



Research article

Socio-administrative conservation and collection practices of the sacred Thal Kedar forest, Uttarakhand, India

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ABSTRACT

The long-lasting association of humans with the forest is directly linked to the livelihood of natives without cultures, traditions, and beliefs. A survey conducted for the phytodiversity of the sacred Thal Kedar forest, Uttarakhand, India, reveals it as a center of spiritual approach and controlled by moral values rather than regulatory norms for conservation and sustainable benefits. Detailed investigation via group discussions, key informant interviews, observation of participants, and secondary data collection deciphers that the sacred forest plays a potential role in the food and health of the people, both at the local and regional levels. In the present survey, we found that local people are effectively controlled and guided to use all resources through moral duty, beliefs, and worship rituals, an inherited practice for ecological protection, and honesty to the Deity. Forest tourism based on holy baths, a current social demand, has been emerging as a sustainable job for local youths but requires stringent parallel administrative supervision along the established social norms to avoid any materialistic mind deeds to the sacred forest. The impact of climate change and the shift of various species to higher elevations is a matter of advanced strategy to the policymakers to preserve the floristic diversity of the sacred Thal Kedar forest.

1. Introduction

Forests are a primary source of food, water, medicine, fruits, shelter, bedding materials, fuel, fodder, and appliances for agriculture in rural areas, globally [1, 2]. The Himalayan mountainous forests have an additional feature as the 'sacred natural forest sites', a common center of different cultures, different social groups, different traditions, and different beliefs associated to express the inner human feelings including the untold pain of life. It is a domain of interaction with human beliefs and nature [3, 4]. These sacred sites play an important role in the socio-cultural and religious life of the local people in Uttarakhand, India, where rituals and ceremonies are often carried out to propitiate ancestral spirits and deities for good agricultural yields, ample rain, the well-being of animals and humans, and free from natural calamities [5, 6, 7, 8, 9, 10, 11]. The sacred Thal Kedar forest is one of these sites [4, 10, 11, 12], and the

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age of the sacred site is more than 800 years [4]. Upreti and Tiwari (2020) have described the unique plant diversity, and ecological health benefits of the natural heritage sites with special emphasis on the benefits, and day-to-day requirements of the indigenous tribes [12]. The authors have cited the diversified flora and fauna of the sacred forest with a good environmental and edaphic factor, a socio-religious institution as well as a reservoir of biodiversity. Upreti et al (2018), and Singh (2011) have reported the cultural, and ethnomedicinal importance of the Thal Kedar sacred grove [11, 13].

A study on the rich species diversity of the main floral (angiosperms, gymnosperms, ferns, mosses, lichens, and algae) and faunal groups (mammals, birds, reptiles, amphibians, and butterflies) of the sacred Thal Kedar forest have inspired to document a certain specific feature which has been compiled as a research report in the present article.

The sacred Thal Kedar forest (1497-2602 MSL) is a traditionally conserved forest guarded by a group of surrounding villages through their own set of rules, in the form of taboos, religious sanctions, and belief systems. The sacred forest is spread over 195 ha, dedicated to Lord Shiva and local deities [12], therefore, not exploited for the sake of livelihood, and is undisturbed. There are about 15 villages with 869 households in the surroundings of the Thal Kedar Sacred Natural Site (TKSNS). These villagers are judiciously using the forest resources as per the requirement and by following the set rules including a total ban on green felling, transportation, and trade [14], except with the permission of the District Forest Officer. These moral-based set rules have maintained the distinctive cultural identities, livelihood styles, integrity, and health of the indigenous people and the forest ecosystem on which they depend. The main objective of this article is to widely popularize the wisdom to conserve associated with the sacred Thal Kedar forest and utilize its herbal treasure as modern green medicines.

2. Methodology

2.1. Study sites and method

The survey was conducted to achieve authentic information with extensive dialogue with the inhabitants of villages around the sacred forests using Participatory Rural Appraisal (PRA) tools [15]. The respondents comprised of the above 18 years young and old, male, and female. Identification of plants and documentation of uses, the procedure adopted for value addition by local/-rural peoples, traditional knowledge holders/-local Vaidas including Ayurvedic Doctors were personally approached to know the local names, religious, cultural, and medicinal importance of the mentioned plants. The collected plant specimens were identified by the botanist using different floras and manuscripts, standard literature [16, 17, 18].

