Annals of Science and Allied Research **Vol. 2 (1) June, 2024: 66-75.**
https://doi.org/10.5281/zenodo.12621997
ISSN – 2584-2307 (Online)

TRENDS OF KAFAL TREE RESOURCES UTILIZATION IN GARHWAL HIMALAYA: DECADAL DYNAMICS FROM 1985 TO THE PRESENT

Shalini Rawat, Preeti Khanduri*, Dinesh Singh Rawat*, Suniti Kumar Kuriyal & Gulshan Kumar Dhingra

Department of Botany, Pt. L. M. S. Campus, Sri Dev Suman Uttarakhand University, Rishikesh -249201, Uttarakhand, India

*Authors for correspondence: khanduripreeti23@gmail.com, dsrwt7@gmail.com

(Received on June 10, 2024; Revised on June 19, 2024; Accepted on June 26, 2024)

ABSTRACT

This study deals with the utilization of 'Kafal' tree resources in the Garhwal Himalayas, focusing on the decadal trends from 1985 to the present. The 'Kafal' tree (*Myrica esculenta*) is culturally and ecologically vital to the region, offering wild edible fruits and being utilized for various medicinal and agricultural applications. Despite its importance, there is a lack of comprehensive understanding regarding the decadal dynamics of its utilization. Therefore, this study aims to fill this gap by documenting traditional knowledge and practices related to 'Kafal' tree resource utilization and analyzing the trends through a decadal analysis approach. Field visits were conducted across 15 villages in Chamoli, Pauri, and Tehri districts of Uttarakhand, where data on traditional uses of 'Kafal' tree resources were collected through interviews and discussions with local communities. The use citation index (UCI) was calculated to classify the prevalence of different uses, ranging from predominant to not used. Additionally, a decadal trend analysis was performed, categorizing individuals into decadal classes based on their age and capturing the evolving patterns of resource utilization over time. Results indicate a significant decline in the consumption of 'Kafal' tree resources across various use categories from 1985 to 2024. This decline reflects shifting socio-economic dynamics and resource utilization patterns in the region.

Keywords: Decadal trend analysis, 'Kafal' tree, Resource utilization, Traditional knowledge, Uttarakhand.

INTRODUCTION

The Indian Himalayan region (IHR) has a remarkable diversity of vegetation types, as evidenced by its wide range of forest types (Champion & Seth, 1968). These include dry-deciduous tropical forests, evergreen broad-leaved rainforests, broad-leaved mixed forests, evergreen coniferous forests, and treeless alpine forests (Bahuguna et al., 2016). The mid-elevation zones of the IHR are primarily characterized by evergreen broad-leaved tree species, which form broad-leaved-conifer mixed forests at both their upper and lower elevational transitions (Das et al., 2020). Among the various evergreen broad-leaved tree species in the montane zone of the IHR, *Myrica esculenta* stands out as one of the most popular trees among the local inhabitants. This popularity is largely attributed to its delicious fruits, which are highly valued by the local communities (Bisht et al., 2010; Gusain & Khanduri, 2016; Sawian et al., 2023). The tree not only provides nutritional benefits but also contributes to the ecological stability and biodiversity of the Himalayan forests.

Myrica esculenta Buch.-Ham. ex D.Don (family Myricaceae), commonly known as the Box berry or Himalayan bayberry, is called Kafal (or Kaphal) in Uttarakhand. *Myrica esculenta* is an evergreen tree that can grow up to 18 meters high **(Figure 1.A).** The leaves are alternate and crowded at the ends of branches, measuring 6–16 cm in length and 3–6 cm in width. They are glossy on the upper side and dotted with a glaucous hue on the underside. The flowers are minute and unisexual. Male flowers are 1.2–1.5 cm long, pale-brown to reddish catkins, and appear in branched axillary clusters **(Figure 1.B).** Female flowers grow in erect axillary spikes. The fruits are sessile, up to 1 cm long, ovoid or

ellipsoid, succulent, dark red or purplish when ripe, and contain a rough stone **(Figure 1.C–E).** Fruiting starts at the beginning of mid-April and lasts till the month of mid-July.

