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Polygonatum cirrhifolium Royle and *Polygonatum verticillatum* (L.) Allioni: Status assessment and medicinal uses in Uttarakhand, India

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***Polygnatum verticillatum* (Linn) All. and *Polygonatum cirrhifolium* (Wall.) Royle (Liliaceae) growing in the Himalayan region is assigned as vulnerable by International Union for Conservation of Nature and Natural Resources (IUCN). To elucidate the status of the plants in the Uttarakhand Himalaya population assessment of the species is done in the study region. The study area is divided into five sites (Kilburry, Jageshwar, Dunagiri, Chaubattia and Aboot mount) in Kumaun division and five sites (Bhavisya Badri, Tangnath, Dayara, Bharsar and Binsor) in Garhwal division. Population is accessed based on frequency, density, abundance and importance value index (IVI) of the plants in per square meter area following Mishra (1986). Threat assessment of species was done through six parameters (that is, habitat preference, distribution range, population size, use pattern, extraction trend and native area. Ethno-medicinal uses of the plants are also documented through interview and gathering with local informers/folk healers. Some conservation strategies are also suggested.**

Key words: International Health Regulations (IHR), population study, status, quadrat, sampling.

INTRODUCTION

India possesses the world's richest medicinal plant heritage, traditional and local knowledge, and Himalaya is one of the mega biodiversity regions of the world (Heywood, 2000). In recent years, increasing attention is being paid to medicinal plant diversity due to their economic and conservation concern (Dhar et al., 2000).

It has been envisaged earlier that a number of medicinal plants of high importance are depleting at alarming rate (Tewari and Bhattacharjee, 1975). Unscientific harvesting, overexploitation of rhizome and other parts for medicinal use and consequent degradation of natural habitat along with the revival of traditional medicinal system in India and abroad, has put extra pressure on the forests, especially the medicinal plants. At least 90% of the plant species used in herbal industry today is extracted from temperate to alpine zones of the Himalaya. Some important species which are traced directly from wild habitats are: *Aconitum heterophyllum, Picrorhiza kurrooa, Nardostachys grandiflora, Dactylorhiza hatagirea, podophyllum hexandrum, Polydonatum verticillatum, Polydonatum cirrhifolium*, *Berberis* Sp., *Paris polyphylla.* Many species of Himalayan medicinal plants are considered as most endangered and listed in Red Data Book of Indian plants (Nayar and Sastary, 1987, 1988, 1990). In the aforesaid circumstances, their *in-situ* conservation and *ex-situ* production appears to be the only remedy. Quantitative information on the microhabitats preferences and population dynamics are lacking from the region. Studies on these aspects of commercially important plants would be very vital in developing the conservation

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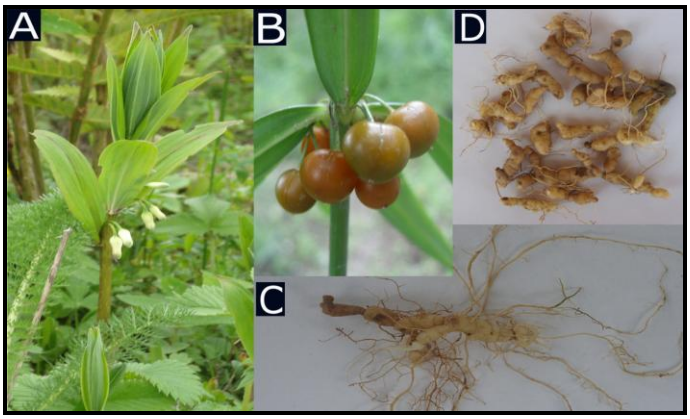

Plate 1. *Polygonatum verticillatum* (Linn.) All: (A) Live plant, (B) Live plant with bearing seeds, (C) Fresh root, (D) Dried root.

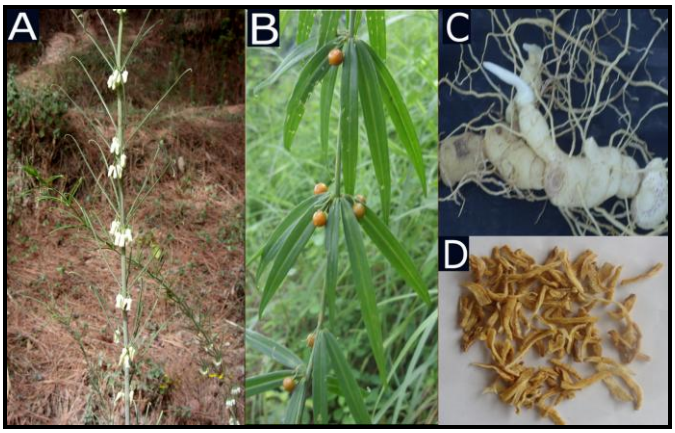

Plate 2. *Polygonatum cirrhifolium* Royle: (A) Live plant, (B) Live plant with bearing seeds, (C) Fresh root, (D) Dried root.

strategies for the area.

