

Medicinal plants in Himachal Pradesh, north western Himalaya, India

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SUMMARY

Himachal Pradesh, in the Indian Himalaya, has a rich diversity of medicinal plants, which are widely used. This paper brings together existing information with the results from recent field surveys. A total of 643 species of medicinal plants are identified; many different plant parts are used for the treatment of various ailments. The number of medicinal plant species decreased with increasing altitude. The plants are classified according to nativeness, endemism, and rarity, and prioritized for cultivation. Existing strategies for *in-situ* and *ex-situ* conservation, cultivation and propagation are reviewed and a range of actions for cooperative implementation by all stakeholders are suggested.

INTRODUCTION

The Indian Himalayan Region (IHR) is a mega hot spot of biological diversity (Myers 2000). It comprises about 18% of India, is more than 2,800 km long and 220 to 300 km wide, with altitudes from 200–8000 m (Anonymous 1992). The flora includes about 8,000 species of angiosperm (40% endemic), 44 species of gymnosperm (16% endemic), 600 species of pteridophyte (25% endemic), 1737 species of bryophyte (33% endemic), 1,159 species of lichen (11% endemic) and 6,900 species of fungi (27% endemic) (Singh and Hajra 1996; Samant *et al.* 1998). These include some 1748 species of medicinal plant with various traditional and modern therapeutic uses (Samant *et al.* 1998), 675 species of wild edible plants (Samant and Dhar 1997), 118 species of medicinal plants yielding essential oils, 279 species of fodder, 155 sacred plants (Samant and

Pant 2003) and 121 rare-endangered plants (Nayar and Sastry 1987, 1988, 1990).

A large number of studies on medicinal plants have been carried out in the IHR (Jain 1991; Samant *et al.* 1998; Rai *et al.* 2000). However, in particular in Himachal Pradesh, such studies are fragmentary and mainly focused on inventory (Chauhan 1988, 1989, 1990, 1996, 1999; Jain 1991; Samant *et al.* 1998, 2001; Badola 2001; Sood *et al.* 2001; Badola and Pal 2003, Bhattacharya and Uniyal 1982; Gammie 1898; Kapahi 1990; Rau 1960; Samant and Pant 2006; Kala 2006a). Some workers (Collett 1902; Chauhan 1989, 1990, 1999; Aswal and Mehrotra 1994; Sharma and Singh 1996; Dhaliwal and Sharma 1997, 1999; Sharma and Dhaliwal 1997a, 1997b; Singh and Rawat 2000; Kaur and Sharma 2004) have mentioned medicinal uses

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of plants in ethnobotanical notes, floristic and biodiversity studies.

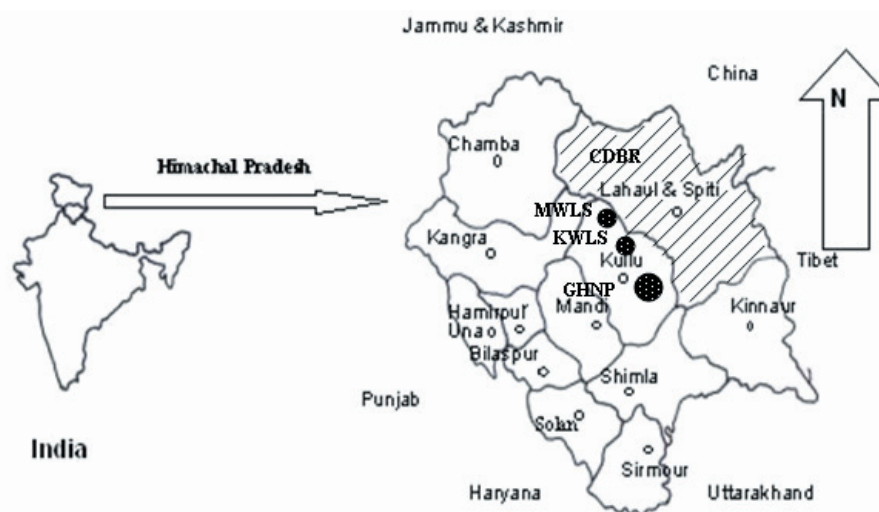
Medicinal plants are used in the Ayurvedic, Unani and other traditional systems of medicine and in plant-based pharmaceutical industries. The Tibetan system of medicine is also based on Himalayan species (Samant *et al.* 1998). Estimates indicate that at least 90% of medicinal plant species are extracted from the wild (Anonymous 1997); and that 69% of the material is collected through destructive harvesting, which suggests that medicinal plants are significantly threatened (Dhar *et al.* 2000). Excessive anthropogenic pressures have been identified as the main causes of decline in the population and availability of the medicinal plants in the Himalayan region (Samant *et al.* 1998). With increasing demand and renewed global interest in traditional ethnopharmacy, coupled with the increasing preference for natural substances in the healthcare system, the natural stock of medicinal plants of Himachal Pradesh is under tremendous pressure (Samant *et al.* 1998). To provide the information necessary to support further action, this paper brings together existing information with results from recent field surveys.

STUDY AREA

The State of Himachal Pradesh (30°22'40"-33°12'40" N to 75°45'55"-79°04'20" E) includes parts of the Trans and Northwest Himalaya and

covers 55,673 km²: 9% of the IHR (Figure 1). Like other states of the IHR, Himachal Pradesh has a representative, natural, and socio-economically important biodiversity. It has a large altitudinal range (200–7109 m), with diverse habitats, species, populations, communities and ecosystems. Tropical vegetation is distributed in the lower parts (Shiwalik hills) of the state and includes broadleaf deciduous and evergreen forests of *Shorea robusta*, *Tectona grandis* and *Dalbergia sissoo*. Subtropical vegetation ranges from 500 to 1800 m and is dominated by broadleaf deciduous and evergreen forests and evergreen coniferous forests of *S. robusta*, mixed *S. robusta*–*Pinus roxburghii*, mixed *Pinus roxburghii*–*Quercus leucotrichophora* and *Q. leucotrichophora*. Temperate vegetation ranges from 1801 to 2800 m and comprises *Cedrus deodara*, *Aesculus indica*, *Alnus nitida*, *Picea smithiana*, *Pinus wallichiana*, *Q. leucotrichophora* and *Q. floribunda* forests. Subalpine vegetation ranges from 2801 to 3800 m and is dominated by *Q. semecarpifolia*, *Picea smithiana*, *Abies pindrow* and *Betula utilis* forests. Alpine vegetation is usually found above 3800 m but goes down to 3300 m in the valleys. While it mainly comprises herbaceous species, scattered patches of shrubs such as *Rhododendron campanulatum*, *Rh. anthopogon*, *Juniperus indica*, *Rosa macrophylla*, *R. sericea* and *Salix lindleyana* are widespread.

Both state and central governments have undertaken initiatives for the conservation of species, habitats and ecosystems. At present, Himachal



Abbreviations used: CDBR=Cold Desert Biosphere Reserve; MWLS=Manali Wildlife Sanctuary; KWLS=Kais Wildlife Sanctuary; and GNHP=Great Himalayan National Park

Figure 1 Location map of the Himachal Pradesh

Pradesh has one proposed biosphere reserve, two national parks, and 32 wildlife sanctuaries for the *in-situ* conservation of biodiversity. These protected areas are distributed across all the altitudinal zones (Gulati *et al.* 2004). For example, both the Manali Wildlife Sanctuary and the proposed Cold Desert Biosphere Reserve have temperate, subalpine and alpine habitats, and the Great Himalayan National Park has subtropical, temperate, subalpine and alpine habitats.

The population of the Himachal Pradesh is 6,077,248 according to the provisional results of the Census of India 2001 (www.himachal.nic.in). Most live in villages and belong to diverse cultures and communities, with specific traditional knowledge. The Gujjars, Gaddis, Lahules, Spitiens, Pangwalas and Kinnaure tribes have permanent and semi-permanent dwelling places in Pangi and Gadderan (Chamba and Bharmaur), Lahaul and Kinnaur. Since ancient times, the local communities have used plants for various purposes, such as food, medicine, fodder, fuel, agricultural tools and religious and other purposes (Samant *et al.* 1998). They trade some of the high-value medicinal plants for income generation.

METHODS

A range of primary and secondary sources were used. The primary sources derive from two sets of surveys: surveys of the floristic diversity of protected areas (Kais and Manali Wildlife Sanctuaries, Cold Desert Biosphere Reserve: Figure 1); and extensive and intensive field surveys conducted from January 2004 to September 2006. Extensive surveys covered most of the state while the intensive surveys were conducted in 15 biodiversity-rich areas in tropical and subtropical (< 1800 m), temperate (1801–2800 m), subalpine (2801–3800 m) and alpine (> 3800 m) zones of Kullu, Lahaul and Spiti, Mandi, Shimla, Bilaspur, Solan, Sirmaur and Kangra districts. Several visits were made to each of

the intensive survey sites in different seasons. During the intensive surveys, local knowledgeable persons from each of the sites were interviewed and information on indigenous uses of the medicinal plants was collected. One such person from each site was hired to collect samples of medicinal plants from the natural habitats. Fresh samples of each species were collected and identified with the help of local flora (Collett 1902; Chowdhery and Wadhwa 1984; Aswal and Mehrotra 1994; Sharma and Singh 1996; Dhaliwal and Sharma 1999; Singh and Rawat 2000; Kaur and Sharma 2004). Information on altitudinal range, part(s) used, life forms and indigenous uses was collected during the surveys.