The natural distribution of this species extends from the Himalayas to southern China and western and central Malesia, encompassing areas such as Assam, Bangladesh, Borneo, China, Java, Myanmar, Nepal, the Philippines, Sumatra, Thailand, and Vietnam (POWO, 2024). It grows primarily in the montane ecosystems, thriving in open, mixed forests on mountain slopes at elevations between 300 and 2500 meters, and is abundant in Oak-Rhododendron forests, usually in shady localities (Rawat et al., 2018). In India, *M. esculenta* is found in Arunachal Pradesh, Himachal Pradesh, Sikkim, and Uttarakhand at elevations ranging from 1200 to 2100 meters (Singh et al., 2019). In Uttarakhand, it is a common tree in the broad-leaved montane forests between 1000 and 2200 m asl. Besides being found in deep forests and forest margins, the tree also thrives on grassy slopes, in association with chir pine patches, and as an agroforestrytree in terraced hill agriculture (Naithani, 1984, 1985; Gaur, 1999). In Uttarakhand, the fruit of *M. esculenta*, known locally as 'Kafal', is one of the most popular wild edible fruits, along with 'Bedu' (*Ficus palmata* Forssk.), 'Bhamor' (*Cornus capitata* Wall.), 'Hisar' (*Rubus ellipticus* Sm.), 'Melu' (*Pyrus pashia* Buch.-Ham. ex D.Don), 'Kilmor' (*Berberis* spp.), and 'Ghingaur' (*Pyracantha crenulata* (D.Don) M.Roem.).

Figure 1. A–B. 'Kafal' tree at flowering stage, **C.** 'Kafal' tree at fruiting stage, **D–E.** Ripened 'Kafal' fruits collected for consumption.

Annals of Science and Allied Research **Vol. 2 (1) June, 2024: 66-75.**
https://doi.org/10.5281/zenodo.12621997
ISSN – 2584-2307 (Online)

Beyond its value as a source of wild edible fruits, the tree serves multiple purposes in the hills of Uttarakhand. 'Kafal' holds significant pharmacological, ethnobotanical, and phytochemical importance, valued for its edible fruits and its leaves, fruit, and bark used medicinally to treat respiratory disorders, digestive problems, and skin ailments (Jeeva et al., 2011; Kumar & Rana, 2012; Panthari et al., 2012; Rana & Patel, 2016). Its bark is used for dyeing, the fruits are used to make refreshing drinks, and the bark has been traditionally used to intoxicate fish (Gaur, 1999; Singh et al., 2021). Additionally, its branches are used for firewood, the stem for tools and implements, and the trunk for timber (Singh et al., 2022). Recently, *M. esculenta* has attracted significant attention from researchers in Uttarakhand, particularly in the field of pharmacognosy, due to its anticancer, antimicrobial, antioxidant, and ameliorative properties (Bhatt et al., 2023; Chauhan et al., 2023; Joshi et al., 2024; Shukla et al., 2024).

Various cultures, traditions, and traditional practices, along with the traditional knowledge that has been passed down from generation to generation, are disappearing worldwide due to modernization and several other causes. The Garhwal Himalaya is no exception to this phenomenon, where age-old traditional practices and knowledge are vanishing at a rapid rate (Dhingra et al., 2024). In this region, *M. esculenta* is utilized for various purposes, as reported in many previous studies. However, the decadal trends of these uses across the Garhwal Himalayan region have not been studied so far. This study aims to explore the traditional uses of 'Kafal' in selected localities of the Garhwal Himalaya and to analyze the trends of these uses through a decadal analysis.

MATERIALS AND METHODS

Study Sites

The Garhwal Himalaya is located in Uttarakhand. This study was conducted in 15 villages across three districts, viz. Chamoli, Pauri, and Tehri, each district comprising five villages**.** Details of the selected villages are provided in **Table 1.** The selection of these districts was based on their diverse cultures and cultural practices, which influence traditional knowledge and resource utilization patterns. The study focused on areas where *M. esculenta* is abundant, particularly in the middle elevations of the montane zone. Villages were selected based on the presence and abundance of *M. esculenta* compared to other broad-leaved trees like 'Burans' (*Rhododendron arboreum* Sm.), 'Ayar' (*Lyonia ovalifolia* (Wall.) Drude) and 'Banj' (*Quercus leucotrichophora* A.Camus.). The methodology for gathering data involved sourcing total population, household numbers, and sex ratio from the eUttaranchal website, while elevation and geographic coordinates were obtained using the Google Earth application.

