

Original Research Article

A study on the ex situ conservation and promotion of medicinal plants in Dr. Sushila Tiwari Herbal garden, Rishikesh, Uttarakhand

Abstract

A study was conducted at the Dr. Sushila Tiwari herbal garden in Rishikesh, Uttarakhand, with the aim of scientific documentation and data collection of medicinal plants. The study found there are approximately 126 species present in the herbal garden, trees being the most abundant species followed by shrubs, herbs, climbers and grasses. The major families found in the herbal garden are Fabaceae, Lamiaceae, Apocynaceae, Moraceae, Poaceae, and Solanaceae etc. Critically endangered species such as *Chlorophytum borivilianum*, Endangered species such as *Oroxylum indicum*, *Ginkgo biloba*, *Cammiphora wightii*, *Rauwolfia serpentina*, and *Strychnos lucida*. Near threatened species such as *Aegle marmelos*, were also found in the garden. Herbal gardens are crucial for conserving rare and endangered medicinal plants, while also promoting the utility of commonly available and frequently used medicinal plants among people, beneficiaries and other stakeholders.

Keywords: Herbal garden, Exsitu conservation, Rishikesh, Medicinal plants, Critically endangered.

Introduction

Herbal Gardens are centre for the conservation of medicinal and aromatic plants. Medicinal plants are important components of medicine that contribute to global biodiversity [1]. Over 75 to 80% of the world's population is estimated to dependent primarily on plants and plant extracts for health treatment [2]. India has a long tradition of indigenous valued plant species with documented medicinal properties. The significance of medicinal plants has been attributed to their historic medicinal applications, as well as its connection to human culture and nutrition [3]. India is one of 12 mega biodiversity hotspots, with over 45,000 plant species. Its richness is unparalleled due to the presence of 16 distinct agroclimatic zones, ten vegetative zones and fifteen biotic provinces. There are 18,000 higher plants in the country [4]. ~~In fact, 18,000 species of higher plants that have been recorded in India, out of these around 7,000 species are possess medicinal properties [5]. The number of medicinal and aromatic plants has decreased in the wild due to over harvesting, habitat loss and endangering the viability of the species [6]. Due to anthropogenic factors many are on the verge of extinction, if adequate conservation strategies are not implemented it leads to huge loss for the biodiversity [7].~~ The globe is currently experiencing a revival of herbal remedies to cure illness and enhance immunity. Medicinal plants are important components of the world biodiversity as well as the conventional health care system [8]. While about 22% of the total raw pharmaceuticals used in India are obtained through medicinal plants cultivation, remaining are obtained from natural sources [9]. Propagation of medicinal and aromatic plants is necessary, not only for their growth in number supports their long-term presence in nature [10]. Herbal gardens have the potential to play a key role in the ex-situ conservation of Medicinal and aromatic plants assessed by [11]. ~~Ce~~ontribution of floral diversification to health has been well documented by [12]. Study related to Herbal Garden development and uses was assessed by [13, 14, 15, 16]. The conservation, cultivation of vulnerable and valuable medicinal plants in north-eastern India was investigated by [17]. Ex situ Conservation of medicinal plants at the University of Agricultural Sciences in Bangalore, Karnataka recorded by [18]. A tuberous, endangered medicinal plant, Diversity, ethno-medicinal applications and conservation of medicinal plants researched carried by [19, 20, 21]. Medicinal plants, like many other biological resources are condemned to become extinct [22]. Ex-situ conservation and promotion of medicinal plants at Telangana's forest college and research institute carried by [23]

Comment [A1]: Please focus only on Herbal Garden no need to add unnecessary details of biodiversity of flora and fauna.

Comment [A2]: Please remove the periods after number.

Comment [A3]: INCOMPLETE

Methodology

Study area

This study had conducted in Dr.Sushila Tiwari herbal garden is located in Rishikesh often spelled Hrishikesh, is a city near Dehradun in the Indian state of Uttarakhand (Latitude 30.126542 N and longitude 78.294979 E). Herbal garden is connecting to the National highway 34 which is a bypass road towards Rishikesh to Dehradun. This garden site is devoid of shade and good exposure to sunlight. The study site had average annual rainfall 2136.7 mm. The temperature reaches a high of 40 degrees Celsius in summers. In the winters the highest temperature reaches about 20 degrees Celsius.

Data collection of medicinal plants

A preliminary survey was conducted in the study area to determine the objective, which is the scientific documentation of medicinal plants. Signboards were utilized to enlist most of the species. Later on, information about each species such as habit, family, conservation status and medicinal uses were enlisted through online resources such as IUCN, the Botanical Survey of India Medicinal plant database and Plants of the World Online Kews Gardens. These sources were used to ensure the standardization of data Later on, the data had been analysed in Microsoft excel.

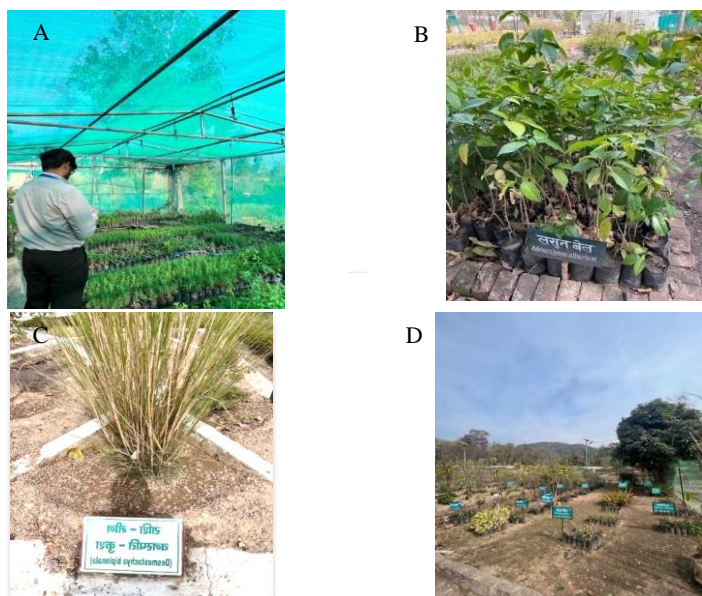


Fig 1:Data collection (A) Documentation of species process (B) *Allium Sativum* with sign board (C) *DesmostachyaBipinnata* with sign board (D) Herbs with sign board