The secondary sources include a study of the flora of the Great Himalayan National Park (Singh and Rawat 2000) and literature on the medicinal plants of Himachal Pradesh (Samant *et al.* 1998; Chauhan 1989, 1990, 1999; Chowdhery and Wadhwa 1984; Aswal and Mehrotra 1994; Sharma and Singh 1996; Dhaliwal and Sharma 1997, 1999; Sharma and Dhaliwal 1997a,b; Singh and Rawat 2000; Kaur and Sharma 2004; Samant and Pant 2006; Samant *et al.* 2007; Kala 2006a,b). For nomenclature and nativity of the species, Anonymous (1883–1970) and Samant *et al.* (1998) were followed. Endemism of the species was assessed based on biogeographical distribution: species restricted to the IHR were identified as endemic, while those species also found in adjacent countries were identified as near-endemic (Dhar and Samant 1993; Samant *et al.* 1998). Rarity categorization is based on Samant *et al.* (1998), Dhar *et al.* (2002), and Ved *et al.* (2003). The prioritization of species for cultivation in each altitudinal zone was determined according to medicinal uses (Ved 2001), availability (based on the primary surveys carried out in the state), trade values (Sultan and Singh 2006), demand in local, national and international markets and pharmaceutical preparations (Ved 2001) (Table 1).

Table 1 Criteria used for prioritization of the medicinal plants for cultivation in Himachal Pradesh

Himachal Pradesh					
Score	Medicinal uses	Availability	Trade values	Demand	Pharmaceutical preparation
10	> 15	High	High	High	> 150
6	5–15	Moderate	Medium	Medium	50–150
2	< 5	Low	Low	Low	< 50

RESULTS

Diversity

The study identified 643 species of medicinal plants in 388 genera and 137 families. Of these, the endemic, near-endemic and rare endangered species are listed in Appendix 1, which also shows their distribution in Kais and Manali Wildlife Sanctuaries, the Cold Desert Biosphere Reserve and the Great Himalayan National Park. These 643 species represent different life forms: trees (106 spp.), shrubs (121 spp.) and herbs (416 spp.). The dominant families and genera are presented in Figures 2 and 3. Fifty-one families are monotypic, indicating a poor genetic base.

Distribution

Along an altitudinal gradient, the maximum number of medicinal plants (417) was found in the tropical and sub-tropical zone (< 1800 m), followed by the temperate (1801–2800 m) (356 spp.), subalpine (2801–3800 m) (303 spp.) and alpine (> 3800 m) (158 spp.) zones. The representative species of each altitudinal zone are given in Table 2. Many species were found in more than one zone.

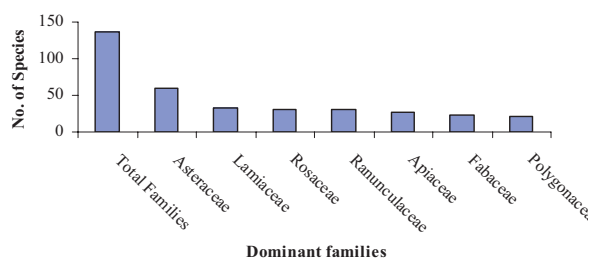


Figure 2 Dominant families of medicinal plants in Himachal Pradesh

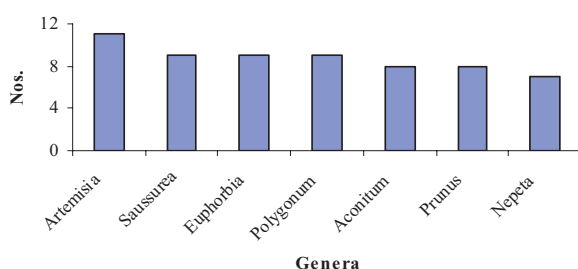


Figure 3 Dominant genera of medicinal plants in Himachal Pradesh

Native and endemic species

A total of 269 species were native to the Himalayan region, while 374 species were non-native, from biogeographic regions including Africa, Australia, Oriental India, Tropical Asia, Europe, America, China, Malaya, Java, Japan, New Zealand and Sri Lanka. A total of 17 species were endemics restricted to the IHR; 131 species were identified as near-endemics. The number of native, endemic and near-endemic species appears to increase along an altitudinal gradient irrespective of the total species richness (Appendix 1).

Utilization and commercial exploitation

Different plant parts, such as roots/rhizomes/tubers (224 spp.), whole plants (185 spp.), leaves (164 spp.), seeds (82 spp.), fruits (81 spp.), bark (72 spp.), flowers (49 spp.), stems (24 spp.), latex (13 spp.), resin (10 spp.), aerial parts (8 spp.), inflorescences (7 spp.), fronds, gum, nuts, wood, oil and grain (2 spp. each), and wax, cones and twigs (1 spp.) are used by native communities for pharmaceutical preparations. Species used in > 50 pharmaceutical preparations are presented in Table 3 (Ved 2001).

The interviews with knowledgeable persons indicated that the local inhabitants exploit some of the commercially-viable medicinal plants from the wild for income generation. They are traded either in the local markets of the state or in the national markets. Exact trade values of the exploited species could not be obtained from the inhabitants; however, recent available trade values for some of the species known from different markets of the country are presented in Table 4 (Sultan and Singh 2006).

Rarity

Using the criteria of the International Union for Conservation of Nature and Natural Resources (IUCN), 12 species were categorized as critically endangered, 21 species as endangered, 27 species as vulnerable, 2 species as near threatened and 3 species as data-deficient (Ved et al. 2003) (Appendix 1).

Table 2 The representative medicinal plants of the different altitudinal zones in Himachal Pradesh

Altitudinal zones	Representative species
Tropical and Sub-tropical < 1800 m	<i>Justicia adhatoda</i> , <i>Achyranthes aspera</i> , <i>Mangifera indica</i> , <i>Apium graveolens</i> , <i>Rauwolfia serpentina</i> , <i>Acorus calamus</i> , <i>Calotropis gigantea</i> , <i>Asparagus adscendens</i> , <i>A. racemosus</i> , <i>Azardirachta indica</i> , <i>Artemisia absinthium</i> , <i>A. japonica</i> , <i>Tagetes minuta</i> , <i>Berberis asiatica</i> , <i>Rorippa indica</i> , <i>Bauhinia variegata</i> , <i>B. vahlii</i> , <i>Caesalpinia decapitala</i> , <i>Cassia fistula</i> , <i>Terminalia atata</i> , <i>T. arjuna</i> , <i>T. chebula</i> , <i>Cyperus rotundus</i> , <i>Dioscorea bulbifera</i> , <i>Emblica officinalis</i> , <i>Swertia angustifolia</i> , <i>Hypericum perforatum</i> , <i>Curculigo orchioides</i> , <i>Ajuga parviflora</i> , <i>Mentha arvensis</i> , <i>M. piperata</i> , <i>Ocimum canum</i> , <i>O. sanctum</i> , <i>Salvia plebeia</i> , <i>S. lanata</i> , <i>Cinnamomum tamala</i> , <i>Aloe barbadensis</i> , <i>Woodfordia fruticosa</i> , <i>Tinospora cordifolia</i> , <i>Syzygium cuminii</i> , <i>Malaxis acuminata</i> , <i>Zizypus mauritiana</i> , <i>Prinsepia utilis</i> , <i>Rubia cordifolia</i> , <i>Zanthoxylum armatum</i> , <i>Sapindus mukorossii</i> , <i>Bergenia ligulata</i> , <i>Bacopa monnieri</i> , <i>Withania somnifera</i> , <i>Atropa belladonna</i> , <i>Urtica parviflora</i> , <i>Hedychium spicatum</i> , <i>Elaeagnus conferta</i>
Temperate 1801–2800 m	<i>Ferula jaeschkeana</i> , <i>Heracleum candicans</i> , <i>Asparagus filicinus</i> , <i>Ainsliaea aptera</i> , <i>Berberis aristata</i> , <i>Betula alnoides</i> , <i>Sagina saginoides</i> , <i>Corylus Jacquemontii</i> , <i>Rosularia rosulata</i> , <i>Gentiana kurroo</i> , <i>Skimmia laureola</i> , <i>Geranium nepalense</i> , <i>Elsholtzia fruticosa</i> , <i>Rhododendron arboreum</i> , <i>Malva verticillata</i> , <i>Oxalis corniculata</i> , <i>Phytolacca acinosa</i> , <i>Polygala sibirica</i> and <i>Taxus baccata</i> subsp. <i>wallichiana</i>
Subalpine 2801–3800 m	<i>Allium humile</i> , <i>Bunium persicum</i> , <i>Malaxis muscifera</i> , <i>Carum carvii</i> , <i>Geranium wallichianum</i> , <i>Angelica glauca</i> , <i>Archangelica himalaica</i> , <i>Bupleurum falcatum</i> , <i>Heracleum lanatum</i> , <i>Arisaema flavum</i> , <i>Saussurea auriculata</i> , <i>S. costus</i> , <i>Tanacetum gracile</i> , <i>T. tenuifolium</i> , <i>T. tomentosum</i> , <i>Impatiens glandulifera</i> , <i>Arnebia benthamii</i> , <i>Eritrichium canum</i> , <i>Rhododendron campanulatum</i> , <i>Ribes orientale</i> , <i>Polygonatum multiflorum</i> , <i>P. verticillatum</i> , <i>Plantago depressa</i> , <i>Aconitum ferox</i> , <i>A. leave</i> , <i>A. heterophyllum</i> , <i>A. falconeri</i> , <i>Pedicularis pectinata</i> , <i>Polygonatum verticillatum</i> , <i>Dactylorhiza hatagirea</i> , <i>Picrorhiza kurroo</i>
Alpine > 3800 m	<i>Cortia depressa</i> , <i>Selinum tenuifolium</i> , <i>Heracleum wallichii</i> , <i>Inula royleana</i> , <i>Saussurea graminifolia</i> , <i>S. obvallata</i> , <i>S. simsoniana</i> , <i>S. gossypiphora</i> , <i>Arnebia euchroma</i> , <i>Corydalis meifolia</i> , <i>C. govaniiana</i> , <i>Iris kumaonensis</i> , <i>Fritillaria roylei</i> , <i>Polygonum affine</i> , <i>Rhododendron anthopogon</i> , <i>Rheum australe</i> , <i>R. moorcroftianum</i> , <i>R. webbiana</i> , <i>Dactylorhiza hatagirea</i> , <i>Picrorhiza kurroo</i> , <i>Aconitum heterophyllum</i> , <i>A. rotundifolium</i> , <i>A. violaceum</i> , <i>A. spicatum</i> , <i>Delphinium cashmerianum</i> , <i>D. vestitum</i> , <i>Nardostachys grandiflora</i>

