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Usha Devi
CCRUM-Drug Standardization
Research Institute, PCIM and H
Campus, Kamla Nehru
Nagar, Ghaziabad, Uttar
Pradesh, India

Pankaj Sharma
Government College Rajgarh,
Sirmaur, Himachal Pradesh,
India

Anees Ahmad
CCRUM- Regional Research
Institute of Unani Medicine,
University of Kashmir, Srinagar,
Jammu and Kashmir, India

Asma Sattar Khan
CCRUM-Drug Standardization
Research Institute, PCIM and H
Campus, Kamla Nehru
Nagar, Ghaziabad, Uttar
Pradesh, India

Corresponding Author:
Usha Devi
CCRUM-Drug Standardization
Research Institute, PCIM and H
Campus, Kamla Nehru
Nagar, Ghaziabad, Uttar
Pradesh, India

Wild plant resources used as food in Spiti Valley: A cold arid zone of Himachal Pradesh, India

Usha Devi, Pankaj Sharma, Anees Ahmad and Asma Sattar Khan

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Abstract

An attempt has been made to explore the wild edible plants (WEPs) of Spiti Valley, a cold desert region in Trans Himalaya. The Spiti Valley is inhabited by the *Bhotia* or *Bhot* tribal community and largely depends on wild resources to meet day-to-day needs. During the study, extensive field surveys were conducted from 2012 to 2017 in different localities of the valley. A total of 65 plant species belonging to 45 genera and 21 families were collected. A questionnaire was developed and first-hand information was gathered by conducting interviews of native people. These plants were consumed either raw and/or cooked. Leaves were the most harvested parts (37 spp.) followed by fruits (11 each spp.), roots (10 each spp.), seeds (6 spp.), inflorescence (4 spp.), aerial part (3 spp.), whole plant (3 spp.), bulb (2 spp. each). The habitat of most of the plant species has shrunk due to environmental degradation primarily due to heavy livestock grazing, the uncontrolled and unscientific harvest of species, unregulated tourism, and the construction of roads etc. Thus, community participation is the suggested solution for the conservation and sustainable use of the wild edible plants in the study area.

Keywords: Wild edible, cold desert, traditional knowledge, Spiti, India

Introduction

Globally, an estimated 1.02 billion people are undernourished (FAO, 2009) ^[1]. Worldwide, it seems more common in food insecure areas people usually feed on wild edible plants for survival during food shortages (Bisht *et al.*, 2017; Ojelel and Kakudi, 2015; Balemie and Kebebew, 2006) ^[2-4]. According to WHO regulations, wild plants are more nutritionally rich than cultivated and may satisfy the daily human need for elementary nutrition sources, particularly those of Vitamin C and A, and for some minerals (Duguma 2020; Kaval, *et al.*, 2015; Aberoumand and Deokule 2010; Lentini and Venz 2007) ^[5-8]. Indian Himalayan region with its wide range of altitudes, topography, and climatic conditions, is rich with plant resources and biodiversity which have always fulfilled the primary needs of native people. The flora of cold deserts is of immense importance, particularly for edible purposes. The traditional peoples of the arid and cold region of H.P. have a unique understanding of plant resources. Non-timber forest products (NTFP) collection has been identified as one way in which rural communities maintain food security and treat medical problems. Due to poor accessibility, harsh climatic and geographical conditions native people of these areas were forced to search for their food, medicine, shelter, fuel, fodder, etc. Wild edible plants are mainly used as supplementary foods in remote areas of the Himalayas.

Materials and Methods

Study area

Lahaul and Spiti, a district of Himachal Pradesh, comprises two different mountain tracts, one known as Lahaul and the other as Spiti. The valleys of Lahaul and Spiti fall into the region with a mean altitude of 4000 m above mean sea level, because of its extreme climatic and edaphic conditions it is an integral part of the Indian cold desert area located in the alpine arid zone of Himachal Pradesh (Murti, 2001; Aswal and Mehrotra, 1994) ^[9, 10]. The Spiti Valley, having an area of 31,528 sq km, is located in the trans-Himalayan range between latitudes 31° 42' and 33° N and longitudes 77° 37' and 77° 85' E (Balokhra, 2003 and Murti, 2001) ^[11, 9]. The *Bhot* or *Bhotia* indigenous ethnic groups live in the area, which has a low population density of three people per km as the per 2011 census.