Polygonatum is a genus of erect or decumbent perennial herbs belonging to family Liliaceae and distributed in the temperate regions of the northern hemisphere. Thick fleshy creeping sympodial rhizomes characterize the genus. According to Miller (1754) the generic name of *Polygonatum* is derived from the character of the rhizome which resembles much as yovi, a Knee, because it has many little Knees. Linnaeus (1753) listed three species of *Polygonatum* under the genus *Convallaria*, namely, *Convallaria verticillata*, *Convallaria polygonatum* and *Convallaria multiflora* in his book '*Species Plantarum*'. These were treated under the generic name *Polygonatum* by Alloni (1785). In the natural system of classification of Angiosperms (Bentham and Hooker, 1862, 1883) family Liliaceae was classified in the series Coronarieae. *Polygonatum* is represented by 57 species in the world concentrated in Himalayas (Ohara et al., 2007). Out of the species occurring in Indian Himalayan Region (IHR), two (*P. verticillatum* (Linn.) All., and *P. cirrhifolium* (Wall.) Royle) are imperative ingredients of Asthaverga.

P. verticillatum (Linn.) All. syn. *C. verticillata* Linn., is known as whorled Solomon's seal in English and locally known as mitha dudhia (Nautiyal and Nautiyal, 2004) and Kantula (Gaur, 1999). The species is recognized as 'mahameda' in Ayurveda and in Sanskrit as Tridanti, Devamani and Vasuchhidra. It is an erect tall herb, 60 to 120 cm high. Leaves are whorled, sessile, 10 to 20 cm long, linear or lanceolate, acute or rarely tip carcinate, glaucous beneath, occasionally ciliolate on margins and veins. Flowers are white, pinkish white or pale green, in whorled racemes, rarely lilac. The flowering and fruiting takes place in the month of June to October. This species is found in the temperate Himalayas at altitudes of 1800 to 3900 m (Plate 1). *P. cirrhifolium* (Wall.) Royle syn. *C. cirrhifolia* Wall is another member of Asthaverga recognized as King's Solomon's seal in English, locally as Khakan (Gaur, 1999), 'meda' in Ayurveda, Dhara, Manichhidra and Svalpaparni in Sanskrit (Plate 2). It is also a tall erect, perennial herb, 60 to 120 cm high with whorled (3 to 6) sessile, linear leaves having tendril like tips. Flowers are white, green purplish or pink on short stocks and the fruits are round blue-black berry, when ripen found in the temperate Himalayas at the altitudes of 1200 to 4200 m. Rhizomes are thick and fleshy.

STUDY AREA

The state of Uttarakhand (28° 53' 24" and 31° 27' 50" N latitude and 73° 34' 27" and 81° 02' 22" E longitudes) includes parts of Trans and North west Himalaya, covers 55,672 km^2 area, 9% of IHR (Figure 1). Like other states of IHR, Uttarakhand has a representative natural and socio-economically important bio-diversity. It has a large altitudinal range (200 to 7105 m), with diverse habitats, species, populations, communities and ecosystems. The state embodying Kumaun region (28° 51 N latitude and 30° 49' E longitude) and Garhwal region (77° 33' 5" to 80° 6' E longitude and 29° 31' 9" to 31° 26' 5" N latitude) (Nand and Kumar, 1989), centers of spiritual knowledge, religiosity and pilgrimage from ancient times and it is also rich in biodiversity. The study was conducted in sub-temperate to sub-alpine zones of both Kumaun (Kilburry, Jageshwar, Doonagiri, Chaubattia, Abott mount) and Garhwal (Bhavisya Badri (Chamoli), Tungnath (Rudraprayag), Dayara (Uttarkashi), Bharsar, Binsor (Pauri)), at five different sites to calculate the population status and for preparing conservation strategies for further research.