Data Collection

Field visits were conducted in 2023 to document traditional knowledge and practices related to 'Kafal' tree resource utilization among local communities. Periodic meetings, interviews, and discussions were held with residents, including shepherds, teachers, traditional healers (*vaidyas*), and priests (*pujaris*), to gain insights into their practices and knowledge. The use citation index (UCI) was calculated to classify the prevalence of different uses: Predominant (Pd): If a particular use is cited by over 70% of respondents; Common (Co): If a particular use is cited by 40% to 70% of respondents; Occasional (Oc): If a particular use is cited by 10% to 40% of respondents; Rare (Ra): If a particular use is cited by less than 10% of respondents; Not Used (–) : If a use category is not cited by any respondent.

Decadal Trend Analysis

In this study, the selection of decadal classes (DCs) played a crucial role in capturing the temporal dynamics of 'Kafal' tree resource utilization. The primary criteria for categorizing individuals into these DCs were their age, serving as a proxy for the study period's temporal context. Each decadal class represented a specific timeframe: DC1 encompassed participants aged over 60 years, corresponding to the years 1985–1994; DC2 included individuals aged between 51 and 60 years, reflecting the period from 1995–2004; DC3

consisted of participants aged between 41 and 50 years, representing the years 2005–2014; and DC4 covered individuals aged between 30 and 40 years, indicating the period from 2015–2024. Participant's experiences and knowledge about 'Kafal' tree resource utilization during their mature years (20–30 years) were considered indicative of prevalent trends during that particular decade. This comprehensive approach allowed for a nuanced understanding of evolving utilization patterns over the study period. A minimum of 5–10 representatives from each decadal class were interviewed using a semi-structured questionnaire method. The questionnaire encompassed inquiries about resource collection, quantity (in local scale), and utilization, thereby providing insights into evolving patterns across different timeframes.

RESULTS AND DISCUSSION

Traditional Uses

The 'Kafal' tree, one of the most versatile and multipurpose trees in the Indian Himalayas, exhibits diverse applications that play a significant role in supporting regional biodiversity, ecosystems, culture and local livelihoods. Timber from the tree is commonly used in carpentry and furniture making, building construction, and agricultural tools, although its use is more prevalent in Chamoli than in Pauri and Tehri **(Table 2).** In agriculture, stems and branches serve as tools and handles, and young trees are used as poles for supporting structures. Additionally, the tree's wood is a crucial source of firewood for cooking and heating, especially during cultural ceremonies.

The 'Kafal' tree provides edible wild fruits that are popular in Uttarakhand and occasionally sold in markets. About 80% of households consume 'Kafal' fruits during the season. However, the proportion of families involved in income generation through selling 'Kafal' fruits is low, averaging about 2-3% per village. Its juice is occasionally prepared and sold as a refreshing drink. The tree holds sacred significance in some areas, marking places of worship (Bhatt & Rawat, 2020). During dearth periods, its fresh twigs and branches are used as fodder for livestock. Leaves and twigs are employed for manure and bedding material for cattle **(Figure 2. A)**. Medically, bark paste is used to alleviate headaches, and the fruit aids in digestion. The bark of the 'Kafal' tree is used for catching fish, making local beverages, and producing yellow dye. Fresh leaves are used to produce a green colour for creating 'Chakra' (a type of sacred rangoli) during 'Athabali' worship. Most of the reported uses in this study are consistent with findings from previous research conducted in other regions of Uttarakhand (Gaur, 1999; Shukla et al. 2017).

Decadal Analysis

The results on the average consumption of 'Kafal' tree resources per village per year indicates a significant decline across nearly all use categories from 1985 to 2024 **(Table 3)**.