The terrain and climate of Spiti Valley is rugged and inhospitable. The bare mountains exhibit typical desert coloration of rocks due to peculiar solar weathering (Murti, 2001) [9]. The climate of the valley shows a remarkable variation. Arctic conditions are experienced in winter as the valley remains under a thick blanket of snow. October to almost the middle of April are winter months when the valley experiences heavy snowfall; from the middle of April to July are spring/summer months, when the snow starts melting. The summers are clear and cloudless. There are occasional scanty monsoon showers. Spiti River along with its tributaries constitute the drainage system of Spiti. Agriculture is the main occupation of the tribal of the valley. The village of Spiti is situated above 3300 m elevation and up to about 4600 m. The area remains cut off from the rest of the state for more than 6-7 months every year due to snowfall and local people depend upon the ambient wild plant resources to fulfill their day-to-day requirements.

A number of information is available on plant diversity and their ethno medicinal uses from the Lahaul and Spiti districts (Bishist *et al.* 2022; Thakur *et al.* 2020; Sumati *et al.* 2019; Devi *et al.* 2013; Singh *et al.* 2012; Devi and Thakur, 2011; Chandrasekar and Srivastava, 2009, 2005; Lal and Singh, 2008; Singh and Lal, 2008) [12-21]; however, previously the emphasis has been mainly on medicinal, aromatic, and other ethno botanically important plants. Though, the present study has taken aim to document the knowledge on the utilization of wild edible plants used by the Bhotia tribes of Spiti Valley.

Data Collection

Floristic diversity and ethno botanical study of the study area were done in Spiti valley from 2008-2017. Plants collected from different localities of the area were brought to the laboratory and herbarium specimens were prepared. The plant species were identified with the help of relevant published flora of Lahaul-Spiti (Aswal and Mehrotra, 1994; Chowdhery and Wadhwa, 1984; Polunin and Stainton, 1984) [10, 22-23]. The voucher specimens were also matched and compared with the authentic specimens lying with the herbarium (BSD) of Botanical Survey of India (BSI), Dehradun, and were deposited in the Laboratory Herbarium of HPU, Shimla as reference material. The information on the wild edible plants was collected from the interactions with the local residents, shepherds, women, elderly people, children, etc. Most wild plants were collected by women, children, and shepherded but the participation of men was stumpy. Information about the local names of the plants and their uses was recorded. Data were tabulated with plant name, taxa/family, local name, life form, part consumed, collection period, form of consumption, and their edible uses (Table 1). For botanical nomenclature, the latest system of classification (APG IV, 2016) [24] has followed.

Results and discussion

Species diversity

Wild Edible Plants (WEPs) have special significance in the livelihoods of tribal people of the area and were consumed both at times of plenty and scarcity. A total of 65 plant species belonging to 45 genera and 21 families were collected from Spiti Valley (Table 1).

Table 1: List of identified wild edible plants (WEPs) of Spiti Valley

Sr. No.	Taxa/family	Local name	Life Form	Part consumed	Collection Period	Form of consumption	Local use(s) (edible)
Amaryllidaceae							
1	<i>Allium carolinianum</i> DC. Redoute	Lapod, Laot	H	LF, INF., BL	July - Aug	Vegetable, flavoring agent	Green leaves are cooked as vegetables. Dried leaves and inflorescence (flower head) is preserved for winter for use as a vegetable and flouring agent. Dried leaf is added in the traditional dish "thukpa" as a spice in place of onion or garlic. Vegetable prepared from leaves and bulb is consumed to cure stomach diseases.
2.	<i>Allium humile</i> Kunth	Phorna	H	LF	July - Aug	Vegetable, flavoring agent	Green leaves are used as vegetable and dried leaves are used as flouring agents.
	<i>Allium jacquemontii</i> Kunth	Neulogu	H	LF, BL	July - Aug	Vegetable, flavoring agent	Green leaves are used as vegetable and dried leaves are used as flouring agents. Bulb is consumed for indigestion.
	<i>Allium przewalskianum</i> Regel	Kocho	H	LF	July - Aug	Vegetable, flavoring agent	Green leaves are cooked as a vegetable. Dried leaves are used for flouring dishes. Leaves are consumed for indigestion.
Amaranthaceae							
	<i>Amaranthus spinosus</i> L.	Zansho	H	LF, ST, RT	July - Aug	Vegetable	Green leaves are cooked, steamed, or fried. Young leaves and stems are eaten raw as salad. Boiled leaves and roots are eaten as laxatives.
	<i>Atriplex crassifolia</i> Ledeb.	-	H	LF	June - Aug	Vegetable	Young leaves are cooked as a vegetable.
	<i>Chenopodium album</i> L.	Chilm	H	LF, ST	June - Aug	Salad, vegetable	Tender shoots are eaten as salad. Leaves of young plant are cooked as vegetable and are a good source of iron.
	<i>Chenopodium foliosum</i> Asch.	Yer	H	LF	July - Aug	Vegetable	Leaves are used as pot herb and eaten as vegetable. Leaves are boiled in milk and taken for body weakness
	<i>Dysphania botrys</i> (L.) Mosyakin &	Zanchi	H	WP	June - Aug	Vegetable	Tender plant is cooked as a vegetable.