FIELD METHODS

Selection, sampling and population estimation

P. verticillatum (Linn.) All. and *P. cirrhifolium* (Wall.) Royle, which have high trade and conservation value, were selected for the present study (Plate 1). The population assessment of this species was carried out from May, 2010 to May, 2012, during the peak season of flowering for the study of plant diversity and specimen collection from all the altitudinal zones. The study area was surveyed extensively and 10 populations (5 in Kumaun region and 5 in Garhwal region) mentioned in Table 1 were identified for comparative assessment of the species. Various habitats were

Figure 1. Site map: Uttarakhand.

Table 1. Region-wise selected study sites.

Region	Selected study sites
Kumaun	Kilburry (Nainital District), Jageshwar, Chaubattia, Doonagiri (Almora District), Abott Mount (Champawat District)
Garhwal	Bhavisya Badri (Chamoli District), Tungnath (Rudraprayag District), Dayara (Uttarkashi District), Bharsar, Binsor (Pauri District)

identified based on altitude, topography, presence of perennial water channels and physiognomy of vegetation. Fresh samples of each species were collected and identified with the help of flora (Gaur, 1999; Naithani, 1984), herbarium of Regional Research Institute of Himalayan Flora, Thapla, Ranikhet (Acronym-Rkt) and Taxonomists.

For the phytosociological study in every study sites, herbaceous species was studied by laying 30 quadrats of 1 m × 1 m (1 sq m) size randomly, tree species and shrub species were studied by laying 30 quadrats of 10 m × 10 m (100 sq m) size at different altitudinal range (Misra, 1968). The size and the number of quadrats were determined by the species curve (Mishra, 1968) and the running means methods (Kershaw, 1973). In each quadrat, trees were recorded with > 31.5 cm cbh (circumference at breast height that is, 1.37 m above the ground) individually measured. Individuals within the cbh range of 10.5 to 31.4 cm were considered as shrubs + saplings and individuals < 10.5 cm cbh were considered as herbs + seedlings. Individuals of all species were counted in each quadrat. To determine status of the species, mean values of each quantitative parameter of three stands of transect were considered for further interpretation. During the population analysis, some sites where individuals of representative species were very few (1 to 5) are not considered as stands. However, these individuals were also marked and counted as area of occurrence and for the demographic observations for threat category assessment.

The threat category of *P. verticillatum* (Linn.) All. and *P. cirrhifolium* (Wall.) Royle) were identified using six attributes (that is, habitat preference, distribution range, population size, use pattern, extraction trend, native and endemic species) and following Samant et al. (1998) and Ved et al. (2003) (Table 2).

Quantitative analysis

The important quantitative analysis such as density, frequency and abundance of tree species, shrubs and herbs species were determined as per Curtis and McIntosh (1950). Pattern of the species was analyzed on the basis of abundance to frequency (A/F) ratio. Value of A/F < 0.025 was categorized regular, between 0.026 to 0.050 random and > 0.050 contiguous type of distribution (Kershaw, 1973). Similarly, relative values of frequency, density and dominance and importance value index (IVI), were calculated following the methods of Curtis (1959). IVI was calculated through the sum of relative frequency, relative density and relative dominance.

Statistical analysis

To calculate the significant and non-significant variations among various phytosociological features (frequency, density, abundance

Table 2. Threat assessment of the medicinal plant diversity.

Habitat	Distribution	Population (Ind/Location)	Use pattern	Extraction trend	Native and endemic	Score
Single	<500	250 Ind/ upto 2 locality	4 and >4	Commercial	Native and Endemic	10
2-3	500-1000	250–1000 Ind/3–5 locality	2-3	Self use	Native/ Endemic	6
>3	>1000	1000 Ind/>5 locality	Single	No Use	Non Native	2

Table 3. Study sites with dominant species at Kumaun.

Code	Location	Latitude/ Longitude	Altitude (m)	Dominant species
P1	Kilburry	29°23'56.36"N/79°26'80"E	2210	*Ageratum conizoides* L., *Anisomeles indica* Edgew, *Blumea laciniata* (Roxb.) DC.,*Ranunculus arvensis* L.
P2	Jageshwar	29°38'59.99"N/79°34'59.98"E	2020	*Anaphalis contorta* (D.Don) Hook.f., *Cynoglossum zeylanicum* (Vahl ex Hormem.) Thunb. Ex Lehm., *Scutellaria repens* Buch.-Ham. ex D.Don, *Anemone obtusiloba* D.Don
P3	Duangiri	30°30'54"N/79°52'E	2400	*Asparagus adscendens* Roxb., *Ageratum conizoides* L., *Ajuga bracteosa* Wall. ex Benth., *Themeda arundinacea* (Roxb.) Ridley
P4	Chaubattia	29°36'49.61"N/79°27'22.77"E	1829	*Adiantum lunulatum* Burm., *Boenninghausenia albiflora* (Hook.) Meisn., *Thalictrum foliolosum* DC., *Galinsoga parviflora* Cav.
P5	Abott Mount	29°24'13.69"N/80°5' 24.43"E	2133	*Taraxicum officinale* Weber, *Paspalum scrobiculatum* L., *Oxalis corniculata* L., *Origanum vulgare* L.

