



## Medicinal and economic uses of some introduced plant species and their conservation in the Botanic Garden of Indian Republic, Noida

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Plants are an important part of human communities and their conservation should be done on priority basis. These plant species have been used for medicinal and economic purposes by the tribal human communities for many centuries. In the 21<sup>st</sup> century, many such plant species are under threat due to loss of habitats, over-exploitation, alien/invasive species and several other anthropogenic reasons. Thus, these plant species need to be conserved for the future generations before their permanent extinction from the planet earth. The Botanic Gardens have a very important role in their conservation. In the present study, an attempt has been made to conserve such medicinally and economically important plants at the Botanic Garden of Indian Republic (BGIR), Noida. Many plant species from all over India have been introduced in this garden for conservation since 2002. Out of them, a total of 51 species were selected and their medicinal and economic uses were studied and evaluated during the study along with other details like Hindi names, areas of distribution in India, and flowering and fruiting period at the BGIR. More details like the type of diseases treated from these plant species and particular plant parts used for the treatment have also been discussed. This paper will provide a comprehensive study of the uses of plant species conserved in the Botanic Garden from different phytogeographical regions of India.

**Keywords:** Botanic Garden, Conservation, Economic, Introduced, Medicinal

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In India the plants have been used for medicinal and economic purposes since time immemorial. They are well-mentioned in Vedas and other ancient Indian scriptures. Traditional medicinal systems like Ayurveda, Siddha and Unani were quite popular among people in ancient India. The concept of Ayurveda came into practice between 2500 and 500 BC in India<sup>1</sup>. The economic and medicinal benefits of plant species are well-documented in Ayurveda, and ancient people made ample use of these in their day-to-day life<sup>2-4</sup>. The main aim of Ayurveda is to keep structural and functional entities in a state of equilibrium which is considered as a sign of good health. It is a system of science and longevity as it offers a complete regimen to live a long and healthy life<sup>5</sup>. In the 21<sup>st</sup> century, the use of plant-based medicines is still quite common among ethnic-indigenous communities all over the world and India is no exception<sup>6,7</sup>. The over-exploitation of many such

plant species for medicinal purposes has brought these species under threat of extinction in the wild<sup>8,9</sup> along with the habitats loss and invasive plant invasion<sup>10</sup>. Therefore their conservation is required in the Botanic Gardens, National Parks and Wildlife Sanctuaries. The BGIR was established in 2002 and thereafter many plant species from different phytogeographical regions of the India have been introduced here for the purpose of conservation and creating germplasm conservatory. Many of these species had been acclimatised in the alien environmental conditions and are now producing viable fruits and seeds throughout the year. These species were found to have rich medicinal and economic uses as mentioned in previously published literature. Due to this, a step has been taken in the present study to comprehensively document their medicinal and economic importance for the use of future generations and to promote their conservation prospects inside the Botanic gardens (*ex-situ* conservation) and as well outside or at site conservation (*in-situ* conservation in

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the national parks, wildlife sanctuaries and sacred grooves).

## Methodology

### Study area

The study was conducted at the Botanic Garden of Indian Republic (BGIR), Noida, India. It was set up in 2002 to facilitate *ex situ* conservation and propagation of rare, threatened, endemic, indigenous, medicinal and economic plants of the country. It is situated on the eastern bank of river Yamuna (N = 28°58' and E = 77°33'; altitude = 197 m) in Noida (Sector 38-A) of Gautam Budh Nagar district of the U.P. province in India. The total area of the Botanic Garden is 167 acres and is bound from all the four sides by urban set up of the Noida city. The climate of the region is monsoonal and experiences an extreme hot and dry summer (April to June) marked by scorching heat, with the mercury rising as high as 48°C, followed by a rainy season (July to September) with 650 mm rain per year and cold and dry winter (October to February).