	<i>Clematis</i> syn. <i>Chenopodium botrys</i> L.						
Apiaceae							
	<i>Chaerophyllum aromaticum</i> L.	-	H	Lf	July - Aug	Vegetable	The leaves are cooked as vegetable.
	<i>Chaerophyllum villosum</i> Wall. & DC.	Shingu-jeera	H	Lf	July - Aug	Vegetable	The leaves are cooked as vegetable.
	<i>Carum carvi</i> L.	Mao, Siazira	H	SD, LF	Sept	Condiment	Seeds are used as a spice for culinary purposes and are one of the main ingredients of local dishes. Young leaves are cooked as a vegetable.
	<i>Elwendia persica</i> (Boiss.) Pimenov & Kljuykov. syn. <i>Bunium persicum</i> (Boiss.) Fedtsch.	Kala jeera	H	SD	Sept	Condiment	Seeds are an economically important spice commonly used as a flavor enhancer in local dishes.
Asteraceae							
	<i>Anaphalis nepalensis</i> (Spreng) Hand-Mazz.	Moonpig	H	INF	June -July	Raw edible	Young inflorescence buds are edible.
	<i>Anaphalis triplinervis</i> Sims ex C.B. Clarke	Tayung	H	INF	June-July	Raw edible	Young inflorescence buds are edible.
	<i>Artemisia gmelinii</i> Web. Ex. Stechm. Syn. <i>Artemisia sacrorum</i> Ledeb.	Burmach, Khampa, Nurcha	S	INF and LF	July-Sept	Fermentation	Plant inflorescence and leaves mixed with wheat flour and water to prepare ferments.
	<i>Lactuca tatarica</i> C.A. Mey.	Khala	H	Lf	July-Aug	Salad	Leaves are eaten as a salad.
	<i>Sonchus oleraceus</i> L.	Dodak	H	Lf	July-Aug	Salad	Leaves are eaten raw as salad.
	<i>Taraxacum officinale</i> F.H. Wigg.	Sarshan mendo	H	Lf	May-Sept	Soup, salad, vegetable	Young leaves are used for making soups, salads, and vegetable.
Boraginaceae							
	<i>Arnebia euchroma</i> I.M. Johnst.	Khamet	H	Rt	Aug-Sept	Coloring agent	Roots used for coloring foodstuff.
	<i>Arnebia guttata</i> Bunge	Dimok	H	Rt	Aug-Sept	Coloring agent	Roots are used for coloring and enhancing the test of foodstuff.
Brassicaceae							
	<i>Capsella bursa-pastoris</i> Medik.	Chuchi	H	Lf	July-Aug	Salad, soup	Fresh young leaves are eaten as a salad and for making soup.
	<i>Christolea crassifolia</i> Cambess.	Lukmik	H	Lf	June-Aug	Vegetable	Young leaf is eaten as a vegetable and fresh leaves are chewed to improve eyesight.
	<i>Lepidium apetalum</i> Willd.	-	H	Lf	July-Aug	Vegetable	Leaves are eaten as a vegetable.
	<i>Lepidium capitatum</i> Hook. f. & Thoms	-	H	Lf, St	July-Aug	Vegetable, soup	The leaves and stem of the young plant are used in traditional dishes such as soups, local dishes (thupka), and vegetable.
	<i>Lepidium latifolium</i> L.	Tharag-Thokpa khang phug	H	Lf	June-Aug	Vegetable	Leaves are cooked as a green vegetable.
Campanulaceae							
	<i>Codonopsis clematidea</i> C.B. Clarke	Ludud-dorje-nakpo	H	Rt	July-Sept	Raw edible	Raw root is edible.
	<i>Codonopsis ovata</i> Benth.	Ludut	H	Rt	July-Sept	Raw edible	Raw root is edible.
Capparaceae							
	<i>Capparis spinosa</i> L.	Chileep	S	Fr, Lf	June-Sept	Raw edible, vegetable	Ripen fruits are edible and a good source of vitamin C. Young leaves and tender shoots are used as vegetable. Unripe fruits are also eaten as vegetable.
	<i>Stellaria media</i> (L.) Vill.	Kurso mendok	H	Wp	June-Sept	Vegetable	The plant is cooked as vegetable.
Crassulaceae							
	<i>Hylotelephium ewersii</i> (Ledeb) H. Ohba. Syn. <i>Sedum ewersii</i> Ledeb.	-	H	Lf	June-Sept	Raw edible, vegetable	Leaves eaten raw or cooked as vegetable.
Elaeagnaceae							
	<i>Hippophae rhamnoides</i> L. syn. <i>Elaeagnus rhamnoides</i> (L.) A. Nelson	Chharm, Tarpu	S	Ft	Aug-Oct	Raw edible, juice, jam, tea	Fruits are edible. Ripen fruits are used to make juices, jams. Leaves are used to make herbal tea.
	<i>Hippophae tibetana</i> Schltld.	Chharma	S	Fr	Aug-Oct	Raw edible, juice, jam	Ripen fruits are edible and also used to make juices, and jams.
Ephedraceae							
	<i>Ephedra gerardiana</i> Wall. Ex Stapf.	Chhedum	S	Ft	July-Oct	Raw edible, juice	Ripen fruits are edible. Ripe fruits are sweet and eaten by shepherds and

