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Review

Conservation status of the critically endangered and endangered species in the Nandiar Khuwar catchment District Battagram, Pakistan

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This paper communicates the vascular plant diversity and problems associated with the conservation of flora of Nandiar Khuwar, District Battagram-Pakistan. Floristically, the area is placed in the Western Himalayan Province. It is located on the western edge of Himalaya, dominated by Sino-Japanese vegetation. A total of 37 taxa were reported which includes 14 critically endangered and 23 endangered species. The information was collected from 270 people including 220 male and 50 female. Major threats to the flora are loss of habitat, unplanned collection, deforestation, over grazing, erosion, attack of pathogens and effect of introduced taxa. Measures for the conservation of plant resources of Nandiar Khuwar catchment are suggested.

Key words: Pakistan, Nandiar Khuwar, Battagram, conservation.

INTRODUCTION

Biological diversity refers to organisms found within the living world and consists of species diversity, ecosystem diversity and genetic diversity (Ahmad, 2003). The planet earth is the homeland of more than 270,000 vascular plant species (Walter and Gillet, 1998) which are surviving in various ecosystems. Due to the tremendous increase in human population, urbanization, habitat fragmentation, and over exploitation of natural resources, the natural flora in certain areas is rapidly disappearing (Alam and Ali, 2009). Biodiversity loss is one of the world's most pressing crises. It has been estimated that the current species extinction rate is between 1,000 and 10,000 times higher than it would naturally be (IUCN, 2008). More than 6,000 species of vascular plant species have been reported from Pakistan (Ahmad, 2003).

The studies on the conservation status of plant species are limited and data in this respect are variable. Nasir (1991) reported more than 580 flowering plants as "threatened". Chaudhri and Qureshi (1991) declared 709 plants as threatened and endangered in Pakistan. Walter and Gillet (1998) listed only 14 flowering plants as threatened. Adopting IUCN (1994) criteria 20 species were identified as target species in Pakistan (Shah and Baig, 1999). In the Red list of IUCN (2008) 19 flowering plants were listed as threatened in Pakistan. According to Ali and Qaiser (2010), 21 flowering plants are threatened in Pakistan. In order to determine the conservation status of a taxon, it is necessary to determine the fluctuation in its population size, the area that it occupies and to maintain long lasting observation. Such studies have never been done in Pakistan (Alam and Ali, 2009).

Endemic and rare taxa of an area are most vulnerable because they occupy small geographic ranges and specific habitats. Endemic and rare species, particularly species with a narrow area of distribution in Pakistan deserve immediate attention. Nandiar Khuwar is a very important mountain territory with respect to plant diversity (Haq et al., 2010). Haq et al. (2010), worked on species diversity of vascular plants and reported 380 species from tropical sub humid forests to alpine pastures. Part of his results obtained during the survey were presented in an international conference (Ahmad et al., 2010).

The objectives of the study were to: explore species diversity of vascular plants; document plant uses, rate of consumption and availability profile of vascular plants; collect information regarding conservation status of vascular plants; and recommend ways for sustainable utilization of the local resources.

The study area

The Nandiar Khuwar occupies 3,4521 ha in the northeast part of Khyber Pukhtoonkhwa (North-West Frontier Province) of Pakistan between 34˚ 33́ and 34˚ 47́ N latitudes and 72˚ 55́ and 73˚ 14́ E longitudes. It is bounded by Allai valley in the north, by Siran valley in the east, by the Konsh and Agror valleys in the south and by the Black mountain and river Indus in the west. It comprises of four categories of land, that is agricultural land, wasteland, forest and alpine vegetation. Total population of Nandiar Khuwar catchment is 225,782 (Anonymous, 1998). The Nandiar Khuwar is mostly mountainous ranging in altitude from 525 masl at Thakot to 3,817masl at Malkisar. The area is rough having gentle to precipitous slopes. The climate varies from sub-tropical at the base of the hills to alpine at the higher reaches (Mohammad, 2003).

The catchments area of Nandiar Khuwar, a tributary of river Indus, occupies sub valleys like Nandiar, Hill, Deshan, Tikri and Thakot. All the small streams coming from sub valleys join the main Nandiar Khuwar, which runs from northeast of Hillian and flows across the Hill and Battagram arty to join River Indus at Thakot. The nullahs, which feed the main stream, are Nilban, Hill, Shahkhel, Doba, Largram, Nilishang and Tikri Khuwars (Anonymous, 1998; Muhammad, 2003).