Prioritization of medicinal plants for cultivation

Past studies have shown that the cultivation of medicinal plants within the distribution range has been more successful than cultivation of species outside the distribution range (Samant and Pal 2003). Cultivation outside the distribution range affects the concentration of active ingredients (Samant and Pal 2003). The prioritization of medicinal plants for cultivation within different altitudinal zones of Himachal Pradesh is shown in Table 5. Most of these species have also been prioritized by the National Medicinal Plant Board, constituted by the Government of India (www.nmpb.nic.in).

DISCUSSION AND CONCLUSIONS

This paper provides comprehensive information on the diversity, distribution pattern, nativity, endemism, rarity and uses of medicinal plants in

Table 3 Some important medicinal plants used in pharmaceutical preparations

Botanical name	Vernacular name	No. of preparations
<i>Terminalia chebula</i>	Hararrh	219
<i>Terminalia bellirica</i>	Bahera	219
<i>Embelica officinalis</i>	Amla	219
<i>Glycyrrhiza glabra</i>	Yashtimadhu	141
<i>Justicia adhatoda</i>	Vasaka	110
<i>Withania somnifera</i>	Ashwagandha	109
<i>Cyperus rotundus</i>	Mustaka	102
<i>Tinospora cordifolia</i>	Gulanacha	88
<i>Berberis aristata</i>	Daruharidra	65
<i>Tribulus terrestris</i>	Gokshuru	65
<i>Aegle marmelos</i>	Bael	60
<i>Boerhaavia diffusa</i>	Punarnava	52
<i>Acorus calamus</i>	Vacha	51

(Source: Ved 2001)

Himachal Pradesh. The finding that 37% of the total recorded species of medicinal plants of the

Table 4 Trade values of some medicinal plants in different markets of the country (Source: Sultan and Singh 2006)

Botanical name	Part(s) used	Rates (Rs/Kg)				
		Delhi	Saharanpur	Dehradun	Amritsar	Solan
<i>Aconitum heterophyllum</i>	Rt	–	3500–4000	3600–4100	4150–4600	3300–3800
<i>Acorus calamus</i>	Rh	40–45	40–48	35–42	38–42	35–40
<i>Aegle marmelos</i>	Bk, Lf, Fr	16	17–20	18–22	20	18
<i>Aloe vera</i>	Ghritkumari	70	65–70	70–72	68–74	75
<i>Andrographis paniculata</i>	Shoot	20	23–26	24–30	18–22	18–25
<i>Asparagus racemosus</i>	Rt	200–240	200–220	210–230	225–250	180–250
<i>Berberis aristata</i>	Rt, St	10–12	12	15–18	14–17	15
<i>Bergenia ligulata</i>	Rh, Rt	37	30–35	40	20	25
<i>Boerhaavia diffusa</i>	Lf, Rt, Wp	26	22	25–36	24	22
<i>Cassia fistula</i>	Fr, Gum, Sd	18–25	22–25	26–30	23–28	20–22
<i>Centella asiatica</i>	Lf	55–65	58	60–70	62–72	60–68
<i>Cinnamomum tamala</i>	Lf	20–35	22–28	20–28	25–28	25
<i>Commiphora wightii</i>	Gum	160–173	180	200–210	200–250	200–240
<i>Curculigo orchiodes</i>	Rt	50	52	50–55	52–55	48
<i>Dactylorhiza hatagirea</i>	Rt	1450–1700	1050–1100	1100–1150	950–1120	500–900
<i>Derris indica</i>	Sd	40	45–50	40–50	44–48	42
<i>Eclipta alba</i>	Shoot	13–15	16–22	24	18–23	–
<i>Embelica officinalis</i>	Fr	39	30–32	40–45	38	18–24
<i>Eulophia campestris</i>	Rt	4000–4300	4000–4600	–	4300–5000	4200–4600
<i>Evolvulus alsinoides</i>	Wp	19–21	19–20	20–25	17–18	18–20
<i>Glycyrrhiza glabra</i>	Rt	30–35	36–42	40–46	36–40	40
<i>Gymnema sylvestre</i>	Sd	28–32	30	28–34	30–36	20–25
<i>Hedychium spicatum</i>	Rh, Rt	15	19	19–22	15–18	20
<i>Malaxis muscifera</i>	Rt	65	70	–	68–72	65
<i>Mucuna pruriens</i>	Sd	10–15	18–20	12–18	13–17	15–20
<i>Murraya koenigii</i>	Lf	19	21–25	20–26	22–25	18
<i>Myrica esculenta</i>	Bk	26–30	34–38	–	42–50	25
<i>Nardostachys grandiflora</i>	Rh/Rt	180	190–200	200–210	170–190	160–175
<i>Ocimum sanctum</i>	Lf	140	145	150	145–155	150
<i>Picrorrhiza kurrooa</i>	Rh, Rt	250–260	250–280	250–270	240–250	230–250
<i>Piper longum</i>	Fr	115–135	132	140	120–130	115–125
<i>Pistacia integerrmia</i>	Lf	83–88	70–80	80	58–64	50–60
<i>Plumbago zeylanica</i>	Rt	11–13	28–33	–	30	28–32
<i>Rauvolfia serpentina</i>	Rt	100–120	90–110	110–120	148–155	145–150
<i>Sapindus mukorossii</i>	Fr	34	45	35–42	42–47	42–45
<i>Saussurea costus</i>	Rt	120–130	135–140	150	136–145	130–150
<i>Solanum nigrum</i>	Wp, Lf	50–60	50–65	60–70	70–80	55–60
<i>Swertia chirata</i>	Wp	160	–	200–220	210	–
<i>Syzigium cumini</i>	Sd	12–15	16	12–15	13–16	18
<i>Terminalia arjuna</i>	Bk	10–11	12–15	12–16	11–13	10
<i>Terminalia bellirica</i>	Fr	11–12	10	12–15	13–15	12–13
<i>Terminalia chebula</i>	Fr	40	32	45	43–46	42–48
<i>Tinospora cordifolia</i>	St	8–10	10	11–14	9–12	10
<i>Tribulus terrestris</i>	Fr	–	25	35–45	28	25–30
<i>Valeriana jatamansi</i>	Rh	90–100	105–115	110–120	85–100	90–100
<i>Withania somnifera</i>	Rt	65–70	73–75	80–100	71–78	60–70

Abbreviations: Rt = Root, Rh = Rhizome; Tb = Tuber; Bk = Bark; Wp = Whole plant; Lf = Leaf; Fr = Fruit; Fl = Flower; Res = Resin; Sd = Seed

Table 5 Prioritization of medicinal plants for cultivation at different altitudinal zones in Himachal Pradesh