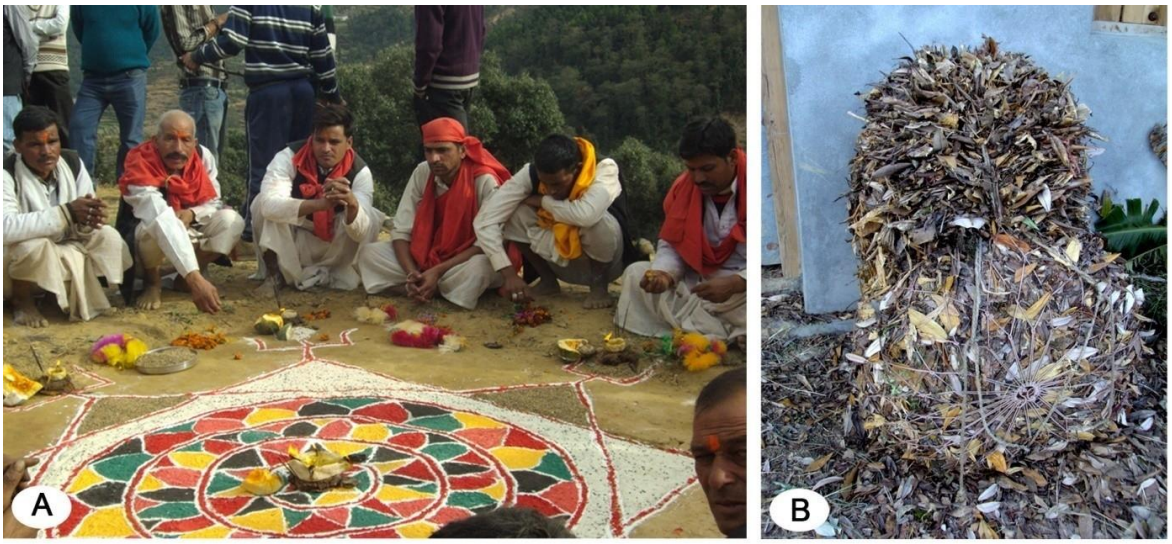

Figure 2. A. 'Chakra' prepared during 'Asthabali' worship (green powders prepared from 'Kafal' leaves), **B.** Dry litter collected for animal bedding/ mannuring purpose.

Annals of Science and Allied Research **Vol. 2 (1) June, 2024: 66-75.**
https://doi.org/10.5281/zenodo.12621997
ISSN – 2584-2307 (Online)

This trend reflects changing socio-economic dynamics and resource utilization patterns in the Indian Himalayas. The use of 'Kafal' timber for carpentry and furniture work dropped from 1500 kg in 1985–1994 to 0 kg in 2015–2024, while its use in building construction decreased from 300 kg to 0 kg in the same period. This sharp decline can be attributed to various factors, such as the availability of alternative materials (e.g., other tree species with straight, branchless trunks that are easier to work with mechanically; the replacement of wooden structures with metallic ones) and changing construction practices (shifting from traditional houses with a high amount of wood to modern lintered/cemented houses with almost no wood). The consumption of 'Kafal' wood for agricultural tools and handles has also reduced, though more gradually, from 400 kg to 150 kg. Similarly, the use of Kafal wood for firewood and fuel has significantly decreased from 2100 kg to 150 kg over the years. This decline can be attributed to several factors, including the availability of modern metallic tools and other wood species for tools and handles. Additionally, agricultural practices are decreasing at an alarming rate in the hill region of Uttarakhand due to various factors, such as migration to cities, low agricultural production, and damage to crops by wild animals. The reduction in fuelwood consumption might also be due to the increased availability of alternative fuels like LPG.

