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Medicinal Plants Used for the Management of Eye Diseases in Garhwal Region of Uttarakhand State in India

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ABSTRACT The prevalence of eye diseases increases with age due to age-related muscular degeneration and diabetic retinopathy however, at present, the poor air quality has accelerated such diseases. Historically, eye diseases were treated by traditional medicinal practitioners using herbal formulations. The present study, therefore, attempts to document ethno-medicinal plant use for treatment of eye diseases in Garhwal region of Uttarakhand state in India. Besides literature review, the local herbal healers were interviewed for gathering information on use of plants. A total of 36 plant species were documented, which were used to treat eye diseases. Herbs were used in highest number (n=21), followed by trees (n=8), and shrubs (n=7). *Berberis aristata, Berberis asiatica, Berberis jaeschkeana, Thalictrum foliolosum* and *Thalictrum minus* were reported frequently by respondents for their use to treat eye diseases. The findings of the present study are discussed in view of the significance and implication of traditional ethno-medicinal system.

INTRODUCTION

The World Health Organization reports that at least 2.2 billion people have vision impairment or blindness all over the world, of which at least 1 billion have a vision impairment that could have been prevented or has yet to be addressed (WHO 2019). When an eye condition affects the visual system, which includes the eyes, optic nerves, and pathways to and between different structures, the vision impairment takes place. The vision impairment includes a large range of vision conditions from low vision to blindness (Gothwal and Herse 2000). The prevalence of vision impairment increases with age due to age-related muscular degeneration, cataract, diabetic retinopathy, and glaucoma (CDC 2022). Though, the eyes have natural mechanism to protect themselves against diseases, the defense mechanisms may be disrupted due to bacterial, fungal, and other microbial agents, resulting in ocular inflammation (Sandhu et al. 2011). Despite the advancement in medical sciences for dealing the eye or ophthalmic diseases, the vision impairment remains a major health problem in various countries (Shayanfar et al. 2019).

Historically, the different eye diseases or vision impairment were treated by traditional medicinal practitioners using herbal formulations. The Greek era (ca. 460–375 BCE) had also described several treatments for eye diseases (Tewari et al. 2019). Various eye diseases including *Adhimanth* (Glaucoma), *Abhishyand* (Conjunctivitis), and *Timir* (Cataract) along with their potential curative properties have been mentioned in the Sushrut Samhita, a compendium of Ayurvedic knowledge or an established Indian system of medicine written in 500 BC (Pooja et al. 2014).

Despite the use of a large number of plant species to treat eye diseases traditionally across the world, there has been a gradual shift and decline in traditional therapeutic systems (Kala 2010). Moreover, the treatment of various eye diseases is a costly affair, at present, which demands expertise, equipments, and effective disease control system (O'Neil et al. 2019; Tewari et al. 2019). A large population living in both rural and urban areas, especially in the developing countries, may not be able to afford the cost of modern medical services (Kala 2015). Besides, people living in mountainous areas may not have easy accessibility to the modern health care facilities due to poor road connectivity (Cattell 2001; Kala 2020a). The traditional system of medicine may remain a vital system for treatment of their various eye diseases. With this background, the present study aims to document the use of plants for treatment of eye diseases in Garhwal region of Uttarakhand state of India.

METHODOLOGY

Study Area

The present study was conducted in Garhwal region, which is one of the two administrative

divisions of the Indian State of Uttarakhand. The Garhwal Region is bounded on the northwest by Himachal Pradesh, on the south by Uttar Pradesh state of India, on the east by Kumaon region of Uttarakhand, and on the north by Tibet (China). It comprises of 7 districts namely Uttarkashi, Chamoli, Rudraprayag, Pauri, Tehri, Dehradun and Haridwar. The Garhwal region is known for the origin of many rivers including Alaknanda, Bhagirathi and the Ganges. According to the census of 2011, the population of Garhwal region is 5,857,294, of which 78 percent lives in rural areas. Primary health care centers are limited in the study area (Kala 2019, 2020b).

The Garhwal region spans over a wide altitudinal range (210 m-7,817 m), which supports diverse forest types along its altitudinal gradient. The forests are predominated by chir pine and oak species. Agriculture is the major source of livelihood for majority of population, as they cultivate variety of cereals, millets, pulses, spices and vegetables in their agricultural land. The rich biological diversity of the region is closely associated with the various cultural groups, who have developed unique ethnobotanical and ecological knowledge for use and conservation of biodiversity (Kala 2016). The local people remained isolated for long period due to high rising mountains, which created geographical barriers for movement of communities in the past. However, it supported to preserve some of the traditional practices and knowledge associated with utilization of surrounding natural resources (Kala 2003, 2010).