and IVI), single factor analysis of variance (ANOVA) was applied (Data analysis tool Pack- MS office-2007).

Ethno-botanical assessment

To access the ethno-medicinal uses of the plants, personnel interview and bilateral discussion were carried out in the premises of healers/informers. After the documentation of folk claims, validation of the information was also done through cross checking with the help of codified texts of Ayurveda.

RESULTS

The site and habitat characteristics have been presented in Tables 3 and 4 for Kumaun and Garhwal region of Uttarakhand, respectively. The area surveyed in Kumaun varying in the altitudinal gradient from 1,829 to 2,210 m while in Garhwal, altitude is ranging from 2,480 to 3,680 m. To access the structural pattern of *Polygonatum verticillatum* (Linn.) All., five sites were accessed in both regions of Uttarakhand namely Kumaun (Kilburry (P1), Jageshwar (P2), Dunagiri (P3), Chaubattia (P4), Abott Mount (P5) and Garhwal (Bhavisya Badri (P6), Tungnath (P7), Dayara (P8), Bharsar (P9), Binsor (P10).

Structural pattern of *P. verticillatum* (Linn.) All.

In Kumaun, at site P3 the species had lowest frequency (50), with the density 1.13 plants/m^2 and IVI of 8.99.

While in Garhwal, at site P9 the species is showed lowest frequency (43.33), with the density of 2.27 plants/m^2 and IVI = 15.69 (Tables 5 and 6).

Structural pattern of *P. cirrhifolium* Royle

In Kumaun, at site P4 the species had the lowest frequency (50), with a density of 0.87 plants/m^2 and IVI of 8.99. While in Garhwal, at site P7 the species showed lowest frequency (53.33) with the density of 1.70 plants/m^2 and IVI of 15.69 (Tables 7 and 8).

Table 4. Study sites with dominant species at Garhwal.

Code	Location	Latitude/Longitude	Altitude (m)	Dominant species
P6	Bhavisya Badri	30°28.738”N/79°40’.604”E	2,744	*Ageratum conizoides* L., *Anisomeles indica* Edgew, *Blumea laciniata* (Roxb.) DC., *Asparagus racemosus* Willd.
P7	Tungnath	30°34.632”N/79°06’.937”E	3,680	*Anaphalis contorta* (D.Don) Hook.f., *Cynoglossum zeylanicum* (Vahl ex Hormem.) Thunb. Ex Lehm., *Scutellaria repens* Buch.-Ham. ex D.Don, *Blumea laciniata*(Roxb.) DC.
P8	Dayara	30°83.49”N/78°54’.37”E	3,048	*Asparagus adscendens* Roxb., *Ageratum conizoides* L., *Ajuga bracteosa* Wall. ex Benth., *Themeda arundinacea* (Roxb.) Ridley
P9	Bharsar	30°06.52”N/78°99’.81”E	2,550	*Adiantum lunulatum* Burm., *Boenninghausenia albiflora* (Hook.) Meisn., *Thalictrum foliolosum* DC., *Galinsoga parviflora* Cav.
P10	Binsor	29°58.23”N/79°09’.39”E	2,480	*Taraxicum officinale* Weber, *Paspalum scrobiculatum* L., *Oxalis corniculata* L., *Origanum vulgare* L.

Table 5. Phytosociological features of *Polygonatum verticillatum* (Linn.) All. in 5 sites of Kumaun

Site code	Frequency	Density/m^2	Abundance	IVI
1	53.33±0.37	1.20±0.12	2.25±0.15	12.02±0.14
2	66.67±1.82	1.73±0.32	2.60±0.42	12.06±0.26
3	50.00±0.26	1.13±0.21	2.27±0.024	8.99±0.65
4	70.00±2.15	1.27±0.25	1.81±0.28	11.60±0.37
5	60.00±3.32	1.63±0.24	2.72±0.27	13.75±0.82
F value significant at P = 0.05	1.91^{NS}	17.17***	42.07***	38.56***

Table 6. Phytosociological features of *Polygonatum verticillatum* (Linn.) All. in 5 sites of Garhwal.

