Lichen wealth of Jammu and Kashmir- A promising plant source for Bioprospection

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Abstract: So far 279 lichen species belonging to 79 genera and 33 families have been reported from the state of Jammu & Kasmir. The taxa under lichen families Parmeliaceae and Physiaceae dominates the state. Genera such as *Xanthoria, Cladonia, Lecanora and Caloplaca* showed the maximum diversity of species. The paper presents occurrence and probable utilization of lichens for bioprospection in the state.
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Introduction:

Lichens comprise a unique group of plant that consists of two unrelated organism, a fungus and an alga, growing together in a close symbiotic association. Lichens are extremely biologically diverse (Galloway, 1992; Hawksworth, 2001), and functionally important in terrestrial ecosystems (Knops et al., 1991, 1996; Arseneault et al., 1997). The study of lichen remains quite neglected throughout the world, though they together with mosses form dominant organisms in ecosystem covering over 10% of the earth terrestrial habitats, particularly at higher elevations (Nash and Egan 1988). Given the modern emphasis on biodiversity conservation (Heywood, 1995; Gaston & Spicer, 2004), and the importance of biogeographical research in tackling major conservation issues, it is critical that biogeographical studies include diverse, though often neglected, components of the world's biota (Klironomos 2002). Lichens are one example of a biological group that is often neglected in mainstream biogeographical and ecological study.
Lichens with specific biological structures are known as the best bioindicator organisms of air pollution, due to susceptibility of species to pollutants, especially sulphur dioxide (Saxena et al 2007), and also as biomonitors for trace element and heavy metal accumulation and deposition in their thalli (Garty 2001). However, many lichen species can tolerate extreme environmental conditions, for instance variations in temperature, humidity and light (Hauck et al., 2007). As adaptations for life in marginal habitats, lichens produce a lot of (more than 1,500) unique chemical compounds (Upreti and S. Chatterjee 2007). These organisms produce nalkane, unusual betaine and glycolipids, unsaturated, oxygenated, branched, and halogenated fatty acids (Torres et al 2003). Lichen substances have many medicinal roles, including antibiotic, antibacterial, antiviral, anti-inflammatory, analgesic, antipyretic, anti-proliferative and other activities (Upreti and S. Chatterjee, 2007; Dembitsky, 1992).

The state of Jammu and Kashmir lies between the coordinates 32º 17" and 36º 58" North Latitudes and 73º 26" and 80º 30" East Longitudes and falls in the lichenogeographic zone constituting of mountainous to semi mountainous plains, Shiwalik ranges, mountains of Kashmir valley, Pir Panjal range of Ladakh and Kargil. Including Jammu and Kashmir the Himalaya is often called the "Hot Spot" of lichen diversity in India. The climate in the state varies from tropical, subtropical to alpine. This varied climate together with varied altitudinal range provide different kinds of substrates and niches for colonization and growth of lichens. The lichen collection in the state started during early thirties of last century where Smith (1931) identified and published some lichen species collected by Kashyap. However, more rigorous exploration in the state was started since early 50s and Sheikh *et al* (2006a) provided a historical account of lichen study in Jammu and Kashmir. Recently, workers like Negi and Upreti (2000) collected lichen specimens from Ladakh region of the Kashmir valley and reported 21 species from the area. Sheikh *et al* (2006b) reported 48 species from three districts of the Kashmir valley. Subsequently, Sheikh *et al* (2006a) listed a total of 279 lichen species from whole Jammu & Kashmir. Sheikh *et al.* (2009) reported 30 lichen species from Surinsar-Mansar Wild Life Sanctuary of Jammu district. Though lichens are utilized for different purposes in other states of India but they are scantly utilized in Jammu and Kashmir. The manuscript provides the information as to how lichens can be used in the state.

Methodology:

The study is based on the lichen specimens recently collected from different sites of Jammu & Kashmir and specimens preserved in lichen herbarium of National Botanical Research Institute, Lucknow(LWG); personal lichen collection of D. D. Awasthi (AWAS). The literature available on lichens of Jammu & Kashmir carried out by different workers (Smith 1931; Awasthi & K Singh 1970; Negi & Upreti 2000; Sheikh *et al* 2006 a & b, 2009) from different localities in Jammu & Kashmir were thoroughly consulted. Regarding commercial use of lichens, research work carried out by different workers (Brij Lal 1988, 1990; Brij Lal & Upreti 1995; Saklani & Upreti 1992; Upreti et al 2005; Upreti & Chatterjee 2007 and Nayaka et al 2010) was consulted.

