# Diversity of wild edible plants and fungi consumed by semi-nomadic *Gaddi* and *Sippi* tribes in Doda district of Union Territory of Jammu and Kashmir

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## Research

## Abstract

*Background:* Consumption of Wild edible plants (WEPs) is a cultural heritage of tribal and other rural communities. WEPs have a vital role to play not only in ensuring nutritional security and combating malnutrition but also in meeting medicinal requirements, income generation for these communities, and crop improvement through plant breeding programmes. The present study was conducted with the objective of documenting traditional knowledge and practices of utilizing WEPs by *Gaddi* and *Sippi* tribes of Doda district of Union Territory of Jammu and Kashmir (JKUT).

*Methods:* An ethnobotanical survey was conducted in five villages of Doda district (JKUT) inhabited by *Gaddi* and *Sippi* tribes. The random sampling method was used for the selection of informants. The data was collected through interviews and focused group discussion with the informants as per semi-structured schedules. The uses of WEPs were recorded as use-reports, and culture importance value (CI) and factor informant consensus ($F_{ic}$) were calculated from these values.

*Results:* A total of 77 species spread across 58 genera and 39 families were reported by 203 informants (148 males and 55 females). Angiosperms represented by 63 species were the major source of forest foods followed by 9 fungal species. WEPs with the highest number of species were vegetables (34 species), and fruits and nutraceuticals (27 species each). The most important species on the basis of CI were *Geopora arenicola* (Lev.) Kers. (CI = 0.66), *Geopora sumneriana* (Cooke) M. Torre. (0.60), *Diplazium esculentum* (Retz.) Sw. (0.56), *Diplazium frondosum* C. Chr. (0.54), and *Mentha arvensis* C. Presl. (0.52). Values of $F_{ic}$ ranged between 0.91 (nutraceuticals) and 0.99 (cooked WEPs). The knowledge of WEPs significantly increased with age and decreased with education level of the informants.

*Conclusions:* The *Gaddi* and *Sippi* tribes are utilizing a good number of WEPs, and more importantly they exchange this information among themselves. As far as future prospects of this study are concerned, nutritional and nutraceutical properties of species like *Anethum sowa*, *Arisaema propinquum*, *Diplazium frondosum*, *Dipsacus inermis*, *Elaeagnus umbellate*, *Elwendia persica*, *Geopora sumneriana*, *Impatiens glandulifera*, *Morchella crassipes*, *Morchella conica*, *Prinsepia utilis*, *Sageretia thea*, *Solanum villosum*, *Thymus mongolicus*, and *Ziziphus oxyphylla* may be studied to make them popular amongst masses.

*Keywords:* Ethnobotany; Fungi; *Gaddi* and *Sippi* tribes; wild edible plants.

## Background

Wild edible plants (WEPs) are uncultivated plant species which grow under natural conditions in the wild habitats without any management by the human beings and which are consumed as food by indigenous communities (Mallick *et al.* 2020). They have been used by humans for one or another purpose since time immemorial (Fils *et al.* 2020). According to "India State of Forest Report – 2021", 24.62 percent of the total geographical area of India is covered by forests (ISFR 2021) and a population of more than 40 million tribal people in India lives in close proximity of forests (Wankhade 2015) consuming wild fruits, vegetables, flowers, seeds, bulbs, tubers, and rhizomes (Mallick *et al.* 2020). Although tribal and other forest based communities are by and large uneducated, they are highly knowledgeable about wild food resources because of their long experience with nature and this invaluable knowledge is transmitted orally from one generation to the next (Das 2013). The consumption of WEPs by rural communities is an integral part of their cultural gastronomic heritage (Abdullah and Andrabi 2021; Kidane and Kejela 2021) and it broadens the menu choice of their daily diet (Prabakaran *et al.* 2013). Mostly the wild vegetables are consumed after cooking (Garcia-Herrera *et al.* 2020) and wild fruits are eaten raw, however, some wild fruits are consumed after cooking and a few are made into pickles and chutney (Murtem and Chaudhry 2016).

WEPs act as source of nutrition not only for humans but also for wild animals and birds (Dogan *et al.* 2004; Al-Fatimi 2021).They differ from conventional crop plants in that they are mostly disease free, drought resistant, not treated with chemical fertilizers and pesticide, highly nutrient rich, and do not include GMO plants (Shaheen *et al.* 2017). Most of the wild fruits have longer shelf life than their cultivated counterparts (Biswas *et al.* 2018). Some of the wild foods have nutraceutical properties as they also provide health or medical benefits (Singh *et al.* 2016). Nutraceutical plants have gained popularity because their consumption for therapeutic purpose is considered to be safe and free from any side effects for human health. Thus wild fruits and vegetables could be recommended for treatment of nutrient deficiency diseases (Garcia-Herrera *et al.* 2020). Several wild fruits and vegetables help in alleviating risk of different diseases like stroke, cardiovascular diseases, cancer of lungs and alimentary canal, and may play a crucial role in maintaining good health (Aberoumand and Deokule 2009). WEPs could also play an important role under COVID-19 pandemic like situations as they boost the immunity to fight against different diseases (Sen 2021). However, such plants should be subjected to further scientific investigations for determining the presence of bioactive compounds and anti-nutritional contents so as to assess and validate their nutritional and medicinal values which will help in utilizing these plants more effectively and safely (Duguma 2020; Rana *et al.* 2012).

A radical change has been observed in the dietary pattern of the local communities particularly the younger generations who are least interested in traditional foods and are more inclined towards fast food and packed food which has detrimental effect on human health (Bhattarai *et al.* 2009). The factors held responsible for this change are modernization, urbanization, improvement in socio-economic conditions, road connectivity to rural areas, advanced agricultural practices, and social stigmas associated with the consumption of WEPs (Singh *et al.* 2016; Bhatia *et al.* 2018). Migration of tribal population from villages to towns and cities in search of job has led to their cultural intermingling with urban society and is another important cause of vanishing of traditional gastronomic culture (Sachan *et al.* 2013).

The practice of eating WEPs and the concomitant traditional knowledge is thus fading away at a faster pace and needs to be documented for the common good of the mankind (Abdullah and Andrabi 2021; Golait *et al.* 2021). It is therefore advisable that WEPs should be brought under cultivation so as to reduce pressure on their natural population growing in the wild habitat which will lead to their conservation. It will also help in safeguarding food security and income generation for the tribal communities (Golait *et al.* 2021). Afforestation and agro-forestry programmes should include planting of wild fruit trees in addition to conventional fruit trees and wood trees as it will go a long way in conservation of WEPs (Paul *et al.* 2020). Other methods of conservation of WEPs include sustainable harvesting methods, community involvement, and folk traditions (Cao *et al.* 2020).

*Gaddis* (Kapoor *et al.* 2008; Pandey 2015) and *Sippis* are shepherds by occupation who rear large flocks of goat and sheep and have a semi-nomadic life style as one or two male members (locally known as *palh*) of the family undergo seasonal migration along with their livestock in order to avoid harsh weather conditions and to facilitate grazing of their flock. The semi-nomadic *Gaddi* shepherds of Jammu & Kashmir undergo seasonal migration along with flock of their goat and sheep to the upper reaches of Himalayas during summer and to the foothills of Himalayas during winter (Dutt *et al.* 2015). *Gaddi* and *Sippi* tribes have been notified as scheduled tribe in 1991, vide the Constitution (Scheduled Tribes) Order (Amendment) Act, 1991 (GOI 1991). Their settlements are located on higher reaches of NW Himalayas in the close vicinity of forests and thus these forest dwelling tribes are geographically and culturally isolated from rest of the world. *Gaddis*, *Sippis* and other tribes rely on a good number of WEPs for meeting their dietary requirement (Rani *et al.* 2013; Radha *et al.* 2018; Thakur *et al.* 2020) and the consumption of forest foods is the cultural heritage of *Gaddi* and *Sippi* tribes of the study area.