Survey Methods

An extensive literature review was conducted for compilation of medicinal plants used for the treatment of various eye diseases. The plant parts used to cure various eye diseases were also compiled. Besides, the field surveys were undertaken across various localities in the Garhwal region of Uttarakhand for gathering information on availability and uses of medicinal plant species. The traditional herbal healers were approached for collection of information through semi-structured questionnaire surveys. Besides, the group discussions were organized with local people for sharing their knowledge on use of plants for treatment of eye diseases. The collected data was cross-checked by repeated interviews with more than three healers on the specific uses of a plant species. In view of verifying the identity of medicinal plant species as mentioned during the group discussions and questionnaire surveys, field visits were undertaken with the herbal healers.

RESULTS AND DISCUSSION

The present study area holds a good number of medicinal plants, of which 36 plant species belonging to 27 families were documented during the present study, especially for treatment of eye diseases (Table 1). Family Lamiaceae contributed highest number of plant species (n=4) to treat eye diseases, followed by Berberidaceae (n=3). Different life forms of plants were used to treat eye diseases, of which herbaceous species were used in highest numbers (n=21), followed by trees (n=8), and shrubs (n=7). Different plant parts (for example, root, rhizome, bulb, bark, leaf, fruit, flower, stem, and seed) of these 36 plant species were used for treatment of eye diseases, of which roots of highest number of species (n=12) were used, followed by leaves (n=8), whole plants (n=7) and seeds (n=6).

Three species of *Berberis* such as *Berberis aristata*, *Berberis asiatica*, and *Berberis jaeschkeana* and two species of *Thalictrum* such as *Thalictrum foliolosum* and *Thalictrum minus* were reported frequently by respondents for their use to treat eye diseases during the present study. The roots of *Berberis* species after drying in shade are boiled in water to prepare a decoction. Once the decoction is dried up at low temperature, the concentrated extract, which is called as *'rasont'* is used for treatment of eye diseases. The use of *rasont* for treatment of eye infections was reported by Kirtikar and Basu (1981) for India and particularly for Himachal Pradesh – a neighboring state of Garhwal region of Uttarakhand - by Uniyal et al. (2006). The sap extracted from the stems, spines, and apical shoots of *Berberis* are also applied directly on the eyes for treatment of infections.

Many species as documented during the present study are reported for their use to treat eye diseases by researchers, elsewhere. The flowers of *Butea monosperma* are reported to treat eye diseases in north Maharashtra (Patil et al. 2006). The fruits of *Terminalia chebula* are used to treat eye diseases in South-East Asia (Lee et al. 2010). The root stock of *Geranium walli-*

Table 1: Medicinal plants used for the treatment of eye diseases in Garhwal region of Uttarakhand state in India

S. No.	*Species*	*Family*	*Life form*	*Plant part used*
1	*Aegle marmelos* (L.) Correa	Rutaceae	Tree	Leaf, root
2	*Albizia lebbeck* (L.) Benth.	Mimosaceae	Tree	Seed, bark, root
3	*Allium cepa* L.	Liliaceae	Herb	Bulb
4	*Argemone maxicana* L.	Papaveraceae	Herb	Whole plant
5	*Arnebia benthamii* (Don) John.	Boraginaceae	Herb	Root
6	*Berberis aristata* DC.	Berberidaceae	Shrub	Root
7	*Berberis asiatica* Roxb. ex DC.	Berberidaceae	Shrub	Root
8	*Berberis jaeschkeana* Sch.	Berberidaceae	Shrub	Root
9	*Butea monosperma* (Lamk.) Kuntze	Fabaceae	Tree	Flower, bark, seed
10	*Cannabis sativa* L.	Cannabinaceae	Herb	Leaf, seed
11	*Centella asiatica* (L.) Urban	Apiaceae	Herb	Flower, leaf, root
12	*Cuscuta reflexa* Roxb.	Convolvulaceae	Climber herb	Whole plant
13	*Euphorbia hirta* L.	Euphorbiaceae	Herb	Whole plant
14	*Euphrasia himalaica* Wettst.	Schrophulariaceae	Herb	Whole plant
15	*Ficus benghalensis* L.	Moraceae	Tree	Latex
16	*Geranium wallichianum* D. Don ex Sweet	Geraniaceae	Herb	Root
17	*Hedychium spicatum* Ham. ex Smith	Zingiberaceae	Herb	Rhizome
18	*Nepeta eriostachya* Benth.	Lamiaceae	Herb	Whole plant
19	*Ocimum sanctum L.*	Lamiaceae	Herb	Whole plant
20	*Oxalis corniculata* L.	Oxalidaceae	Herb	Leaf
21	*Phlomis bracteosa* Royle	Lamiaceae	Herb	Flower
22	*Picrorhiza kurrooa* Benth	Scrophulariaceae	Herb	Root
23	*Punica granatum* L.	Punicaceae	Tree	Stem, fruit cover
24	*Pyrus pashia* Buch.-Ham.	Rosaceae	Shrub	Fruit
25	*Rheum australe* Don.	Polygonaceae	Herb	Root
26	*Ricinus communis* L.	Euphorbiaceae	Shrub	Seed, leaf
27	*Solanum nigrum* L.	Solanaceae	Herb	Fruit, leaf, seed
28	*Tectona grandis* L.	Verbenaceae	Tree	Wood
29	*Terminalia chebula* Retx.	Combretaceae	Tree	Fruit, seed
30	*Thalictrum foliolosum* DC.	Ranunculaceae	Herb	Root
31	*Thalictrum minus* L.	Ranunculaceae	Herb	Root
32	*Thymus linearis* Benth.	Lamiaceae	Herb	Whole plant
33	*Viola canescens* Wall.	Violaceae	Herb	Leaf, flower
34	*Vitex negundo* L.	Verbenaceae	Shrub	Stem, flower, leaf
35	*Woodfordia fruticosa* (L.) Kurz.	Lythraceae	Shrub	Flower
36	*Ziziphus mauritiana* Lam.	Rhamnaceae	Tree	Fruit