Altitude zone	Taxa	Score	Taxa	Score
< 1800 M	<i>Emblica officinalis</i>	42	<i>Zanthoxylum armatum</i>	30
	<i>Terminalia chebula</i>	42	<i>Terminalia arjuna</i>	30
	<i>T. bellirica</i>	42	<i>Justicia adhatoda</i>	30
	<i>Acorus calamus</i>	40	<i>Thalictrum foliolosum</i>	26
	<i>Rauwolfia serpentina</i>	38	<i>Gloriosa superba</i>	26
	<i>Asparagus racemosus</i>	38	<i>Mentha piperata</i>	26
	<i>Tinospora cordifolia</i>	36	<i>Tagetes minuta</i>	26
	<i>Azadirachta indica</i>	34	<i>Bergenia ligulata</i>	24
	<i>Withania somnifera</i>	34	<i>Gymnema sylvestre</i>	22
	<i>Aegle marmelos</i>	34	<i>Glycyrrhiza glabra</i>	22
	<i>Solanum nigrum</i>	34	<i>Coleus forskohlii</i>	22
	<i>Bacopa monnieri</i>	32	<i>Cinnamomum tamala</i>	22
1801–2800 M	<i>Swertia chirayita</i>	34	<i>Hedychium spicatum</i>	26
	<i>Valeriana jatamansi</i>	30	<i>Skimmia laureola</i>	24
	<i>Taxus baccata ssp. wallichiana</i>	30	<i>Dioscorea deltoidea</i>	22
	<i>Angelica glauca</i>	30	<i>Bergenia ligulata</i>	22
	<i>Plantago ovata</i>	28	<i>Polygonatum verticillatum</i>	18
	<i>Swertia angustifolia</i>	26	<i>Heracleum candicans</i>	18
	<i>Swertia chirayita</i>	34	<i>Berberis lycium</i>	18
	> 2801 M	<i>Podophyllum hexandrum</i>	38	<i>Dactylorhiza hatagirea</i>
<i>Picrorhiza kurrooa</i>		38	<i>Nardostachys grandiflora</i>	30
<i>Jurinea macrocephala</i>		38	<i>Saussurea costus</i>	30
<i>Aconitum heterophyllum</i>		34	<i>Inula racemosa</i>	22
<i>Rheum australe</i>		34	<i>Carum carvi</i>	22
<i>Angelica glauca</i>		30	<i>Artemisia maritima</i>	22

IHR are found in the state indicates the rich diversity of its medicinal plants (Samant et al. 1998). Sixty-five per cent of these species occur in the altitudinal zone < 1800 m, identifying this zone as having high potential for supplying medicinal plants and also for conservation efforts. The rich diversity may be due to mild climatic conditions and diverse habitats, together with a large number of human habitations with diverse cultures and communities that utilize this diversity for the treatment of various ailments (Samant and Dhar 1997; Samant et al. 1998). The finding that 42% of species are native, 21% near-endemic and 2.6% endemic indicates the importance of conservation. These species are well adapted to the local environmental conditions and are likely to be resistant to pests and diseases. Therefore, they can play a vital role in tracing the evolution of the species in the region (Samant et al. 1998). As in the IHR as a whole, the topography, wide altitudinal range and macro- and micro-environmental conditions of Himachal Pradesh play important roles in speciation (Samant

et al. 1998). The diversity of the native, endemic and near-endemic species increases along an altitudinal gradient irrespective of the species richness. This indicates relatively less anthropogenic pressure on the higher altitude habitats. However, the case is reversed in the diversity of non-native medicinal plants. This may be due to high anthropogenic pressure on the natural habitats and invasion by non-native species at lower elevations.

Utilization of roots/rhizomes/tubers of 35% of species, the whole plant of 29%, seeds of 13%, fruits of 13%, bark of 11%, flowers of 8% and stem of 4% of species of the medicinal plants indicated a high degree of threat to these species. Medicinal species are used in the plant-based pharmaceutical industries in traditional systems of medicine and most are extracted from natural habitats. According to the All India Trade Survey of prioritized medicinal plants, demand for some high-value medicinal plants has increased 50%, whereas availability has declined by 26% (Anonymous 2001). The ever-increasing demand for these species in

the pharmaceutical industries has increased habitat degradation and levels of overexploitation from wild habitats. If the overexploitation of entire medicinal plants and their various parts continues, many species may decrease in, and ultimately disappear from, their natural habitats. This applies particularly to medicinal plants with multiple uses (Samant et al. 1998; Samant and Pal 2003). This study has also found that 65 species (10% of the total) were critically endangered, endangered, vulnerable, near threatened or data deficient. Many other species face high pressures, indicating a need for adequate planning for the *in-situ* conservation of all these species beyond the existing protected areas. While notifications of protected areas have helped to a great extent in *in-situ* conservation, the status of biodiversity including medicinal plants is known for only a few protected areas. Similarly, there are a number of reserve forests and unprotected biodiversity-rich areas in different altitudinal zones whose status is still unidentified. The inventory and monitoring of medicinal plants of these protected and unprotected areas would help in identification of the status of medicinal plants and prioritization of these areas for *in-situ* conservation.

Complementing existing *in-situ* conservation initiatives, there has been some development of *ex-situ* conservation within Himachal Pradesh. Central and state government organizations, NGOs and pharmaceutical industries have promoted some development of herbal gardens, medicinal plant nurseries and cultivation in farmers' fields. Recently, the State Medicinal Plant Board was established to promote the medicinal plants sector, to fund conservation of medicinal plants (Kala and Sajwan 2007).

In order to satisfy the increasing demand for medicinal plants, cultivation of commercially viable species will be essential. Unfortunately, in spite of efforts in agrotechnological innovation and progress in biotechnology, only a few Himalayan medicinal plants are under cultivation by a few farmers and NGOs – and at a small scale. These species include *Saussurea costus*, *Humulus lupulus*, *Artemisia maritima*, *Bunium persicum*, *Carum carvi*, *Podophyllum hexandrum*, *Inula racemosa*, *Angelica glauca*, *Acorus calamus*, *Heraclium candicans*, *Dioscorea deltoidea*, *Valeriana jatamansi*, *Picrorhiza kurrooa* and *Hedychium spicatum* (Samant et al. 2001). However, appropriate agrotechniques and post-harvest

technologies for most medicinal plant species are not available. Therefore, the development of agrotechniques for commercially viable medicinal plants and their large-scale cultivation in farmers' fields are necessary for their conservation and to reduce pressures on natural habitats. Further, the establishment and maintenance of nurseries and herbal gardens in different altitudinal zones with stocks of medicinal plants are required to ensure the availability of quality planting material and to introduce medicinal plants as cash crops.

Attempts have been made to develop propagation protocols for commercially viable medicinal plants using tissue culture. Organizations including the Institute of Himalayan Bioresource Technology (IHBT, Palampur), Dr. Y.S. Parmar University of Horticulture and Forestry (Solan), Choudhary Saran Kumar Himachal Pradesh Krishi Vishvavidyalaya (Palampur), and Himachal Pradesh University (Shimla) are actively engaged in developing *in-vitro* techniques for some commercially viable medicinal plants.

In summary, to ensure the long-term conservation of medicinal plants in Himachal Pradesh and the availability of the derived medicines to the millions who depend on them for their health, a range of actions are required. These include: 1) more effective *in-situ* conservation based on comprehensive knowledge of the distribution of species and levels of extraction; 2) identification of endangered and commercially-viable species; 3) documentation of indigenous uses and traditional practices, linked to analysis and identification of active ingredients for quality certification, which requires well-equipped laboratories that are currently not available; 4) development of agrotechniques and propagation protocols using nurseries and *in-vitro* methods; 5) capacity-building for farmers, including the organization of training programmes, exposure visits and awareness camps on various aspects of medicinal plants, to enhance their skills in cultivation, conservation and marketing; and 6) development of cooperatives of farmers growing medicinal plants in order to facilitate marketing and ensure the maximum benefits to local communities, which will require effective linkages between the farmers and pharmaceutical industries. All of these actions require increased attention by central and state governments, pharmaceutical industries, research organizations, NGOs, and farmers, all working together.