A number of studies (Srivastava 1988; Dhar and Dhar 2000; Rashid *et al.* 2008; Khan *et al.* 2009; Kumar and Hamal 2009; Dad and Khan 2011; Dangwal *et al.* 2014; Khan and Hussain 2014; Mir 2014; Bhatia *et al.* 2018; Pandita and Dutt 2018; Showkat and Akhtar 2018; Singh and Bedi 2018; Thakur *et al.* 2019; Mir *et al.* 2020a; Sarwar and Nigam 2020; Thakur and Dutt 2020; Farooq 2021; Khajuria 2021; Kidane and Kejela 2021; Mahmood and Farooq 2021; Singh *et al.* 2021; Bagal *et al.* 2022; Bhagat *et al.* 2022; Gangoo 2022; Peerzada *et al.* 2022; Sharma *et al.* 2022) have been conducted on the traditional knowledge of WEPs in the Union Territory of Jammu and Kashmir (JKUT). However, as of now, no study has been executed on ethnic forest foods consumed by *Gaddi* and *Sippi* tribes in JKUT.

The present study was performed with an objective to document the traditional knowledge, utilization pattern, and associated knowledge of WEPs amongst the semi-nomadic *Gaddi* and *Sippi* tribes of district Doda (JKUT). The hypotheses proposed for the study are; (i) women informants are more knowledgeable than men informants, (ii) the knowledge of WEPs increases with age, (iii) WEPs knowledge decreases with education level, and (iv) a great degree of consensus regarding WEPs exists among the *Gaddi* and *Sippi* tribes.

## Material and Methods

**Study area**

Doda is a hilly district of JKUT, which is located between outer and middle Himalayan ranges in eastern part of Jammu division. It lies between geographical coordinates of 32° 53′ to 34°21′N latitude and 75°1′ to 76° 47′E longitude (Fig. 1). Geographical area of Doda is 4500 $Km^2$ and its average altitude is 1107 m amsl (Arya *et al.* 2014). The district is bounded by district Anantnag in the North, district Ramban in the West, district Udhampur in the Southwest, district Kishtwar in the Northeast and district Kathua and district Chamba of Himachal Pradesh in the South.

Because of mountainous topography, district Doda has a wide range of altitude and thus the climate is not uniform throughout the district. Three different climates zones viz. sub-tropical, temperate and alpine zones are found along the altitudinal gradients of this mountainous district. The varied climatic and topographic conditions favour growth of a wide variety of plant species and thus the district is an abode of rich phytodivesity. The area receives an average annual rainfall of 35.08 inches and the average temperature ranges between 26 and 29 °C during summer, and 2 and 15 °C during winter (http://kvkdoda.nic.in/district_profile.html). High altitude places of district Doda receive heavy snowfall during winter and the mountainous peaks in the Southwest of Bhaderwah valley remain covered with snow for most time of the year. The area is drained by the mighty Chenab River. District Doda comprises of 18 tehsils and the Population of *Gaddi* and *Sippi* tribes is found mainly in 6 tehsils namely Doda, Bharat Bagla, Bhaderwah, Bhalla, Assar, and Marmat. Most of the settlements of *Gaddi* and *Sippi* tribes are located on higher elevations on tough slopes of Himalayas.

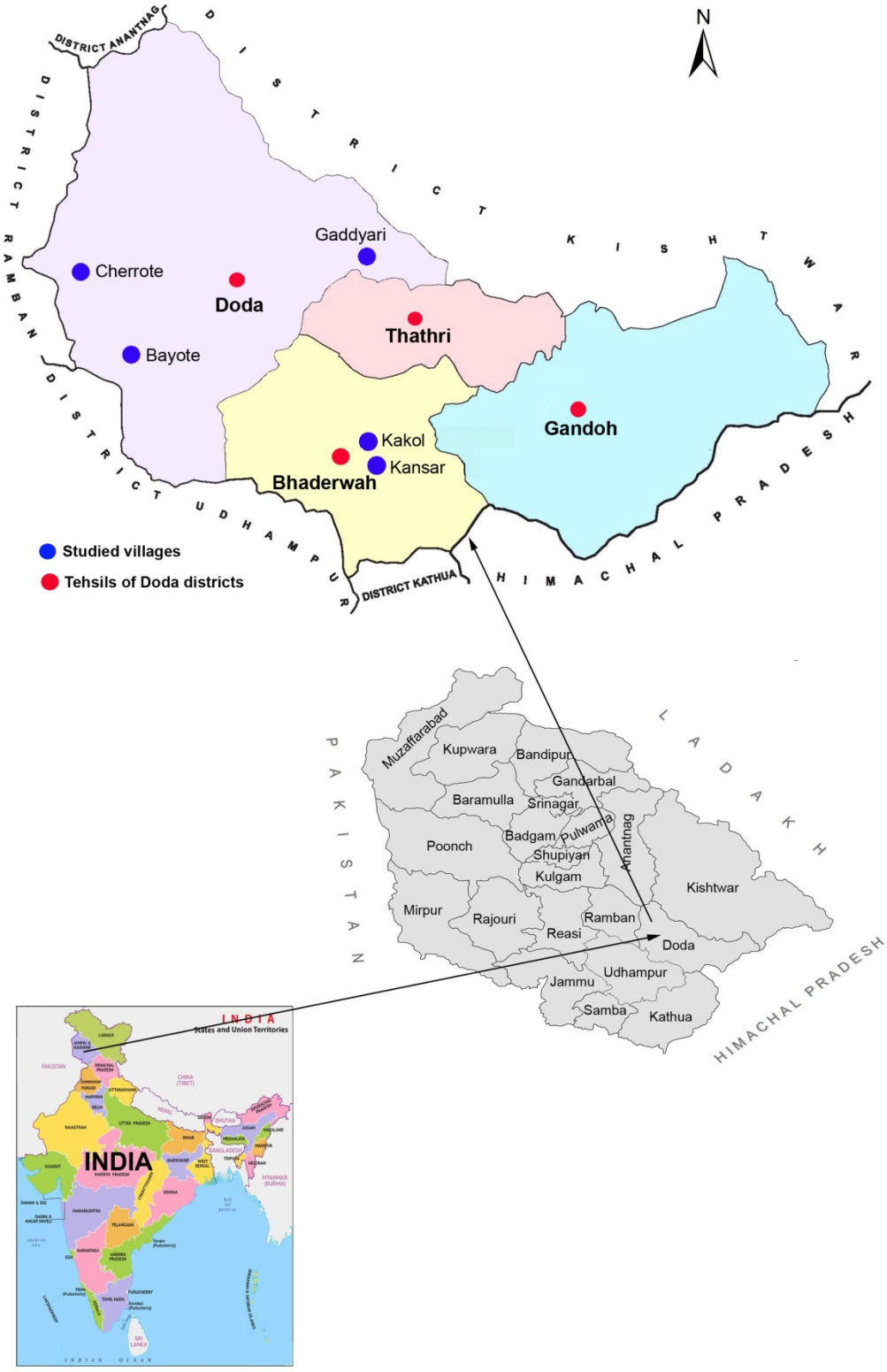


Figure 1. Location of the sampled villages.