2.2. Study area

The study area is located between $29^{\circ}31'53.61''$ north longitudes and $80^{\circ}41'26.73''$ east latitudes District Pithoragarh, Uttarakhand, India (Figure 1). The forest has an extended area of about 195 ha at the elevation 1497-2603 MSL at the confluence of Kali and Saryu at South, Pancheshwar, the border of District Champhat, Uttarakhand, India. It is a *Quercus leucotrichophora* and *Rhododendron arboretum* rich type sacred forest [11, 19]. The scattered terrace cultivated land at the bottoms of the sacred forest with human settlements, where different plant species are in use for day-to-day activities, even in traditional ceremonies, and their home remedies, with associated folks. Villages, namely Barabey, Gyalpani, Toli, Chobat, Aath-Goa-Siling, Nakhel, Bhelot, and Gurna, were selected for ethnobotanical analysis and folk applications.

2.3. 3. Data collection and analysis

The research methods followed in the present investigation were group discussions, key informant interviews, observation of

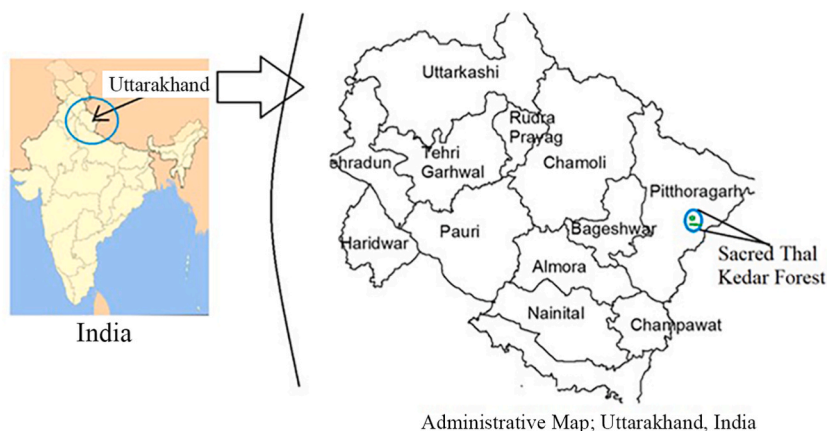


Figure 1. Graphic map of the survey site.

Table 1

Folklore herbs and associated knowledge from the sacred Thal Kedar forest, Uttarakhand, India.