Table 1. Details of the surveyed villages from district Chamoli, Pauri and Tehri Garhwal (Uttarakhand)

Name of Village (Block, Tehsil)	**Total population**	**Households**	**Sex Ratio**	**Elevation (m)**	**Latitude/Longitude**
District - Chamoli					
Gulari (Ghat, Chamoli)	309	66	1146	1870	0°16'50.85"N/ 79°31'50.56"E
Jhinjholi (Narayan Bagar, Tharali)	222	53	1523	1900	30° 4'19.62"N/ 79°26'28.75"E
Kunakhet (Gairsain, Gairsain)	435	97	1186	2090	30° 0'23.77"N/ 79°14'28.03"E
Mandal (Dasholi, Chamoli)	452	108	1027	1600	30°27'21.09"N/ 79°16'29.82"E
Tundari (Tharali, Tharali)	168	33	953	1800	30° 3'17.63"N/ 79°33'11.95"E
District - Pauri Garhwal					
Adwani (Nainidanda, Dhoomakot)	79	19	1079	1960	30° 4'20.28"N/ 78°43'7.49"E
Kafald (Thailisain, Thailisain)	592	119	1234	1900	30° 1'1.45"N/ 79° 1'46.18"E
Khaitali (Bironkhal, Thailisain)	194	40	1587	1875	29°56'26.55"N/ 79°6'48.93"E
Rikhad (Bironkhal, Thailisain)	268	62	1233	1400	29°51'19.32"N/ 79°2'29.49"E
Sundar Gaon (Thailisain, Thailisain)	245	45	1130	2250	29°59'6.26"N/ 79°6'22.81"E
District - Tehri Garhwal					
Akhori (Bhilangana, Ghansali)	1,136	267	1263	1900	30°27'5.25"N/ 78°45'22.04"E
Dhar Payakoti (Kirtinagar, Devprayag)	906	194	1178	2000	30°19'55.17"N/ 78°47'4.29"E
Jhanau (Devprayag, Devprayag)	410	103	1071	2000	30°18'1.50"N/ 78°37'5.48"E
Kothar (Kirtinagar, Devprayag)	950	191	1230	1750	30°28'26.70"N/ 78°41'16.65"E
Sukri (Pratapnagar, Pratapnagar)	550	104	923	1900	30°29'26.04"N/ 78°30'51.73"E

Table 2. Utility of 'Kafal' tree resources in the study area.

Use category	**Particulars** (Local name or term in parentheses & italicized**)**	**Part used**	**Use citation index (UCI)***		
			Chamoli	**Pauri**	**Tehri**
Timber	Carpentry/furniture work: The plywood (*Pattal*) obtained from mature trunks is used to make boxes (*Bhakar*), stools (*Thella*), tables (*Maiz*), etc.	Trunk	Co	Oc	Oc
	Building construction: The processed plywood is used for making doors (*Dwaar*), door and window supports (*Mor-Sangar*), other components (*Diyeyi*), etc.	Trunk	Co	Oc	Ra
	Agricultural tools & handles: Various local implements and parts are made (including *Hau* or *Hal*, *Pata*, *Daniyaw*, *Sarn*, *Nasur*, *Chappar*, *Laath*, *Dathul*, etc.)	Stem & Branches	Oc	Oc	Oc
	Pole/supporting structures: Used as poles in hedges to bind wires, as supporting (*Thagara*) climbing vegetable crops (e.g., cucumber, beans), and for to tie cattle (*Keel/Killad*).	Young trees	Co	Ra	Ra
	House wooden structures: Used in constructing various parts of the house (including *Gundi*, *Theeki*, and *Pariyo*).	Stem & Branches	Co	Ra	Ra
Wood	Firewood and fuel wood: Chopped wood pieces (*Lakhar*) and dry branches (*Jhiyar*) are used for fuelwood for cooking and heating purposes in *Chuliyan* and *Agethi*. Apart from the house, the wood is also used as firewood during outdoor cultural ceremonies including worship, crematorium, camping, etc.	Stem & Branches	Pd	Pd	Pd
Wild edible fruit	Wild fruit: Ripe or, rarely, raw wild fruits are among the most popular in Uttarakhand. Some families also sell these fruits in the local market during the season to earn an income.	Fruit	Pd	Pd	Pd
	Juice: Additionally, fruit juice is prepared as a refreshing drink and is sometimes sold in the market.	Fruit	Oc	Oc	Ra
Sacred tree	A particular tree, considered as God's tree (*Dev dali*), often marks a sacred place (*Dev sathan*) dedicated to a specific deity. The area near the base of this tree is designated for worship, which is organized occasionally by the locals.	Live tree	Ra	–	–
Fodder	During dearth periods, such as prolonged snowfall or the rainy season (*Chomas*, *Saggar*), fresh leafy twigs and branches are collected as fodder for goats, sheep, rabbits, and horses.	Fresh twigs	Oc	Ra	–