Resuts and Discussion

A total of 279 species belonging to 79 genera and 33 families of lichen species have been reported fom the state of Jammu & Kashmir. Out of different districts of the state the Anantnag district shows the maximum diversity of lichens represented by 105 species. Baramulla and Srinagar district are represented by the occurrence of 70 and 57 species of lichens respectively. In areas of Leh, Pulwama, Jammu, Doda and Budgam districts there are 34, 22, 20, 19 and 12 species of lichens respectively. Gilgit, Kargil and Udhampur districts are poorly explored for lichens as records of only 7, 5, and 1 species are available from these districts respectively. There are absolutely no collection available from frontier distict of Kupwara, Kathwa, Rajouri and Poonch. Lichen families Parmeliaceae and Physciaceae are the dominant families of the state, while *Xanthoria, Cladonia, Lecanora, Caloplaca, Flavoparmelia, Phaeophyscia, Anaptychia, Dermatocarpon, Xanthoparmelia, Heterodermia, Peltigera, parmelina, Chrysothrix, Parmelia and Physconia* are the dominant genera in the state.

Lichens of medicinal importance

In India the ethnomedicinal use of lichens has been carried out since the middle of the last century. Brij Lal(1988,1990); Brij lal & Upreti (1995); Saklani & Upreti (1992); Upreti *et al* (2005); Upreti & Chatterjee (2007) and Nayaka *et al* (2010) provide information regarding the ethnomedicinal use of lichens in India. Nayaka *et al* (2010) listed 137 species of lichens used in antimicrobial, anticancer, antioxidant, anti-inflammatory activities. *Cladonia pyxidata* (L) Hoffm., is used against the symptoms that include difficulty in breathing, anxious and nervousness, dryness of tongue, lips, throat and skin. *Evernia prunastri* (L) Ach., mentioned in Pharmacopia Universalis of 1846 bears antimicrobial and antioxidant activities. *Everniastrum cirrhatum* (Fr.) Hale commonly known as '*Charila*' is the common lichen in temperate Himalaya and is used in Ayurveda and Unani system of medicine for stomach disorders, bronchitis, bleeding piles, scabies, leprosy, spermatorroea, amenorrhea, enlarged spleen, tooth ache, soreness of throat and wound healing. Besides, it has antibacterial and antifungal activities. The intestinal worms are treated by *Flavoparmelia caperata* (L.) Hale, and dried powder of the thallus can be applied on burns. *Heterodermia diademata* (Taylor) D. Awasthi is applied on wounds as plaste to protect from water and infection. The apothecia of *Peltigera canina*(L) Willd., popularly known as 'dog lichen', resembles dog teeth and are widely used in the treatment of dog bites and rabies. *P. polydactyla* (Neck.) Hoffm., is used as antiseptic and applied on cuts to stop bleeding. *Usnea longissima* Ach., along with other ingredients is used in bone fracture. It also benefits urinary tract infection and stop swelling in female genitals. *Xanthopaermelia stenophylla* (Ach.) Ahti & Hawk is used in treating snake bites and is applied for the treatment of venearal diseases such as Syphilis. *Xathoria parietina* (L) Th. Fr. a yellow coloured lichen is used in jaundice.

Dye yielding lichens

A number of lichens, in particular belonging to the genera Xanthoria and Caloplaca are pigmented orange or red due to the presence of hydroxyanthraquinones. One of the widely spread anthraquinone is parietin. The lichen genera as *Evernia, Lobaria, Ochrolecia, Parmelia, Umbilicaria*, *Xanthoria* and *Xanthoparmelia* have different colouring compounds. *Acarospora strigata* (Nyl.) Jatta, *Candellaria vitellina* (Ehrh) Mull. Arh., *Chrysothrix chlorina* (Ach.) Laundon, *Dermatocarpon miniatum* (L) Mann, *Evernia prunastri* (L) Ach. *Lecanora frustolosa* (Dick) Ach., *Lecanora muralis* (Schreber) Rabenh., *Parmelia saxatilis* (L) Ach., *Peltigera canina* (L) Willd., *P. praetextata* (Flork) Zopf., *Rhizoplaca chrysoleuca* (Sm) Leuck. & Poelt, *Xanthoparmelia mexicana* (Gyeln) Hale, and *Xanthoria parietina* (L) Th. Fr. are the lichen species found in the state of Jammu and Kashmir and can be used for dye yielding.