S. No.	Botanical Name	Local Name	Family	Habit	Food/ Fodder	Parts used	Medicinal value	Other uses
1	<i>Berberis aristata</i> DC.	Kirmoda	Berberidaceae	Shrub	Fodder	Roots Fruit	Decoction of roots is used in diarrhea, jaundice, skin disease, and fever	Fresh berries are edible.
2	<i>Cornus capitata</i> Wall.	Kasmol	Cornaceae	Tree	Fodder	Leaves fruits	Bark decoction is used to clean dogs with their allergy.	Wood for pulleys, shuttle, bobbins, mallet heads, and for gunpowder, charcoal.
3	<i>Daphne papyracea</i> Wall.	Baruwa	Thymeleaceae	Tree	Fodder	Stem Bark flowers	The plant is diuretic, expectorant, and purgative, and is also used for fever and gastric disorder.	The bark is used for making paper, dyeing wool, cotton, and flowers offered in the temple.
4	<i>Eleagnus umbellata</i> Thunb.	Gyali	Eleagnaceae	Shrub	Food	Fruits	_____	The fruit is edible.
5	<i>Jasminum humile</i> Linn.	Pilichameli	Oleaceae	Shrub	Fodder	Root Flowers	Roots used in ringworm treatment	The root yields a yellow dye, and the flowers yield aromatic oil.
6	<i>Lyonia ovalifolia</i> Drude	Angyar	Ericaceae	Tree	Fodder	Leaves Flowers	Leaf and flowers in skin allergies and are also used as insecticides.	A good fire-resistant and soil binder. Wood for turnery work.
7	<i>Mahonia napaulensis</i> DC.	Kaniya	Berberidaceae	Shrub	Food	Fruit Roots	Berries are edible and considered a diuretic	Used as fuel.
8	<i>Myrsine africana</i> Linn.	Ghani/ banwan	Myrsinaceae	Shrub	Fodder	Fruits Leaves	Fruits are anthelmintic given in ringworm and tapeworm infection, and useful in dropsy and colic pain.	The villagers use it for making a broom. Plant gum is edible and used for making adhesive.
9	<i>Persea duthiei</i> Kostem.	Gardar	Lauraceae	Tree	Food	Fruits Leaves	Extract of plant has antibacterial activity.	Fruits are edible, Wood is used as fuel.
10	<i>Pinus roxburghii</i> Sarg.	Kulain	Pinaceae	Tree	Food/ Fodder	Resin	The resin of the plant applied to sprains and septic wounds	Used widely as fuel and construction work.
11	<i>Pyrus pashia</i> Buch.-Ham. ex D. Don	Mehal	Rosaceae	Tree	Food/ Fodder	Leaves Fruits	Fruits used to treat digestive disorders	Stem is used for making walking sticks and building work. Fruit is edible.
12	<i>Pyracantha crenulata</i> Roem.	Ghingharu	Rosaceae	Shrub	Food/ Fodder	Root Fruits	The root is boiled in water and used to bath to cure body pain	Wood is used for making tools and Walking sticks.
13	<i>Quercus leucotrichophora</i> A.Camne	Banj	Fagaceae	Tree	Fodder	Leaves	Barks, leaves, and seeds of the species are used to treat human ailments as well as for the livestock	Used for agricultural implements.
14	<i>Quercus floribunda</i> Lindl.	Tilonj	Fagaceae	Tree	Fodder	Leaves	_____	Used as firewood.
15	<i>Quercus lanata</i> Sm.	Rianj	Fagaceae	Tree	Fodder	Leaves	_____	Used for agricultural implements and as firewood.
16	<i>Rhododendron arboretum</i> Sm.	Brunj	Rosaceae	Tree	Food/ Fodder	Leaves flowers	Paste of leaves is useful in wounds and cut, also in cold and cough.	Leaves are used as a vegetable. Flowers are used for making juice, used for fuel & charcoal, also for building, tool handles & toys, boxes, etc.
17	<i>Rubus biflorus</i> Buch. Ham. ex D. Don	Kala Hisalu	Rosaceae	Shrub	Food/ Fodder	Leaves fruits	_____	Fruits are edible.
18	<i>Rubus ellipticus</i> Sm.	Hisalu	Rosaceae	Shrub	Food/ Fodder	Leaves fruits Roots	Root juice cures stomachache	Fruit is edible and sweet.
19	<i>Rubus niveus</i> Thunb.	Gowriphal	Rosaceae	Shrub	Food/ Fodder	Fruit Leaves Root	Root juice is used in colic pain, and canned leaves for relaxing uterus muscles, are given during painful periods in women.	Fruit is edible and sweet.
20	<i>Rubus paniculatus</i> Sm.	Kala anchhu	Rosaceae	Climber	Food/ Fodder	Leaves Fruits	_____	Fruit is edible.
21	<i>Sarcococca hookeriana</i> Rehd. Ex Wilson	Sukat sing	Buxaceae	Shrub	Fodder	Leaves	Leaves are used to treat fever, rheumatism, reduce blood pressure	_____
22	<i>Spiraea canescens</i> D,Don	Takoi	Rosaceae	Shrub		Fruit Leaves	_____	Used for making dye.

(continued on next page)

Table 1 (continued)

S. No.	Botanical Name	Local Name	Family	Habit	Food/ Fodder	Parts used	Medicinal value	Other uses
23	<i>Symplocos chinensis</i> Chin Moore	Lodh	Styraceae	Tree	Fodder	Leave Bark	—————	A yellow dye is obtained from the bark and the leaves
24	<i>Symplocos ramosissima</i> Wall. ex GDon	Lodra	Styraceae	Shrub	Fodder	Bark Seed Leaves	Bark extract used in eye disease.	Bark and leaves are used for yellow dye, as a mordant with Madar seed oil illuminant, and wood for bend work and carving.
25	<i>Viburnum cotinifolium</i> D. Don	Gwiya	Verbenaceae	Shrub	Food/ Fodder	Seed Bark	Roots and stem bark aromatic	—————
26	<i>Viburnum mullah</i> Buch. Ham. ex D. Don	Lal Titmuliya	Verbenaceae	Shrub	Food/ Fodder	Bark Fruit	The root and stem bark aromatic	Branches are used for making walking sticks, wood is used as fuel.
27	<i>Wikstroemia canescens</i> Meissn.	Chamliya	Thymeleaceae	Shrub	Fodder	Bark	The bark is used as a purgative	Bark fiber for making ropes.
28	<i>Zanthoxylum armatum</i> DC.	Timru	Rutaceae	Shrub	Fodder	Seeds	Seeds used in toothache. The bark is useful in intoxicating fish. Leaf oil is antifungal.	The twigs are used as toothbrushes. Seed oil for making soaps and hair lotion.
29	<i>Ageratum conyzoides</i> Linn.	Ganya	Asteraceae	Herb	Fodder	Stem Leaves	The powder of the plant is applied to the wounds of cattle.	—————