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Appendix I Diversity, distribution pattern and indigenous uses of the endemic, near-endemic and rare endangered medicinal plants in the Himachal Pradesh

Taxa	Altitudinal range (m)	Part/s used	Status	Nativity	Lifeform	Occurrence	Indigenous uses
Acanthaceae							
<i>Strobilanthes atropurpureus</i> Nees*	1300–3600	Infl, Oil		Reg Himal	H	1,2,3,4	Diarrhoea
Alliaceae							
<i>Allium humile</i> Kunth*	3200–3700	Bb		Reg Himal	H	2,3,4	Stomach ache & related problems
<i>A. stracheyi</i> Baker	3000–4200	Wp	VU	Reg Himal	H	4	Stomach ache & related problems
Apiaceae							
<i>Angelica glauca</i> Edgew.**	2000–3800	Rt	E (G)	Reg Himal	H	1,2,3,4	Dysentery, gastric complaints, menorrhoea, stomach complaints, vomiting
<i>Bunium persicum</i> (Boiss.) Fedtis.	3000–4000	Fr	VU	Persia	H	4	Liver complaints, gastric
<i>Bupleurum longicaule</i> var. <i>himalayense</i> (Kl.) Cl.*	3300–4500	Wp		Reg Himal	H	–	Colic, gastrointestinal diseases, renal complication
<i>B. lanceolatum</i> Wall. ex DC.*	2200–2800	Rt		Reg Himal	H	2,3,4	Snake bite
<i>B. thompsoni</i> Cl.*	1500–2500	Fr		Reg Himal	H		Stomach ache
<i>Cachrys pabularia</i> (Lindl.) Hermst. & Heyn.*	2000–3000	Wp		Reg Himal	H	–	Carminative, diarrhoea, diuretic, itching, stimulating, stomachic, veterinary galactagogue
<i>Cortia depressa</i> (Don) Norm.*	3300–4900	Wp		Reg Himal	H	1,2,3,4	Abdominal diseases, antiinflammatory, rheumatism, sedative, stomach ache
<i>Ferula joeschkeana</i> (L.) Vatke	2800–3800	Rt, Res	VU	Reg Himal Bor Occ Turkest	H	1,4	Rheumatism, toothache, wounds, poultices
<i>Heracleum nepalense</i> D. Don*	1800–3600	Rt		Reg Himal	H	1	Menstrual complications, leucoderma
<i>Heracleum lanatum</i> Michx.	2500–4500	Rt, Wp, Fr	VU	Reg Himal Amer Bor As Occ	H	1,2,3,4	Menstrual complications, leucoderma, piles
<i>Pleurosporum angelicoides</i> (DC.) Cl.	2500–4000	Rt	DD	Reg Himal	H	1,2,3,4	Anthelmintic, gastric, stomach ache
<i>P. candollii</i> (DC.) Cl.**	3500–4200	Fr		Reg Himal	H	1,2,3,4	Dyspepsia, renal pain, stomach ache
<i>P. densiflorus</i> Hk.f.**	3000–4000	Wp		Reg Himal	H	1,2,3,4	Incence, insecticidal, cough and cold
<i>Selinum tenuifolium</i> Wall.*	2500–4800	Rt		Reg Himal	H	1,2,3,4	Incence, insecticidal, nerve, sedative
Apocynaceae							
<i>Rauwolfia serpentina</i> Benth. ex Kurz	Up to 1000	Rt	CR	Ind Or Java	Sh	–	Anthelmintic, antidote, blood pressure, fever, stomach trouble
Araliaceae							
<i>Aralia cachemirica</i> Decne*	2500–4000	Rt		Reg Himal	H	1,2,3,4	Gastric complaints
Araceae							
<i>Zalacca beccarii</i> Hk.f.**	Up to 1000	St, Rt		Ind Or	T	–	Stomach disorder
Asclepiadaceae							
<i>Ceropegia bulbosa</i> Roxb.	Up to 1500	Tb	DD	Ind Or	H	–	For vitality
Asteraceae							
<i>Ainsliaea aptera</i> DC.*	1500–3500	Rt		Reg Himal	H	1,2,3	Stomach ache
<i>Artemisia roxburghiana</i> Bess. *	2400–5600	Lf		Reg Himal	H	1,2,4	Eczema, pimples, sores
<i>A. maritima</i> L.	2600–4500	Wp	NT	Europe Reg Caucas Sibir	H	1,2,4	Anthelmintic, cuts, gastric complaints, blood purifier
<i>Aster tibeticus</i> Hk.f.*	3000–4000	Rt		Tibet Occ	H	4	Malaria
<i>Carduus edelbergii</i> Reich.f. *	2700–4000	Wp		Reg Himal	H	1,2,3,4	Blood purifier, diuretic, tonic
<i>Erigeron bellidioides</i> (Don) Benth.*	1400–4300	Wp		Reg Himal	H	3,4	Blood purifier
<i>Inula racemosa</i> Hk.f.**	2500–3700	Rt, Infl		Reg Himal	H	–	Gastrointestinal, rheumatism, incense

Taxa	Altitudinal range (m)	Part/s used	Status	Nativity	Lifeform	Occurrence	Indigenous uses
<i>I. royleana</i> Cl.*	2100–4000	Wp		Reg Himal	H	–	Dermatitis, stimulant, high blood pressure
<i>Jurimella macrocephala</i> (Royle) Aswal et Goel*	3200–4300	Rt	E	Reg Himal	H	2,3,4	Antiseptic, colic, fever, laxative
<i>Ligularia jacquemontiana</i> (Decne) Rau*	3200–4000	Rt		Reg Himal	H	–	Unripe boils
<i>Saussurea auriculata</i> (DC.) Sch.-Bip.*	3000–3800	Lf		Reg Himal	H	–	Renal diseases
<i>S. bracteata</i> Decne.**	3800–4800	Wp		Reg Himal	H	–	Cold, cough, fever
<i>S. cratocarpa</i> Decne*	3500–5000	Wp		Reg Himal	H	–	Colic, headache, lumbar pain, renal pain
<i>S. graminifolia</i> Wall.*	3500–5000	Wp		Reg Himal	H	4	Headache, fever
<i>S. gossypiphora</i> D. Don	3800–5600	Wp	CR	Reg Himal	H	1,4	Burns, cuts
<i>S. heteromalla</i> (D. Don) Hand.-Maz.*	3000–4000	Sd		Reg Himal	H	2,3	Carminative, horse bite
<i>S. obtallata</i> (DC.) Sch. – Bip.	3600–4500	Wp, Rt	CR	Reg Himal	H	1,4	Burns, cuts
<i>S. simpsoniana</i> (Field & Gard.) Lipsch.*	3800–5600	Inf		Reg Himal	H	1,2	Fever, snakebite
<i>Tanacetum dolichophyllum</i> Kitam.*	3000–4400	Wp		Reg Himal	H	1,2,3,4	Fever, headache, body ache
<i>T. gracile</i> Hk.f. & Th.*	2800–3600	Wp		Reg Himal	H	1,3,4	Febrifuge
<i>T. tenuifolium</i> Jacq.*	3400–4200	Wp		Reg Himal	H	–	Angina, body ache, headache, renal colic
<i>T. tomentosum</i> DC.*	3500–4500	Wp		Reg Himal	H	–	Colic, diarrhoea, earache
Balanophoraceae							
<i>Balanophora involucreta</i> Hk.f.	2100–3500	Wp	DD	Reg Himal	H	1	Cough, cold
Begoniaceae							
<i>Begonia picta</i> Sm.*	600–2800	Lf		Reg Himal	H	–	Bristles on tongue, ulcer on mouth
Berberidaceae							
<i>Berberis aristata</i> DC.*	1500–3000	Rt, Bk		Reg Himal	Sh	1,2	Bite of rat, snakes, boils, eye complaints
<i>B. jaeschkeana</i> Sch.*	3000–3500	Rt		Reg Himal	Sh	1,2,3,4	Astringent, blood purifier, diuretic, eye disease, jaundice, menorrhoea, skin disease
<i>B. kashmiriana</i> Ahrendt.**	2000–3300	Rt		Reg Himal	Sh	–	Fever
<i>B. lycium</i> Royle*	1600–3000	Rt, St, Bk, Fr		Reg Himal	Sh	1,2,3,4	Fever, eye complaints
<i>B. pseudumbellata</i> Parker**	2000–2800	Rt, Lf		Reg Himal	Sh	1,4	Intestinal disorder
<i>B. petiolaris</i> Wall. ex G. Don**	1800–2700	Rt		Reg Himal	Sh	–	Eye & skin complaints
Betulaceae							
<i>Abnus nitida</i> (Spach.) Endl.*	1000–2700	Bk		Reg Himal	T	1,2,3	Antipoisous
<i>Betula utilis</i> D. Don	3000–4500	Bk, Res,	E	Reg Himal Japon	T	1,2,3,4	Antiseptic, fever, cuts, ear complaints, hysteria, jaundice, wounds
Boraginaceae							
<i>Arnebia benthamii</i> (Don) John.*	3000–4500	Rt	CR (G)	Reg Himal	H	1,2,4	Antiseptic, boils, cuts, wounds, hair tonic, fungal hair infection
<i>Arnebia euchroma</i> (Wall. ex G. Don) John.	3000–4800	Rt, Wp	CR	Reg Himal Turke	H	1,4	Antiseptic, boils, cuts, wounds, hair tonic, fungal hair infection
<i>Eritrichium canum</i> (Benth.) Kitam.*	3500–4600	Wp		Reg Himal	H	1,2,3	Facilitates children birth
<i>Lindolefia longifolia</i> (Benth.) Baill.*	3200–4600	Lf		Reg Himal	H	1,2,3,4	Diarrhoea
<i>Microula tibetica</i> Benth.*	5600	Wp		Reg Himal	H	–	Cough, pulmonary disorder
Buxaceae							
<i>Buxus wallichiana</i> Baillon*	1800–2700	Lf, Bk, Wd		Reg Himal	T	1	Combs, purgative, diaphoretic, rheumatic, syphilis