**Data collection**

Frequent rounds of field visits were carried out to the study area from March 2019 to March 2022 for the collection of ethnobotanical information. Doda district has total thirty five villages inhabited by *Gaddi* and *Sippi* tribes, and the present study was conducted in Kakol, Kansar, Cherrote, Bayote, and Gaddyari villages (Fig. 1). The selection of villages and informants was done as per random sampling method. The number of households to be sampled in the five villages was determined using formula given by Cochran (1977):

$$n = \frac{N}{1+N(e)^2}$$

where, n = sample size; *N* = total number of households in sample villages (414); *e* = maximum variability or margin of error 5% (0.05), and 1 = the probability of event occurring. Thus, for the present study, the number of households to be sampled is 203.

The survey was completed in two phases: (i) household survey and (ii) habitat survey. Initially household survey was conducted with the objective of obtaining information from the informants. The data was collected through semi-structured interviews and group discussions among the informants in their local tribal dialect known as *Gadyali* or *Gaddi* language and the information thus collected was recorded in semi-structured interview schedules. The information collected include local name of different wild edible plants, habit, edible plant part, method of use, medicinal use if any, flower colour and time of availability. Once the information was collected through household survey, habitat survey was conducted for identification and collection of wild edible plant specimen from their natural habitat. During habitat survey some of the learned informants accompanied the first author to natural habitats of the plant species and identified plants based on their local names. Photographs of the plants were also taken in the field along with collection of plant specimens. The collected plant specimens were identified with the help of faculty and scientists of University of Jammu and IIIM Jammu, respectively. The specimens were submitted to the Herbarium of Department of Botany, University of Jammu, Jammu, JKUT. All the plant names were verified from https://www.ipni.org.

**Data analysis**

The data was collected from the informants as use-reports (UR). The information was further analysed for cultural importance index (CI) and informant consensus factor ($F_{ic}$). CI was calculated as the sum total of UR for a species in various use categories divided by number of informants (N), and mathematically expressed as:

$$CI = \sum_{u=u_i}^{u_{NC}} \sum_{i=i_1}^{i_N} UR_{ui} / N$$

where, the eleven use-categories (*u*)are $u_{1\text{-}11}$ and informants (*i*) are $i_{1\text{-}203}$. According to Tardio and Pardo-de-Santayana (2008), CI accounts for the growth and flexibility of usage. They added that the maximum value of CI, the total number of uses across all use categories, makes it a superior index than other indices.

The factor informant consensus ($F_{ic}$) given by Trotter and Logan (1986) was used to examine the homogeneity of information and knowledge sharing about the WEPs. The $F_{ic}$ was calculated as:

$$F_{ic} = \frac{n_{ur} - n_t}{n_{ur} - 1}$$

where $n_t$ is the number of plants utilised for a specific use category and $n_{ur}$ is the total number of citations for that use category. If there is no information sharing among informants about the use of WEPs, $F_{ic}$ values are low (around 0), and they approach one (1) in case the maximum information is shared amongst informants (Bhatia *et al.* 2018).

**Statistical analysis**

The characteristics of the informants with respect to gender, age, education, knowledge of WEPs, and citations of WEPs were analysed using Analysis of Variance (ANOVA), and Student's t-test. Log transformation was used to normalize the data. When the value of the ANOVA was significant at $P < 0.05$, Fisher's Least Significant Difference (LSD) was used as a multiple range test to compare the mean values of age, WEPs known, and citations of WEPs for the male and female informants. Relationship between informant's age and

education with knowledge of WEPs was established using correlation analysis. All the analysis and tests were performed using data analysis function of Microsoft Excel 2007 software.

## Results

### Informants

A total of 203 informants/households, 148 males and 55 females, were sampled in the present study (Table 1). All the informants belong to the *Gaddi* and *Sippi* tribes and speak *Gaddi* language. The age of the informants ranged between 30 and 80 yrs. Age of the male informants (58.5 yrs) was significantly (F = 7.37, *P<0.001*) higher than the female informants (51.9 yrs). Most of the informants (54.2%) have never attended the school whereas 17.2% informants left the school after primary education. The male informants also had significantly higher knowledge of WEPs both for number of species (F = 19.36, *P<0.001*) and citations (F = 19.37, *P<0.001*).

Table 1. Basic information of informants; age, education, and knowledge of WEPs

| Attributes | Gender | | ANOVA | |
|---|---|---|---|---|
| | Female (n = 55) | Male (n = 148) | *F* | *P-value* |
| Age (yrs) | 51.9[b]± 14.2 | 58.5[a]± 15.8 | 7.37 | 0.007 |
| Education qualification | | | | |
| Never attended a school | 31 | 79 | | |
| Primary | 8 | 27 | | |
| Middle | 5 | 14 | | |
| High School | 6 | 7 | -1.94 | 0.04[¥] |
| Secondary | 2 | 12 | | |
| Graduate | 1 | 7 | | |
| Post-graduate | 2 | 2 | | |
| WEPs (no.) | 17.7[b]± 6.5 | 22.7[a]± 7.3 | 19.36 | < 0.001 |
| Citations of WEPs (no.) | 20.1[b]± 7.8 | 25.6[a]± 7.9 | 19.67 | < 0.001 |

Values given in the table for Age, Wild Edible Plants (WEPs), and citations are mean ± standard deviation, and Analysis of variance (ANOVA) was performed for these three attributes. Fisher's Least Significant Difference (LSD) was used as a multiple range test to compare the mean values of age, WEPs known, and citation of WEPs for the male and female informants. In case of education qualification, the values given are number of individuals and t-test[¥] was applied to compare the number of informants under various academic levels among the two genders.

### Diversity of WEPs

The findings of the present study reveal that the *Gaddis* and *Sippis* of Doda district have expertise in identification and utilization of a good number of locally available WEPs (Fig. 2 and 3). In present study, 77 plant species belonging to 58 genera and 39 families have been documented (Table 2). Angiosperms with 63 species were the major source of WEPs followed by fungi (9 species), gymnosperms (3), and pteridophytes (2).

Rosaceae was the most represented family with 12 species (Fig. 4), followed by Polygonaceae (5 species), Lamiaceae (4), Amaranthaceae, Apiaceae, Berberidaceae, Malvaceae, Moraceae and Morchellaceae (3 species, each). A total of twenty-two families were represented by only one species each.

### Characteristics of WEPs

With regard to habit, herbs dominated with 48.1% contribution, followed by 24.7% trees, and 13% shrubs (Fig. 5). The most commonly used edible parts (Fig. 6) were leaves (31.7 %) followed by fruits (29.3%) fruiting bodies of fungi (11.0 %), and seeds (8.5 %).

### Diversity of usage of WEPs

For the convenience of study, all the reported plant species were divided into following 12 edible usage categories:

### Leaves cooked as vegetable

This is the largest category of vegetables represented by 20 species (Table 3). The species with most acceptability were *Diplazium esculentum* (Retz.) Sw. (CI = 0.56), *Diplazium frondosum* C.Chr. (0.50), *Amaranthus spinosus* L. (0.42), *Amaranthus viridis* L. (0.42), *Chenopodium album* L. (0.38), and *Malva sylvestris* L. (0.38).