### Data collection and selection of plants

In the Botanic Garden, more than 900 plant species (herbs, shrubs, trees and climbers) have been introduced under different sections/areas like Economic Plant, Green Belt/Woodland, Fruit, Medicinal Plant, Cactus & Succulents, Nurseries and Water bodies. The plant saplings (live or seeds) for introduction have been collected from the Terai region of Uttarakhand, Andhra Pradesh, Telangana, Orissa, Punjab, Haryana, Uttar Pradesh, Himachal Pradesh and North-East India. The primary objective of the plant collection is to conserve rare, threatened, endemic and indigenous (medicinally and economically useful) plant species including the

representative elements of some selected ecosystems of the country and to conserve their germplasm. These plant species were identified refereeing through the volumes of flora of India, different State floras and other relevant taxonomic literature. There are nearly 100 plant species which have been introduced in the medicinal and economic plant section, but only 51 species have been able to acclimatise under the BGIR environment producing flowers, fruits and seeds. Due to this reason 51 species are selected for documentation of data on their medicinal and economic uses of fruits, seeds and other parts by the indigenous people and tribal communities in India for their daily needs since time immemorial. The information collected from published literature (research articles and books on medicinal and economic uses in India<sup>8</sup>) includes the Hindi names, Botanical names, areas of distribution in India, medicinal uses (mode of crude drug preparations, and administration and treatment of the diseases) and economic uses (fodder, timber, food etc.). The time of flowering, fruiting and seed setting of these species in the BGIR has been recorded from time to time under phenological studies of introduced plant species.

## Results and Discussion

Many medicinally and economically important plant species are being introduced under *ex-situ* programme at the BGIR for the past 18 years to conserve their germplasm. During the study, 51 plant species were assessed for their medicinal and economic utilization by the indigenous and tribal communities all over India along with their distribution in the country. These species are either endemic to the Indian region or are naturalised. Besides this, some exotic species are also present which are under cultivation in India (Table, 1). These 51 species belong to 42 genera of 24 flowering plant

Table 1 — List of medicinal and economic uses of introduced plant species in BGIR, Noida

S. No.	Botanical names/ Family/ Habit	Hindi names	Fruit/ Seed collection period	Distribution in India	Medicinal & Economic uses
1	<i>Abrus precatorius</i> L. Fabaceae Climber	Ratti	Nov.-Dec.	Throughout in the Indian Himalaya up to 1000 m and also in Andamann & Nicobar Islands.	Seeds are purgative, emetic, tonic, and are used in nervous disorders. Paste of seeds used in stiffness of shoulder joint and paralysis.
2	<i>Acacia catechu</i> (L.) Willd. Fabaceae Tree	Khair, Khayer	Feb.-March	Sub-Himalaya up to 1200 m from Punjab to North-East and in MP, AP, Tamil Nadu.	Used for timber and fodder. Kattha prepared from the bark of tree and used in medicines.
3	<i>Albizia lebbek</i> (L.) Benth. Fabaceae Tree	Siris	Nov.- Dec.	Throughout India.	Bark is used to treat inflammation.

(Contd.)