Site code	Frequency	Density/m^2	Abundance	IVI
6	70±8.16	2.43±0.34	3.05±0.42	23.65±7.10
7	70±8.16	2.83±0.29	3.54±0.36	24.14±6.57
8	60±8.16	2.60±0.51	3.71±0.73	21.85±7.46
9	43.33±4.71	2.27±0.29	4.53±0.57	15.69±2.51
10	60±8.16	22.95±0.18	4.42±0.20	51.19±13.01
F value significant at P = 0.05	1.38^{NS}	0.83^{NS}	0.83^{NS}	0.01*

Table 7. Phytosociological features of *Polygonatum cirrhifolium* Royle in 5 sites of Kumaun.

Site Code	Frequency	Density/m^2	Abundance	IVI
1	70.00±2.17	1.13±0.11	1.62±0.07	13.38±0.13
2	50.00±2.16	1.60±0.12	3.20±0.10	14.06±0.21
3	56.67±1.86	0.63±0.22	1.12±0.06	9.63±0.17
4	50.00±2.31	0.87±0.20	1.53±0.09	11.39±0.21
5	76.67±3.26	1.90±0.55	2.48±0.36	11.01±0.19
F value significant at P = 0.05	6.00**	28.07***	58.61***	187.86***

Table 8. Phytosociological features of *Polygonatum cirrhifolium* Royle in 5 sites of Garhwal.

Site code	Frequency	Density/m^2	Abundance	IVI
6	56.67±4.71	1.23±0.21	2.06±0.34	10.45±1.48
7	53.33±4.71	1.70±0.64	3.40±0.75	13.73±1.97
8	60±8.16	2.27±0.05	3.77±0.07	26.93±6.64
9	70±8.16	2.87±0.90	4.10±1.28	28.85±5.82
10	60±8.16	3.20±0.51	4.57±0.73	28.62±4.79
F value significant at P = 0.05	1.59^{NS}	4.31*	3.18^{NS}	7.31**

Statistical analysis

For *P. verticillatum*, in Kumaun, frequency (F = 1.91, P = 0.05, df = 14) was found non-significant while density (F = 17.17, P = 0.05, df = 14), abundance (F = 42.07, P = 0.05, df = 14) and IVI (F = 38.56, P = 0.05, df = 14) were found highly significant. In Garhwal, frequency (F = 1.38, P = 0.05, df = 14), density (F = 0.83, P = 0.05, df = 14) and abundance (F = 0.83, P = 0.05, df = 14) of the plant species were found non-significant, while IVI (F = 0.01, p = 0.05, df = 14) value was found significant. In Kumaun, frequency of *P. cirrhifolium* was found highly significant (F = 6.00, P = 0.05, df = 14). Density (F = 28.07, P = 0.05, df = 14), abundance (F = 58.61, P = 0.05, df = 14) and IVI (F = 187.86, P = 0.05, df = 14) were also found highly significant. In Kumaun, frequency (F = 1.59, P = 0.05, df = 14) and abundance (F = 3.18, P = 0.05, df = 14) were found non-significant while density (F = 4.31, P = 0.05, df = 14) and IVI (F = 7.31, P = 0.05, df = 14) were found significant.

Threat categorization

An area specific threat categorization is very important for short or long term management planning. In the present study, the threat categorization of the species was done through the six parameters (that is, habitat preference, distribution range, population size, use pattern, extraction trend, native and endemic species). Both the species *P. verticillatum* (Linn.) All. and *P. cirrhifolium* Royle are found vulnerable in the study area on the basis of six parameters stated earlier. This indicates that these species are facing threats due to high anthropogenic pressure, overexploitation, habitat destruction and fragmentation.

Ethno-botanical uses

P. verticillatum (Linn.) All. and *P. cirrhifolium* Royle are the main ingredients of Astaverga (an Ayurvedic formulation). As per Ayurveda (Sharma et al., 1979), the main property of these two plants is to treat the vata, pitta, general weakness, aphrodisiac etc. During the field survey, some ethno-medicinal uses of *P. verticillatum* (Linn.) All. and *P. cirrhifolium* Royle were also accessed, which are more or less same for both plants.

1. Bulbs of *P. verticillatum* (Linn.) All. are dried, powdered and taken after mixing with honey to cure tuberculosis.
2. Powder of bulbs is taken with milk to cure general debility, and acts as tonic.
3. Powder of bulbs is taken twice daily with water to cure leucorrhoea.