Figure 2. Some of the WEPs used by *Gaddi* and *Sippi* tribes


Figure 3. Wild edible fungi, and some WEPs preparations.

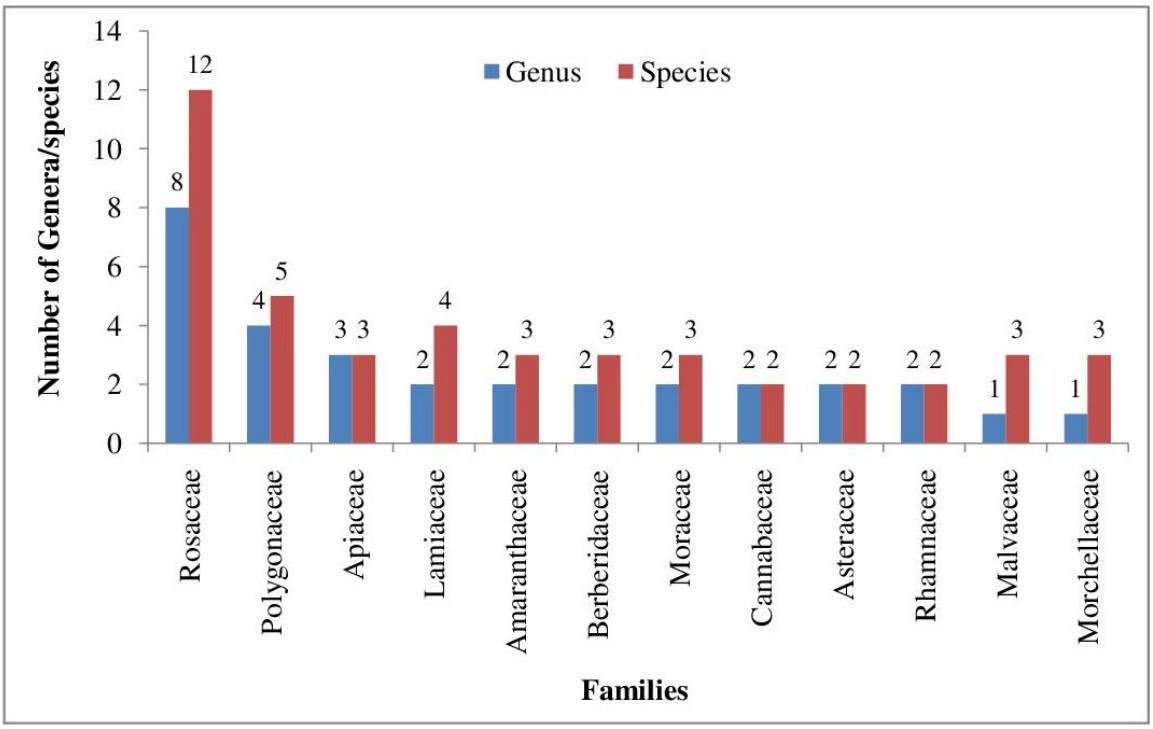


Figure 4. The most represented families of WEPs

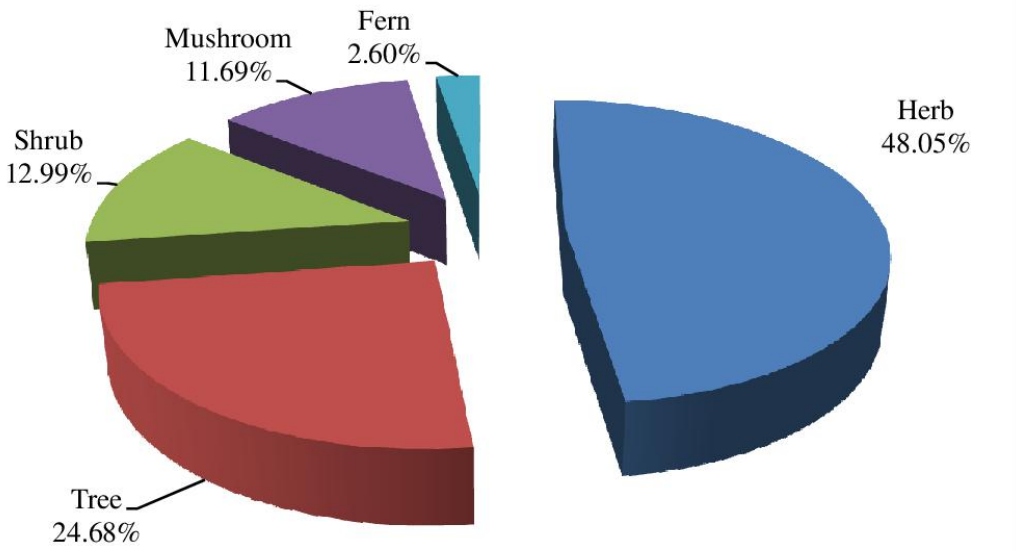


Figure 5. Percentage representation of various plant habits of WEPs.

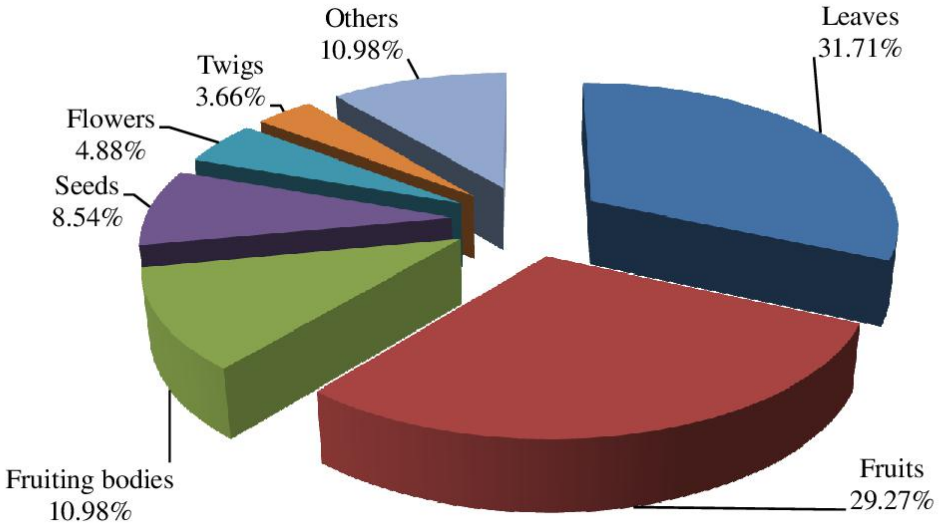


Figure 6. Percentage contribution of different plant parts of WEPs.

**Fruiting bodies of mushrooms cooked as vegetable**

This is the second largest category of vegetables and consists of fruiting bodies of eight fungal species. The highest CI values were recorded for *Geopora arenicola* (CI = 0.66), *Geopora sumneriana* (0.60), *Sparassis radicata* Weir. (0.37), *Sparassis crispa* (Wulfen) Fr. (0.36), and *Boletus edulis* Bull. (0.31).

**Fruit cooked as vegetable**

Only *Sinopodophyllum hexandrum* T.S. Ying (CI = 0.03) falls under this category.