Lichens that can be used as food and fodder

Lichens are extensively used in making spices, ingredients and flavouring agents for meat and vegetables and are a better option than adulterated and carcinogenic counterparts available in the market. Upreti (2005) mentioned a list of lichens exploited for food materials. The common lichen taxa exhaustly collected in other parts of India for their

use as spices are *Canoparmelia texana* (Tuck) Elix & Hale, *Everniastrun cirrhatum* (Fr) Hale, *Flavopunctelia flaventior* (Stirton) Hale, *Heterodermia diademata* (Taylor) D. Awasthi, *Heterodermia lecomela* (L) Poelt, *Parmotrema tinctorum* (Nyl) Hale, *Parmotrema reticulatum* (Taylor) Choisy, *Ramalina sinensis* Jatta, *Usnea orientalis* Mot. and bear a promise in the state of Jammu and Kashmir as well.

Pollution monitoring studies

Due to fast pace of urbanization, the rate of deforestation and vehicular activities have increased tremendously in the state. Lichens have a long history of use as biological indicators of air quality (Rao & LeBlanc, 1967; Vestegaard, 1986). The tolerance of lichens to most of the heavy metals and their slow growth rate, are among the main factors that make them good indicators of both organic and inorganic metal pollution. Among the different lichen species *Phaeophyscia hispidula* (Ach) Essl., has been used for conducting pollution monitoring studies in different parts of India. Being foliose lichen it is easy to collect and can be utilized for pollution monitoring (Shukla & Upreti, 2007). *Phaeophyscia hispidula* together with other members of the lichen family Physciaceae are well known for their toxitolerant nature and are growing frequently in the different region of the state can be used for pollution monitoring.

Ecological studies

Lichens play a major role in balancing the ecosystem and are the pioneers in succession of community. They are proficient in indicating the climate of forest. Lichens usually grow on all kinds of substrata but certain lichens are host specific. Presence of *Lobaria* and *Sticta* species indicate the moist dense undisturbed forest area. *Peltigera, Cladonia, Stereocaulon* and *Xanthoparmelia* indicate the less erosive and animal trampling activities in the forerst. *Usnea* is related to old aged forest with better air quality. Members of family Parmeliaceae indicate the sunlit forest sites, however, members of Physciaceae indicate the dry forest with increasing anthropogenic activities. The coloured nature of *Xanthoria* is related to harsh exposed, open alpine areas with high infra red and UV radiation intervention. Besides this lichens are known to date surfaces near glacier snouts, landslides, old monuments, grave yards and river terrace formation. Only few studies regarding this aspect are accomplished in India. The biomonitoring technique commonly known as lichenometry was undertaken in Gangotri Glacier area.

Conclusion

The state of Jammu & Kashmir sustains an abundantly rich lichen flora. A good number of people live in the remote areas near the forests and have little knowledge about the possible uses of lichens, rather, are bent on cutting the forests and exploiting other forest resources which is a menace and drawback on our conservation policies and strategies. The information provided in the present paper can be used to establish small scale cottage industries for preparation of spices and dyeing material in remote areas. This particular practice may lead to employment generation at village level. This will in turn minimize the pressure on our forests and will act as a strategy for conservation of diversity indirectly. Lichens are promising sources of medicines, dyes, spices and perfumes. They can prove as a best alternative to artificial dyes which are carcinogenic and a lot of capital and human resource can be saved to channelize it in the development of state which otherwise is utilized against these fatal diseases.

To avoid the overexploitation of this gifted resource the conservation measures as suggested by Upreti & Nayaka (2008) should be taken for sustainable use of lichens.

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