Results and discussion

Medicinal and Aromatic Plant specimens

According to the scientific documentation, there are approximately 127 species in the herbal garden that represent a diversity of families. This suggests that the herbal garden is

well-populated with a variety of plant species from different families and habit, which can contribute to the garden's overall health, provides a range of benefits to the local ecosystem and productivity of raw material to the various stakeholders (Table 1).

Table 1 - The list of documented medicinal and aromatic plants in Dr.Sushila Tiwari Herbal garden, Rishikesh, Uttarakhand.

S.no	Scientific name	Common name	Family name	Habit	Plant part used	Medicinal uses
1	<i>Abrus precatorius L.</i>	Rosary pea, Precatory bean,	Fabaceae	Climber	Roots, leaves and seeds	Tetanus and to prevent rabies
2	<i>Achyranthes aspera L.</i>	Latjira	Amaranthaceae	Herb	Seeds, roots and leaves	Decoction of herb is diuretic and used in renal dropsies.
3	<i>Acorus calamus L.</i>	Bach, Gora bach	Acoraceae	Herb	Rhizome	Epilepsy, mental ailments, chronic diarrhoea, dysentery, glandular and abdominal tumours
4	<i>Aegle marmelos (L.) Correa</i>	Bel	Rutaceae	Tree	Unripe fruits and pulp	Astringent, digestive, stomachic, diarrhoea and dysentery
5	<i>Alangium salviifolium (L.f.) Wangerin</i>	Akola, Dhera	Cornaceae	Tree	Bark, Root bark and leaves	Cutaneous troubles, hypoglycaemia, astringent, anthelmintic, purgative, emetic and diaphoretic
6	<i>Allium cepa L.</i>	Piyaz	Amaryllidaceae	Herb	Bulbs	Used against flatulence, diuretic, expectorant and dysentery
7	<i>Aloe vera (L.) Burm.f.</i>	Ghee kunvar	Asphodelaceae	Herb	Leaves and roots	Treatment of chronic ulcers, juice is used for fever and roots for colic
8	<i>Artocarpus heterophyllus Lam.</i>	Jackfruit, Kathal	Moraceae	Tree	Leaves and latex	Skin infections, burns, toothache and relieving stomach ache.
9	<i>Asparagus racemosus Willd.</i>	Shatavari	Asparagaceae	Climber	Roots	Schistosomiasis, tuberculosis, tonic, astringent, vermifuge, cholera and rheumatism(Contd.)

10	<i>Azadirachta indica</i> A. J. uss.	Neem, Indian lilac	Meliaceae	Tree	Bark, leaves, flowers and berries	Antiseptic properties, ulcers, boils, eczema, purgative and emollient
11	<i>Barleria prionitis</i> L.	Porcupine flower	Acanthaceae	Shrub	leaf, stem, root, bark and flower	Fever, phlegm, and to prevent cracking
12	<i>Bauhinia variegata</i> L.	Mountain ebony, Kachannar	Fabaceae	Tree	Whole Plant	Piles, haematuria, menorrhagia, diarrhoea, mesentery, worm infestation, dyspepsia, flatulence, obesity, scrofula, skin diseases, human blood agglutinating activity and antifungal
13	<i>Berberis aristata</i> DC.	Citra	Berberidaceae	Shrub	Stem, leaves and roots	Diarrhoea, gynaecological disorders, osteoporosis, diabetes, eye infections, ear infections, wound healing, jaundice, skin diseases and malaria
14	<i>Bergerakoenigii</i> L.	Kathneem, Mitha neem	Rutaceae	Tree	Leaves and roots	Used in diarrhoea, dysentery and vomiting.
15	<i>Bixa orellana</i> L.	Arnalto, Achiotte, Sinduri	Bixaceae	Tree	Root-Bark and Seeds	Gonorrhoea, in case of uncomplicated intermittent, remittent and continued fevers, fever decoction and jaundice
16	<i>Boswellia serrata</i> Roxb.	Salai	Bursaceae	Tree	Bark	Diarrhoea, skin troubles, pulmonary infections and cutaneous troubles
17	<i>Butea monosperma</i> (Lam.) Kuntze	Flame of forest, Dhak, Pal	Fabaceae	Tree	Bark, flowers, Gums and Seeds	Astringent for piles and diarrhoea, tumours, menstrual disorders, powerful rubefacient and dhobi's itch
18	<i>Calliandra haematocephala</i> Hassk.	Red powder puff	Fabaceae	Shrub	flower, leaf, and bark	Anti-inflammatory, anticonvulsant, immunomodulatory and blood purifier
19	<i>Callicarpa macrophylla</i> Vahl	Perfumed cherry	Lamiaceae	Shrub	Leaves, fruits and roots	Diarrhoea, dysentery, diabetes, fever, tumour and polydipsia.
20	<i>Calotropis procera</i> (Aiton) W.T. Aiton	Akada, Kavana	Apocynaceae	Shrub	Root bark	Leprosy, rheumatism, mumps, antidote for snake bite, sinus fistula, burn injuries and body pain. (Contd.)