**Leaves consumed raw**

Leaves of five species are consumed raw, prominently of *Oxalis corniculata* L. (CI = 0.19) and *Quercus floribunda* Lindl. ex A.Camus. (0.15).

**Fruits consumed raw**

*Gaddis* and *Sippis* are forest dwelling pastoral tribes who collect and eat wild fruits while grazing their livestock and doing other pastoral activities in the forests. Twenty-seven species of fruits were eaten raw by *Gaddi* and *Sippi* tribes. Fruits of *Juglans regia* L., *Prunus persica* (L.) Batsch., *Viburnum grandiflorum* Wall. ex DC., *Rubus ellipticus* Sm., and *Morus alba* L., with CI values 0.39, 0.38, 0.37, 0.34, and 0.33, respectively were the most commonly consumed fruits.

Table 2. Taxonomical details, use-reports, frequency of citations (FC), and relative frequency of citations (RFC) of WEPs used in the study site.

| Botanical Name | Herbarium Accession No. | Family | English name | Local Name | Habit | Edible part | Usage (use reports) | CI | Ref. |
|---|---|---|---|---|---|---|---|---|---|
| *Allium stracheyi* Baker. | JUH-16755 | Amaryllidaceae | Himalayan seasoning Allium | *Farni* | Herb | Tender leaves | Fresh or dried leaves are crushed and used as substitute for onion for cooking pulses and vegetables (56). Dried leaves are slightly warmed on griddle (*tawa*), crushed to powder, mixed with salt, sprinkled on kedgree (*khichdi*) as condiment followed by addition of ghee and eaten (26). Fresh leaves are also used for making chutney (6). | 0.43 | 16. |
| *Amaranthus spinosus* L. | JUH-16751 | Amaranthaceae | Spiny pig weed | *Chawli* | Herb | Tender Leaves | Vegetable (86) | 0.42 | 1, 2, 4, 7, 11, 16. |
| *Amaranthus viridis* L. | JUH-16752 | Amaranthaceae | Pig weed | *Chawli* | Herb | Leaves | Vegetable (85) | 0.42 | 1, 4, 6, 11, 21, 22, 24, 25, 26, 29. |
| *Anethum sowa* Roxb. ex Fleming. | JUH-16756 | Apiaceae | Dill | *Soye* | Herb | Fruits or seeds | Eaten raw (64), nutraceutical (15) | 0.39 | 16, 22. |
| *Angelica glauca* Edgew. | JUH-16757 | Apiaceae | Smooth Angelica | *Chora* | Herb | Roots | Small pieces of roots are boiled in water with Kidney beans (*rajmash*), beans, and black gram lentil (*maash*) as an ingredient for cooking these dishes to enhance flavor (75). | 0.37 | 1, 8, 13, 16, 22. |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Arisaema propinquum* Schott. | JUH-16762 | Araceae | Wallach's cobra lily | *Shundgal* | Herb | Rhizomes | Small pieces of cleaned rhizomes are boiled in water with tamarind (*imli*) for 7-8 hours to neutralize its toxic affect. The outer membranous covering of the rhizomes is removed after boiling and the rhizomes are then dried. Ingredients like oil and spices are added to boiled and dried rhizomes and pickle is prepared following traditional recipe (19). Boiled rhizomes are crushed with hands to form paste which is added to wheat dough in the ratio 1:2 (approx.) which is then fermented, fried in oil as chapatti (*babru*) (46). | 0.32 | 22 |
| *Berberis aristata* DC. | JUH-17029 | Berberidaceae | | *Dharu Kishmay* | Shrub | Fruits, leaves, tender twigs | Fresh leaves (19) and Ripe fruit (51) are eaten raw, tender twigs are sour and eaten raw after peeling (8), nutraceutical (1). | 0.39 | 1, 3, 4, 5, 11, 22, 27. |
| *Berberis lycium* Royle. | JUH-16776 | Berberidaceae | Boxthorn barberry | *Kishmay* | Shrub | Fruits, leaves, tender twigs | Fresh leaves (16) and Ripe fruit (56) are eaten raw, tender twigs are sour and eaten raw after peeling (4), nutraceutical (2). | 0.38 | 1, 3, 4, 5, 6, 10, 11, 13, 14, 15, 17, 21, 22, 23, 24, 27, 30. |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Bistorta amplexicaulis* (D.Don) Greene | JUH-16834 | Polygonaceae | Red mountain fleece | *Troodh* | Herb | Roots | Roots used for making tea (30), nutraceutical (5). | 0.17 | 5, 13, 15, 16, 21, 22, 23, 27. |
| *Boletus edulis* Bull. | JUH-16893 | Boletaceae | Indian Barberry/ Tree turmeric | *Buthapad* | Mushroom | Fruiting bodies | Fruiting bodies are eaten after roasting or cooking as vegetable (62). | 0.31 | 9 |
| *Cannabis sativa* L. | JUH-16783 | Cannabaceae | Hemp | *Bhang* | Herb | Leaves | Fresh leaves are used for making snacks (*pakora*) (17) and a sedative milk drink (*shardhai*) (59) generally on the occasion of *Shivratri*, a Hindu festival devoted to Lord Shiva, nutraceutical (4). | 0.39 | 5, 21, 22, 25, 27, 29. |
| *Celtis australis* L. | JUH-16788 | Cannabaceae | European nettle tree | *Khedak* | Tree | Fruits | Eaten raw (55). | 0.27 | 3, 5, 6, 22, 23. |
| *Chenopodium album* L. | JUH-16753 | Amaranthaceae | Lamb's quarters | *Kunha/ Bathu* | Herb | Tender leaves | Vegetable (77). | 0.38 | 1, 2, 3, 4, 6, 11, 12, 13, 15, 17, 21, 22, 23, 24, 25, 27, 29, 33. |
| *Cichorium intybus* L. | JUH-16770 | Asteraceae | Chicory | *Hindri* | Herb | Leaves | Vegetable (64), nutraceutical (20). | 0.41 | 1, 11, 12, 13, 17, 22, 23, 31. |
| *Crataegus songarica* K. Koch. | JUH-16851 | Rosaceae | Asian hawthorn | *Patakein/ Pendakh* | Tree | Fruits | Eaten raw (52). | 0.26 | 5, 22, 23, 27. |
| *Diospyros lotus* L. | JUH-16792 | Ebenaceae | Date plum | *Amlook* | Tree | Fruit | Eaten raw (61). | 0.30 | 1, 3, 15, 21, 24, |
| *Diplazium esculentum* (Retz.) Sw. | JUH-16889 | Athyriaceae | Vegetable fern | *Kasrod* | Fern | Tender leaves | Vegetable (114) | 0.56 | 2, 3, 6, 13, 15, 16, 21, 24, 22, 27, 31. |
| *Diplazium frondosum* C. Chr. | JUH-17023 | Athyriaceae | | *Kasrod* | Fern | Tender leaves | Young fronds are used as vegetable (102) and for making pickle (7). | 0.54 | 3, 4, 5, 11, 24, |
| *Dipsacus inermis* Wall. | JUH-16784 | Caprifoliaceae | Himalayan teasel | *Thanthana* | Herb | Tender leaves | Vegetable (47), nutraceutical (7). | 0.27 | 2, 4, 5, 8, 11, 16, 22, 23, 30, 31. |
| *Duchesnea indica* (Andrew) Focke. | JUH-16852 | Rosaceae | Indian mockstrawberry | *Gilad* | Herb | Fruits | Eaten raw (36) | 0.18 | 4, 5, 6, 10, 11, 15, 21, 24. |
| *Elaeagnus umbellata* Thunb. | JUH-16793 | Elaeagnaceae | Autum olive | *Ban kanak* | Shrub | Fruit | Eaten raw (44) | 0.22 | 4, 5, 11, 22, 24, 27. |