							children. Fruits are used to prepare juice and juice is taken in the affection of respiratory passage.
	<i>Ephedra intermedia</i> Schrenk & C.A. Mey.	Khaut	S	Ft	July-Oct	Raw edible	Ripen fruits are sweet and edible.
Fabaceae							
	<i>Chesneya cuneata</i> (Benth.) Ali.	Cheepcha	H	Sd	Aug-Sept	Vegetable	The beans are edible as vegetable.
	<i>Cicer microphyllum</i> Royle ex Benth.	Chiri	H	Lf, Fl, sd	Aug-Sept	Raw edible, vegetable	Leaves, flowers, seeds are eaten raw. Young shoots mixed with other potherb and cooked as vegetable. Cooked seeds are also eaten.
Gentianaceae							
	<i>Gentiana tianschanica</i> Rupr.	Wanglo (L)	H	Wp	July-Sept	Salad	The whole plant is used as salads.
Grossulariaceae							
	<i>Ribes orientale</i> Desf.	Nayangay, Yange	S	Fr	Aug-Sept	Raw edible	Ripen fruits are edible.
Lamiaceae							
	<i>Dracocephalum heterophyllum</i> Benth.	Toksa, Jibkar	H	Rt	July-Sept	Vegetable	The root is cooked as a vegetable.
	<i>Elsholtzia eriostachya</i> Benth.	Jirug serpo	H	Lf	July-Sept	Flouring agent, chutney	Leaves are used for making chutney and as the flouring agent.
	<i>Mentha longifolia</i> (L.) L.	Khoit	H	Ap, Lf	July-Sept	Flouring agent, chutney	Aerial part is used as vegetables or in the form of spices. Leaves are used for making chutney and as the flouring agent.
	<i>Nepeta flocosa</i> Benth.	-	H	Lf	June-Aug	Raw edible	Crushed fresh leaves are eaten with curd.
	<i>Thymus linearis</i> Benth.	Pedumba	H	Lf, Fl, Ap	June-Oct	Flouring agent, tea	Leaves and flowers are used as flouring agents. The aerial part is used to prepare herbal tea.
	<i>Trigonella emodi</i> Benth.	Tuljima	H	Lf	July-Aug	Vegetable	Tender leaves cooked as vegetable.
Linaceae							
	<i>Linum perenne</i> L.	-	H	Sd	Sept	Roasted	Roasted/cooked seeds are edible.
Malvaceae							
	<i>Malva verticillata</i> L.	Chyamba, Pho	H	Lf, St	June-Aug	Vegetable	Young leaves are eaten as vegetable. Stem is used to make soup. Leaves are used to prepare herbal tea.
	<i>Malva neglecta</i> Wallr.	Sonchala, Khubbasi	H	Lf	June-Aug	Vegetable	Young leaves are cooked as vegetable.
	<i>Plantago depressa</i> Willd.	Tharam	H	Lf	June-Aug	Vegetable	Young leaves are cooked as vegetable.
Polygonaceae							
	<i>Oxyria digyna</i> Hill	Chumcha	H	Lf	July-Aug	Vegetable, salad	Young leaves are cooked as vegetable and are also eaten as salad.
	<i>Polygonum aviculare</i> L.	Kesru	H	Ap	July-Sept	Raw edible, vegetable	The aerial part of young plant eaten raw or cooked as vegetable.
	<i>Persicaria vivipara</i> (L.) Ronse Decr. Syn. <i>Polygonum viviparum</i> L.	Maslun	H	Rt	July-Sept	Salad	Fresh roots are eaten as salad.
	<i>Rheum australe</i> D. Don	Chhucha	H	Rt	June-Aug	Salad	Leaf stalk and stem are edible as salad.
	<i>Rheum moorcroftianum</i> Royle	Lachu	H	Rt	July-Aug	Salad	Young leaves are edible as salad.
	<i>Rheum spiciforme</i> Royle	Lechu	H	Rt	June-Aug	Raw edible, vegetable	Young leaves, stems and leaf stalk eaten as raw or cooked as vegetables.
	<i>Rheum webbianum</i> Royle	Lechu	H	Lf, Sk, St	June-Aug	Salad and chutney	Leaf stalk and young stem eaten as salad, and chutney.
	<i>Rumex nepalensis</i> Spreng.	Chuomsa	H	Lf	June-Aug	Vegetable	Young leaves and shoot parts are cooked as vegetable.
	<i>Rumex patientia</i> L.	Shyomang	H	Lf	June-Aug	Vegetable, raw edible	The leaves are cooked as green leafy vegetables. The leaves stalk is eaten in raw form.
	<i>Rumex hastatus</i> D. Don	-	H	Lf	June - Aug	Vegetable	Leaves eaten as vegetables
Rosaceae							
	<i>Prunus armeniaca</i> L.	Chuli, Chult	T	Sd, Fr	Aug-Sept	Raw edible, souring agent, oil	The fruits are consumed fresh Sun-dried fruits are stored for prolonged winter, and used as a souring agent in food preparations Seeds oil is edible.
	<i>Potentilla atosanguinea</i> Lodd.	-	H	Lf	July-Aug	Vegetable	Young leaves are eaten raw or cooked as vegetables.