Annals of Science and Allied Research **Vol. 2 (1) June, 2024: 66-75.**
https://doi.org/10.5281/zenodo.12621997
ISSN – 2584-2307 (Online)

Mannuring and cattle bedding material	Dry leaves, often collected along with other broad leaves, are used as bedding for cattle (*Pattiyall*). After being used as bedding for 1 or 2 days, these leaves are swept up along with the dung and left to decompose further as manure (*Mou*). Additionally, during the rainy season, when the ground litter and shed leaves remain wet, locals use fresh leafy twigs (*Saunoo*) as bedding material for buffalo, cows, etc.	Leaves & twigs	Pd	Oc	Oc
Medicine	Bark paste is applied externally to the head as a cooling agent for headaches. Additionally, the fruit is believed to help control constipation, improve digestion, and possess properties for cleansing the alimentary canal.	Bark & fruit	Co	Oc	Oc
Fishes catching	Fishes are intoxicated using a paste made from fresh bark, which is used in small-scale fish catching in smaller streams and slow-moving ponds.	Bark	Co	Ra	Ra
Local beverage	Fresh bark and occasionally fruits, serve as essential ingredients in the preparation of local alcoholic beverages (*Kachchi*). They contribute both starch for fermentation and unique flavoring.	Bark & fruit	Oc	Oc	No
Dye and colour	Yellow dye is extracted from the fresh bark, while green color is obtained by grinding fresh leaves. These colors are used in worship, such as 'Asthabali', and other religious ceremonies, particularly for creating religious symbols like 'Chakra' (a type of sacred rangoli), as well as for coloring the thread or fiber used in these ceremonies.	Bark & Leaves	Co	Ra	Ra

*** Use citation index (UCI): Mo** (Most preferred, **Co** (Common), **Oc** (Occasional), **Ra** (Rare), **'–'** (Not used in particular usedcategory).

Wild edible fruit consumption remained significant but declined from 550 kg to 200 kg. The production of juice, a relatively new use, showed minimal consumption, peaking at 15 kg in 2005–2014. Uses for fodder, manure, and cattle bedding materials have also seen reductions, likely due to changes in agricultural practices and livestock management. This decline is linked to various factors, including a decrease in the number of cattle reared by households compared to earlier times, which directly correlates with the reduced collection of manure and cattle bedding materials. The use of 'Kafal' tree resources for medicinal purposes, fish catching, local beverages, and dyes virtually disappeared by the 2015–2024 periods. These trends reflect a broad reduction in the dependence on 'Kafal' tree resources over the decades. The near disappearance of the use of 'Kafal' tree resources for medicinal purposes, fish catching, local beverages, and dyes by 2015–2024 suggests a decline in traditional practices and knowledge, possibly influenced by modernization and the availability of commercial substitutes.

Table 3: Average consumption of 'Kafal' tree resources per village per year (kg)

Use category and Sub-use category	**Households involved (Avg.)**	**DC1** (1985–1994)	**DC2** (1995–2004)	**DC3** (2005–2014)	**DC4** (2015–2024)
Timber					
Carpentry/furniture work	3%	1500	800	200	0
Building construction	4%	300	150	50	0
Agricultural tools & handles	25%	400	300	200	150
Pole/supporting structures	15%	350	300	200	100
House wooden structures	2%	150	50	0	0
Wood Firewood and fuel wood	35%	2100	1500	500	150
Wild edible fruit					
Wild fruit*	80%	550	350	250	200
Juice	1%	0	0	15	5
Fodder	4%	30	10	5	2
Mannuring and cattle bedding material	15%	250	150	100	40
Medicine	1%	4	2	1	0
Fishes catching	2%	15	8	0	0
Local beverage	1%	20	15	5	0
Dye and colour	1%	50	20	0	0

*The income generated by weaker households through selling 'Kafal' fruits in local markets has been increasing recently, attributedto improved connectivity via transit villages to nearby urban areas.