participants, and collection of secondary data. Interview data were the basic sources of information as the circumstances and feelings of the respondents could be understood better through voice [20]. Further, interviews were more useful as a voice for the relationship between the associated wildlife of the forest and villagers. The details on the household application of plants in healthcare were documented (Table 1). The information via interviews of elderly people (both male and female) of villages on wildlife-related folk stories of the Thal Kedar forest, cultural practices, and religious beliefs were the same for everyone. Semi-structured interviews were conducted with village leaders (Gram Pradhans), and youths including traditional healers, priests, and available educated persons with key tipsters and public opinion in selected villages. Many of these elderly persons who were actively engaged in religious activities have revealed folklore stories and offered rich explanations of historic and natural events, village regulations, productive and sacred forests, and the wild-animal-protection strategy adopted by all villagers. Ten households were arbitrarily selected from each village and worked tremendously with these families using a semi-structured application to understand the interrelationship between forest wealth and their livelihoods. Based on the available village population and average expected participants, four focus groups, each of 26 participants (12 men and 14 women) aged between 35 and 80 years (verbally, birth certificates were not available) were made, but the total number present participants were 79 [22 from village Barabe, 18 from (Toli, Gyalpani and Chobat), 20 from Aath-Goa-Siling, and 19 from Bhelot and Gurna]. Discussions were held with all participants in four groups with the help of village leaders based on their rich indigenous knowledge and participation in cultural ceremonies and rituals. With the help of these groups, the most important events related to forest wealth including conservation practices were gathered.

For the key indicative group discussions and interviews, the interview question paper was segregated into three parts, each with a distinct goal. The first part was to gather household knowledge on forest wealth including conservation. Each interviewee was asked to narrate the folktales, their religious faiths, and associated emotions with sacred forests, traditional customs, and culture. In the second part, participants were asked to narrate their role and activities in annual rituals at certain sites of the sacred forest, they believed in the legend of sacred cow footprints. Further, interviewees were asked to answer about the legacy of native healing knowledge associated with plants from the sacred Thal Kedar forest. The respondents were also asked about the effectiveness of rural regulations in protecting the forest's wealth, the tourism benefits of the holy bath at Lateshwar Mahadev Temple, and the possible commercial use of medicinal plants from the sacred forest.

3. Results

3.1. Physiographic zones of the sacred Thal Kedar forest

On the Southeast of Pithoragarh city, there is a beautiful sighting view of the middle hill surrounded by the dense forest, the Thal Kedar Forest Rest House (FRH) about 18 km from the Pithoragarh-Aath Gaon Siling-Deodar-Thal Kedar Road. This FRH was built in 1962 at an elevation of 1951MSL. The forest road to the FRH which bifurcates from the Deodar village is about 10 km. The ancient temple of Shiva, popularly known as Thal Kedar Temple on a hilltop (2602 MSL), is a very popular, and highly sacred site. Forest nursery is one km away from the FRH, a worthy nursery to visit researchers and a gene pool center of the sacred forest. A drive on the Deodar-Thal Kedar-Bhiloant forest road about 12 km is a primary view to understand the wildlife (Giant Flying Squirrel, Porcupine, Jungle Cat, Leopard, Indian fox, Jackal, barking deer, black bear, Sambar, Ghural, etc.) of the sacred Thal Kedar forest [21].

The Pithoragarh town is located at a height of 1645 m above sea level. The district lies between 29.4° to 30.3° North latitude and

80°–81° East longitude along the eastern and southern part of the central Himalayas with the Indo-Tibetan watershed divide in the north and the Kali River forming a continuous border with Nepal in the east. The Pithoragarh district is surrounded by the national boundaries of Almora, Champawat, Bageshwar, and Chamoli districts and extends over an area of 7217.7 sq. Km. The Forest Department, Uttarakhand, India is the main regulatory agency of the sacred Thal Kedar forest for effective support services, though hardly any unruly incidents [22].