<i>Rosa macrophylla</i> Lindl.	Sia	S	Fr	Sept-Oct	Raw edible	Fruits and seeds are edible. Fruits are eaten to reduce fever.
<i>Rosa Webbiana</i> Wall. ex-Royle	Sia mendo (Fruit)	S	Fr	Sept-Oct	Raw edible	Rippen fruits are edible.
Saxifragaceae						
<i>Ribes alpestre</i> Wall. ex Decne. Syn <i>R. grossularia</i> auct. non. L.	Nayangay	S	Fr	Aug-Sept	Raw edible	Shepherds and children eat ripe fruits
<i>Ribes orientale</i> Desf. Syn <i>R. villosum</i> Wall.	Yange	S	Fr	Aug-Sept	Raw edible	Shepherds and children sometimes eat ripe fruits

Abbreviations: Ap: Aerial part, Aug: August, Bl: bulb, Fl: Flower, H: Herb, Inf.: Inflorescence, Lf: Leaves, Rt: Root, Sept: September, Oct: October, Sh: Shrub, Sd: Seed, Sk: Stalk T: Tree, Wp: Whole plant.

Herbs constitute 53 species; 11 species are shrubs and 01 species are trees. Polygonaceae is the most prominent family with 10 species, followed by Asteraceae and

Lamiaceae (5 species each), Amaryllidaceae, Apiaceae, Rosaceae (4 species each), etc. (Figure A).

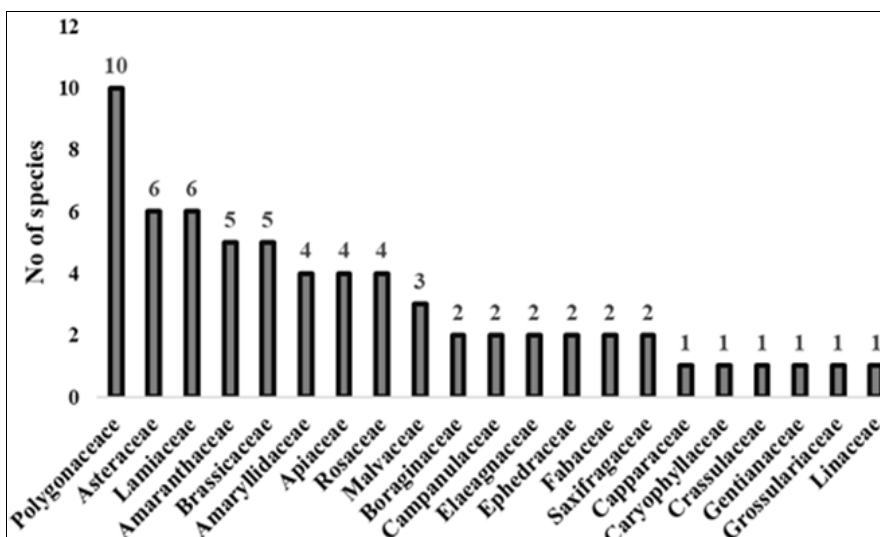


Fig A: Distribution of WEPs in families

All wild edible plants are classified by their edible parts. The most commonly consumed part of the plant is leaf (37 spp.),

fruit (11 spp.), root (10 spp.) followed by seed, stem, inflorescence, aerial part, whole plant, and bulb (Figure B).