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4	<i>Annona squamosa</i> L. Annonaceae Tree	Sitaphal	March- April	Cultivated in India and some time in wild.	Fruits edible. Bark decoction used to stop diarrhoea and root decoction used during dysentery.
5	<i>Aristolochia indica</i> L. Aristolochiaceae Small Tree	Hooka-bel	Jan.-Feb.	Mostly in south India in degraded moist deciduous forests, also in the plains growing along fences	Fruits extensively used as antidote for snake-bite and its seeds used in inflammation and biliousness.
6	<i>Asparagus racemosus</i> Willd. Asparagaceae Shrub	Shatavari, Shatamuli	Feb.- March	Throughout India ascending up to the Himalaya.	Extract of fruits used for the treatment of gastric ulcers, dyspepsia and for nervous disorders.
7	<i>Azadirachta indica</i> A. Juss. Meliaceae Tree	Neem	June- July	Tropical and semi-tropical regions of India.	Oil extracted from the seeds used to improve liver function, to detoxify the blood. Dried leaves used as insecticides.
8	<i>Bombax insigne</i> Wall. Malvaceae Tree	Simal	March- April	Evergreen, Semi- evergreen and moist deciduous forests of India.	Fibre obtained from seed floss used as a stuffing material or spun. Vegetable prepared from young flowers in Himachal Pradesh.
9	<i>Cassia fistula</i> L. Fabaceae Tree	Amaltas	March-April	Many parts of India and also cultivated as ornamental plant.	Ethanol extract of pods is considered hypoglycaemic, antiviral and anticancer. Seeds emetic and used in jaundice. The gum of seeds used as a substitute for Gaur gum.
10	<i>Ceiba pentandra</i> (L.) Gaertn. Malvaceae Tree	Safed semal	July- August	It is a native of Africa and cultivated in India for seed fibre.	Bark decoction used as a diuretic, aphrodisiac, for headache, type II diabetes. Seed oil (Kapok oil) has potential as bio-fuel and in paint preparations.
11	<i>Clerodendrum indicum</i> (L.) Kuntz. Verbenaceae Shrub	Bharangi	March-April	Cultivated as ornamental and also naturalised in India.	Decoction of leaves improves circulation of blood in body, relieving from cough and cold.
12	<i>Clitorea terneta</i> L. Fabaceae Herb	Aparajita	Sept.- Oct.	Naturalised in India.	Whole plant used in piles, healing ulcers, brain weakness, as blood purifier and in asthma.
13	<i>Coix lachrymajobi</i> L. Poaceae Grass	Samkru, Vyjanti	Nov.- Dec.	Cultivated in India.	Grains are useful as a source of food (cereals) and in folk medicine. Dried seeds cooked as a grain.
14	<i>Cordia dichotoma</i> G. Forst. Boraginaceae Tree	Lasoda, Dela, Gunda	July- August	Dry deciduous forests of Rajasthan. Moist deciduous forests of Western Ghats. North Indian Himalaya up to 1500 m.	Edible as vegetable and used in preparation of pickle.
15	<i>Cymbopogon citratus</i> (DC) Stapf. Poaceae Grass	Gandhatri na, Nimbughas	Jan.- Feb.	Throughout India in tropical grasslands.	Oil obtained used in food and beverages (as Lemon tea).
16	<i>Cymbopogon martini</i> (Roxb.) Wats. Poaceae Grass	Aghin ghas	Jan.- Feb.	Throughout India in tropical and sub-tropical grasslands.	Palmarosa oil obtained and used in food and beverages.
17	<i>Dalbergia latifolia</i> Roxb. Fabaceae Tree	Kala shisham, Vilayati shisham	April- May	Tropical monsoon forests of south east India.	Wood is durable, resistant to rot and insects and used as timber. Bark used to treat diarrhoea, indigestion and leprosy.
18	<i>Dalbergia sissoo</i> Roxb. Fabaceae Tree	Shisham	Feb.-March	Western Himalaya up-to 1500 m and from Sikkim to upper Assam.	Wood has a good quality timber value.

(Contd.)