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|---|---|---|---|---|---|---|---|---|---|
| *Elwendia persica* (Boiss.) Pimenov & Kljuykov | JUH-17022 | Apiaceae | Black caraway | *Kala zeera* | Herb | Seeds | Spice (57) | 0.28 | 22, 31, 30. |
| *Fagopyrum cymosum* (Trevir.) Meisn. | JUH-16836 | Polygonaceae | Tall buckwheat | *Fafra* | Herb | Tender leaves | Vegetable (69), nutraceutical (13). | 0.40 | 15, 21, 27. |
| *Ficus palmata* Forssk. | JUH-16819 | Moraceae | Wild fig | *Fagra* | Tree | Fruits | Eaten raw (26). | 0.13 | 1, 3, 4, 5, 6, 10, 11, 15, 21, 22, 24, 25, 27, 29, 33. |
| *Fragaria vesca* L. | JUH-16853 | Rosaceae | Wild strawberry | *Bhununu* | Herb | Fruits | Eaten raw (58), nutraceutical (14). | 0.35 | 1, 12, 13, 14, 16. |
| *Geopora arenicola* (Lev.) Kers. | JUH-16906 | Pyronemataceae | Earth cups | *Kundi* | Mushroom | Fruiting bodies | Vegetable (133). | 0.66 | 9, 16, 21, 23. |
| *Geopora sumneriana* (Cooke) M. Torre | JUH-17024 | Pyronemataceae | Earth cups | *Kundi* | Mushroom | Fruiting bodies | Vegetable (121). | 0.60 | 9 |
| *Impatiens glandulifera* Royle. | JUH-16775 | Balsaminaceae | Earth cups | *Hallu* | Herb | seeds | Eaten raw (36). | 0.18 | 1, 13, 22, 23. |
| *Juglans regia* L. | JUH-16902 | Juglandaceae | Walnut | *Akhod* | Tree | Fruits | Kernel eaten raw (79), nutraceutical (20). | 0.49 | 3, 4, 5, 11, 13, 15, 19, 21, 22, 24, 27, 31. |
| *Malva neglecta* Wallr. | JUH-16815 | Malvaceae | Dwarf mallow | *Sonchal* | Herb | Leaves | Vegetable (72), nutraceutical (24). | 0.47 | 5, 8, 12, 17, 22, 23. |
| *Malva parviflora* L. | JUH-16816 | Malvaceae | Cheeseweed mallow | *Sonchal* | Herb | Leaves | Vegetable (76), nutraceutical (19). | 0.47 | 1, 11, 15, 21, 24, 25, 27. |
| *Malva sylvestris* L. | JUH-16817 | Malvaceae | Tall mallow | *Sonchal* | Herb | Leaves | Vegetable (77), nutraceutical (16). | 0.46 | 1, 2, 3, 23. |
| *Mentha arvensis* C.Presl. | JUH-16808 | Lamiaceae | Cornmint | *Potna* | Herb | Leaves | Condiment (29), Chutney (61), nutraceutical (15). | 0.52 | 4, 5, 11, 13, 24. |
| *Mentha longifolia* (L.) L. | JUH-16809 | Lamiaceae | Himalayan horsemint | *Potna* | Herb | Leaves | Fresh leaves are used as Condiment (16) and for making Chutney (58). Dried crushed leaves are used to garnish curd (20), nutraceutical (9). | 0.51 | 1, 3, 4, 6, 12, 14, 15, 17, 21, 22, 25, 27, 31, 33. |
| *Mentha spicata* L. | JUH-16810 | Lamiaceae | Spearmint | *Potna* | Herb | Leaves | Condiment (26), Chutney (65), nutraceutical (10). | 0.50 | 20, 22, 29. |
| *Morchella conica* Pers. | JUH-16894 | Morchellaceae | Black morels | *Thunthu* | Mushroom | Fruiting bodies | Vegetable (51). | 0.25 | 9 |

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|---|---|---|---|---|---|---|---|---|---|
| *Morchella crassipes* (Vent.) Pers. | JUH-17025 | Morchellaceae | Bigfoot morels | *Thunthu* | Mushroom | Fruiting bodies | Vegetable (51). | 0.25 | - |
| *Morchella esculenta* (L.) Pers. | JUH-16895 | Morchellaceae | Yellow morels | *Thunthu* | Mushroom | Fruiting bodies | Vegetable (51). | 0.25 | 3, 4, 5, 9, 11, 12, 16, 18, 21, 23, 28, 29, 31, 32. |
| *Morus alba* L. | JUH-16820 | Moraceae | White mulberry | *Toot* | Tree | Fruits | Eaten raw (66). | 0.33 | 1, 3, 4, 11, 12, 13, 14, 15, 18, 20, 21, 22, 23, 24, 25, 33. |
| *Morus nigra* L. | JUH-17026 | Moraceae | Black mulberry | *Kala toot* | Tree | Fruits | Eaten raw (55). | 0.27 | 3, 4, 11, 15, 22, 23, 24, 29, |
| *Oxalis corniculata* L. | JUH-16824 | Oxalidaceae | Creeping wood sorrel | *Amloodi* | Herb | Aerial parts | Eaten raw (39), chutney (9), nutraceutical (2). | 0.25 | 1, 3, 4, 5, 6, 10, 11, 15, 16, 21, 22, 24, 25, 27. |
| *Oxyria digyna* (L.) Hill. | JUH-16838 | Polygonaceae | Alpine mountain sorrel | *Chukru* | Herb | Tender leaves | Vegetable (42). | 0.21 | 1, 2, 4, 8, 11, 13, 14, 16, 22, 27. |
| *Phytolacca acinosa* Roxb. | JUH-16826 | Phytolaccaceae | Indian pokeweed | *Ransag* | Herb | Tender leaves | Tender leaves are boiled in water, drained and cooked as vegetable (29), nutraceutical (4). | 0.16 | 1, 4, 5, 11, 16, 21, 22, 24, 27. |
| *Pinus roxburghii* Sarg. | JUH-16886 | Pinaceae | Chir pine | *Drab chill* | Tree | Seeds | Eaten raw (32). | 0.16 | 1, 4, 10, 11, 24, 29, |
| *Pinus wallichiana* A.B.Jacks. | JUH-16887 | Pinaceae | Blue pine | *Chill* | Tree | Seeds | Eaten raw (31). | 0.15 | - |
| *Portulaca oleracea* L. | JUH-16845 | Portulacaceae | Common purslane | *Kulfa* | Herb | Tender leaves | Vegetable. (69). | 0.34 | 1, 2, 11, 17, 23, 24, 27, 29, 30. |
| *Prinsepia utilis* Royle. | JUH-16854 | Rosaceae | Himalayan cherry prinsepia | *Jeentai* | Shrub | Seeds | Oil obtained from dried seeds is used for cooking vegetables (24), nutraceutical (1). | 0.12 | 10, 21. |
| *Prunus armeniaca* L. | JUH-16855 | Rosaceae | Apricot | *Cheir* | Tree | Fruits/seeds | Fruits eaten raw (53), seed oil is used for frying vegetables (9). Seed oil together with jaggery is eaten with chapatti as postpartum tonic for women (18). | 0.39 | 3, 5, 14, 15, 16, 22, 24. |