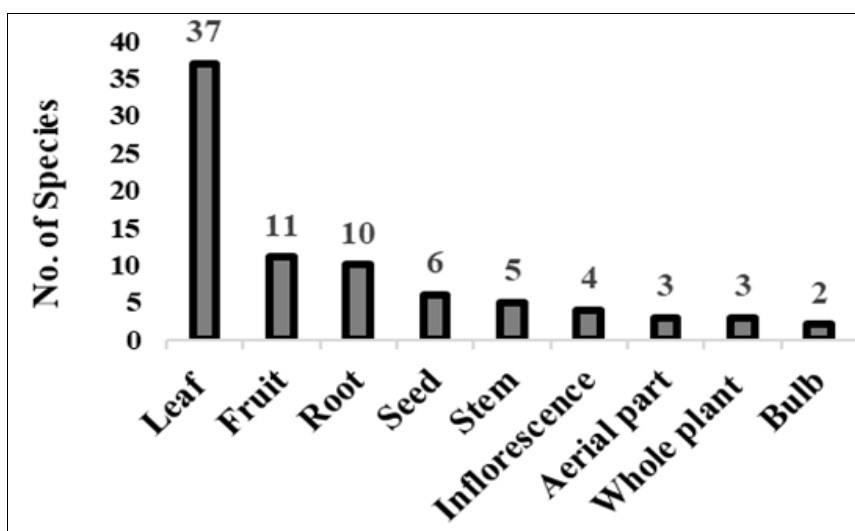


Fig B: Different Plant Parts used for edible purposes

These edible plant species are categorized in different forms of consumption viz. vegetables, raw edibles, salad, flavoring agents, condiments, chutney, juice, soup, tea, coloring agent,

jam, souring agent, fermentation, and roasted. The most commonly consumed form is vegetables (33 spp.), followed by another form of consumption (Figure C).

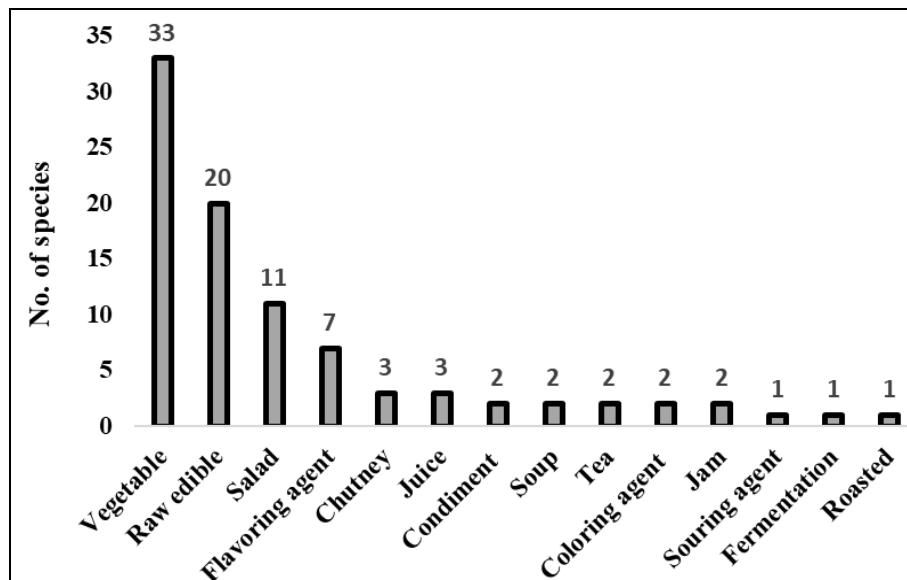


Fig C: Form of consumption of WEPs

Traditional uses of WEPs

The current study demonstrated that the *Bhotia* tribes of the study area utilized several wild plants as food in order to maintain their way of life (Figure 1-50). During collection shepherds, women, and children, had shared a greater number of edible plant species. The people of this far-flung area have been dependent on wild resources for certain leafy vegetables which were eaten fresh and in dried form after chopping. The wild leafy plants are the largest food category of WEPs used

by Spiti valley people, with 32 species. Species such as *Amaranthus spinosus*, *Atriplex crassifolia*, *Chenopodium album*, *Rumex patientia*, *Chenopodium botrys*, *Dysphania botrys*, *Rumex nepalensis* etc. are weedy and often used as leafy vegetables during food shortages. Tender leaves and shoot of *Taraxacum officinale*, *Sonchus oleraceus*, *Lactuca tatarica*, *Oxyria digyna* etc. species were preferred to cook as vegetables, soups, and in the raw form used as salad as they are considered to be rich in vitamins and minerals.