Taxa	Altitudinal range (m)	Part/s used	Status	Nativity	Lifeform	Occurrence	Indigenous uses
Campanulaceae							
<i>Codonopsis affinis</i> Hk.f. & Th.**	2500–3500	Rt		Reg Himal	H	4	Rheumatism, swollen joints, bruises
<i>C. ovata</i> Benth.*	3000–4200	Rt		Reg Himal	H	1,2,3,4	Swollen joints, bruises
Caprifoliaceae							
<i>Lonicera angustifolia</i> Wall. ex DC.*	2700–3600	Fr		Reg Himal	Sh	1,2,3	Gastric troubles
<i>Viburnum cotinifolium</i> D. Don*	1800–3600	Bk		Reg Himal	Sh	1,2,3,4	Menorrhoea
Caryophyllaceae							
<i>Cerastium cerastoides</i> (L.) Britl.*	1500–4700	Wp		Reg Himal	H	–	Backache, body ache, headache, renal pain, cough
Celastraceae							
<i>Euonymus pendulus</i> Wall.*	1800–2600	Ap		Reg Himal	T	–	Eye complaints, constipation
Corylaceae							
<i>Corylus jacquemontii</i> Dcne.*	2400–2800	Nut		Reg Himal	T	1,2,3,4	Tonic
Crassulaceae							
<i>Rhodiola heterodonta</i> (Hk.f. & Th.) Boiss.	3000–5000	Rt	VU (G)	Reg Himal	H	1,2,3,4	Sexual potency, stomach ache, intestinal discomfort
Cupressaceae							
<i>Juniperus polycarpus</i> C.Koch	3000–3600	Lf,	E	Reg Himal	T	4	For animals, the oil is used for wound healing, repel flies, nervous disorder
Cyperaceae							
<i>Carex obscura</i> Nees*	3000–4500	Wp		Reg Himal	H	–	Antiviral
Daisiaceae							
<i>Daisica annabina</i> L.	1000–2500	Lf, Rt	E	Oriens Reg Himal	H	4	Diuretic, febrifuge, purgative, rheumatism, sedative
Dioscoreaceae							
<i>Dioscorea deltoidea</i> Wall. ex Royle	2000–3500	Tb	E (G)	Ind Or	H	1,2,3,4	Fever, gout, digestive problems
Elaeagnaceae							
<i>Hippophae rhamnoides</i> L.	2600–3500	Sd, Fr	VU	Europe As Trop	Sh	4	Aphrodisiac, lung disease
<i>H. salicifolia</i> D. Don	2600–3500	Bk, Fr	NT	Nepal	T	1,3,4	Cuts, ulcers, wounds
Ephedraceae							
<i>Ephedra saxatilis</i> Stapf.**	2300–5200	Lf, Rt, St		Reg Himal	Sh	–	Asthma
<i>Ephedra Gerardiana</i> Wall. ex Stapf.	2800–4000	Lf, Rt, St	E	Europe As Bor	H	4	Asthma, blood purifier, headache, hepatitis, rheumatism
Ericaceae							
<i>Rhododendron anthopogon</i> Don*	3000–5200	Lf	VU	Reg Himal As Bor	Sh	1,2,3,4	Bronchitis, cold, cough
<i>R. anthopogon</i> Wall. subsp. <i>hypananthum</i> (Balf.f.) Cullen**	3300–5000	Lf		Reg Himal	Sh	1	Bronchitis, cold, cough
<i>R. campanulatum</i> Don*	3000–4000	Rt, Lf, Fl	VU	Reg Himal	Sh	1,2,3,4	Boils, cold, cough, headache, rheumatism, sciatica, skin disease, syphilis, tonic, fever
<i>R. lepidotum</i> Wall. ex D. Don	2400–4500	Rt, Lf, Fl	VU	Reg Himal	Sh	1,2,3,4	Boils, cold, cough, headache, rheumatism, sciatica, skin disease, syphilis, tonic, fever
Euphorbiaceae							
<i>Euphorbia fustiformis</i> Don*	Up to 600	Rt		Ind Or	H	–	Fever, gout, rheumatism
<i>E. royleana</i> Boiss.*	1000–1500	Lt		Reg Himal	Sh	1	Bleeding, burns, cuts, ear complications, skin diseases, wounds
<i>E. thomsoniana</i> Boiss.*	3000–4000	WP		Reg Himal	H	–	Purgative, skin diseases, eruptions
<i>E. tibetica</i> Boiss.*	3200–4500	Lt, Rt		Reg Himal	H	–	Nausea

Taxa	Altitudinal range (m)	Part/s used	Status	Nativity	Lifeform	Occurrence	Indigenous uses
Fabaceae							
<i>Astragalus candolleanus</i> Royle ex Benth.*	3400–4500	Rt		Persia	H	–	Blood purifier, cough, skin disease
<i>Indigofera pulchella</i> Roxb.*	800–1500	Lf, Rt		Reg Himal	Sh	–	Cough, epilepsy, menorrhagia, swelling face in labor
<i>Oxytropis mollis</i> Royle ex Benth.*	2500–3000	Wp		Reg Himal	H	4	Wounds
<i>Pueraria tuberosa</i> (Willd.) DC.*	300–1500	Rt		Reg Himal	Sh	–	Abdominal pain, antiemetic, asthma, body ache, chest pain, cholera, diarrhoea, fever, lactation, menorrhoea, rheumatism, skin disease, swelling, syphilis, tonic, ulcers, veterinary lactation
Fumariaceae							
<i>Corydalis flabellata</i> Edgew.*	3000–4400	Wp		Reg Himal	H	4	Fever
Gentianaceae							
<i>Gentiana carinata</i> (D. Don) Grises.*	1500–3500	Wp		Reg Himal	H	1,2,3,4	Fever, headache
<i>Gentiana kurroo</i> Royle	1800–4200	Rt	CR (C)	Reg Himal	H	1,4	Appetite, gastric secretion, stomachic, fever, urinary complaints
<i>Gentianella moncroffiana</i> (Wall. ex Griseb.) Airy Shaw*	2900–5200	Wp		Reg Himal	H	1,2,3,4	Blood purifier, cold, cough, fever, headache
<i>G. tenella</i> (Rottb.) Borne*	3000–5000	Wp		Reg Himal	H	2,3,4	Fever
<i>Gentianopsis detonsa</i> (Rottb.)*	3200–4200	F1		Reg Himal	H	–	Cough, fever, headache, nausea
<i>Jaeschkea oligosperma</i> (Griseb.) Knobl.*	2700–4300	Wp		Reg Himal	H	2,3,4	Blood purifier, fever
<i>Saevitia chirayita</i> (Roxb. ex Flem.) Karstem*	1500–2600	Wp	CR	Reg Himal	H	2	Antiemetic to pregnant women, asthma, bilious, blood purifier, bronchitis, fever, inflammation, leprosy, scabies, skin diseases, stomach ache, thirst, tonic
<i>S. petiolata</i> Don*	3800–5600	Wp		Reg Himal	H	1,2	Body ache, headache, gall disorder
<i>S. thomsonii</i> Cl. ex Hk.f. & Th.*	3000–3800	Wp		Reg Himal	H	–	Fever, headache
Geraniaceae							
<i>Geranium himalayense</i> Klot.*	2500–4200	Rt		Reg Himal	H	3,4	Bruises, stomach ache
<i>G. wallichianum</i> Don ex Sw.*	2100–4200	Rt		Ind Or China	H	1,2,3,4	Astringent, ear & eye disease, toothache
Gesneriaceae							
<i>Didymocarpus pedicellata</i> R.Br.	800–1700	Lf	VU	Reg Himal	H	–	Kidney & bladder stones
Hippocastanaceae							
<i>Aesculus indica</i> Leb. ex Camb.*	1500–2500	Bk, Fr, Rt, Sd		Reg Himal	T	1,2,3	Anthelmintic, dislocated joints, diuretic, leucorrhoea, skin fissures, cracks, veterinary medicine, wounds
Hypericaceae							
<i>Hypericum perforatum</i> L.	1000–2500	Lf, Oil	VU	Reg Himal	H	1,2,4	Antidepressant, cancer, tumors, antiviral, lung ailments
Iridaceae							
<i>Iris nepalensis</i> Don*	1800–4000	Bb		Reg Himal	H	–	Rheumatic pain
<i>I. kashmiriana</i> Baker**	2800–4200	Bb		Reg Himal	H	1,3,4	Rheumatism
Juglandaceae							
<i>Juglans regia</i> L.*	1000–3000	Bk, Lf, Fr		As Occ Reg Himal	H	1,2,3,4	Anthelmintic, astringent, frost bite, rheumatism, sores of toes, toothache