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19	<i>Datura metel</i> L. Solanaceae Shrub	Sada Dhatura	Jan.- Feb.	Tropical to Temperate parts of India.	Seeds poisonous.
20	<i>Desmodium gangeticum</i> (L.) DC. Fabaceae Climber	Anshumati , Dhruva, Shalparni	May-June	More or less throughout the country.	Whole plant useful in vomiting, fever and relieves burning sensation.
21	<i>Desmodium oojeinensis</i> (Roxb.) Hochr. Fabaceae Tree	Sandan	March-April	Mostly North India, Nainital Uttarakhand.	Paste of the bark applied on cuts and wounds to treat them.
22	<i>Dodonea viscosa</i> (L.) Jacq. Sapindaceae Shrub	Sanatta, Vilayti mendi	March-April	All over India-Naturalised.	Leaves useful for the digestive disorders and skin infections.
23	<i>Duranta repens</i> L. Verbenaceae Shrub	Neelkanthi	March- April	Cultivated as ornamental in India.	Plant parts used in the treatment of fevers, skin itches and also as insect repellent.
24	<i>Ehretia laevis</i> (Rottler ex G.Don) Roxb. Boraginaceae Tree	Chamror	June-July	Throughout India.	Root and bark used in treatment of venereal diseases.
25	<i>Ficus carica</i> L. Moraceae Tree	Anjeer	Feb.-March	Naturalised all over India.	Wood and fruits used in preparation of anti-poison medication which is diuretic, emollient and laxative.
26	<i>Ficus racemosa</i> L. Moraceae Tree	Gular	Nov.-Dec.	It occurs throughout India along the sides of ravines and banks of streams.	Fruits astringent, stomachic, carminative and used in menorrhoea and haemoptysis.
27	<i>Glycosmis pentaphylla</i> (Retz.) DC. Rutaceae Climber	Ban Nimbu	April-May	Commonly found in the stream banks, wet areas from plains to 900 m in India.	Fruits edible and used in folk medicines.
28	<i>Guazuma ulmifolia</i> Lam. Malvaceae Tree	Jangli rudraks	March- April	Cultivated in India for more than 100 years.	Beverages of crushed seeds soaked in water used to treat diarrhoea, dysentery, cold, cough, contusions, and venerel disease.
29	<i>Guilandina bonduc</i> L. Fabaceae	Katkaranj, Puttikaranj	Feb.-March	Naturalised in South India along the streams up-to 1000 m.	Seeds used to prepare a bitter tonic used in Ayurvedic medicines.
30	<i>Helicteres isora</i> L. Malvaceae Tree	Maror phali	Nov.- Dec.	Common in South India. Found in deciduous forests from 400- 1200 m.	Seeds extract used as ear drops, for diarrhoea, asthma, cough, skin diseases and during abdominal pain. Fried pods kill intestinal worms in children.
31	<i>Holoptelea integrifolia</i> Planch. Ulmaceae Tree	Papri, Kanju	June-July	Sub-Himalayan tracts, Ajmer, Assam and Western Peninsula.	Paste of stem-bark and seeds used in ringworm diseases. Seeds soaked in water applied over swellings.
32	<i>Jatropha curcas</i> L. Euphorbiaceae Shrub	Ratanjot, Jamal ghota	Oct.-Nov.	Cultivated in India and also naturalised.	Seeds edible. Seed oil used in production of biodiesel and to treat ulcers, tumour, scabies, wound, rheumatism and skin diseases.
33	<i>Lagerstroemia parviflora</i> Roxb. Lythraceae Tree	Dhaura, Sida, Bakli	May-June	Moist and dry deciduous forests of Tropical Indian Himalaya.	Edible gum is obtained from tree. Bark is a source of tannins and used in black dye.
34	<i>Lagerstroemia speciosa</i> (L.) Pers. Lythraceae Tree	Jarul	Nov.-Dec	Naturalised in India.	Fruits used to cure mouth ulcers. Seeds are narcotic. Decoction of dried leaves used in diabetes.
35	<i>Mentha spicata</i> L. Lamiaceae Herb	Pahari Pudina	March-April	Throughout Indian Himalaya.	Leaves used in fever, bronchitis, headaches and migraines.

(Contd.)