Annals of Science and Allied Research **Vol. 2 (1) June, 2024: 66-75.**
https://doi.org/10.5281/zenodo.12621997
ISSN – 2584-2307 (Online)

CONCLUSION

The results emphasize the significant role of the 'Kafal' tree in the Garhwal Himalaya. From providing timber and edible fruits to serving various purposes such as manure, traditional medicine, and cultural practices, the 'Kafal' tree is deeply embedded in the region's socio-economic fabric. The average consumption of 'Kafal' tree resources per village per year has shown a marked decline from 1985 to 2024 across various use categories. However, there is noticeable variation in the frequency and extent of these uses across different districts, reflecting local practices and needs. This highlights the importance of documenting and conserving traditional knowledge to preserve the cultural and ecological significance of the 'Kafal' tree. The decline in the use of 'Kafal' tree resources from 1985 to 2024 can be attributed to several factors, including the availability of alternative materials and modern tools, changing construction practices, decreased agricultural activities due to migration and crop damage, increased availability of alternative fuels like LPG, changes in livestock management, and a general decline in traditional practices and knowledge influenced by modernization and commercial substitutes.

ACKNOWLEDGEMENTS

We thank all the respondents for generously providing valuable information and sharing their time. We also express our sincere gratitude to the Director, Pt. L.M.S. Campus, Sri Dev Suman Uttarakhand University, Rishikesh, Uttarakhand, for his perennial encouragement.

REFERENCES

Bahuguna VK, Swaminath MH, Tripathi S, Singh TP, Rawat VRS, Rawat RS (2016). Revisiting forest types of India. Int For Rev 18(2), 135–145.

Ballabha R, Rawat DS, Tiwari JK, Tiwari P, Gairola A (2013). Wild edible plant resources of the Lohba Range of Kedarnath Forest Division (KFD), Garhwal Himalaya, India. Int Res J Biol Sci, 2(11), 65–73.

Bhatt SC, Kumar V, Gupta AK, Mishra S, Naik B, Rustagi S, Preet MS (2023). Insights on bio- functional properties of *Myrica esculenta* plant for nutritional and livelihood security. Food Chem Adv, 3, e100434.

Bhatt VP, Rawat DS (2020). God's tree: A culturally coded strategy for conservation (A casestudy of Gairsain ecoregion of district Chamoli, Uttarakhand). In: Khasim S, Long C, Thammasir K, Lutken H (Eds.), Medicinal Plants: Biodiversity, Sustainable Utilization and Conservation (pp. 237–247). Springer Nature.

Bisht VK, Negi JS, Bhandari AK (2010). Ethnobotanical uses of *Myrica esculenta* Buch-Ham. ex D.Don in Garhwal, India. J Ethnopharmacol, 127(2), 316–319.

Champion HG, Seth SK (1968). A Revised Survey of Forest Types of India. Govt. of India Publication, Delhi.

Chauhan A, Dhatwalia J, Neetika, Dutta, V, Gopalakrishnan C, Rana G, Hikku GS, Kumari A, Duglet R, Ghotekar S (2023). An investigation of the antimicrobial and antioxidant efficacyof copper oxide (I) nanoparticles: A green approach from *Myrica esculenta* fruit extract. Chem Phys Impact, 7, e100390.

Das DS, Rawat DS, Maity D, Dash SS, Sinha BK (2020). Species richness patterns of different life-forms along altitudinal gradients in the Great Himalayan National Park, Western Himalaya, India. Taiwania, 65(2), 154–162

Dhingra GK, Rawat DS, Kuriyal SK (2024). The vanishing tradition: God's tree cultural practice on the verge of extinction in Uttarakhand Hills. In: Rani M, Uniyal M (Eds.), Traditional Knowledge System of Uttarakhand (pp. 1–8). Pacific Books International, New Delhi.