Fig 1-50: Some WEPs of Spiti Valley (1) *Allium carolinianum*; (2) *Allium humile*; (3) *Allium jacquemontii*; (4) *Allium przewalskianum*; (5) *Amaranthus spinosus*; (6) *Atriplex crassifolia*; (7) *Chenopodium album*; (8) *Chenopodium foliosum*; (9) *Dysphania botrys*; (10) *Elwendia persica*; (11) *Carum carvi*; (12) *Chaerophyllum aromaticum*; (13) *Chaerophyllum villosum*; (14) *Anaphalis nepalensis*; (15) *Anaphalis triplinervis*; (16) *Artemisia gmelinii*; (17) *Lactuca tatarica*; (18) *Sonchus oleraceus*; (19) *Taraxacum officinale*; (20) *Arnebia euchroma*; (21) *Arnebia guttata*; (22) *Capsella bursa-pastoris*; (23) *Christolea crassifolia*; (24) *Lepidium apetalum*; (25) *Lepidium capitatum*; (26) *Lepidium latifolium*; (27) *Codonopsis clematidea*; (28) *Codonopsis ovata*; (29) *Capparis spinosa*; (30) *Stellaria media*; (31) *Sedum ewersii*; (32) *Elaeagnus rhamnoides*; (33) *Ephedra gerardiana*; (34) *Ephedra intermedia*; (35) *Chesneya cuneata*; (36) *Cicer microphyllum*; (37) *Dracocephalum heterophyllum*; (38) *Elsholtzia eriostachya*; (39) *Mentha longifolia*; (40) *Nepeta flocossa*; (41) *Thymus linearis*; (42) *Trigonella emodi*; (43) *Linum perenne*; (44) *Malva neglecta*; (45) *Malva verticillata*; (46) *Plantago depressa*; (47) *Oxyria digyna*; (48) *Polygonum aviculare*; (49) *Persicaria vivipara*; (50) *Rheum austral*

Wild fruits play a significant role in providing nutrition to people of rural and tribal communities since they have long been an excellent source of various minerals, vitamins, carbohydrates, proteins, and fibers. The majority of the ripened fruits are eaten raw, which helps to compensate for the day-to-day requirement of calories. The ripened fruits of *Chenopodium foliosum*, *Ephedra* sps. *Hippophae* sps. *Ribes orientale*, *Rosa* sps. Are collected and immediately consumed by children. The fruits of *Prunus armeniaca* are eaten fresh or sun-dried fruits stored for prolonged winter. Such foraging activities provide essential supplies of Vitamins and minerals, particularly for children. Ripen fruits of *Cappris spinosa* are added to sauces, jams, or eaten raw. *Cappris spinosa* is a potential source of valuable nutrients such as vitamin C, digestible protein, and essential minerals (Nirmala *et al.* 2022) [25]. The significant amounts of antioxidants present in Caper fruit confirm its nutritional and medicinal value. *Hippophae rhamnoides* (sea buckthorn) fruits have commercial value, as it is used for medicinal purpose, making juices, jams, etc. The seed has antioxidant activity, and bioactive oil used for skin care and other uses in the cosmetic and pharmacy industries. Sea buckthorn is also used for the treatment of heart diseases, lung diseases, and various other diseases (Chen *et al.* 2023; Chauhan *et al.* 2008; Dwivedi and Ahmed, 2006) [26-28]. Sea buckthorn fruits have high nutritional properties rich in protein, amino acids, potassium, and other nutrients (Chen *et al.* 2023) [26]. Several herbal products and drinks like herbal multivitamin beverages, herbal appetizers, sea buckthorn nectar, and medicated herbal health beverages are traded in the market (Chauhan *et al.* 2008) [27]. The fresh leaves, young stalks, and stems of some species such as *Capsella bursa-pastoris*, *Lactuca tatarica*, *Lepidium capitatum*, *Taraxacum officinale*, etc. can be consumed raw, in salad, garnishing, or added to soups. Flower buds of *Anaphalis* species are eaten raw. *Artemisia gmelinii* is locally used as a fermenter. *Linum perenne* seeds are edible after cooking or roasting as raw seeds are toxic. The cooked seeds are perfectly safe. Most of these wild edible species along with some cultivated fruits like plums, apples, and vegetables such as spinach, carrot, and tomato gathered during the summer are cut in slices, dried, and consumed during its scarcity in winter. Basically, for this remote area, they are high-calorie food for the winter.