21	<i>Cassia fistula L.</i>	Amaltas	Fabaceae	Tree	Flowers and pods	Relieving the symptoms of leprosy, ringworm, heart related disorders, asthma and fever
22	<i>Catharanthus roseus (L.) G.Don</i>	Bright eyes, Cape Periwinkle, Graveyard plant	Apocynaceae	Shrub	Root and leaves	Relieving muscle pain, cancer and diabetes, septic wounds, depression of the central nervous system and to heal wounds.
23	<i>Cestrum nocturnum L.</i>	Lady of the night, Night Jessamine, Raat-ki-Rani	Solanaceae	Shrub	Leaves	To treat various illnesses such as coughs, flu, sore throat, fever, colds, and respiratory infections.
24	<i>Chlorophytumborivili anum.Santapau&R.R. Fern.</i>	Safed musli	Asparagaceae	Herb	Leaves and roots	Revitalizing, aphrodisiac, natural sex tonic, and useful in the treatment of sexual disorders
25	<i>Chrysopogonzizanioides (L.) Roberty</i>	Khasa, Bena	Poaceae	Grass	Roots	For alleviating tension, as well as for mental traumas and shock, lice, and repelling insects.
26	<i>Cichoriumintybus L.</i>	Kasani, Kashini	Asteraceae	Herb	Roots	Used in homoeopathy for liver and gall ailments, dried roots are diuretic, tonic, stomachic and depurative
27	<i>Cinnamomumcamphora (L.) J.Presl</i>	Camphor Tree, Kapoor Tree	Lauraceae	Tree	Stems, Fruits and Leaves	Diaphoretic, anthelmintic, antiseptic, muscular strains, inflammations, and rheumatic
28	<i>Cinnamomumtamala (Buch.-Ham.) T.Nees&C.H.Eberm.</i>	Tejpat, Tejapatta, Malabar leaf,	Lauraceae	Tree	Leaves	Treatment of foul breath, black patches on the face, dental caries, oedema, cough, and tb problems.
29	<i>Cinnamomumverum J. Presl</i>	Cinnamon, Dalchini	Lauraceae	Tree	Shoots of outer Cork	Carminative, blood purifier, digestive, antiseptic, antifungal, antiviral, antibacterial, antioxidant, anti-inflammatory, immunomodulatory cholesterol, blood sugar and nausea
30	<i>Cissusquadrangularis L.</i>	Hadjora, Harsankari	Vitaceae	Climber	Roots	Scurvy and bone fracture's
31	<i>Citrus × aurantiifolia (Christm.) Swingle</i>	Kaghzi-nimbu	Rutaceae	Tree	Roots, bark, leaves and	Treatment of foul breath, black patches on the face, dental caries, oedema, cough,

					fruits	diarrhoea and loose motions
32	<i>Clerodendrum phlomis</i> L.f.	Sage Glory Bower	Lamiaceae	Shrub	Leaves and roots	It improves appetite and aids in proper digestion
33	<i>Clitoria ternatea</i> L.	Aparajit	Fabaceae	Climber	Roots	Fever, inflammation, pain, and diabetes
34	<i>Commiphora wightii</i> (Arn.) Bhandari	Bdellium-tree, Gugal	Burseraceae	Shrub	Resin	Treatment of joint disorders and heart diseases
35	<i>Croton tiglium</i> L.	Jamalgota	Euphorbiaceae	Shrub	Seeds	Purgative, remedy for cancerous sores and tumours, carbuncles, colds, dysentery, fever, paralysis and scabies
36	<i>Curculigo orchioides</i> Gaertn.	Kali musli, Syahmusali	Hypoxidaceae	Herb	Roots	It is used to treat piles, skin troubles, diarrhoea, jaundice, as a demulcent, diuretic and to treat asthma.
37	<i>Cymbopogon citratus</i> (DC.) Stapf	lemon grass	Poaceae	Grass	leaves	Antispasmodic, hypotensive, antirheumatic, antiseptic, and treatment for neurological and gastrointestinal diseases and fevers
38	<i>Cymbopogon nardus</i> (L.) Rendle	Ganjni	Poaceae	Grass	Leaves	Insecticides, spraying liquids, and disinfectants.
39	<i>Cymbopogon winterianus</i> Jowitt ex Bor	Java citronella	Poaceae	Grass	Leaves	Used in perfumes and cosmetics.
40	<i>Cynodactylon</i> (L.) Pers.	Dhub, Hariali	Poaceae	Grass	Rhizome	Used in genito urinary troubles
41	<i>Dalbergia sissoo</i> Roxb. ex DC.	Shisham, Sissoo	Fabaceae	Tree	Leaf and stem	Dysentery, eruptions, gonorrhoea, scurf, and leprosy
42	<i>Dendrocalamus strictus</i> (Roxb.) Nees	Bans kaban, Bans khurd	Poaceae	Grass	Leaf, roots and bark	Cough, fever and injuries
43	<i>Desmostachya bipinnata</i> (L.) Stapf	Dab, Durva	Poaceae	Grass	Whole plant	Used in dysentery, diarrhoea, skin diseases, renal calculi, menorrhagia and culms diuretic.
44	<i>Diploknemabutyraea</i> (Roxb.) H.J.Lam	Butter tree	Sapotaceae	Tree	Bark, leaves, flowers and seeds	Diabetes, rheumatism, ulcers, bleeding and tonsillitis. (Contd.)