Taxa	Altitudinal range (m)	Part/s used	Status	Nativity	Lifeform	Occurrence	Indigenous uses
Lamiaceae							
<i>Ajuga parviflora</i> Benth.*	600–1500	Wp	VU (G)	Reg Himal	H	1,3	Ascariasis, febrifuge
<i>Eremosyachys superba</i> Royle ex Benth.	Up to 1000	Lf	VU	Reg Himal	H	–	Enhanced lactation
<i>Hyssopus officinalis</i> L.	2800–4200	Lf, Fl	VU	Ind Or	H	4	Stimulant, carminative, nervous disorders, urinary trouble
<i>Nepeta ciliaris</i> Benth.*	2300–3600	Wp		Reg Himal	H	4	Eye disorders, fever
<i>N. erostachya</i> Benth.*	2300–4000	Wp		Reg Himal	H	3,4	Eye complications
<i>N. glutinosa</i> Benth.*	3300–4400	Wp		Reg Himal	H	–	Pneumonia, fever
<i>N. royleana</i> Stew.*	2400–3600	Wp		Reg Himal	H	–	Cerebral tonic, in madness
<i>Roylea cinerea</i> (Don) Baill.*	1200–3700	Lf, Rt	VU (G)	Reg Himal	Sh	–	Blood purifier, fever, pimples, snuff in tonsil
<i>Salvia bisor</i> Wall.*	2200–3200	Sd		Reg Himal	H	–	Astringent, anthelmintic
<i>S. macrophylla</i> Wall. ex Benth.*	1500–2700	Sd		Reg Himal	H	1,2,3	Emetic, hemorrhoids, colic, dysentery
<i>S. lanata</i> Roxb.*	1000–1600	Rt, Sd		Reg Himal	H	1,2,3	Adulterant, colic, diarrhoea, cold, cough
Lauraceae							
<i>Cinnamomum tamala</i> Nees*	400–2000	Br, Lf	VU	Reg Himal	T	–	Heart & throat complaints
<i>Litsea glutinosa</i> (Lour.) Robins.	300–1500	St, Bk, Wp, Lf	VU	Reg Himal	T	–	Boils, bone fracture, cold, cough
Liliaceae							
<i>Colchicum luteum</i> Baker*	1000–2700	Rt	VU (G)	Reg Himal	H	–	Carminative, laxative, aphrodisiac, allergy, appetizer, gout, rheumatism, spleen inflammation
<i>Eremurus himalaicus</i> Baker	2100–3800	Bb	LC	Reg Himal	H	4	Wounds, stomach disorder
<i>Fritillaria roylei</i> Hk.*	3000–4600	Bb/Rt	E (G)	Reg Himal	H	1,2	Asthma, bronchitis, burns, stomach disease, tonic
<i>Gloriosa superba</i> L.	600–1500	Rt, Rh, Lf	VU	As Trop	H	–	Abortifacient, anthelmintic, snake bite, fever, gout, scabies, leprosy
<i>Lilium polyphyllum</i> Don	2100–3300	Bb/Rt	GR	Reg Himal	H	2,4	Tonic, aphrodisiac, refrigerant
<i>Paris polyphylla</i> Sm.	1800–3000	Rh	E	Reg Himal	H	1	Diarrhoea, fever
<i>Polygonatum cirrhifolium</i> (Wall.) Royle	2000–2800	Tb, Tender	E	Reg Himal	H	1,2,3,4	Fever, blood purifier, cuts, wounds
<i>P. multiflorum</i> (L.) All.	2000–3000	Tb	VU	Reg Himal	H	1,2,3,4	Appetite, nerve tonic, aphrodisiac.
<i>P. verticillatum</i> (L.) All.	2000–35000	Tb	VU	Reg Himal	H	1,2,3,4	Appetite, nerve tonic, urinary problems
Malvaceae							
<i>Lavatera kashmiriana</i> Camb.**	1800–3600	Rt		Reg Himal	H	1	Urinary irritation, throat problems, mild laxative
Morinaceae							
<i>Morina coulteriana</i> Royle*	3000–3600	Rt	VU	Reg Himal	H	1,4	Abscesses
<i>M. longifolia</i> Wall. ex DC.*	3200–3800	Rt		Reg Himal	H	1,2,3	Boils, wounds, burns
Myrsinaceae							
<i>Embelia tsjeriam-cottam</i> A.DC.	Up to 1400	Fr, Bk, Rt, Lf, Sd	VU	Ind Or	Sh	–	Blood purification, bronchitis, cholera, fever, itch, pneumonia, pregnancy problems, sores, throat complaints, ulcers
Oleaceae							
<i>Fraxinus xanthoxyloides</i> (G. Don) DC.*	2000–3000	Ap	VU	Reg Himal	T	4	Abdominal disorder in animals
Orchidaceae							
<i>Dactylophiza hatagirea</i> (Don) Soo*	2800–4000	Tb	GR	Reg Himal	H	1,2,3,4	Astringent, bone fracture, expectorant, tonic, wounds
<i>Malaxis muscifera</i> (Lindl.) Ktze.	2800–4400	Tb	GR	Reg Himal	H	–	Tonic for kidney
<i>Habenaria intermedia</i> D. Don*	2000–3000	Tb	E (G)	Reg Himal	H	2,3	Tonic

Taxa	Altitudinal range (m)	Part/s used	Status	Nativity	Lifeform	Occurrence	Indigenous uses
Papaveraceae							
<i>Mecopopsis aculeata</i> Royle*	3200–3800	Wp	E (G)	Reg Himal	H	1,2,3,4	Backache, colic, renal pain, tonic
Parnassiaceae							
<i>Parnassia pusilla</i> Hk.f.*	2200–4400	Rt		Reg Himal	H	–	Washing burns & other wounds
Pittosporaceae							
<i>Pittosporum eriocarpum</i> Royle**	600–1400	Br, Rt		Reg Himal	T	–	Bronchitis, expectorant, febrifuge, rheumatism
Pinaceae							
<i>Cedrus deodara</i> (Roxb.) Loud.*	1500–2500	Res, St		Reg Himal	T	1,2,3,4	Anthelmintic, rheumatism, ulcers
<i>Pinus roxburghii</i> Sarg.*	1100–2100	Res		Reg Himal	T	1	Boils, bone fracture, cracks in sole of feet, leprosy, skin diseases, snakebite, sprains, swelling, ulcers, urine complaints
<i>P. gerardiana</i> Wall. ex Lam.*	1800–3000	Sd, Res		Reg Himal	T	–	Carminative, stimulant, expectorant
<i>P. wallichiana</i> Jacks.*	1800–3600	Res, Bk		Reg Himal	T	1,2,3,4	Abscess, dislocation of joints, ulcers, unconsciousness
<i>Abies spectabilis</i> (D. Don) Mirb.*	2400–4400	Res, Bk		Reg Himal	T	1	Carminative
<i>A. pindrow</i> Spach.*	2100–2500	Res, Bk		Reg Himal	T	1,2,3,4	Rheumatism, ulcers
Plantaginaceae							
<i>Plantago himalaica</i> Pilg.*	1500–3000	Wp		Reg Himal	H	1,2,3,4	Diarrhoea, dysentery
Podophyllaceae							
<i>Podophyllum hexandrum</i> Wall. ex Royle	2300–4000	Rh, Fr, Sd	E	Reg Himal	H	1,2,3,4	Cancer, cough, cuts, wounds, fever, ulcer, tumor
Polygonaceae							
<i>Polygonum affine</i> Don*	1600–4800	Rt		Reg Himal	H	1,2,3,4	Cold, diarrhoea
<i>P. recurvum</i> Royle ex Bab.*	1800–2700	Wp		Reg Himal	H	1,2,3,4	Abscess, blood purification, boil, skin disease
<i>P. rumicifolium</i> Royle ex Bab.*	3200–4400	Lf, Fl, Rt		Reg Himal	Sh	1,2,4	Abscess, antidote to aconite poison, diarrhoea, giddiness, headache, thirst
<i>P. steuartianum</i> Diels.*	3500–4300	Wp		Reg Himal	H	–	Tonic
<i>Rheum australe</i> Don*	3000–4200	Rt	E (G)	Reg Himal	H	1,2,3,4	Abdominal pain, appetite, asthma, bronchitis, fever, cuts, dysentery, laxative, eye disease, piles, skin disease, sprain, swelling ulcers, wounds
<i>R. macrostachyum</i> Royle*	3500–4800	Rt	E	Reg Himal	H	1,2,4	Cuts, wounds, appetite
<i>R. webbianum</i> Royle*	2400–4200	Lf, Rt	VU (G)	Reg Himal	H	1,2,3,4	Abdominal disease, appetite, boils, astringent, purgative, wounds
<i>R. spiciforme</i> Royle*	3600–4800	Rt	VU	Reg Himal	H	1,2,3,4	Wounds, boils, cuts, abdominal diseases
Ranunculaceae							
<i>Aconitum chasmanthum</i> Stapf. ex Holms*	3000–4200	Rt	(G)	Reg Himal	H	1	Rheumatism
<i>Aconitum denonathizum</i> Stapf.	2800–4500	Rt	E	Reg Himal	H	–	Poison, sedative
<i>A. falconeri</i> Stapf. var. <i>latilobum</i> **	Above 3000	Rt		Reg Himal	H	1	Diarrhoea, fever, rheumatism
<i>A. ferox</i> Wall.**	2100–3800	Rt		Reg Himal	H	4	Stimulant, cardiac tonic, febrifuge
<i>A. laeve</i> Royle**	2000–3500	Rt		Reg Himal	H	4	Anthelmintic, cough, diarrhoea, digestive complaints, dysentery, fever, gastric, stomach ache, vomiting
<i>A. heterophyllum</i> Wall.*	3000–3700	Rt	CR (G)	Reg Himal	H	1,2,3,4	Anthelmintic, cough, diarrhoea, digestive complaints, dysentery, fever, gastric, stomach ache, vomiting