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36	<i>Millettia pinnata</i> (L.) Panigrahi Fabaceae Tree	Karanj, Papadi	Oct.-Nov	Throughout India up-to 500 m.	Wood yields black gum. Oil obtained from seeds used to cure rheumatism.
37	<i>Mimusops elengi</i> L. Sapotaceae Tree	Maulsari	March- April	Throughout India and mostly in Western Ghats.	Fruits edible. Seeds astringent, anthelmintic, febrifuge and used for dental ailments-pyorrhoea and bleeding gums.
38	<i>Mitragyna parvifolia</i> (Roxb.) Korth. Rubiaceae Tree	Kaim, Guri	Jan.-Feb.	Throughout India up to 1300 m in semi-evergreen to dry deciduous forests.	Leaves used as fodder. Flute is made from the wood. Extracts of fruits used to kill pain and as anti-inflammatory agents.
39	<i>Ocimum gratissimum</i> L. Lamaceae Herb	African Tulasi	Dec.- Jan.	Cultivated in India and also in wild.	Sacred herb in Ayurveda and have anti-oxidant properties.
40	<i>Ocimum tenuiflorum</i> L. Lamaceae Herb	Tulasi	Dec.- Jan.	Cultivated in India and also in wild.	Mixture of seeds with black pepper is given to pregnant women suffering from malaria.
41	<i>Bauhinia purpurea</i> L. Fabaceae Tree	Kaniar	April- May	Throughout India.	Decoction prepared from flower bud used to treat asthma, dysentery and piles.
42	<i>Bauhinia variegata</i> L. Fabaceae Tree	Kachnar	April- May	Throughout India.	Traditional curry prepared using flower buds, yogurt, and onions which is good for health. Decoction of flower buds used for skin diseases, ulcers and leprosy.
43	<i>Piper longum</i> L. Piperaceae Climber	Pippali	April- May	Hotter parts of India- Central Himalaya and Western Ghats.	Fruits used as spice and useful in treatment of rheumatoid arthritis.
44	<i>Psidium guajava</i> L. Myrtaceae Tree	Amrood	All most throughout the year	Cultivated in India and also in wild.	Fruit edible and useful during diarrhoea.
45	<i>Punica granatum</i> L. Lythraceae Tree	Annar	Sept. - Feb.	Cultivated in India and also in wild.	Edible fruits used in folk medicines as contraceptive and abortifacient.
46	<i>Schleichera oleosa</i> (Lour.) Merr. Sapindaceae Tree	Kusum	Feb.-March	Tropical Himalaya from Punjab to Nepal.	Fruits edible. Edible oil obtained from seeds and used in cooking, lighting and in traditional medicines for skin problems and in rheumatism (massage of oil).
47	<i>Spondias pinnata</i> (L.f.) Kurz. Anacardiaceae Tree	Amra, Ambari	Oct.- Nov.	Moist deciduous and semi-evergreen forests and in the plains.	Fruit possesses antiscorbutic and astringent properties. Used in bilious dyspepsia. Un-ripped fruits good for rheumatism and sore throat. Ripe fruit is tonic (aphrodisiac and astringent to the bowels, cures burning sensation).
48	<i>Terminalia arjuna</i> (Roxb.) Wight & Arn. Combretaceae Tree	Arjun	Feb.-March	Throughout India.	Used for treatment of heart disease, wounds, hemorrhages and ulcers.
49	<i>Terminalia bellerica</i> Roxb. Combretaceae Tree	Bahera	March-April	Throughout the plains of India.	Oil obtained from seeds is sweet, cold in potency, good for hair.
50	<i>Ziziphus mauritiana</i> Lam. Rhamnaceae Tree	Ber	March-April	Naturalised throughout India. Also cultivated.	Fruits eaten raw, pickled or used in beverages. Used in treating bleeding disorders, excessive thirst, fever and burning sensation. Seeds have anti cancer potential.
51	<i>Ziziphus nummularia</i> (Burm.f.) Wight & Arn. Rhamnaceae Shrub	Jharber	Feb.,-March	Throughout the deserts of India.	Fruits eaten fresh, pickled, dried or made into confectionery. Dried fruits are astringent used during bilious affliction.

families. Of these, 13 species are represented by the family Fabaceae, followed by Malvaceae with 4 species; Lamiaceae, Lythraceae and Poaceae with 3 species each; Boraginaceae, Combretaceae, Moraceae, Rhamnaceae, Sapindaceae, Verbenaceae with two species each; and the rest of the families are represented by only single species (Fig. 1). On the basis of habit/ life-forms: 33 species are trees, 7 shrubs, 4 herbs and climbers each, and remaining 3 are grass species (Fig. 2).

These plants and their respective parts are traditionally used for the treatment of 26 different types of diseases in human beings and have 11 types of economic uses in the form of edible fruits and seeds, dye production, timber value, spices, beverages, pickle, oil, biodiesel production and fodder. Out of the total plant species, nine (4.59%) are used to cure fever, cough and cold, and equal number of species are used to treat headache/migraine, sore throat, joint pains, cuts and wounds. There are seven plant species (3.57%) which are used for the treatment of intestinal and stomach disorders, seven for the treatment of ulcers and liver dysfunctions, and seven for different kinds of skin problems. For rheumatism,

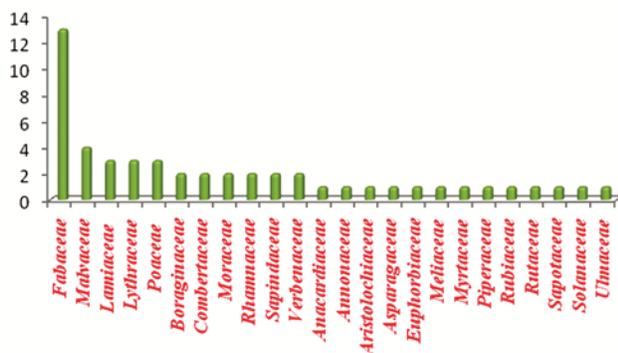


Fig. 1 — Statistical representation of the numbers of introduced plant species from different families used for medicinal and economic uses.