Gaur RD (1999). Flora of the District Garhwal: North West Himalaya (with Ethnobotanical Notes). Transmedia, Srinagar Garhwal.

Gaur RD, Tiwari P, Tiwari JK, Rawat DS, Ballabha R (2014). Bee forage potential of Garhwal Himalaya, India. Indian J Fundam Appl Life Sci, 4(1), 196–204.

Gusain YS, Khanduri VP (2016) *Myrica esculenta* wild edible fruit of Indian Himalaya: need a sustainable approach for indigenous utilization. Ecol Environ Conserv, 22, 267–270.

Jeeva S, Lyndem FG, Sawian JT, Laloo RC, Mishra BP (2011) *Myrica esculenta* Buch.- Ham. ex D.Don. - A potential ethnomedicinal species in a subtropical forest of Meghalaya, northeast India. Asian Pacific J Trop Biomed, 1(2), Supplement, S174–S177.

Joshi M, Pandey M, Ved A (2024). Assessment of ameliorative effect of *Myrica esculenta* in a DSS-induced murine model against ulcerative colitis. Adv Gut Microbiom Res, 2024(1), e6616549.

Kabra A, Martins N, Sharma R, Kabra R, Baghel US (2019). *Myrica esculenta* Buch.-Ham. ex D. Don: A natural source for health promotion and disease prevention. Plants, 8(6), 149.

Kumar A, Rana AC (2012) Pharmagnostic and pharmacological profile of traditional medicinal plant: *Myrica nagi*. Int Res J Pharma 3(12), 32–37.

Naithani BD (1984). Flora of Chamoli, Vol. I. Botanical Survey of India, Howrah.

Naithani BD (1985). Flora of Chamoli, Vol. II. Botanical Survey of India, Howrah.

Panthari P, Kharkwal H, Kharkwal H, Joshi DD (2012) *Myrica nagi*: A review on active constituents, biological and therapeutic effects. Int J Pharma Pharmace Sci, 4(5), 38–42.

POWO (Plants of the World Online). *Myrica* L. POWO, Royal Botanic Gardens, Kew. https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:30023028-2 accessed 01 June 2024.

Rana RK, Patel RK (2016). Pharmacological evaluation of antiasthmatic activity of *Myrica nagi* bark extracts. Antiinflamm Antiallergy Agents Med Chem,15:145–152.

Rawat DS, Tiwari JK, Tiwari P, Nautiyal M, Parveen M, Singh N (2018). Tree species richness, dominance and regeneration status in western Ramganga valley, Uttarakhand Himalaya, India. Indian For, 144(7), 595–603.

Sawian CE, Susngi AM, Manners B, Sawian JT (2023). *Myrica esculenta*. In: Belwal T, Bhatt I, Devkota H (Eds.), Himalayan Fruits and Berries (pp. 287–303). Academic Press.

Shukla AK, Pramanick KK, Watpade S (2017). Kafal (*Myrica esculenta*) - a potential underutilized fruit in temperate ecosystem. Int J Trop Agric, 35(3), 431–433.

Shukla MK, Sharma A, Kumar R, Pandey S, Kumar D (2024). Anticancer Potential of *Myrica esculenta* Plant: A Comprehensive Review. In: Sobti RC, Ganguly NK, Kumar R (Eds) Handbook of Oncobiology: From Basic to Clinical Sciences. Springer, Singapore.

Singh H, Hussain J, Bagri AS, Rawat V, Rawat DS, Tiwari JK (2022). Uses, preference, cultural importance and informant consensus factor of tree species in Uttarakhand: A case study from Bhilangana Watershed (Western Himalaya, India). Ecol Quest, 33(3), 1–25.

Singh N, Tiwari P, Bagri AS, Rawat V, Rautela B, Rawat DS (2021). Pattern of forest resourceutilization in some villages of Pauri Garhwal, Uttarakhand, India. J Mt Res, 16(3), 279–289.

Singh P, Dash SS, Sinha BK. (2019). Plants of Indian Himalayan Region (An Annotated Checklist & Pictorial Guide), Part I. Botanical Survey of India, Kolkata. p. 438.