Ecological survey

Field trips to various parts of Nandiar Khuwar and its catchment area were undertaken between 1st May 2008 and 31st August 2009 to collect plant specimens. The information about critically endangered and endangered species was collected from 270 people including 220 male and 50 female of different ages belonging to different localities by using semistructured questionnaires and oral interviews. The segments of Nandiar Khuwar visited repeatedly included Rajmera, Mirani, Chail, Ganja, Serai, Donga, Shahkhel, Sasambora, Hill, Baleja, Rajdowari, Anora, Sarmast, Gada, Jutial, Nilishang, Batangi, Paimal, Nawshera, Dharian, Ghazikot, Khairabad, Pirari, Shaead, Machaisar, Deshan, Tikri and Thakot. Each species was individually evaluated in the field for its use patterns, historical range of distribution, present frequency and compared with the existing extent and its normal ecological niche. The number of the plants scored with reference to its ecological amplitude and calculated historical distribution were compared with IUCN criteria (IUCN, 2001), for elaborating the conservation status of the species concerned.

The field studies included observation, guide field walks/transact walks and GPS. Information about local uses of plants, quantity of plant used, rate of consumption, and rate of availability, fuel wood, timber, fodder species, preference of use and major threats to the reduction in population size were obtained.

The plant material were pressed, poisoned, mounted on standard size herbarium sheets and preserved in the Herbarium of Hazara University (HHU). The specimens were identified through different publications focused on the flora of Pakistan (Nasir and Ali, 1970-1989; Ali and Nasir, 1990-1992; Ali and Qaiser, 1993-2009). The criteria published by IUCN, 2001; version 3.1 was used for allotting conservation status to various species. (Figure 1).

RESULTS

In the present study status of 37 vascular plants belonging to 31 families were evaluated. Among them, 14 species were critically endangered and 23 were endangered. During the study it was noted that: 7 species are confined to a single locality, exclusively in patches in a highly specific habitat, while 12 species are only rarely distributed in more than single locality and still 18 species can be found in whole tract.

Our observation and the information given by local people decline in the population size of these species were due to the factors such as decline in the area of occupancy, extent of occurrence, loss of habitat, actual or potential level of exploitation, effects of introduced taxa and attack of pathogens.

The taxonomic description and use of the species have been given below.

Family: Aceraeceae

Botanical name: *Acer caesium* Wall.

Local name: Terkana

Description, uses and conservation status

The plant was found in the mid hill and high altitudinal zones between 2200 to 3100 m of Nandiar and Hillian sub valleys on open grassy places. The plant is locally collected for fuel wood, timber and leaf fodder. The species is critically endangered locally as its total population size was reduced by 86% (local people). It follows the criteria A of critically endangered species.