chianum is used to cure eye troubles in Pakistan (Ismail et al. 2012). The leaf juice of *Ocimum sanctum* is used to cure cataract, glaucoma, and conjunctivitis (Rajan et al. 2020), and the oil of *Ricinus communis* is used to cure dry eyes, redness, swelling, and watery eyes (Sandford et al. 2021).

Studies conducted elsewhere have also reported use of plant-based ethno-medicines for the treatment of eye diseases, traditionally. Xiaosheng powder, a herbal formulation made up of about 8 plant species, is widely used to treat eye diseases in traditional Chinese medicine (Xu 2020). In traditional southern African medicine, there are reports on use of 137 plant species for treatment of eye diseases (Cock et al. 2022). In traditional Iranian medicine, a total of 89 plant species have been compiled through literature review of ancient records by Shayanfar et al. (2019) for treatment of eye disorders. The inhabitants of Kenya are known to use 58 species of plants for treatment of various eye diseases (Klauss and Adala 1994).

Likewise, the various prescriptions as made by the *vaidyas* of Ayurveda (Kala 2005), the ancient Iranian medical practitioners advised the patients suffering from early stages of cataract to consume healthy diets and avoid eating meat and fish, as it was believed that the cataract could have been cured in the early stages through proper nutrition and drug therapy (Sheikhrezaee et al. 2017; Shayanfar et al. 2019). A total of 44 plant species have been documented by Tewari et al. (2019) that are traditionally used in management of cataract. Worldwide, one in three

blind people is reported to suffer from cataract (Khairallah et al. 2015).

The formation of blood clot and or narrowing of the blood vessels may cause obstruction in blood flow, which subsequently damages the retina and the vision. If the blockage is prolonged, the retina dies. The vision can be recovered fully if the blockage is removed in time, and the blood supply returns to the retina (Fraser and Adams 2009). Plants and their extract may help to remove the blood clot and or contraction of the blood vessels and subsequently regulate blood flow to the eyes. This may ensure the eliminations of the risk of blindness in the early stages of the disease.

There are reports on the use of phyto-chemicals as extracted from plants for treatment of eye diseases. These botanical compounds exhibit anti-inflammatory, antioxidative, and antiapoptotic properties. The flavonoids as extracted from the *Vitex negundo*, one of the species as figured out in the present study, are used to enhance the antioxidant enzymes, maintain ionic balance, reduce the optical lens oxidative stress, and prevent changes in lens protein (Rooban et al. 2011). The leaf juice of *Aegle marmelos* is scientifically validated in laboratory for its use to prevent cataract formation (Panaskar et al. 2013).

At present, the world is reeling under severe environmental degradation and exposure to polluted air may develop and increase various kinds of eye diseases including retinal layer thinning, conjunctivitis, cataract and glaucoma (Pokhrel et al. 2005; Khan et al. 2006). The sources of outdoor and indoor air pollution may vary hence they may cause different eye diseases (Lin et al. 2022). Indoor air pollution from smoking, cooking, and poor ventilation may cause several eye diseases. The use of medicinal plants and their extract may help to protect eyes from negative environmental factors, as well.

CONCLUSION

The traditional healers and the indigenous communities have discovered a good number of plant species for treatment of various eye diseases. Despite the use of a large number of plant species to treat eye diseases traditionally across the world, the therapeutic properties of most of these plants have been poorly studied. The knowledge of healers on use of plants for treatment of eye diseases as documented during the present study may be scientifically validated for developing possible drugs for future use.

RECOMMENDATIONS

The traditional medicinal practitioners have been treating various eye diseases by using herbs and herbal formulations. There is a need to document such important ethno-medicinal plants and herbal formulations for the welfare of the communities.

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