45	<i>Ecliptaprostrata (L.) L.</i>	False daisy	Asteraceae	Herb	Leaves and shoots	Anti-ageing properties, preventing wounds and snake bites
46	<i>Elaeocarpus angustifolius Blume</i>	Blue Marble Tree	Elaeocarpaceae	Tree	Fruits	Sedative, hypnotic, tranquillizing, anticonvulsant, anti-epileptic, and antihypertensive characteristics
47	<i>Elettariacardamomum (L.) Maton</i>	Bari elachi, Baaraalich	Zingiberaceae	Herb	Seed	Appetizer, digestant, antispasmodic
48	<i>EmbeliaribesBurm.f.</i>	False black pepper	Primulaceae	Climber	Fruits, roots, seeds and leaves	Suggested for headache relief, rhinitis, haemorrhage, epilepsy, fever, chest pain and insomnia
49	<i>Evolvulusalsinoides (L.) L.</i>	Shyamakranta, Sankhahuli	Convolvulaceae	Herb	Whole plant	Used as hair growth tonic
50	<i>Ferulaassa-foetida L.</i>	Hing	Apiaceae	Herb	Rhizome and root of the plant	Hysteria, some psychological illnesses, bronchitis, asthma, and whooping cough are all treated with it.
51	<i>Ficusauriculata Lour.</i>	Broad-leaf Fig, Roxburgh Fig, Giant Indian Fig	Moraceae	Tree	Stem bark, Root latex and fruits	Juice is effective for diarrhoea, cuts and wounds. Root latex is used in mumps, cholera, diarrhoea and vomiting.
52	<i>Ficusbenghalensis L.</i>	Bergad	Moraceae	Tree	Latex and Bark	Rheumatism, lumbago, diarrhoea, dysentery and diabetes
53	<i>Ficuscarica L.</i>	Anjir	Moraceae	Tree	Fruit	Emollient, laxative and diuretic
54	<i>FicusinfectoriaRoxb.</i>	Egyptian senna, Tinnevelly senna,	Moraceae	Tree	Leaf and bark	One of the herbal remedies for liver ailment
55	<i>Ficusracemosa L.</i>	Gular, Umar	Moraceae	Tree	Leaf and roots	Diarrhoea, diabetes and bilious infections.
56	<i>Ficusreligiosa L.</i>	Pipal	Moraceae	Tree	Bark	Treating skin and ulcers
57	<i>FicusvirensAiton</i>	White Fig, Pilkhan, Pakkan	Moraceae	Tree	Bark	Decoction used for gargling. (Contd.)
58	<i>Flacourtiaramontchi</i>	Indian	Salicaceae	Tree	Leaves, roots	Used for treatment of snakebite, treating arthritis,

	<i>L'Hér.</i>	plum			and bark	intermittent fever, bacterial throat infection and diarrhoea
59	<i>Ginkgo biloba L.</i>	Maidenhair tree	Ginkgoaceae	Tree	Leaf	It is used in medicine to regulate cerebral blood flow, defend against free radicals and diabetes.
60	<i>Glycyrrhiza glabra L.</i>	Mulhatti, Jethimadh	Fabaceae	Herb	Rhizomes and roots	Expectorant, demulcent, laxative, allaying coughs and catarrhal infections,
61	<i>Gmelina arborea Roxb. ex Sm.</i>	Gamhar, White Teak	Lamiaceae	Tree	Leaves, root and fruit	Demulcent, cooling decoctions, fever and bilious infections
62	<i>Gymnemasylvestre (Retz.) R.Br. ex Sm.</i>	Gur-mar, Merasingi	Apocynaceae	Climber	Leaf	Diuretic
63	<i>Helicteresisora L.</i>	Maroraphali, Marodaphali	Malvaceae	Shrub	Fruits and roots	Colic, diarrhoea, chronic dysentery and stomach infections
64	<i>Hemidesmus indicus (L.) R.Br.</i>	Anantamul, Kapuri	Apocynaceae	Climber	Dried roots	Diaphoretic, diuretic and used in treatment of rheumatism, gravel and urinary troubles
65	<i>Hibiscus rosasinensis L.</i>	Jasut, Jasum	Malvaceae	Shrub	Flowers, leaves, and roots.	To treat hypertension, cholesterol production, and cancer progression.
66	<i>Juglans regia L.</i>	Akhrot, Akrut	Juglandaceae	Tree	Leaves	Used as astringent, tonic and anthelmintic.
67	<i>Justicia adhatoda L.</i>	Malabar nut, Adulsa, Vasa	Acanthaceae	Shrub	Leaves, bark, roots and flowers	Treating bronchitis, tuberculosis and lung disorders
68	<i>Kalanchoe pinnata (Lam.) Pers.</i>	Life plant	Crassulaceae	Herb	Leaves	Wounds, bruises, boils, bites of venomous insects swelling and sloughing ulcers
69	<i>Solanum virginianum L.</i>	Yellow-berried Nightshade	Solanaceae	Herb	Whole plant	It is used in managing diabetes, liver damage, inflammation, cancer, asthma and brain disorders.
70	<i>Madhuca longifolia (L.) J.F. Macbr.</i>	Mahuwa, Butter Tree,	Sapotaceae	Tree	Leaves, bark and seeds	To treat wounds, anti-diabetic, anti-ulcer, hepatic protective, anti-pyretic, anti-fertility, analgesic, anti-oxidant, swelling, inflammation and piles. (Contd.)
71	<i>Mangifera indica L.</i>	Mango, Aam	Anacardiaceae	Tree	Leaves, Kernel, stem	Diabetes, externally in burns and scalds, diarrhoea, menstrual disorders, haemorrhage's and