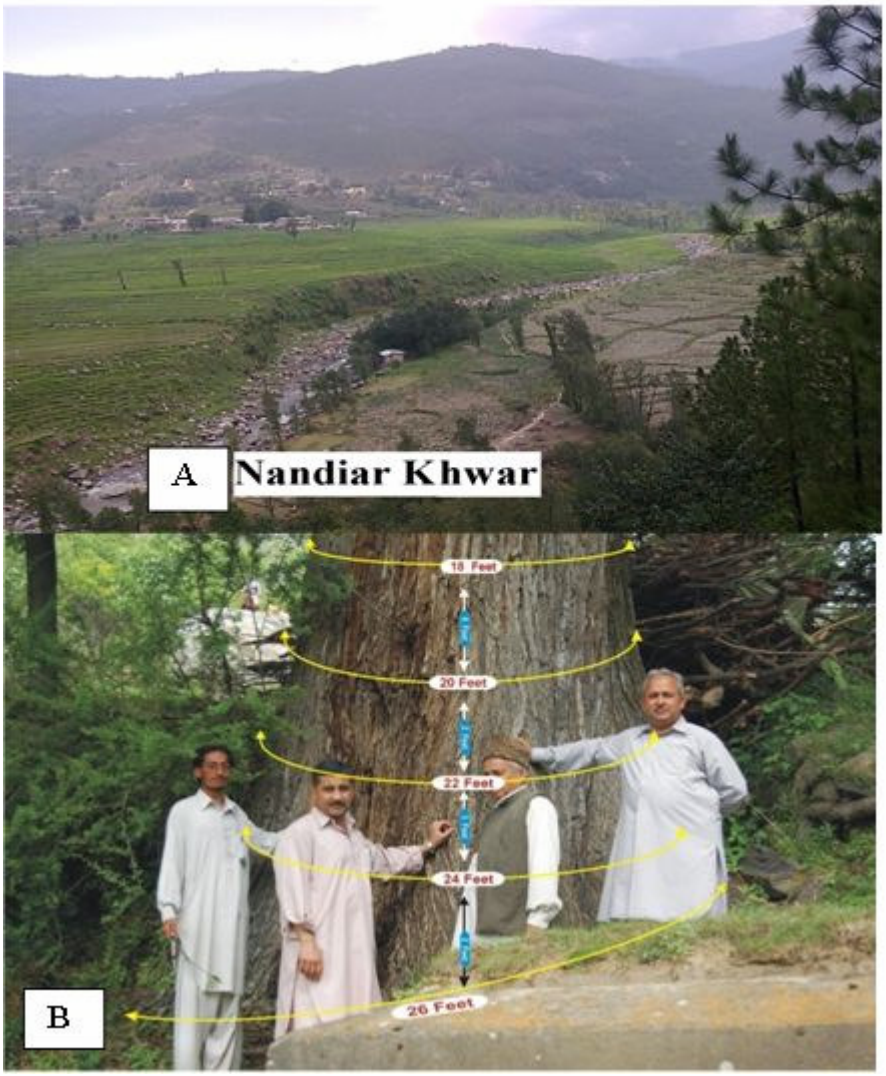

Figure 1. (A) A view of Nandiar Khuwar, the study area. (B) A huge tree of *Ulmus wallichiana (*Critically Endangered) having 26ft girth at ground level preserved in the Graveyard of Trari Baba near the Town Shamlai of Nandiar Khuwar (Battagram, elevation of 4943ft, N = 34 42. 008N and 073 07. 211E, GPS reference).

Family: Anacardiaceae

Botanical name: *Pistacea integerrima* (J. L. Stewart) Rech.f.

Local name: Shnai

Description, uses and conservation status

The species was found up to an elevation of 1400 m in Nandiar, Peshora, Tikri and Thakot areas. It is collected for fuel wood and medicinal uses. Its population size has been reduced by 93% (local people) and therefore falls under criteria A of critically endangered species.

Botanical name: *Rhus javanica* Linn.

Local name: Tetray

Description, uses and conservation status

It was found between 1200 to 2400 masl, rarely distributed in various parts of the area. The plant is collected for medicinal and fuel wood purposes. As 62% reduction in population size was observed (local people), hence it falls under endangered category criteria A.

Family: Apocynaceae

Botanical name: *Trachelospermum lucidum* (D. Don) Schum.

Description, uses and conservation status

It was found between 1300 to 2000 m in Nandiar and Hallian sub valleys. Due to the loss of habitat and the reduction by 66% of the population size (personal and local people), it falls under criteria A of endangered category.

Family: Asparagaceae

Botanical name: *Asparagus officinalis* Linn.

Local name: Tindoray

Description, uses and conservation status

It was found up to an elevation of 1200 m, distributed from Peshora to Thakot and Tikri. As the population size reduced by 68% (local people), it falls under criteria A of endangered species. It is collected for medicinal uses.

Family: Asteraceae

Botanical name: *Picris hieraciodes* Linn.

Local name: Sra booti

Description, uses and conservation status

It was found in the mid hills. Its population size is reduced by 60% (local people), falling under criteria A of endangered species. It is affected by the loss of habitat and the introduction of other species (personal observation).

Family: Betulaceae

Botanical name: *Betula utilis* D. Don

Local name: Boraj

Description, uses and conservation status

The plant was found in higher altitudinal zones between 2800 to 3800 m of Hallian sub valley. It is collected for fuel wood, leaf fodder and bark paper for amulet due to its medicinal properties. The plant is critically endangered locally as its population size reduced by 98% (local people), falling under criteria A of critically endangered.

Family: Boraginaceae

Botanical name: *Ehretia serrata* Roxb.

Local name: Bara/Shawa

Description, uses and conservation status

Rarely found in the mid hills of the whole tract along the nullah beds and stream banks; with a total number of 240 mature individuals, it falls under criteria D of endangered. The reduction in the number is due to fuel wood and timber collection (personal observation).

Family: Cactaceae

Botanical name: *Opuntia dilleni* Haw.