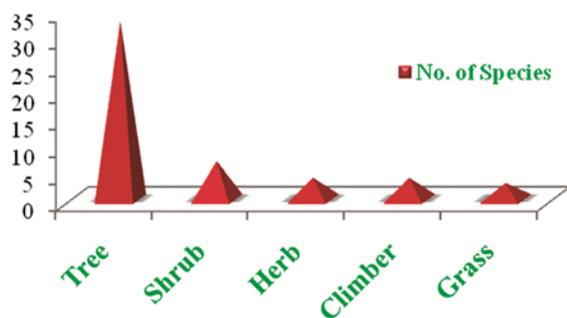


Fig. 2 — Statistical representation of the habit of introduced plant species used for medicinal and economic use.

inflammation, burning sensation, digestive disorders and sexual disorders, a total of 5 species each (2.55%) are used. It is further found that four species are used for the treatment of diseases like Asthma, Jaundice and blood-related infections; three species each for the treatment of bilious infections and as anti-poison and anti-oxidants. Two species each (1.02%) are used for the treatment of 8 different types of diseases viz. nervous disorder, heart disease/paralysis, cancer, piles, leprosy, hair/brain tonic, bronchitis/haemoptysis and diabetes. Out of the total, one species each is used for the cure of dental problems, ailments related to bowels, tumours, scabies and excessive thirst, respectively. The study shows that a total of 26 types of major diseases are cured from the 51 plant species which have been introduced in the BGIR (Table, 2).

These introduced species are also economically valuable and are used for a total of 11 different types

Table 2 — Statistical analysis of medicinal uses of the introduced plant species in the BGIR.

S. no.	Diseases	No of plants used (%)
1	Fever, cough and cold	9 (4.59)
2	Headache/migraine, sore throat, joint pains, cuts and wounds	9 (4.59)
3	Intestinal disorders, Diarrhoea Stomachic & Dysentery	7 (3.57)
4	Ulcers (gastric & mouth), Liver function & Swellings	7 (3.57)
5	Skin problems	7 (3.57)
6	Rheumatism	5 (2.55)
7	Inflammation and Burning sensation	5 (2.55)
8	Digestive problems	5 (2.55)
9	Sexual problems	5 (2.55)
10	Asthma & Jaundice	4 (2.04)
11	Blood diseases	4 (2.04)
12	Bilious affliction	3 (1.53)
13	As anti-poisonous and anti-oxidant	3 (1.53)
14	Nervous disorder	2 (1.02)
15	Heart disease & Paralysis	2 (1.02)
16	Anti-cancerous	2 (1.02)
17	Piles	2 (1.02)
18	Leprosy	2 (1.02)
19	Hair and Brain tonic	2 (1.02)
20	Bronchitis & Haemoptysis	2 (1.02)
21	Diabetes	2 (1.02)
22	Dental ailments	1 (0.51)
23	Bowels	1 (0.51)
24	Tumour	1 (0.51)
25	Scabies	1 (0.51)
26	Excessive thirst	1 (0.51)

Table 3 — Statistical analysis of economic uses of the introduced plant species in the BGIR.

S. no.	Economic uses	No of plants used (%)
1	Edible (Fruits, seeds, grains)	5 (2.55)
2	Oil	5 (2.55)
3	Beverages	3 (1.53)
4	Insecticides and insect repellent	3 (1.53)
5	Pickle	2 (1.02)
6	Biodiesel	2 (1.02)
7	Edible gum & gum	2 (1.02)
8	Dye and paint preparations	2 (1.02)
9	Timber	1 (0.51)
10	Fodder	1 (0.51)
11	Spices	1 (0.51)

of economic purposes besides their medicinal importance. The fruits, seeds and grains of the five species have edible value and are consumed regularly by the indigenous communities<sup>11,12</sup>. It is also found that five species yield vegetable oil as well as commercial oil. Three species are commercially used for the production of beverages and as insecticides and insect-repellents. The fruits of two species are used for pickle preparation and the same numbers of species are used for biodiesel production. Two species yield edible and commercially-used gum and two are used in dye and paint preparation. The wood of one tree species (*Acacia catechu*) has been found to being used as timber due to its timber value and insect resistant properties. One species each is used as fodder and as a spice in traditional preparations (Table, 3).

