxb.	Dipterocarpaceae	Endangered	IUCN Red list version 3.1
80.	*Buchanania barberi* Gamble	Anacardiaceae	Critically endangered	IUCN Red list version 3.1
81.	*Hopea canarensis* Hole	Dipterocarpaceae	Endangered	IUCN Red list version 3.1
82.	*Pyrenaria cherrapunjeana* Mir	Theaceae	Endangered	IUCN Red list version 3.1
83.	*Asparagus adscendens* Roxb.	Liliaceae	Endangered	IUCN Red list version 3.1
84.	*Drimia indica* L.	Asparagaceae	Endangered	IUCN Red list version 3.1
85.	*Euphorbia fusiformis* Buch. Ham.ex D.Don	Euphorbiaceae	Endangered	IUCN Red list version 3.1
86.	*Gloriosa superba* L.	Colchicaceae	Endangered	IUCN Red list version 3.1
87.	*Andrographis paniculata* Nees	Acanthaceae	Vulnerable	IUCN Red list version 3.1
88.	*Withania somnifera* Dunal	Solanaceae	Endangered	IUCN Red list version 3.1
89.	*Rauvolfia serpentina* Benth ex Kurz	Apocynaceae	Endangered	CITES Appendix II
90.	*Dipterocarpus indicus* Bedd.	Dipterocarpaceae	Endangered	IUCN Red list version 3.1
91.	*Flacourtia jangomos* Raeusch.	Salicaceae	Least concern	IUCN Red list version 3.1
92.	*Lamprochaenium microcephalum* Benth.	Asteraceae	Endangered	IUCN Red list version 3.1
93.	*Palaquium ravii* Sasidh. & Vink	Sapotaceae	Endangered	IUCN Red list version 2.3
94.	*Acer oblongum* Wall. Ex DC.	Sapindaceae	Least concern	IUCN Red list version 3.1
95.	*Hopea Jacobi* C. Fischer	Dipterocarpaceae	Endangered	IUCN Red list version 2.3
96.	*Utleria salicifolia* Bedd. Ex Hook.f.	Apocynaceae	Critically endangered	IUCN Red list version 3.1
97.	*Stevia rebaudiana* Bertoni	Asteraceae	Endangered	IUCN RED list

				version 3.1
98.	*Asparagus racemosus* Willd.	Asparagaceae	Endangered	IUCN RED list version 3.1
99.	*Piper barberi* Gamble	Piperaceae	Endangered	IUCN RED list version 3.1
100.	*Coptis teeta* Wall.	Ranunculaceae	Endangered	IUCN RED list version 3.1

Table 2: Some famous threatened medicinal plants of Gorakhpur, A district of Uttar Pradesh.

Botanical name	Family	Common name	Conservation Status	Reason of decline	Reference
Acorus calamus L.	Araceae	Sweet flag, Bach, Bal	Critically endangered	Genetic variation is low among accessions	[11]
Asparagus racemosus Willd.	Asparagaceae	Satawari	Endangered	Destructive harvesting, habitat destruction and deforestation	[12]
Chlorophytum tuberosum Baker	Asparagaceae	Safed musli	Least concern	Over exploitation and habitat destruction	[13]
Flacourtia jangomas (Lour.) Raeusch.	Salicaceae	Indian plum or scramberry, Paniala(in Hindi)	Endangered	Lack of understanding of its cultivaton, nutritional value	IUCN Red List Version 3.1
Dipterocarpus indicus Bedd.	Dipterocarpaceae	Garjan	Endangered	Over exploitation of timber and oleoresin leads to threat	IUCN Red List version 3.1
Rauvolfia serpentina (L.) Bent. & Kurz.	Apocynaceae	Indian snakeroot, Sarpagandha	Endangered	Its indiscriminate use in pharmaceuticals and poor method of conventional propagation	CITIES Appendix II (CITIES)
Gloriosa superba L.	Colchicaceae	Flame lily, glory lily tiger claw, agnishikha	Endangered	Due to extensive use for medicinal purpose	IUCN Red list version 3.1
Withania somnifera (L.)Dunal	Solanaceae	Ashwagandha or winter cherry	Endangered	Due to over exploitation from natural resources for medicinal purposes	IUCN Red list version 3.1
Saraca ascoca (Roxb.)W.J.de Wilde	Fabaceae	Ashoka	Vulnerable	Unsustainable and indiscriminate practices have led to the depletion of wild population	IUCN Red list version 2.3
Euphorbia fusiformis buch.-ham. Ex. D.Don	Euphorbiaceae	Banmuli	Endangered	Due to indiscriminate collection from natural habitat	[14]
Butea monosperma (Lam) Taub.var.Lutea	Fabaceae	Flame of forest, dhak and Palash	Rare	Climate change ,agriculture expansion and anthropogenicdisturbances	IUCN Red list version 3.1
Andrographis paniculata (Burm.f.)Nees	Acanthaceae	Kalmegh,chirett	Vulnerable	Over exploitation due to high medicinal properties	[14]
Prosopis cineraria (L.) Druce	Fabaceae	Shami	Endangered	Climate change	[15]