Local name: Zaqoom

Description, uses and conservation status

The plant was found up to an elevation of 1500 m, now restricted only to Battagram and Ooghozbanda, covering an area of 3 km² in both sub localities and the population size reduced by 90% (local people). The plant is critically endangered under population reduction criteria A and with geographical range criteria B2 in the form of area of occupancy less than 10 km². The reduction in population size is due to loss of habitat, uprooted by farmers, effect of introduced taxa and attack of pathogens (local people and personal observation).

Family: Caesalpinaceae

Botanical name: *Bauhinia variegata* Linn.

Local name: Kulyar

Description, uses and conservation status

It was found at base of hills up to an elevation of 1300 m, from Kas to Thakot. There are only 230 mature individuals in the wild (personal observation), and it falls under restricted population size criteria D for endangered species.

Family: Cornaceae

Botanical name: *Cornus macrophylla* Wall.

Local name: Khadang

Description, uses and conservation status

Only 47 mature individuals were found in altitudinal zones

between 1800 to 3000 m of Nandiar and Hillian sub valleys (personal observation). It is collected for fuel wood and timber. The plant is critically endangered locally as its very restricted population falls under criteria D of critically endangered species.

Family: Dioscoreaceae

Botanical name: *Dioscorea deltoidea* Wall. ex Kunth

Local name: Kaneez zela

Description, uses and conservation status

The plant was distributed in the mid hills between 1500 to 2400 m. Population size reduced by 68% (local people), falling under endangered criteria A. The main causes of reduction are medicinal, as fish poison collection and loss of habitat (local people).

Family: Ericaceae

Botanical name: *Rhododendron arboreum* Sm.

Local name: Gulnamair

Description, uses and conservation status

It was rarely distributed between 1400 to 3000 m. The plant is collected for fuel wood and for medicinal purposes. In most of the places the local people have destroyed the habitat (personal observation). The total reduction in the population size was 69% (local people). It falls under criteria A of endangered category.

Family: Euphorbiaceae

Botanical name: *Glochidon velutinum* W.

Local name: Kalmen

Description, uses and conservation status

A total of 198 mature individuals were found in the *Pinus roxburghii* forests along roadsides and stream banks. It falls under criteria D of endangered category. The reduction is due to fuel wood collection and loss of habitat (personal observation).

Family: Fagaceae

Botanical name: *Quercus glauca* Thunb.

Local name: Banjay

Description, uses and conservation status

The 230 mature individuals were restricted to Gada, covering an area of 3 km² between 1300 to 1600 m. The plant is collected as fuel wood and leaf fodder (personal observation). It is critically endangered under criteria B2 and also falls within C2 with all individuals in one sub population.

Botanical name: *Quercus semecarpifolia* Sm.

Local name: Banjar / tor banj

Description, uses and conservation status

It was found at altitudinal zone of 2200 to 3400 m, distributed in Chail, Shaeed, Machai and Hillian components. The plant is collected for fuel wood and agricultural instruments. The population size has reduced by 67% (local people), hence falls under criteria A of endangered category.

Family: Hippocastanaceae

Botanical name: *Aesculus indica* (Wall.ex Cambl.) Hook.f.

Local name: Banakor / Joz

Description, uses and conservation status

Only 149 mature individuals were found in the wild between 1800 to 3000 m on Halian and Nandiar valley, falling under restricted population size criteria D for endangered species. The reduction in the number is due to fuel wood collection, timber, wood used in making house and agricultural tools (personal observation).

Family: Lamiaceae

Botanical name: *Colebrookia oppositifolia* Sm.

Local name: Badi kosar

Description, uses and conservation status

It was distributed at the base of hills in the scrub and *Pinus roxburghii* forests up to an elevation of 1300 m. The plant is locally endangered as the population size reduced by 61% (local people) and falls under criteria A due to loss of habitat.

Family: Liliaceae

Botanical name: *Notholirion thomsonianum* D. Don

Description, uses and conservation status

It was found up to an elevation of 1800 m in fields and rocky slopes along the stream banks. The reduction in population size is 58% (local people) and falls under endangered category criteria A. The reduction is due to over grazing and loss of habitat (local people).

Family: Loranthaceae

Botanical name: *Viscum album* Linn.

Description, uses and conservation status

V. album was the parasitic epiphyte of *Ulmus wallichiana* in the selected area. It is also critically endangered because only 24 individuals of the host plant were found, being *Viscum* present only in 9 of them (personal observation). Therefore, the loss of the host plants has also reduced the population size of *V. album*.