					bark.	rheumatism.
72	<i>Mansoa alliacea</i> (Lam.) A.H.Gentry	Grape vine	Bignoniaceae	Climber	Leaves	Antibacterial, antifungal, anti-inflammatory, anti-rheumatic, and antiviral
73	<i>Melaleuca citrina</i> (Curtis) Dum. Cours.	Bottlebrush Tree, Crimson bottlebrush	Myrtaceae	Tree	Leaves, flowers, stem backs and roots	Antimicrobial, antinociceptive, fungicide and anti-inflammatory purposes
74	<i>Mentha × piperita</i> L.	Paparaminta, Gamathi	Lamiaceae	Herb	Leaves	Functional dyspepsia, infantile colic, pruritus gravidarum and symptoms of stomach hypermotility.
75	<i>Mesua ferrea</i> L.	Ironwood, Nagkesar, Mesua	Calophyllaceae	Tree	Seeds, Flowers, Bark	Skin troubles, rheumatism, cough, dysentery, and sudorific
76	<i>Mimosa pudica</i> L.	Lajwanti, Chui-mui	Fabaceae	Herb	Leaves and roots	Antibacterial, alterative, and blood purifier; also used externally in fistulous sores, piles, and scorpion sting.
77	<i>Mimusops elengi</i> L.	Indian Medlar, Spanish Cherry, Maulshree	Sapotaceae	Tree	Bark, Dried flowers, pounded seeds	Diarrhoea, dysentery, snuff, suppositories for constipation.
78	<i>Moringa oleifera</i> Lam.	Drumstick tree	Moringaceae	Tree	Whole plant	Antitumor, antipyretic, antiepileptic, anti-inflammatory, cholesterol lowering, antioxidant, and antidiabetic properties.
79	<i>Neolamarckiacadamba</i> (Roxb.) Bosser	Burflower tree, Laran, Kadam, Cadamba	Rubiaceae	Tree	Fruit, seed, leaves	Fever, uterine complaints, skin diseases, inflammation, anaemia, dysentery, leprosy.
80	<i>Nerium oleander</i> L.	Oleander, Rose Bay,	Apocynaceae	Shrub	Flowers, latex, bark and leaves	Used for the treatment of microbial and fungal diseases.
81	<i>Nyctanthes arbor-tristis</i> L.	Tree of Sadness	Oleaceae	Tree	Leaves	For the treatment of sciatica, fevers, and arthritis. (Contd.)
82	<i>Ocimum basilicum</i> L.	Common Basil	Lamiaceae	Herb	Leaves and flowers	To treat indigestion and other digestive troubles
83	<i>Ocimum gratissimum</i>	Clove basil,	Lamiaceae	Herb	Leaves	To treat diabetes, cancer, inflammation, anaemia,

	<i>L.</i>	African basil				diarrhoea, pains, fungal and bacterial infections.
84	<i>Ocimum tenuiflorum L.</i>	Holy Basil	Lamiaceae	Herb	Whole plant	Aiding cough, asthma, diarrhoea, arthritis, eye diseases, indigestion and gastric ailments
85	<i>Olea europaea L.</i>	Common Olive	Oleaceae	Tree	Bark, fruits, leaves, wood and seeds	Laxative, demulcent, and emollient properties.
86	<i>Oroxylum indicum (L.) Kurz</i>	Indian Trumpet Flower, Bhut-vriksha, Tarlu	Bignoniaceae	Tree	Root bark, Seeds, Leaves.	Used for Tonic, astringent and diarrhoea.
87	<i>Phyllanthus emblica L.</i>	Amla, Amlika	Phyllanthaceae	Tree	Whole plant	Effective against a variety of maladies including inflammation, cancer, osteoporosis, neurological problems, hypertension, as well as lifestyle diseases, parasitic and other infectious diseases.
88	<i>Pinus roxburghii Sarg.</i>	Himalyan Long Needle Pine, Chir Pine	Pinaceae	Tree	Bark	Chronic bronchitis, gangrene of lungs, to arrest minor haemorrhages, rheumatic infections
89	<i>Piper longum L.</i>	Pipal, Pipli	Piperaceae	Climber	Roots and fruits	Analgesic for muscular pains and inflammation, respiratory tract. Sedative in insomnia and epilepsy. It acts as a choleragen in bile duct and gall bladder obstructions.
90	<i>Piper sarmentosum Roxb.</i>	Tippili, Pipul	Piperaceae	Shrub	Roots and fruits	Used for diseases of respiratory tract, analgesic for muscular pains and inflammation.
91	<i>Platanus orientalis L.</i>	Oriental plane tree	Platanaceae	Tree	leaves	Used in the treatment of diarrhoea, dysentery, hernias and toothache.
92	<i>Pleurolobus gangeticus (L.) J.St.-Hil. ex H. Ohashi & K. Ohashi</i>	Sarivan, Salpan	Fabaceae	Shrub	Roots	Febrifuge, expectorant, and diuretic. (Contd.)
93	<i>Plumbago zeylanica L.</i>	Wild white leadwort	Plumbaginaceae	Shrub	Leaves and roots	Used in mal absorption syndrome, leprosy, inflammation, piles, and

worms and to cure cough.