Taxa	Altitudinal range (m)	Part/s used	Status	Nativity	Lifeform	Occurrence	Indigenous uses
<i>A. violaceum</i> Jacq.*	3500–4000	Rt	VU	Reg Himal	H	1,2,3,4	Gastrointestinal complaints, renal pain, rheumatism, stomach ache
<i>A. spicatum</i> (Bruhl) Stapf.*	3400–4500	Rt		Reg Himal	H	–	Antipyretic, analgesic
<i>Adonis chrysoyathus</i> Hk.f. & Th.*	2700–4600	Wp		Reg Himal	H	–	Poison
<i>Clematis graveolens</i> Lindl.*	900–3000	Wp		Reg Himal	Sh	1,2	Skin ailments, antiseptic
<i>Delphinium cashmerianum</i> Royle**	2700–4800	Wp		Reg Himal	H	1,3,4	Abdominal pain, cuts, dropsy, dyspepsia, headache, renal pain, stomach ache, swelling, wounds
<i>D. denudatum</i> Royle*	1500–2500	Rt		Reg Himal	H	1,2,4	Abdominal pain, antihelminthic, respiratory complaint, toothache, ulcer, lice, ticks
<i>D. vestitum</i> Wall. ex Royle*	2700–4700	Wp		Reg Himal	H	–	Snakebite, cuts, wounds, fever, diarrhoea
<i>D. viscosum</i> Hk. & Th.*	3000–5200	Rt		Reg Himal	H	–	Oedema, rheumatism
<i>Thalictrum minus</i> L. var. <i>majus</i> (Jacq.) Hk. f. et Th.*	2000–4000	Wp		Europe As et Afr Bor	H	4	Eye disorders, fever
Rhamnaceae							
<i>Rhamnus triquetra</i> (Wall.) Brandis*	1500–2100	Fr, Br		Reg Himal	T	1,2,3	Blood purifier, boils, scabies, skin disease, veterinary tonic
<i>R. purpureus</i> Edgew.*	1500–3000	Fr, Rt		Reg Himal	Sh	1,2,3	Purgative
Rosaceae							
<i>Cotoneaster marginatus</i> Sch.*	2000–2500	Ap		Reg Himal	Sh	–	Cuts, wounds
<i>C. bacillaris</i> Wall. ex Lindl.*	1700–3200	Lf		Reg Himal	Sh	1,2,3,4	Scabies, rheumatism, arthritis
<i>C. nannularia</i> Fisch. & Meyer*	600–3600	Fr, Bk, Lf		Reg Himal	Sh	–	Cuts, wounds
<i>Geum elatum</i> Wall. ex G. Don*	3400–4200	Wp		Reg Himal	H	1,2,3,4	Astringent, dysentery, diarrhoea
<i>Potentilla fulgens</i> Wall. ex Hk.f.*	1600–4800	Rt		Reg Himal	H	1	Gum, tooth complaints, tonic
<i>P. nepalensis</i> Hk.*	2000–2700	Rt		Reg Himal	H	1	Cuts, burns, wounds
<i>Rosa webbiana</i> Wall. ex Royle*	2300–3800	Fl		Reg Himal	Sh	1,4	Hepatitis, jaundice, stomach ache
Rubiaceae							
<i>Randia tetrasperma</i> Lamk.*	1000–2000	Fr, Bk, Rt		Reg Himal	Sh	–	Wash hair and clothes
Rutaceae							
<i>Dictamnus albus</i> L.	1800–3300	Rt	LC	Europe As Bor	H	–	Skin diseases, arthritis, jaundice, scorbutic, scabies, eczema
<i>Skimmia laureola</i> (DC.) Zucc.*	2400–3200	Lf		Reg Himal	Sh	1,2,3	Antiseptic, boils, gastric pains, rheumatism, scabies, smallpox
<i>Zanthoxylum armatum</i> DC.	800–2000	Sd, Fr, Rt, St, Bk	E	Reg Himal China	Sh	1,3	Antihelminthic, carminative, cough, cholera, fever, eczema, itch, smallpox, snakebite, stomach disorder, tonic, tooth complaints
Saurauaceae							
<i>Saurauia nepaulensis</i> DC.*	600–2000	Br		Reg Himal	T	–	Poultice to extract splinters
Saxifragaceae							
<i>Bergenia ligulata</i> Engl.*	1600–3200	Rt		Reg Himal	H	1,2,3,4	Asthma, boils, cuts, wounds, burns, fever, liver complaints, ophthalmia, piles, thirst, kidney stones, urine complaints; diarrhoea of cattle
<i>B. stracheyi</i> (Hk.f. & Th.) Engler*	3600–4200	Rt	VU	Reg Himal	H	1,2,3,4	Antiascorbic, astringent, diuretic, fever, ophthalmia, tonic, cuts, wounds
Scrophulariaceae							
<i>Lagotis cashmiriana</i> (Royle) Rupr.**	3300–4500	Wp		Reg Himal	H	1,2,4	Adulterant, fever, dyspepsia

Taxa	Altitudinal range (m)	Part/s used	Status	Nativity	Lifeform	Occurrence	Indigenous uses
<i>Picrothiza kurrooa</i> Benth.	3000–4500	Rh, Rt	E	Reg Himal	H	1,2,3,4	Abdominal pain, anaemia, asthma, cholera, cold, diarrhoea, dysentery, fever, jaundice, stomach disorder
<i>Pedicularis pectinata</i> Wall. ex Benth.*	3200–3800	Wp		Reg Himal	H	1,2,3,4	Body ache, sedative
Solanaceae							
<i>Atropa acuminata</i> Royle	2400–3600	Lf, Rt	CR	Europe Or Ind Or	H	1	Antidote, sedative, narcotic, anodyne
<i>Hyoscyamus niger</i> L.	2100–3300	Sd, Lf, Fl, Wp	E	Europe As Occ Reg Himal	H	4	Astringent, hysteria, muscular pain, sedative, toothache, whooping cough
<i>Physochlita praealtia</i> (Decne) Miers.*	3500–4600	Wp, Sd, Lf	VU	Reg Himal	H	4	Epilepsy, liver complaints, boils, ulcers
Symplocaceae							
<i>Symplocos chinensis</i> (Lour.) Decne	1000–2800	Bk, Lf	LC	Japan	T	1,2	Astringent, diarrhoea
Taxaceae							
<i>Taxus baccata</i> L. subsp. wallichiana (Zucc.) Pilger	2000–3000	Lf, Fr, Bk	E	Reg Bor Temp	T	1,2,3,4	Cancer, aromatic, tumor
Thymelaeaceae							
<i>Daphne papyracea</i> Wall.*	1400–2300	Rt		Reg Himal	Sh	1,2	Intestinal complaints
Trilliaceae							
<i>Trillidium govanianum</i> Wall.*	2800–3600	Tb		Reg Himal	H	1,2,3	Dysentery
Ulmaceae							
<i>Ulmus wallichiana</i> Planch.*	2000–3000	Bk		Reg Himal	T	1	Bone fracture, dislocation of joints
Valerianaceae							
<i>Valeriana jatamansi</i> Jones	2000–3500	Rt	VU	Reg Himal	H	1,2,3,4	Hysteria, urine complaints, hair oil tonic
<i>Nardostachys grandiflora</i> DC.	3000–4000	Rt	E	Reg Himal Malaya	H	1	Blood purifier, cooling, cough, diarrhoea, tonic, ulcer, snakebite
Zingiberaceae							
<i>Hedychium spicatum</i> Ham. ex Sm.*	1000–2000	Rh		Reg Himal	H	1,2,3	Asthma, blood purifier, bronchitis, nausea
<i>Roscoeia alpina</i> Royle*	200–3500	Rt		Reg Himal	H	1,2,3,4	Wounds, cuts of cattle, tonic
<i>R. purpurea</i> Sm.*	1500–3000	Rt		Reg Himal Burma	H	2,3,4	Wounds, cuts of cattle, tonic

Abbreviations: H = Herb; Sh = Shrub; T = Tree; Rt = Root; Rh = Rhizome; Tb = Tuber; Bb = Bulb; Bk = Bark; Wp = Whole plant; Lf = Leaf; Fr = Fruit; Fl = Flower; Res = Resin; Ap = Aerial part; Sd = Seed; St = Stem; Infl = Inflorescence; Lt = Latex; Wd = Wood; Reg Himal = Himalayan region; Ind Or = Indian Oriental; Bor = Boreal; Occ = Occidental; As = Asia; Amer = America; Trop = Tropical; Afr = Africa; Temp = Temperate; * = Endemic; ** = Near endemic; CR = Critically endangered; EN = Endangered; VU = Vulnerable; NT = Near threatened; DD = Data deficient; LC = Least concern; G = Global; 1 = Great Himalayan National Park; 2 = Manali Wildlife Sanctuary; 3 = Kais Wildlife Sanctuary; 4 = Cold Desert Biosphere Reserve