The vegetation of a particular ecosystem is generally influenced by external factors especially anthropogenic activities [4, 23, 24, 25], and sudden changes in the composition of plant structures are associated with the biotic and abiotic factors [26, 27, 28, 29, 30]. The current vegetation of the sacred Thal Kedar forest is completely natural and pristine [4], as there are no interfering external factors in the biotic and abiotic environment, especially for the last six decades the anthropogenic activities are negligible as informed by the elderly people during the interview.

3.2. Faith and beliefs-based forest management

The total area of the sacred Thal Kedar forest is managed by faith and beliefs to maximize conservation, and only need-based utilization of its resources by the local people, with full honor to the order of Divisional Forest Officer (DFO), Govt. of Uttarakhand, India, if any. The art of utilization of forest resources by indigenous people is directly associated with the deep faith in Mother Nature, i.e., the management of the Sacred Thal Kedar Forest is entirely different from commercial value-based scientific forestry [31]. During the survey, all 79 participants were with one voice to have faith in their centuries-old and adopted policy to utilize the forest resources (Table 2).

3.2.1. Sacred tree worship

The high respect for Mother Nature and fear of supernatural powers is the core respect for each plant, especially for the older trees. People like to spend a few minutes being blessed by older trees of their ancestral times for good health and family prosperity, an ancient religious custom of the area.

3.2.2. Customary laws and regulations

During the survey orally was informed that there is no clear policy to punish cutting green trees if any, but a taboo that cutting the main branch of a green tree is equivalent to killing a human. The age-old diseased trees are utilized for fuel on the consent of villagers, it was informed. The dried branches are used for fuel and leaves for fodder are freely available to rural people except for the most sacred sites for centuries, villagers have informed. If any villagers violate established rules, he/she is morally convicted by the family and villagers and punished by forest regulatory officers on the complaint.

This recognition of indigenous arrangement by all villagers effectively guarantees the sustainability of traditional rules, and there is an arrangement by Govt. Forest Dept. for legal action against unruly persons, if any.

3.2.3. Utilization of forest resources

The spiritual view of the native people of the forest and the psychology of fear of cursing for unethical deeds against the indigenous traditional faith-oriented rules inhibit people from destroying the forests. The insight and remembrance of forest welfare prompt them actively protect and care for trees based on the passing down of traditional knowledge. The rich root system of trees results in sturdy soil increases the water contents in mountainous areas and prevents landslide debris. Villagers believe that this is due to the forest deity who firmly grasps the soil and does not harm the forest vegetation. Rich forest resources also bring a wealth of edible wild fruits (e.g., *Berberis aristata*, *Cornus capitata*, *Juglans regia*, *Myrica esculenta*, *Pyracantha crenulata*, *Pyrus pashia*, *Pyrus pyrifolia*, *Rubus ellipticus*, *Rubus occidentalis*, etc.). Villagers teach their children how to identify these fruits on ripen edible stage, and how to pick up them. All these activities promote welfare without any harm to vegetation and lead protection of the forest.

3.2.4. Dev Van of Lateshwar Mahadev and holy bath

A part of the sacred Thal Kedar forest dedicated to the local Deity named 'Lateshwar Mahadev', is located very near and adjoins the road head at village Barabe. 'Dev Van' is a Hindi word that means the forest of God. The Dev Van of Lateshwar Mahadev is a well-

Table 2
Survey report for anthropogenic activities in future at the Sacred Thal Kedar Forest.

S. No.	Query	Response of Participants (%)			Remarks
		Yes	No	No idea	
1	Collect the annual medicinal plants at the stage of highest therapeutic potential	—	100%	—	Against the faith, but ready to follow the Govt. order.
2	Remove dead, dying, and damaged individuals of all species.	—	100%	—	Against the faith, but ready to follow the Govt. order.
3	Remove all useless bush species from the forest.	—	100%	—	Against the faith, but ready to follow Govt. order.
4	Collect the bio-waste as deer's thorns, etc.	—	100	—	Against the faith, but ready to follow Govt. order.

protected and conserved forest with a centuries-old heavy stone wall around it. It has rich vegetation of species such as *Quercus- Q. leucotrichophora*, *Q. semecarpifolia*, *Rhododendron arboreum*, *Myrica esculenta*, *Prunus cerasoides*, etc., and very few trees of *Cedrus deodara* and *Alnus nepalensis*. There is a folklore that in ancient times there was one demon that used to terrorize the villagers. The demon was killed by Lord Shiva by suffocating him with his Matt (cluster of hair) and hence the name Lateshwar was given to the Deity. The villagers and nearby towns of district Pithoragarh have very high respect for the Lateshwar Mahadev and strictly adhere to rituals and associated taboos. A common pathway passes from inside the campus of the Dev Van, but no one dares to pick up even dried twigs or branches unnecessarily from the campus [32].