94	<i>Prosopis cineraria</i> (L.) Druce	Jand	Fabaceae	Tree	Bark	It possesses anthelmintic properties and is used to treat bronchitis, asthma and piles.
95	<i>Pterospermum acerifolium</i> (L.) Willd.	Kanak Champa	Malvaceae	Tree	Flowers	Leprosy, ulcers, inflammations and tumours
96	<i>Punicagranatum</i> L.	Anar, Dalim	Lythraceae	Tree	Fruits	Used in cholera, dysentery, diarrhoea.
97	<i>Pyracantha crenulata</i> (D. Don) M. Roem.	Himalayan Firethorn	Rosaceae	Shrub	Leaves and fruits	Heart failure, paroxysmal tachycardia, myocardial weakness, hypertension, and arteriosclerosis therapy
98	<i>Pyrus pashia</i> Buch.-Ham. ex D. Don	Wild Himalayan pear	Rosaceae	Tree	Fruits	Used for the treatment of dehydration, GI disorder, fever, headache, hysteria and epilepsy.
99	<i>Quercus leucotrichophora</i> A. C. Amus	Oak tree	Fagaceae	Tree	Whole plant	Antioxidant, antibacterial, anti-inflammatory, anti-diabetic, hepatoprotective, gastrointestinal disorder, skin disorder, anti-obesity, anticancer, and neuroprotective effect
100	<i>Rauwolfia serpentina</i> (L.) Benth. ex Kurz	Indian snakeroot or sarpagandha	Apocynaceae	Shrub	Root	Useful in treating excitable patients with hypertension
101	<i>Salix tetrasperma</i> Roxb.	Laila, Indian willow	Salicaceae	Tree	Leaves and bark	Rheumatism, epilepsy, venereal diseases, stones in bladder, piles, swelling and febrifuge.
102	<i>Salvia rosmarinus</i> Penn.	Rosemary	Lamiaceae	Shrub	Leaves	Utilized to relieve muscle pain, enhance the immunological and circulatory systems, and encourage hair growth
103	<i>Sapindus mukorossi</i> Gaertn.	Soap Nut Tree, Ritha	Sapindaceae	Tree	Fruits	Chlorosis, epilepsy and salvation. (Contd.)
104	<i>Sapindus saponaria</i> L.	Wingleaf soapberry	Sapindaceae	Tree	Seeds, roots and stem bark	Used as anxiolytic, astringent, diuretic and expectorant.
105	<i>Sapindus trifoliatus</i> L.	South India soapnut	Sapindaceae	Tree	Fruits, seeds and leaves	To treat colds caused by infection and inflammation.

106	<i>Saracaindica L.</i>	Asoka tree	Fabaceae	Tree	Stem bark, flowers and seeds	For treatment of uterine, genital, and other reproductive disorders in women.
107	<i>Senegalia catechu (L.f.) P.J.H.Hurter&Mabb.</i>	Khair	Fabaceae	Tree	wood	Used in urinary and vaginal discharge, anti-diarrhoeal, haemostatic, used for treat excessive mucous dischargesand antileprotic drug.
108	<i>ShoreaobustaC.F.G aern.</i>	Shorea, Sal	Dipterocarpaceae	Tree	Bark, Resins9 and Leaves	Diarrhoea, dysentery and bleeding gums
109	<i>Solanum khasianumC.B.Clark e</i>	Dutch eggplant	Solanaceae	Shrub	Leaves	To treat diseases like filaria, smallpox, whooping cough, rheumatism, trachoma, bronchitis, snake bites, skin and tooth infections
110	<i>Stevia rebaudiana (Bertoni) Bertoni</i>	Sweetleaf	Asteraceae	Shrub	Leaves	Anti-hypertensive, anti-obesity, anti-diabetic, antioxidant, anti-cancer, anti-inflammatoryand enhancement of renal function.
111	<i>Strychnoswallichiana Steud. ex A.DC.</i>	Nux-Vomica Tree Kuchila, Kucchla	Loganiaceae	Tree	Seeds, leaves, roots and fruits.	Tonic, stimulant, febrifuge, preparations for nervous disorders, sloughing wounds and maggot infested ulcers.
112	<i>Syzygiumcumini (L.) Skeels</i>	Jamun, Black Plum	Myrtaceae	Tree	Seeds and Bark	Diabetes treatment and mouthwashes.
113	<i>Tabernaemontanadiv aricata (L.) R.Br. ex Roem. &Schult.</i>	Pinwheel flower	Apocynaceae	Shrub	Roots, leaves, and flowers	Used to treat hypertension, headaches, scabies, snake and scorpion poisoning.
114	<i>Tamarindusindica L.</i>	Tamarind , Imli	Fabaceae	Tree	Fruit-pulp	Refrigerant, carminative, laxative, given as infusion in biliousness and febrile conditions.(Contd.)
115	<i>Tecoma stans (L.) Juss. ex Kunth</i>	Yellow Bell, Yellow Elder	Bignoniaceae	Tree	Roots	Vermifuge and tonic
116	<i>Terminalia bellirica (Gaertn.) Roxb.</i>	Bahera, Belliric Myrobalan	Combretaceae	Tree	Fruits	Treatment of cough, hoarseness and scorpion sting.

117	<i>Terminalia arjuna</i> (Roxb. ex DC.) Wight & Arn.	Arjun, Arjuna	Combretaceae	Tree	Bark, Fruit and Leaves.	Styptic, diuretic, anti-dysenteric, febrifuge tonic, symptomatic hypertension, treatment of ear-ache.
118	<i>Terminalia chebula</i> Retz.	Harad	Combretaceae	Tree	Fruits	Laxative, stomachic and tonic.
119	<i>Tinosporacordifolia</i> (Willd.) Hook.f. & Thomson	Amrita, Giloe	Menispermaceae	Climber	Stem and bark	Diabetes, excessive cholesterol, upset stomach, gout, lymphoma and other malignancies, rheumatoid arthritis, hepatitis, fever, gonorrhoea and syphilis.
120	<i>Trachyspermum ammi</i> (L.) Sprague	Ajowan, Ajwain	Apiaceae	Herb	Fruits	Flatulence, atonic dyspepsia, diarrhoea, abdominal tumour's, abdominal aches, piles and amenorrhoea
121	<i>Vincetoxicum indicum</i> (Burm.f.) Mabb.	Jangli-pikvam, Antamul	Apocynaceae	Climber	Roots	Used in treatment of asthma, bronchitis, whooping cough, stimulant, emetic, cathartic, expectorant, stomachic, diaphoretic. Dysentery and diarrhoea.
122	<i>Viola canescens</i> Wall.	Himalayan White Violet.	Violaceae	Herb	Flowers	For cough, cold, flu, fever, and malaria and is also given as anti-cancerous drug
123	<i>Viola odorata</i> L.	Sweet Violet	Violaceae	Herb	Leaves and flowers	For treatment of whooping cough, headache, and migraine
124	<i>Vitex negundo</i> L.	Nirgundi, Sambhalu	Lamiaceae	Tree	Leaves, roots and flowers	Rheumatism, dyspepsia, anthelmintic, in dysentery, piles, diarrhoea, fever, and liver complaints.
125	<i>Withania somnifera</i> (L.) Dunal	Ashwagandha	Solanaceae	Shrub	Leaves, roots, flowers, bark, and stem	Used to cure heart problems, pain, liver disorders, fever, respiratory infections, wounds, ulcers, and sex-related diseases
126	<i>Zanthoxylum capense</i> (Thunb.) Harv.	Winged Prickly Ash	Rutaceae	Shrub	Fruits, seeds, and bark	To cure gas trouble, fever, and appetizer. (Contd.)