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|---|---|---|---|---|---|---|---|---|---|
| *Prunus cornuta* (Wall. ex Royle) Steud. | JUH-16856 | Rosaceae | Himalayan bird cherry | *Jamu* | Tree | Fruits | Fruits eaten raw (21). | 0.10 | 5, 13, 14, 22, 23. |
| *Prunus persica* (L.) Batsch. | JUH-16857 | Rosaceae | Peach | *Aadu* | Tree | Fruits | Eaten raw (77). | 0.38 | 15 |
| *Punica granatum* L. | JUH-16814 | Lythraceae | Pomegranate | *Dadooni* | Tree | Seeds | Seeds eaten raw (18) and used for making *chutney* (42). | 0.30 | 1, 3, 4, 5, 10, 11, 15, 16, 21, 22, 24, 25, 27, 31. |
| *Pyrus pashia Buch.*-Ham. ex D.Don | JUH-16858 | Rosaceae | Wild Himalayan pear | *Kaith* | Tree | Fruits | Unripe fruits are kept in paddy husk or barley straw for ripening. Ripe fruits eaten raw (54). | 0.27 | 3, 4, 5, 6, 10, 11, 15, 21, 22, 24, 30. |
| *Quercus floribunda* Lindl. ex A.Camus. | JUH-16801 | Fagaceae | *Mohru* oak | *Maru* | Tree | Leaf galls | Eaten raw (30). | 0.15 | - |
| *Rhizopogon* sp. | JUH-17027 | Rhizopogonaceae | False truffles | *Dudhkatta* | Mushroom | Fruiting bodies | Eaten raw (41). | 0.20 | 5, 9. |
| *Rhododendron arboreum* Sm. | JUH-16795 | Ericaceae | Tree Rhododendron | *Cheu* | Tree | Flowers | Flowers eaten raw (2) and used for making chutney (15). | 0.08 | 3, 4, 10, 11, 16, 21, 22, 24. |
| *Rosa brunonii* Lindl. | JUH-16859 | Rosaceae | Himalayan musk rose | *Kojein* | Shrub | Fruits, Tender twigs | Fruit eaten raw (40), tender twigs eaten raw after peeling (10). | 0.25 | 1, 4, 11, 21, 27. |
| *Rosa macrophylla* Lindl. | JUH-16860 | Rosaceae | Himalayan rose | *Ban gulab* | Shrub | Flowers | *Muraba* (39), nutraceutical (1). | 0.20 | 27 |
| *Rubus ellipticus* Sm. | JUH-16861 | Rosaceae | Yellow Himalayan raspberry | *Aakhedi* | Shrub | Fruit | Eaten raw (69), nutraceutical (5). | 0.36 | 1, 4, 10, 11, 15, 20, 21, 22, 24, 27, 30. |
| *Rubus niveus* Thunb. | JUH-16862 | Rosaceae | Hill raspberry | *Aakhedi* | Shrub | Fruits | Eaten raw (64), nutraceutical (12). | 0.37 | 1, 10, 13, 14, 17, 20, 21, 22, 24, 27. |
| *Rumex hastatus* D. Don. | JUH-16843 | Polygonaceae | Arrow leaf dock | *Amloda* | Herb | Leaves | Vegetable (6), Chutney(43). | 0.24 | 1, 2, 4, 11, 15, 16, 20, 21, 24, 26. |
| *Rumex nepalensis* Spreng. | JUH-16844 | Polygonaceae | Nepal dock | *Harbal* | Herb | Tender leaves | Vegetable (48). | 0.24 | 2, 3, 4, 10, 11, 15, 21, 22, 23, 24, 27, 29, 30, 31. |
| *Sageretia thea* (Osbeck) M.C. Johnst. | JUH-16849 | Rhamnaceae | Mock buckthorn | *Dhrenkolu* | Shrub | Fruits | Eaten raw (47). | 0.23 | - |

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|---|---|---|---|---|---|---|---|---|---|
| *Sinopodophyllum hexandrum* (Royle) T.S.Ying | JUH-16777 | Berberidaceae | Himalayan May apple | *Ban kakru* | Herb | Fruits | Ripe fruit eaten raw (52), unripe fruit cooked as vegetable (7). | 0.29 | 3, 4, 8, 11, 12, 13, 14, 16, 22, 23, 24, 30. |
| *Solanum villosum* Mill. | JUH-16875 | Solanaceae | Hairy nightshade | *Kanya* | Herb | Fruits | Eaten raw (38), nutraceutical (1). | 0.19 | 21, 29. |
| *Sparassis crispa* (Wulfen) Fr. | JUH-16896 | Sparassidaceae | Wood cauliflower mushroom | *Bhed shedi* | Mushroom | Fruiting bodies | Vegetable (73). | 0.36 | 23 |
| *Sparassis radicata* Weir. | JUH-16897 | Sparassidaceae | Rooting cauliflower mushroom | *Bakar shedi* | Mushroom | Fruiting bodies | Vegetable (76). | 0.37 | 9 |
| *Stellaria media* (L.) Vill. | JUH-16789 | Caryophyllaceae | Common chickweed | *Fukku* | Herb | leaves | Vegetable (67). | 0.33 | 2, 12, 15, 17, 23, 24, 26. |
| *Taraxacum officinale* (L.) Weber ex F.H.Wigg. | JUH-16774 | Asteraceae | Common dandelion | *Hindri* | Herb | Tender leaves | Vegetable (67), nutraceutical (24). | 0.45 | 1, 2, 3, 5, 8, 12, 16, 17, 21, 22, 23, 24, 26, 30, 31. |
| *Taxus baccata* L. | JUH-16888 | Taxaceae | Common yew | *Dunnu* | Tree | Bark | Bark used for making tea (12). | 0.06 | 5, 4, 11, 22, 24. |
| *Thymus mongolicus* (Ronniger) Ronniger. | JUH-16813 | Lamiaceae | Himalayan thyme | *Ban jawain* | Herb | Aerial parts | Condiments (34), brewed in water as tea (4). | 0.19 | 13, 22, 31. |
| *Urtica dioecia* Hill. | JUH-16880 | Urticaceae | Common nettle | *Nikki aen* | Herb | Tender leaves | Tender leaves are boiled in water, drained and cooked as vegetable (44), nutraceutical (2). | 0.23 | 5, 6, 10, 15, 16, 17, 21, 22, 23, 27. |
| *Viburnum grandiflorum* Wall. ex DC. | JUH-16749 | Adoxaceae | Stinking Himalayan Viburnum | *Toondhay* | Shrub | Fruits | Eaten raw (75). | 0.37 | 1, 4, 5, 10, 11, 12, 15, 16, 21, 22, 23, 24, 27. |
| *Vicia sativa* L. | JUH-16800 | Fabaceae | Common vetch | *Kukshein* | Herb | Seeds | Eaten raw (43) | 0.21 | 15, 17. |
| *Viola canescens* Wall. | JUH-16881 | Violaceae | Himalayan white violet | *Sanwarful/ Banaksha* | Herb | flowers | A hot drink is prepared by boiling fresh or dried flowers in water or milk (66), nutraceutical (15). | 0.40 | - |
| *Viola odorata* L. | JUH-17028 | Violaceae | English violet | *Sanwarful/ Banaksha* | Herb | Flowers | A hot drink is prepared by boiling fresh or dried flowers in water or milk (66), nutraceutical (15). | 0.40 | 4, 12, 15, 16, 21, 24, 26. |