There is a stream of fresh water from the rock and has the value of the Ganga water, the holy Hindu River. People suffering from skin disease get cured after taking bath, and many medical cases declared as terminal stage have been reported cured by drinking the water, villagers have informed. Many unruly people have been seen regretting their deeds, and publicly asking mercy from the Deity for their crimes inside the campus.

3.2.5. Faith and beliefs-based forest conservation practices

The Sacred Thal Kedar forest is managed under the influence of local common culture, based on ethical values with riders within the clans, and take-over by family traditions. Local people of other beliefs (Christian, Islamic, etc.) have the same respect as the native Hindu population, and never disobey the common duties formed for forest protection. Kids learn these rituals from their day-to-day exposure and interaction with social programs to protect and respect nature, obey simple ecological values, and respect sacred trees. All wild animals including panthers and birds can be easily observed at mid-day time from the Sacred Thal Kedar Forest Rest House.

3.3. Faith and beliefs in animals' conservation

The protection of all wildlife is offered by the indigenous common knowledge, faith, and beliefs of the native peoples of the area. The Super Deity (Lord Shiva) and Deity (local Gods) are assumed to monitor the entire area including all wild animals and birds. There are sacred trees scattered here and there in the forest that are regarded as protecting every living being including the small herb also. The villagers prefer to regard these trees as a symbol of cryptic power and sagacity.

3.3.1. Divine cow worship

There is a site on a rock having the footprints of the ancient Holy Cow, the Kapil. People whenever visit Lord Shiva temple they offer their respect at the site in memory of the Kapil Cow and narrate the concerned folklore to the younger.

3.3.2. Rare Himalayan Bear's conservation

There are a few family constraints to each one of the natives for the protection of animals and vegetation of the sacred Thal Kedar forest, the site of the cave of the rare Himalayan Bear is one of them. The age-old trees at the site reveal the checked anthropogenic activities in themselves, probably it may be based on fear and taboos. During the winter hibernation period, the Himalayan Bear is supposed that Bear is on meditation and worship Lord Shiva; a regret for sin committed during the summer season. This folk knowledge is passed by blood-based social relations to the next generation in all native communities of the surrounding villages.

3.3.3. Nature education-based stories

During the survey key tipsters informed that most of the folklore in their villages is common on birds locally called Ghughut, (Hindi name; Mountain Dove; Zoological name; *Spilopelia chinensis*). The story induces villagers to kind to the infants and considers all factors before punishment to anyone. During spring, a lament-type song of Ghughut inspires each family head to visit his/her married sisters and daughters with a few homemade and self-cooked sweets, locally known as 'Bhetoli'.

A key figure during the survey informed that the spring season overcomes after harsh winter. In the olden days, in the far-away scattered villages, very poor roads were on hilly complex terrain, and difficult. There were no means of communication with the outside village etc., and life was very inconvenient in the region, so practice was adopted to visit the house of the married female of the family to know about her health and well-being. The voice of Ghughut in the regional folklore is considered a silent lyric of the married family female waiting for her parental family members during the spring.

3.3.4. Bird conservation

Like the protection of plants, the indigenous people practice protecting birds, especially Crows during extreme winter as most of the area is covered with snow, and birds have hardly anything to eat. Every year on January 15th there is a Crow Festival in the region. People prepare different indigenous dishes and offer them in the early morning to the Crow. This ritual is also associated with folklore that Crow carries our well-being to our ancestors in Heaven on that day.

3.4. A repository of herbal medicines

The sacred Thal Kedar forest is composed of Deodar, Quercus, Pine, and miscellaneous vegetation. The saucer-shaped area of the forest around Lord Shiva temple is occupied by *Cedrus deodara* at the bottom middle portions are covered with Banj (*Quercus leucotrichophora* A. Camus), Kaphal (*Myrica esculenta*), Moru (*Quercus floribunda* Lindley ex Rehder), Kharsu (*Q. semecarpifolia* J.E. Smith), Burans (*Rhododendron arboreum*), Chir pine (*Pinus roxburghii*), Mehal (*Pyrus pashia* Buch. -Ham. ex D. Don), and Kingora (*Berberis aristata* DC., *B. asiatica* Roxb. ex DC Fairly), Bhuin kafal (*Rubus ellipticus* Smith), etc., as undergrowth. This sacred forest is regarded as

the treasure house of important plant species as it supports the luxuriant growth of angiosperms, gymnosperms, ferns and fern-allies, liverworts, mosses, lichens, algae, and basidiomycetous fungi.