DISCUSSION

Both the species of *Polygonatum* are used variously by pharmaceutical companies, due to which the population in natural habitat is diminishing day by day at alarming stage. The present study is the population assessment of the species that is, *P. verticillatum* (Linn.) All. and *P. cirrhifolium* Royle following the parameters given by the Mishra (1968), to define the status of the plant in the study area and to access the ethno-medicinal uses of the

plant. The study reveals that both the species are vulnerable in the study area and facing the various kind of threats such as: over exploitation, unscientific harvesting and less awareness about the properties of the species. There are some strategies for the conservation of these species for future prospects, such as:

1. A thorough work on threatened medicinal plants should be carried out and detailed information about their natural habitat, climate, soil, adaptability, growing season, flowering time, seed setting stage, etc., should be generated. Accordingly, conservation measures should be developed.
2. Ban on threatened medicinal plants should be strictly materialized, since due to improper attention of administration one can easily see banned medicinal plants in the market.
3. Collection of folklore information on medicinal plants from tribal and elderly people and its proper documentation are very important, otherwise this valuable information will vanish with them and coming generation will be deprived of it.

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REFERENCES

Alloni C (1785). *Flora Pedemontana*. Giovanni Michele Briolo, Turin.
Bentham G, Hooker JD (1862). *Genera Plantarum*, 1-3, L. Reeve and Co., London (1862-1883).
Curtis JT, Mc Intosh RP (1950). The Interrelation of certain analytic and synthetic phytosociological characters. Ecology 31:434-455.
Curtis JT (1959). The Vegetation of Wisconsin. An Ordination of plant communities, University Wisconsin press, Madison Wisconsin. P 657.
Dhar U, Rawat RS, Uprety J (2000). Setting Priorities for Conservation of Medicinal Plants- A case Study in the Indian Himalaya. Biol. Cons. 95:57-65.
Gaur RD (1999). Flora of District Garhwal North West Himalaya, Transmedia, Srinagar Garhwal. P 715.
Heywood VH (2000). Global biodiversity assessment. Cambridge University Press, Cambridge.
Kershaw KA (1973). Quantitative and Dynamic Plant Ecology (2nd Edition), Elbsd and Edward Arnold, London. P 308.
Linnaeus C (1753). *Species plantarum*. Holmiae.
Miller P (1754). The Gardeners Dictionary, ed. 1. 1731. The abridgement of Miller's Gardener's Dictionary of 1754. Bot. Exch. Club Soc. Brit. Isles Rept. 3:426-436.
Mishra R (1968). Ecology Workbook. Oxford and IBH, Calcutta.
Nayar MP, Sastary ARK (1987). Red Data Book of Indian Plants. Botanical Survey of India, Calcutta (1987, 1988, 1990). pp. 1-3.
Naithani BP (1984). Flora of Chamoli. 2 Vols. BSI, Howarh (1984-1985).
Nand N, Kumar K (1989). The holy Himalaya: A geographical interpretation of Garhwal. Daya Publishing House, Delhi.
Nautiyal MC, Nautiyal BP (2004). Agrotechniques of High Altitude Medicinal and Aromatic Plants. Bishen Singh Mahendra Pal Singh, Dehradun.
Ohara MM, Tamura T, Hirose T, Hiei K, Kawano S (2007). Life-history monographs of Japanese plants. 8: *Polygonatum odoratum* (Miller) Druce var. *pluriflorum* (Miq.) Ohwi (*Convallariaceae*). Plant Species Biol. 22:59-64.
Samant SS, Dhar U, Palni LMS (1998). Medicinal Plants of Indian Himalaya: Diversity Distribution Potential Values. Almora: G.B. Pant Institute of Himalayan Environment and Development.
Sharma PV, Guruprasad S (1979). Keyadev Nighantu, Chaukhamba Orientalia, Varansi.
Tewari KC, Bhattacharjee S (1975). Green Development of Central Himalayan Hills. Proc. Assoc. Scientific Workers (CSIR). pp. 1-4.
Ved DK, Kinhal GA, Ravikumar K, Prabhakaran V, Ghate U, Vijaya SR, Indresha JH (2003). Conservation assessment and management prioritization for the Medicinal plants of Jammu and Kashmir, Himachal Pradesh and Uttaranchal. Foundation for Revitalization of Local Health Traditions, Bangalore, India.