Family: Menispermaceae

Botanical name: *Cissampelos pareira* Linn.

Local name: Gorisum

Description, uses and conservation status

It was found up to an elevation of 1700 m, distributed in various parts of the tract. The plant is endangered under criteria A due to its reduction in population size is 69% (local people). The loss of habitat and the effect of introduced taxa are the main causes of reduction in its population size (local people).

Family: Orchidaceae

Botanical name: *Cephalanthera longifolia* (L.) Fritsch

Description, uses and conservation status

It was found between 1800 to 3000 m, rarely distributed in various parts of Nandiar and Hallian sub valleys. The plant is endangered under criteria A due to its reduction in population size (67%) to medicinal collection and loss of habitat due to over grazing (local people).

Family: Paeoniaceae

Botanical name: *Paeonia emodi* Wall. ex Hook. f.

Local name: Mamekh

Description, uses and conservation status

The plant was found in altitudinal zones between 2200 to 3000 m in Chail, Ganja, Hill and Shaeed. It is collected for medicinal uses. The plant is critically endangered locally as its total population size reduced by 81% (local people), falling under criteria A of critically endangered species.

Family: Pinaceae

Botanical name: *Cedrus deodara* Roxb. ex Lamb.

Local name: Ranzrah

Description, uses and conservation status

Only 3 mature individuals were found in altitudinal zones of 1800 to 3000 m of Anora, Sarmast and Hill with in wild (personal observation). Due to its collection for fuel wood, timber and medicinal uses, the plant is critically endangered locally as its population size reduced by 98% (local people), falling under criteria A and D of critically endangered species.

Family: Podophyllaceae

Botanical name: *Podophyllum hexandrum* Wall. ex Royle

Local name: Bankakri

Description, uses and conservation status

It was found between 2300 to 3500 m in Chail, Ganja and Hill on open slopes. Due to its medicinal collection and loss of habitat, the population size is reduced by 68% (local people), falling under endangered category criteria A.

Family: Rosaceae

Botanical name: *Crataegus songarica* C. Koch.

Local name: Batsinga

Description, uses and conservation status

It was rarely distributed in various parts between 1000 to 1700 m. The plant is locally endangered with a population

size of 242 mature individuals falling under criteria D. It is locally used as fuel wood (personal observation).

Botanical name: *Filipendula vestita* (Wall. ex Don) Maxim.

Description, uses and conservation status

It was found at an elevation of 2100 to 3000 m, rarely distributed in Sheed, Machai sar, Mirani and Jutial. The plant is endangered under criteria A, as population size reduced by 65% (local people). The reduction is due to over grazing and loss of habitat (local people).

Botanical name: *Potentilla sericophylla* Parker

Description, uses and conservation status

Potentilla sericophylla was restricted to a single locality from Chailsar to Ganja Kandao in rock crevices in patches at altitude of 2600 m to 3100 m. The patches are located in an area measuring only 4 km² (personal observation). The plant is critically endangered with geographical range criteria B2 in the form of area of occupancy less then 10 km².

Botanical name: *Prunus padus* Hook.f.

Local name: Barith

Description, uses and conservation status

It was distributed in Chail, Donga, Shakhail, Ganja and some other parts of Hillian components between 2100 to 3200 m. The plant is collected as fuel wood and for timber purposes. Its population size was reduced by 64% (local people), falling under criteria A.

Family: Rutaceae

Botanical name: *Skimmia laureola* DC.

Local name: Nazar panra / Ner

Description, uses and conservation status

The plant was found at altitudinal zones of 2400 to 3400 m in Chail, Mirani, Ganja, Hillian components, Shaeed and Machai sar. The population size is reduced due to medicinal collection and loss of habitat due to over grazing. It is critically endangered under population size reduction criteria A, as the population size reduced by 81% (local people).

Family: Salicaceae

Botanical name: *Populus alba* Linn.

Local name: Aspai / Bensa / Shafeda

Description, uses and conservation status

The plant was found up to an elevation of 1500 to 2200 m, restricted only to Sarmast, covering an area of 3 km². It is collected for fuel wood, timber and medicinal uses. The plant is critically endangered locally with geographical range criteria B2 in the form of area of occupancy less then 10 km².

Botanical name: *Salix babylonica* Linn.

Local name: Asela ola

Description, uses and conservation status

Locally, the plant is collected for fuel wood, medicinal and agricultural instruments and it is rarely distributed in the zone of 1200 to 2000 m in the various parts of the area. During the study a total of 196 plants were observed. Hence, it falls under criteria D of endangered category with very small-restricted population size.