Lindernia minima (Benth.) Mukerjee	Linderniaceae		Endangered	Over exploitation and habitat loss	[16]
Bacopa monnieri (L.) Pennell	Plantaginaceae	Brahmi, Indian pennywort	Least concern	Over exploitation due to its medicinal properties	IUCN Red List Version 3.1
Santalum album L.	Santalaceae	Indian sandalwood	Vulnerable	Over exploitation for its essential oil	IUCN Red list version 3.1
Aegle marmelos (L.) Corr.Serr.	Rutaceae	Bael	Vulnerable	Extraction of its biological resources	[14], IUCN Red list version 3.1
Lilium polyphyllum D.Don ex Royle	Liliaceae	Kalihari	Critically Endangered	Climate change and over exploitation for high medicinal properties	IUCN Red list 3.1
Celastrus paniculatus Willd.	Celastraceae	Jyotishmati	Endangered	Over exploitation of plants	[14]
Picrorhiza kurroa Royle ex.Benth	Plantaginaceae	Kutki	Endangered	Over harvesting of wild species for use of Medicine and lack of organized cultivation	Appendix II (CITIES)

Some threatened medicinal plants of gorakhpur division that need urgent conservation

1. ***Rauvolfia serpentina*** **Benth.ex Kurz, Family – Apocynaceae, Common name- Sarpagandha, Conservation status – Endangered**

Phytochemistry

Rauvolfia serpentina has been a prevailing field of research for decades and several workers have explored this area due to its phytochemical properties The various phytochemical compounds or secondary metabolites present in *R. serpentina* include alkaloids, phenols, tannins and flavonoids.[17,18,19]

The plant contains more than 50 different alkaloids which belong to the monoterpenoid indole alkaloid family. The major alkaloids are ajmaline, ajmalicine, ajmalimine, deserpidine, indobine, indobinine, reserpine, reserpiline, rescinnamine, rescinnamidine, serpentine, serpentinine and yohimbine. *R. serpentina* is also known for its antimicrobial, antifungal, anti-inflammatory, antiproliferative, antidiuretic and anticholinergic activities.[20]

Need for conservation

It was found to be endangered in Southern Western Ghats of India. The roots of *Rauwolfia serpentina* are used in the pharmaceutic industry. This plant is harvested to obtain its root. Due to which this plant is on the verge of extinction, hence its preservation is the greatest need of the time. The *Rauvolfia serpentina* plant can be conserved with two important methods in-situ and ex-situ conservation. The plant was described as critically endangered in the Northeast India. There is the need in Vitro and in Vivo for the conservation of this important threatened plant species.