3.4.1. Medicinal plants collection, processing, and marketing

Local traditional healers collect the desired herbs as per need from the Sacred Thal Kedar forest if it is not in their field, even walnut fruits from the forest are not collected, and Himalayan Monkeys were found cracking the nuts and eating during the survey. The excess collection of the herb is associated with the taboo that the healer will be infected with the disease and will use it to cure himself of the excess medicine as reported during the survey.

3.4.2. Interaction between science and traditional knowledge

The traditional healers and Ayurvedic Doctors were very few in villages and were available in the village on holidays only were keen to attend the seminar and workshops on modern molecular science and traditional practices. Traditional healers and youth were not found to know/-exposed to seminars, conferences, and workshops to connect modern molecular science to traditional practices.

4. Discussion

The present survey results reveal that the Sacred Thal Kedar forest is a common sacred center for people of different cultures, traditions, and beliefs, and all respect the common traditional set of rules passed through generations orally. All the communities have a common system for the protection of animals and plants. Their local knowledge integrates the religious and social values accepted by all to protect the environmental system. This moral value-based local knowledge come-into from ancestors and is passed from era to era through stories, rituals, moral constraints, and customs. The folklore stories emphasize the relationship between the environment and human beings and help to decipher the value to protect biodiversity. It is worth noting that moral constraints formed by society are laws for wildlife protection due to the inconvenience in communication between the outside world and the village in the olden days, which are strictly followed by the time. It is due to the strong adherence and severely condemned by all at the same time as someone violates the values. The strong adherence to these moral-based values resulted in reduced trust in the culprit and its effects on his/her normal life, funerals, weddings, and other social roles. Because of the current changing livelihood avenues and material aspirations in urban life, a tendency to use unsustainable means of natural resources [2] may degrade moral-based forest management. Modern forest management is based on scientific art assisted by the police system to restore the ecosystem and biodiversity-based measures [33, 34]. The early stages of the scientific concept neglecting the indigenous contribution have failed [35, 36] and both indigenous contribution and scientific knowledge are equally important to promote the development of biodiversity conservation. The confined local knowledge may lead to adverse effects on wildlife, so scientific intervention is equally important.

The Himalayan mountainous forests are rich in wild edible fruit plants. Wild edible fruiting plants such as *Cornus capitata* Wall ex. Roxb., *Pyracantha crenulata* (D. Don) M. Roem., *Pyrus pashia* Buch.-Ham. ex. D. Don., *Rubus ellipticus* Smith, *Viburnum opulus* Linn., etc. have high market demand as used in herbal healthcare practices. Fruits of these plants control the blood glucose level, increase insulin sensitivity, scavenge free radicals, maintain blood pressure, and reduce cholesterol [37]. These plants have an important position in the spiritual-healthcare system of indigenous peoples of the region and are a source of income [38], such as *P. crenulata* (local name: Ghingharu) fruits are used as a cardio-tonic, coronary vasodilator, and to manage hypertension. The antioxidants of *P. crenulata* fruits scavenge free radicals in our bodies, and its leaves are used in the preparation of herbal tea, sunburn creams, and many cosmetic items in folk [37]. There is a need for a change in moral-based utilization practice in view of localized plant species and their wide application in the healthcare sector, to fulfill the market demand. The collection of edible fruits from the sacred Thal Kedar by adopting community-based trade and profit-sharing patterns under local administration may develop into a sustainable employment form.

'Shinrin-Yoku' (SY), also known as forest bathing (FB), a Japan's traditional healing practice been a form of holy bath (HB) at Deb Van of Lateshwar Mahadev since ancient times for physiological and psychological healthcare purposes [39, 40, 41, 42].

Quercus forests conserve more water as compared to Pine forests [43], so small artificial ponds in the sacred Thal Kedar forest may be more beneficial to collect the rainwater on barren slopes of the mountainous peaks. It will be beneficial to wildlife and natural water resources, especially at the tops of the holy bath centers. There is a need to balance the increased forest tourism, and economic interests like hotels and parks on the barren land with due honor to socio-cultural perspectives, and Govt. regulations.