The plant species under study have -huge potential as medicinal herbs and are used to treat 26 types of different diseases by the traditional communities. These communities used to prepare 12 kinds of different preparations from these plant species (using specific parts) for the treatment of various ailments. In five types of diseases, oil extracted from these plants is used for the treatment. Four diseases each are cured using extracts decocted from different parts of plant species. A paste of these plants is used for the treatment of three diseases and for two diseases a tonic prepared from these plants is used for the cure. Two sex disorders are also cured by using specific plant parts of the species in the form of a contraceptive. One disease each is treated by using the plant parts in the form of antidote, crushed seeds, drops, katha obtained from the bark, fresh seeds and in powder form (Table, 4).

These 51 plant species are extensively used by the indigenous and tribal communities for the treatment

Table 4 — Statistically analysis of the various preparations of introduced medicinal plant species in the BGIR.

S. No.	Various preparation for medicinal uses	Number of diseases
1	Oil	5
2	Decoction	4
3	Extract	4
4	Paste	3
5	Tonic	2
6	Contraceptive	2
7	Antidote	1
8	Crushed seeds	1
9	Drops	1
10	Katha	1
11	Fresh seeds	1
12	Powder	1

of various ailments and for other daily requirements in India. These above-mentioned plant species are also used by pharmaceutical and other industries for the production of drugs, insecticides, oil, biodiesel, pickles, spices and beverages on large scale. Therefore, these species with huge medicinal and economic potential should be conserved at local as well as national level<sup>13</sup> for the sake of future generations<sup>14</sup>. The systematic utilization of plant species and their products by different indigenous and tribal communities<sup>15,16</sup> is well-documented in the past by several scientific workers<sup>17-19</sup>. It has been reported by them how people from these communities made use of wild plant resources for their daily needs<sup>20</sup>, and how aware they were of the need for community-based conservation of such plants around their villages<sup>21-23</sup> as a part of sacred grooves by their social and cultural practices<sup>24-26</sup>.

## Conclusion

India is a huge country with many indigenous and tribal communities which are using wild plant species and their parts for the treatment of various ailments and as a part of their daily requirement in the form of vegetables, fruits, fodder and for timber. The present study shows that these 51 species are widely distributed in different parts of India and are traditionally used for the treatment of 26 ailments. They also have 11 types of economic uses viz. edible fruits and seeds, dye production, timber, spices, beverages, pickle, oil, biodiesel and fodder. Although these communities are aware about their conservation but their extensive harvest and utilization have posed a threat to their existence in the wild. The other disruptive reasons which are also responsible for their

loss from the wild are habitat degradation and invasive plant invasions. Hence, some collective measures are required for the conservation of these species at the local as well as national level. Conservationists need to identify highly important, rare, threatened, endemic plant species with huge medicinal and economic potential to achieve conservation and sustainable utilization. The creation of Botanic gardens under different phytogeographical zones of India will play an important role in the conservation (*ex-situ*) of these wild plant species. The Botanic Garden of Indian Republic is one of the larger botanic gardens in India and has been playing a huge role in the conservation and propagation of rare, threatened, endemic, indigenous, medicinal and economic plants of the country. It also provides live plant material to different institutions for scientific studies along with creating awareness among the people around the Noida city. The national parks, wildlife sanctuaries, sacred grooves will also play same role along with on-site conservation of highly important plant species diversity of India.

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### Conflict of Interest

Authors declare that there has been no conflict of interest.

### Author Contributions

All authors contributed equally during the research work and writing of this manuscript.