Family wise distribution of species

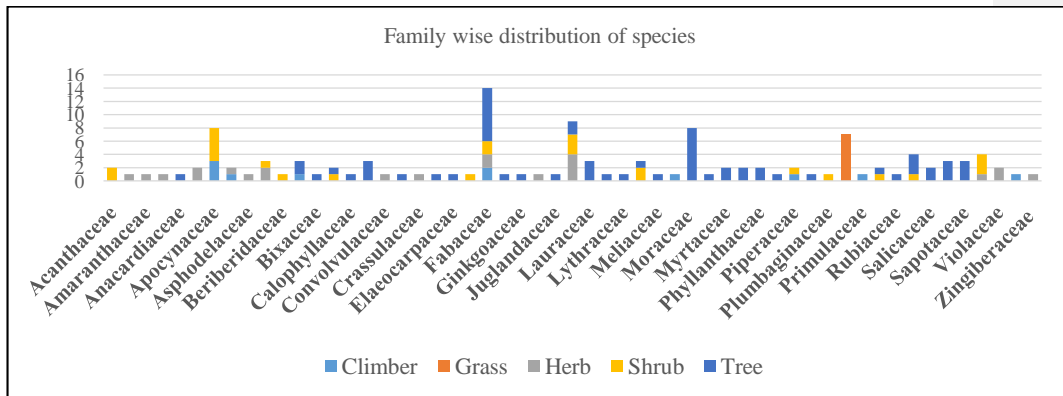


Fig. 2-Family wise distribution of medicinal plants in Dr.SushilaTiwari herbal garden, Rishikesh.

The scientific documentation indicates that out of the 126 species in the herbal garden, 28 families are represented. Some of the major families found in the garden include Fabaceae, Lamiaceae, Apocynaceae, Moraceae, Poaceae, Solanaceae, and others (Fig.2).

Table 2- Ecologically significant species

Formatted: Indent: Left: 2"

Species	Ecological significance
<i>Aloe vera</i>	Several studies have reported the use of <i>Aloe vera</i> as a coagulant or flocculant assist in water treatment to remove pollutants from bodies of water [24].
<i>Tamarindusindica</i>	Employed to environment amelioration due its durability, it is ideal for sequestering carbon from the atmosphere [25].
<i>Quercus leucotrichophora</i>	Banj oak is one of the most significant species in this region for both rural livelihoods and biodiversity [26]
<i>Prosopis cineraria</i>	provides a variety of environmental functions such as shade and shelter, soil enhancement, and sand dune stabilization. It has the potential to be employed as an intercropping species [27].
<i>Ficus religiosa</i>	This tree's leaves are known to emit a lot of oxygen into the surroundings. It can be employed as biomarkers and pollutant mitigators in exhaust from vehicles. It is ideal for roadside plantation, particularly along highways [28].
<i>Ficus benghalensis</i>	It increases soil fertility in its surroundings and a keystone species [29].
<i>Azadiractaindica</i>	Planting neem trees on a wide scale helps to counteract desertification, deforestation, soil erosion and excessive global warming [30].
<i>Sapindustrifoliatus</i>	Soap nuts are biodegradable and beneficial to both the environment and the skin [31].

Habit wise distribution

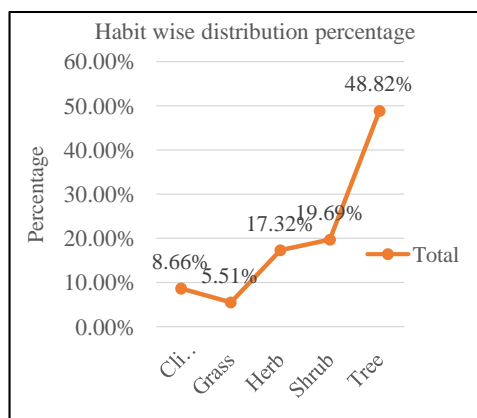


Fig. 3- Habit wise percentage of medicinal plants in the herbal garden

Among the total of 126 species in the herbal garden, trees are the most abundant, accounting for 48.82% of the total species. Shrubs represent the second largest group, comprising 19.69% of the species, while herbs make up 17.32%. Climbers represent a smaller proportion of the species at 8.66%, while grasses make up the smallest group, accounting for 5.51% of the total species. These results suggest that the herbal garden has a diverse array of plant species, with a variety of different growth habits and characteristics. (Fig. 3).

Conclusion

Herbal gardens serve an important role in the preservation of ecosystems and the survival of rare and endangered plant species, as well as other valuable plant genetic resources. Furthermore, these gardens function as educational and training purposes in a variety of sectors, including botany, landscaping, ex-situ conservation and environmental awareness. Herbal gardens provide a means of conserving, preserving and propagating plants in the face of climate change. Overall, herbal gardens contribute significantly to the conservation of plant species as well as the promotion of education and awareness.