Family: Solanaceae

Botanical name: *Withania somnifera* (Linn.) Dunal

Local name: Asghand / Kutilal

Description, uses and conservation status

It was distributed at the base of hills in *Pinus roxburghii* and broad-leaved forests. Its population size reduced by 67% due to its medicinal collection and loss of habitat (local people), hence falling under criteria A of endangered category.

Family: Taxaceae

Botanical name: *Taxus baccata* L. subsp. *wallichiana* (Zucc.) Pilger

Local name: Banaye / Barmi / Sor largay

Description, uses and conservation status

The plant was found at altitudinal zones of 2100 to 3400 m of Hillian components. It is used for fuel wood, medicinal and timber in graves. It is critically endangered under population size reduction criteria A, as the

population size reduced by 87% (local people). It is very rarely distributed.

Family: Tiliaceae

Botanical name: *Grewia optiva* Drum.ex Burret.

Local name: Pastawonay

Description, uses and conservation status

The plant was distributed at the base of hills up to 1200m with total reduction in population size is 69% (local people). It falls under criteria A of endangered category. The reduction is due to collection of fuel wood, timber and loss of habitat (local people).

Family: Ulmaceae

Botanical name: *Ulmus wallichiana* Planch.

Local name: Mannu

Description, uses and conservation status

Ulmus wallichiana has only 24 mature individuals and it was restricted to Nandiar and Hillian sub valleys between 1300 to 2000 m. Most of the mature plants are found in graveyards and only few plants of this taxon are found along the paddy fields and nullahs and Khuwar beds (personal observation). It falls under criteria D of critically endangered. The reduction in the number is due to fuel wood collection, timber, wood used in making house tools, loss of habitat and change in environment (local people).

Family: Violaceae

Botanical name: *Viola canescens* Wall. ex Roxb.

Local name: Banafsha

Description, uses and conservation status

The plant was widely collected for medicinal purposes. It was distributed up to an elevation of 2300 m in the various parts of the whole tract. Its population size reduced by 64% due to its medicinal collection and loss of habitat (local people), hence falling under criteria A of endangered category.

DISCUSSION

The moist temperate Himalaya of Pakistan requires special attention for the conservation of environment and the sustainable use of natural resources. The decrease in forest cover and associated major changes in community composition has led to the decline of indigenous medicinal plants resources and their traditional knowledge (Ibrar, 2003). In the present study distribution of 37 species of vascular plants was explored from sub tropical foothills to alpine pastures in Pakistan Himalaya. Among 37 vascular plants evaluated against IUCN criteria Version 3.1 (2000), 14 species were put under critically endangered and 23 species were grouped as endangered species based on population reduction criteria A, geographic range criteria B, small population size criteria C and very small or restricted population criteria D.

Over exploitation, loss of habitat, attack of pathogens, effect of introduced taxa and change in environments were responsible for making these species either endangered or critically endangered species. Extensive grazing and deforestation which have led to forest fragmentation and degradation of the habitat are the primary causes of species extinction in the area (Sala et al., 2000). In the upland Himalaya where availability of cultivated land is quite less, establishment of botanical gardens, and promotion of home gardens or kitchen garden development may be considered conservation strategy for sustainable use of medicinal plants. The people of the study area mainly depend on the plant diversity for various purposes and thus leading many plants to the verge of extinction (Ahmad et al., 2010). These include; increase the demand of timber, fuel wood, torchwood, fodder and medicinal uses. Damage to the plants are careless and illicit cutting and smuggling of trees and shrubs, overgrazing, loss of habitat, converting the plan slopes in the forests for cultivation also exert enormous stress on the vegetation and result in environmental degradation (Muhammad, 2003; Haq et al., 2010).

A rare species is not only important at national or local level but also for the global biodiversity. Plants in general and medicinal plants in particular in the study area are a finite and precious resource that requires efficient, wise and sustainable management and conservation strategies. Hence, immediate conservation measures as proposed below are urgently necessary in order to protect the taxon from extinction.

i) Proper documentation and conservation of indigenous knowledge need to be done.
ii) Proper training of the local communities about the conservation of Flora needs to be given.
iii) Anthropogenic impacts like overgrazing and deforestation should be reduced.
iv) These species should also be introduced in botanical gardens.
v) Permenant monitroring programmes should be developed.

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