### References

- Subhose V, Srinivas P, & Narayana A, Basic principles of pharmaceutical science in Ayurveda, *Bull Indian Inst Hist Med Hyderabad*, 35 (2) (2005) 83–92.
- Heinrich M, Ethnopharmacy and natural product research-multidisciplinary opportunities for research in the metabolomic age, *Phytochem Lett*, (1) (2008) 1-5.
- Chanda S, Sarethy I P, De B & Singh K, *Paederia foetida*: A promising ethno-medicinal tribal plant of north eastern, *J of Forest Rese* (24) (2013) 801-808.
- Sharma M, Sharma C L & Marak P N, Indigenous uses of medicinal plants in North Garo Hills, Meghalaya, NE India: *Rese J of Rece Scien*, (3) (2014) 137-146.
- Pandey M M, Rastogi S & Rawat A K S, Indian Traditional Ayurvedic System of Medicine and Nutritional Supplementation, *Evid Based Complement Alternat Med*: Online publication, Article ID 376327 (2013) 12 <http://dx.doi.org/10.1155/2013/376327>.
- Shilpa B, Bijay T & Ashalata D, Ethnomedicinal plants of the sacred groves and their use by Karbi tribe in Karbi Anlong district of Assam, North east India, *Indian J Tradit Know*, 19 (2) (2020) 277-287.
- Sajan T, Nawang T, Bishander S, Harish C D & Bikarma S, Ethnobotanical plants used for gastrointestinal ailments by the inhabitants of Kishtwar plateau in Northwestern Himalaya, India, *Indian J Tradit Know* 19 (2) (2020) 388-398.
- Rai L K, Parsad P & Sharma E, Conservation threats to some important medicinal plants of Sikkim Himalaya, *Biol Conser*, 93 (1) (2000) 27-33.
- Hussain S & Hore D K, Collection and conservation of major medicinal plants of Arunachal Pradesh, National Bureau of Plant Genetic Resources Regional Station: *Indian Forester J*, 134 (12) (2008) 1663–1679.
- Kohli R K, Dogra K S, Batish D R & Singh H P, Impact of invasive plants on the structure and composition of natural vegetation of Northwestern Indian Himalayas, *Weed Tech*, (18) (2004) 1296- 1300.
- Jain S K, Methods and approaches in Ethnobotany, *Societies of Ethnobotanists*, (CDRI, Lucknow), 1989.
- Satyavati G V & Gupta A K, *Medicinal Plants of India*, (Indian Council of Medicinal Research) (2), 1987.
- Gangwar A K & Ramakrishnan P S, Ethnobiological notes on some tribes of Arunachal Pradesh, Northeastern India: *Econo Bot*, (44) (1990) 94-31.
- Jaryal R K & Singhal V K, Traditional knowledge and conservation status of some selected medicinal herbs from Uttarkashi district in Uttarakhand: Western Himalayas, *Taiwania*, 64 (1) (2019) 52-64.
- Hamilton A, Medicinal plants and conservation: issues and approaches, *International Plant Conservation Unit*, WWF-UK, Survey, (2003) 151.
- Jain S K, Sinha B K & Gupta R C, *Notable Plants in Ethnomedicine of India*, (Deep Publication, New Delhi), 1991.
- Rastogi R P & Mehrotra B N, Compendium of Indian Medicinal Plants, Central Drug Research Institute, Lucknow, *Publication and Information Directorate*, (1) 1960-1969 & (2) 1970-1979, (1993).
- Jayashree B & Aram I A, Conservation of millets: the role of community leaders in Kolli hills, South India, *Indian J Tradit Know* 19 (1) (2020) 101-110.
- Rana M S & Samant S S, Diversity, indigenous uses and conservation status of medicinal plants in Manali wildlife sanctuary, North westwern Himalaya, *Indian J Tradit Know* 10 (3) (2011) 439-459.
- Dogra K S, Chauhan S K & Jalal J S, Assessment of Indian medicinal plants for the treatment of asthma, *J Med Plants Res*, 9 (32) (2015) 851-862.
- Seema S & Dogra K S, Utilization of Solanaceae for dental care management in India, *Pharma Innov J*, 7 (5) (2018) 71-74.
- Chopra R N, Nayar S L & Chopra I C, *Glossary of Indian Medicinal Plants*, (National Institute of Science Communication, CSIR), 1996.
- Kala C P & Ratajc P, High altitude biodiversity of the Alps and the Himalayas, Ethnobotany, plant distribution and

- conservation perspective, *Biodiversity and Conservation*, 21 (4) (2012) 1115–1126. <http://dx.doi.org/10.1007/s10531-012-0246-x>.
- 24 Shubhashree M N, Matapathi S & Dixit A K, Conservation and preservation of medicinal plants- leads from Ayurveda and Vrikshayurveda, *Int J Complement Alt Med*, (1) (2018) 275-279.
- 25 Kumar P, Medicinal Plants in India. In: *Conservation & Sustainable Utilisation in the Emerging Global Scenario*, (Bishen Singh Mahendra Pal Singh), 2006.
- 26 Jasmine B, Singh Yashaswi, Onial M & Mathur V B, Traditional knowledge systems in India for biodiversity conservation, *Indian J Tradit Know* (15) (2016) 304-312.