Conservation strategies

Since *R. serpentina* is an essential medicinal plant, its conservation is the most significant need of the hour for ecological balance and its medicinal usage. Through

means of ***"in situ conservation***" as well as **"*ex situ conservation***", the *R. serpentina* plants can be very well conserved in our country. In situ conservation is very important for conserving the natural habitat of *R. serpentina* so that shrinkage in the area of its habitat could be ceased. The natural habitats of this plant need to be converted in Gene sanctuary. *R. serpentina* can automatically be conserved by means of conservation and restoration of its natural habitats**.** ***Ex situ conservation*** can also be very helpful in extending the areas where *R. serpentina* could flourish. For this, the plants of *R. serpentina* can be carried to distant places from their natural habitat and preserved. This plant can also be conserved as **Gene bank** and **Germplasm** under the process of ex situ conservation. To help this extremely useful medicinal plant find an ample area for habitat, modern techniques under biotechnology, such as **tissue culture** can also play a vital role and this is the need of the hour.[21]

2. Withania somnifera(L.) Dunal

Family –Solanaceae, **Common name** – Ashwagandha, **Conservation status**-Endangered

Habit- Herb

Phytochemistry

Phytochemical analysis of *W. somnifera* revealed the presence of pharmacologically active steroidal lactones named withanolides.[22,23] Withanine, a group of alkaloids isolated from the roots of the plant, forms 38% of the total weight of alkaloids.[24] The principal withanolides extracted from *W. somnifera* in India were withanolide D and withaferin A which exhibited antitumor and cytotoxic properties.[25] In addition to alkaloids, the plant also consisted of steroids, saponins, phenolics, flavonoids, phytophenols, and glycosides.[26] Also, it is widely used in traditional medicine formulations as an antipyretic, analgesic, adaptogenic, and anti-inflammatory agent.[27]

Need for conservation

W. somnifera has not yet been assessed for the IUCN Red List. However,[28] declared *W. somnifera* as endangered and rare plant. In India, W. *somnifera* is falling in criteria of endangered category. So there is need to conserve this species like highly medicinal wild plant species. The various threats are facing by *W. somnifera* which leads towards the extinction of this highly medicinal species. Increase in human population and constant unplanned over exploitation of this plant for medicinal, firewood and fodder purposes has resulted damage into the *Withania* species.[29]