Carum curvi and *Elwendia persica* are the most valuable condiment. They are collected for domestic use as well as sale purposes due to their high market value. *Carum curvi* seeds are a rich source of protein, B vitamins, vitamin C, and several dietary minerals, especially iron, phosphorus, and zinc (Giordano *et al.*, 2022; Mahboub, 2019) [29,30]. The leaves of the *Allium* sps. Can be consumed raw, or cooked. It is added to salads, and soup and used as a substitute for onion and garlic in local cuisine. Similarly fresh aerial part of *Thymus linearis* used to flavor food recipes as well as to make tea. *Elsholtzia eriostachya*, *Mentha longifolia*, are used for making chutney as well as flouring agents. *Linum perenne* L. *Cicer microphyllum* are wild relative of *Linum usitatissimum* L. and *Cicer* respectively and could thus be used for crop improvement. (Sharma and Rana, 2005) [31].

The study area belongs to the cold desert part of the Himalayas where most of the time the area is covered by snow. Most of the vegetation thrives during the summer season and monsoon from April to September as from October the winter starts. The collection of wild edible plants depends on their maturity and availability. Local people of the area have ideas about the seasons of availability and their habitats. The result of the present study revealed that WEPs

have been harvested during summer and monsoon seasons from May to September. Of the collected edible plants, most of the species have been collected from June to September, when most of the plant's flowering and fruiting occurred.

Aboveground parts such as young leaves, shoots, and stems have gathered mainly during their vegetative stage before flowering and fruiting. Whole plants and underground parts such as bulbs, and roots, have a relatively limited use. Imperatively, for long-term usage of herbal wealth, aerial parts are preferable to whole plants and underground plant parts, since uprooting complete plants may result in permanent loss of herbal wealth from a specific area.

Some collected edible plants viz. *Allium* sps, *Amaranthus spinosus*, *Chenopodium foliosum* *Christolea crassifolia*, *Ephedra gerardiana* are also eaten for medicinal purposes. Species such as *Arnebia euchroma*, *Arnebia guttata*, *Crum curvi*, *Elwendia persica*, *Hippophae rhamnoides*, *Ephedra gerardiana*, *Rheum australe* etc. have been collected from the wild for commercial purposes, because of their wide uses in the pharmaceutical industry. Many WEPs have also been collected locally to cure various health problems. Local people have a firm belief in the traditional medicine system which is based on plants. *Amchies* (traditional healers) were totally depending upon natural resources for the collection of plants and their parts. So, the ruthless and unsustainable gathering of plant species could cause a reduction in their natural populations which could affect their regeneration. So, educating people about the sustainable use and utilization of wild species might help to restore natural populations. Most of the time, these WEPs are typically harvested from the wild, where they naturally grow; but some wild forms are occasionally brought to the garden and cultivated directly, *Carum carvi*, *Elwendia persica*, *Prunus armeniaca* are widely established as cultivated plants. Most of the recorded and identified edible species are comparable with other parts of the Himalayas (Usha *et al.*, 2023; Nirmala *et al.* 2022; Haq *et al.* 2021; Thakur *et al.* 2020; Rana *et al.*, 2014; Rana *et al.*, 2012) [32,25,33-36].

Conclusion

Being a remote area wild edible plants are cultural as well as the ethnic identity of the study area. Wild edible plants not only provide food to the local people but are also a good source of essential nutrition such as vitamins, minerals, and essential amino acids to stay healthy. The traditional knowledge on the use of wild edible plants has been transmitted orally from generation to generation, which is vanishing due to rapid modernization. Therefore, it is crucial to record the traditional knowledge related to a specific tribe. In addition, the local people harvest wild edible plants not only for food but also for other purposes such as fuel, fodder, medicinal uses etc., which has led to a high level of threats to the wild edible plant species. The habitat of most of the plant species has shrunk due to the expansion of the human population and environmental degradation primarily due to heavy livestock grazing, the uncontrolled and unscientific harvest of species, etc. Thus, there is a great need to create awareness among the local people about the plants that are over-exploited. Cultivation of medicinal plants can reduce pressure on these wild plants. Ecological management including protection is required for sustainable use by the locals.

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