REFERENCES

1. Chen SL, Yu H, Luo HM, Wu Q, LiC F and Steinmetz A. Conservation and sustainable use of medicinal plants, problems, progress & prospects. *Chinese medicine* 2016;(11):1-10.
2. Fitzgerald M, Heinrich M and Booker A. Medicinal plant analysis, A historical and regional discussion of emergent complex techniques. *Front pharmacology*2020;(10):1480.
3. Chen SL, Yu H, Luo HM, Wu Q, LiC F and Steinmetz A. Conservation and sustainable use of medicinal plants, problems, progress & prospects. *Chinese medicine* 2016;(11):1-10.
4. Ramakrishnappa K. Impact of cultivation and gathering of medicinal plants on biodiversitycase studies from India2003;<https://www.fao.org/3/AA021E/AA021e00.html>.
5. Kumar SR. Herbal Gardens for Health and Wealth. *Current Agriculture Research Journal* 2020;8 (3):163-165.
6. Negi VS,Kewlani P, Pathak R, Bhatt D, Bhatt ID, Rawal RS and Nandi SK. Criteria and indicators for promoting cultivation and conservation of medicinal and aromatic plants in Western HimalayaIndia. *Ecological indicators* 2018;(93):434-446.
7. Patel DK. Some medicinal and aromatic shrubs introduced in herbal garden for their propagation and ex-situ conservation. *Journal of Medicinal Plants* 2014;2 (6):9-12.

Comment [A4]: Kindly rearrange all references manually in Harvard style or vancouver style .

8. Maunder M, Higgins S and Culham A. The effectiveness of botanic garden collections in supporting plant conservation, a European case study, *Biodiversity and Conservation* 2001; (10):383-401.
9. NMPB. Indian Medicinal Plants- Fact Sheet, National Medicinal Plants Board, New Delhi. <https://nmpb.nic.in/content/medicinal-plants-fact-sheet>. Accessed on 2021;20.06.2021.
10. Patel DK. Herbal gardens role in current scenario conservation of medicinal and aromatic plants. *International Journal of Current Research* 2015;7 (7):18669-18672.
11. Patel DK. Herbal gardens role in current scenario conservation of medicinal and aromatic plants. *International Journal of Current Research* 2015;7 (7):18669-18672.
12. Posey Darrel Addison, Cultural and Spiritual Values of Biodiversity, A Complementary Contribution to the Global Biodiversity Assessment, UNEP (1999).
13. Rao NS and Das SK. Herbal Gardens of India A statistical analysis report. *African Journal of Biotechnology* 2011;10 (31):5861-5868.
14. Stirton C, Education for sustainability, A Garden for a sustainable future Root, (Dec) (1998) 38 – 41.
15. Heywood VH. Botanic Gardens & Taxonomy, Their economic role, *Bull. Botanical Survey of India* 1983;(25): 134 – 147.
16. Thacker C. 1979. The history of Gardens. Beckenham: Croom Helm Publication Ltd, pp 281-284.
17. Shankar R and Rawat MS, Conservation and cultivation of threatened and high valued medicinal plants in north East India, *International Journal of Biodiversity and Conservation*, 5 2013;(9):584-591.
18. Rajkumar MH, Sringswara AN and Rajanna MD. Ex-situ conservation of medicinal plants at university of agricultural sciences, Bangalore, Karnataka. *Recent Research in Science and Technology*, 2011;3(4):21-27.
19. Adhikari BS, Babu MM, Saklani PL and Rawat GS. Distribution, use pattern and prospects for conservation of medicinal shrubs in Uttaranchal State, India. *Journal of Mountain Science* 2007;(4):155-180.
20. Adhikari BS, Babu MM, Saklani PL and Rawat GS. Medicinal plants diversity and their conservation status in Wildlife Institute of India (WII) campus, Dehradun. *Ethnobotanical leaflets* 2010;(14): 46-83.
21. Lawal IO, Uzokwe NE, Igboanugo AB I, Adio AF, Awosan EA, Nwogwugwu JO and Adesoga AA. Ethno medicinal information on collation and identification of some medicinal plants in Research Institutes of South-west Nigeria. *African Journal of Pharmacy and Pharmacology* 2010;4 (1):001-007.
22. Pandey V, Vaishya JK, Murugeswaran R and Sastry LN. Institutional herbal gardens, Strategy for ex-situ conservation and promotion of medicinal plants. *Medicinal Plants-International Journal of Phytomedicines and Related Industries* 2021;13 (1):1-4.
23. Sailaja V, Reeja S, Parvez S, Vennela RP and Saiteja CH. Forest college and research institute, Telangana”. *Frontiers in Microbiology* 2021; 8 (199):1-11.
24. Gaikwad V and Munavalli G 2019. Turbidity removal by conventional and ballasted coagulation with natural coagulants. *Appl. Water Science*. (9): 1-9
25. The National Academies Press, America’s National Research Council. ‘African fruits hold great potential to combat poverty’ (2008); 158.
26. Ghazala Shahabudin, *Down to earth*, (2019) <https://www.downtoearth.org.in/blog/himalayan-oak-forests-under-threat-41826>.
27. Mahony D 199., *Trees of Somalia*, A field guide for development workers, Oxfam Research Paper No.(3):UK & Ireland.
28. Vandana S. Role of medicinal Plant in controlling environmental (Air) pollution, *International Ayurvedic Medical Journal*, 2013;1(5).
29. Anitha P 2021. Deccan herald <https://www.deccanherald.com/spectrum/spectrum-top-stories/figs-and-the-forests-they-nurture-1001708.html>
30. Sateesh MK, Microbiological investigations on die-back disease of neem (*Azadirachta indica* A. Juss.). 1998 Ph.D. Thesis, University of Mysore, India
31. Anuradha Sharma 2010. *Economic times bureau* .<https://economictimes.indiatimes.com>.