There are many traditional conservation practices developed and followed by indigenous communities in different parts of the world for the protection of biodiversity, and sustainable utilization [44, 45, 46]. The sacred forests and sacred groves help in maintaining a healthy ecosystem, protecting the ecosystem, conserving the flora and fauna, and preserving the culture.

The indigenous mountainous people living nearby forests have traditional knowledge to cure various diseases through herbal healing practices [47, 48, 49, 50] based on personal experience and ancestral prescription [51, 52]. These herbs are cheap, effective, and beneficial without severe side effects compared to allopathic, costly medicines [50, 53, 54]. However, the current modernization has reduced indigenous knowledge and affected the collection, transportation, and processing, methodology [48, 55]. Further, the non-scientific and haphazard collection involves uprooting the whole plant species, even if only one part is needed [56], resulting in the extinction of many important herbs including highly economically valuable and endangered species [55, 57].

Medicinal plant marketing is a sustainable job for local people to enhance their income [58], but the increased market demand for herbs has created a much higher pressure on the wild medicinal flora of the sacred forests and groves [59, 60].

Saxena et al. and Singh et al. have reported about the anthropogenic activities of urbanization, and road infrastructures have threatened many sacred forests and groves, and materialistic and economic forces have influenced the traditional communities to discard the community-oriented protection approach [61, 62]. Singh and Saxena have reported on the changes in people's attitudes to

the sacred groves (Orans) at Shekhala village (Rajasthan), India, for conservation and preferred more income generation [63], similarly at Peepasar and Khejarli villages due to preferred grazing [64]. The coffee plantations and human habitation has been recorded around the sacred groves in Kodagu districts, Karnataka, India [65]. Traditional ways of resource management are becoming nonfunctional due to the direct conflict between the ever-increasing human population and limited natural resources [66]. The myths and beliefs of earlier days associated with the sacred forests and groves no longer enjoy the same status and privilege as they used to in the past [65, 67, 68].

5. Conclusions

The case study reveals that a spiritual protective attitude is inherited from generation to generation in the conservation, collection, and sustainable utilization of all the forest assets of the sacred Thal Kedar forest. It has an impactful role in protecting wildlife and conserving the natural forest ecosystem. In this study, we found that the indigenous people effectively controlled the use of natural resources through public opinion constraints, moral constraints, and honesty to their Deity. The whole system is based on respect to Mother Nature and the oral transmission of local art for the protection and survival of wildlife resources in a specific climate of the Himalayan mountains, but the changing livelihood and increasing economic aspirations of present societies, the 'sacred-sites-forest-management strategy' have faced unsustainable use of natural resources, and degradation of forests ecosystem, in many parts of the country. It is time to develop a stringent mechanism to overcome these possible threats in the future. At the same time, forest tourism and holy bath-related activities are rapidly increasing, so a strong guard of the indigenous protection system under the supervision of local forest administration is necessary. The increased tourism and rapid communications pattern of modern societies may affect the spiritual and moral-based forest and wildlife conservation practices, so there is a need to adopt a parallel high-tech administrative vigilance of the forest to secure the untouched natural wealth of the region. A mind-body-spirit experience developed through the holy bath, green and pleasant views of the forest offer an authentic way of healing the mind, body, and spirit, so the elderly population preferred locations such as the sacred forest sites may locally be managed by retired judges, scientists, and army officers.

The impact of global warming and raised temperature may shift different species to higher elevations. The impact of these climate change-induced phenomena is a future task for policymakers, and stakeholders to protect, and manage the sacred Thal Kedar forest.

The erosion of traditional healing procedures and practices due to modernization and anthropogenic pressures is to be checked by digital documentation of the knowledge, which may lead to new drug delivery modes for a particular body ailment. Modern conservational strategies for awareness of biodiversity protection and promotion of herbal healthcare tourism will benefit the sustainable economic development in the region.

Ethical approval

There are no studies on animals or humans, so ethical approval is not required.

Author contribution statement

LineNoBookmarkStart:ID:83 = Name:Line_manuscript_88].

Devi Datt Joshi, Virender Singh Rana, Harendra Kharkwal: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data. Contributed reagents, materials, analysis tools, or data; Wrote the paper.

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Declaration of interest's statement

The authors declare no conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2023.e14619>.

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