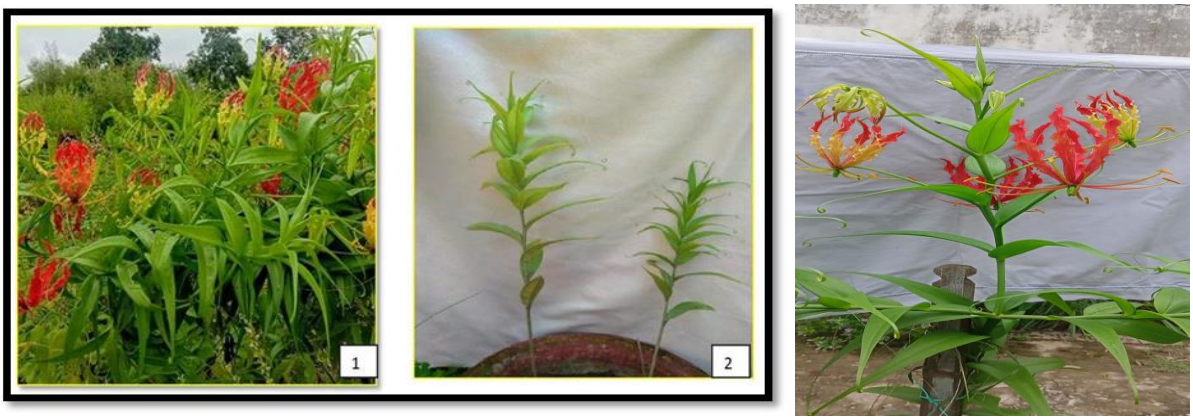
Conservation strategies

W. somnifera is a highly important medicinal plant and used globally in pharmaceutical industry. *Withania* propagates vegetative in its natural state, but this propagation rate is much slow to meet demand of high quality planting material for commercial cultivation.[30] The *W. somnifera* plant is a set and valuable resource that requires wise, efficient as well as sustainable management and conservation strategies. Therefore, instant conservation measures as projected below are immediately necessary in order to protect the plant from extinction. The conservation strategies should be adopted for the conservation of highly medicinal plants.[31] Biotechnological techniques can help us to conserve this miracle plant. A swift and extremely effective method is the micropropagation method for elite selection of *Withania* by auxiliary branching method utilizing shoot tip as explants was standardized by.[31] Shoot cultures were initiated on MS medium containing BA (0.5 - 2.0 mg/L) with NAA (0.2 - 0.5 mg/L) containing 3% commercial sucrose and 0.8% agar. This direct regeneration method which lessens genetic flux that is normally come across during callus mediated regeneration will assist in production of large number of selected superior chemo types ashwagandha which has high- quality demand in the present drug market.[32] established a protocol for synthetic seed production by using artificial coating material (sodium alginate) and complexing agent (calcium chloride) through somatic embryogenesis. This synthetic seed technology can also be very helpful for medicinal plants such as *Withania* species.[33] Have reported an easy and efficient protocol for micropropogation of the endangered medicinal plant *W. somnifera*. This protocol can be used for booming and rapid technique that can be utilized for ex-situ conservation. The implementation of these protocols can aid to diminish the pressure on wild populations and

contribute toward the conservation of the valuable plant *W. somnifera*.

3. Gloriosa superba L.

Family – Colchicaceae, **Common name**- Flame lily, **Conservation status** – Endangered (IUCN 3.1) **Habit**- Perennial Herb



Phytochemistry

Many bioactive compounds are found in this plant: alkaloids, flavonoids, glycosides, terpenoids, tannins, steroids, saponins, phenolics, vitamins, and minerals. Tuber and seeds of the plant contain a high amount of colchicine and its derivatives which is a pharmaceutically important alkaloid; the amount of colchicine is 2–5 times lesser in tubers than in seeds. A single plant can constitute up to 0.9% colchicine and 0.8% colchicoside. Due to the presence of a high amount of colchicine, its seed and tuber are extremely toxic.[34]

Need for conservation

The current annual demand of Glory lily is very high. Due to its high medicinal demand and low production, it is harvested from the wild at a high rate. This plant species has become endangered in Asian countries hence facing local extinction and it is included in 'Red Data Book' by the International Union for Conservation of Nature. Naturally, Glory lily reproduces by seeds and tubers, but it has poor seed germination which can take 3 weeks to months and its tubers have low regeneration frequency. The poor seed germination due to water-impermeable hard seed coat which limits its use in commercial cultivation. Seeds become water-permeable only after repeated cycles of cold and heat environmental conditions.

Conservation strategies

G. superba is a commercially imperative medicinal plant which has diverse medicinal applications and eventually due to over-exploitation this plant is facing local extinction. Sometime plant tissue culture techniques play a key for conservation of this plant. At present Plant tissue culture offers a valuable to overcome the problem regarding conventional propagation, and obtain disease free healthy plants.[35] Its seeds have poor germination and low availability, while propagation by corm also a limiting factor, making micropropagation an essential proposition in order to meet the demand for quite a huge amount for raw material by pharmaceutical industries.[36] Cultivation is not a suitable solution to save and simultaneously utilize sustainably the rare medicinal plant. Mass propagation by tissue culture method is required to conserve this plant. In-vitro regenerated plants might be genetically improved variations like more tolerance to harsh environmental conditions. When the aim is to conserve species, constructive ways for the clonal multiplication of plants include callus induction and tissue proliferation, mainly in the condition of endemism or seed dormancy.[37]

CONCLUSION

Natural resources, such as medicinal and fragment plants, are quite highly valued. Due to increased demand for herbal drugs, natural remedies, and bioactive components from traditional medicines, the use of aromatic and medicinal plants is rapidly increasing around the world. The extinction of some species and a shortage of a number of herbs have resulted from unplanned development and overexploitation of traditional treatments obtained from nonmanaged environmental assets. Plant production and maintenance in botanical gardens, parks, and other appropriate areas, as well as long- term storage of plants propagules, example of *ex situ (beyond the natural niche)* and *in situ* (within the natural niche) herbal medicinal conservation options (pollen bank, seed bank, DNA libraries).

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