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|---|---|---|---|---|---|---|---|---|---|
| *Zanthoxylum armatum* DC. | JUH-16868 | Rutaceae | Winged prickly ash | *Timru* | Tree | Fruits | Eaten raw (29). | 0.14 | 1, 3, 15, 20, 22, 24. |
| *Ziziphus oxyphylla* Edgew. | JUH-16850 | Rhamnaceae | Pointed leaf jujube | *Ber* | Tree | Fruits | Eaten raw (53). | 0.26 | |

**References used in the table**: 1-Srivastava 1988; 2-Dhar and Dhar 2000; 3-Rashid *et al.* 2008; 4-Khan *et al.* 2009; 5-Kumar and Hamal 2009; 6-Tiwari *et al.* 2010; 7-Bhoyar *et al.* 2011; 8-Dad and Khan 2011; 9-Kumar and Sharma 2011; 10-Dangwal *et al.* 2014; 11-Khan and Hussain 2014; 12-Mir 2014; 13-Singh *et al.* 2016; 14-Singh and Bedi 2017; 15-Bhatia *et al.* 2018; 16-Pandita and Dutt 2018; 17-Showkat and Akhtar 2018; 18-Showkat and Hussain 2018; 19-Singh and Bedi 2019; 20-Thakur *et al.* 2019; 21-Sarver and Nigam 2020; 22-Thakur and Dutt 2020; 23-Abdullah and Addrabi 2021; 24-Farooq 2021; 25-Khajuria 2021; 26-Mahmood and Farooq 2021; 27-Singh *et al.* 2021; 28-Bagal *et al.* 2022; 29-Bhagat *et al.* 2022.; 30-Gangoo *et al.* 2022; 31-Peerzada *et al.* 2022; 32-Sharma *et al.* 2022; 33-Sheikh and Modi 2022.

Table 3. Cultural importance of WEPs in various usage categories.

| Botanical Name | Vegetable | Fungi as vegetable | Pickle/ *Murabba* | Vegetable Raw | Fruit Raw | Seeds Raw | Chutney | Drink/ tea | Spice/ condiment | Nutraceutical | Misc. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Allium stracheyi* Baker. | 0.28 | - | - | - | - | - | 0.03 | - | 0.13 | - | - |
| *Amaranthus spinosus* L. | 0.42 | - | - | - | - | - | - | - | - | - | - |
| *Amaranthus viridis* L. | 0.42 | - | - | - | - | - | - | - | - | - | - |
| *Anethum sowa* Roxb. ex Fleming. | - | - | - | - | 0.32 | - | - | - | - | 0.07 | - |
| *Angelica glauca* Edgew. | - | - | - | - | - | - | - | - | 0.37 | - | - |
| *Arisaema propinquum* Schott. | - | - | 0.09 | - | - | - | - | - | - | - | 0.23 |
| *Berberis aristata* DC. | - | - | - | 0.09 | 0.25 | - | - | - | - | 0.00 | 0.04 |
| *Berberis lycium* Royle. | - | - | - | 0.08 | 0.28 | - | - | - | - | 0.01 | 0.02 |
| *Bistorta amplexicaulis* (D.Don) Greene | - | - | - | - | - | - | - | 0.15 | - | 0.02 | - |
| *Boletus edulis* Bull. | - | 0.31 | - | - | - | - | - | - | - | - | - |
| *Cannabis sativa* L. | - | - | - | - | - | - | - | 0.29 | - | 0.02 | 0.08 |
| *Celtis australis* L. | - | - | - | - | 0.27 | - | - | - | - | - | - |
| *Chenopodium album* L. | 0.38 | - | - | - | - | - | - | - | - | - | - |
| *Cichorium intybus* L. | 0.32 | - | - | - | - | - | - | - | - | 0.10 | - |
| *Crataegus songarica* K. Koch. | - | - | - | - | 0.26 | - | - | - | - | - | - |
| *Diospyros lotus* L. | - | - | - | - | 0.30 | - | - | - | - | - | - |
| *Diplazium esculentum* (Retz.) Sw. | 0.56 | - | - | - | - | - | - | - | - | - | - |
| *Diplazium frondosum* C. Chr. | 0.50 | - | 0.03 | - | - | - | - | - | - | - | - |
| *Dipsacus inermis* Wall. | 0.23 | - | - | - | - | - | - | - | - | 0.03 | - |
| *Duchesnea indica* (Andrew) Focke. | - | - | - | - | 0.18 | - | - | - | - | - | - |
| *Elaeagnus umbellata* Thunb. | - | - | - | - | 0.22 | - | - | - | - | - | - |
| *Elwendia persica* (Boiss.) Pimenov & Kljuykov | - | - | - | - | - | - | - | - | 0.28 | - | - |
| *Fagopyrum cymosum* (Trevir.) Meisn. | 0.34 | - | - | - | - | - | - | - | - | 0.06 | - |
| *Ficus palmata* Forssk. | - | - | - | - | 0.13 | - | - | - | - | - | - |
| *Fragaria vesca* L. | - | - | - | - | 0.29 | - | - | - | - | 0.07 | - |
| *Geopora arenicola* (Lev.) Kers. | - | 0.66 | - | - | - | - | - | - | - | - | - |
| *Geopora sumneriana* (Cooke) M. Torre | - | 0.60 | - | - | - | - | - | - | - | - | - |
| *Impatiens glandulifera* Royle | - | - | - | - | - | 0.18 | - | - | - | - | - |
| *Juglans regia* L. | - | - | - | - | 0.39 | - | - | - | - | 0.10 | - |
| *Malva neglecta* Wallr. | 0.35 | - | - | - | - | - | - | - | - | 0.12 | - |
| *Malva parviflora* L. | 0.37 | - | - | - | - | - | - | - | - | 0.09 | - |
| *Malva sylvestris* L. | 0.38 | - | - | - | - | - | - | - | - | 0.08 | - |
| *Mentha arvensis* C.Presl. | - | - | - | - | - | - | 0.30 | - | 0.14 | 0.07 | - |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| *Mentha longifolia* (L.) L. | - | - | - | - | - | - | 0.29 | - | 0.18 | 0.04 | - |
| *Mentha spicata* L. | - | - | - | - | - | - | 0.32 | - | 0.13 | 0.05 | - |
| *Morchella conica* Pers. | - | 0.25 | - | - | - | - | - | - | - | - | - |
| *Morchella crassipes* (Vent.) Pers. | - | 0.25 | - | - | - | - | - | - | - | - | - |
| *Morchella esculenta* (L.) Pers. | - | 0.25 | - | - | - | - | - | - | - | - | - |
| *Morus alba* L. | - | - | - | - | 0.33 | - | - | - | - | - | - |
| *Morus nigra* L. | - | - | - | - | 0.27 | - | - | - | - | - | - |
| *Oxalis corniculata* L. | - | - | - | 0.19 | - | - | 0.04 | - | - | 0.01 | - |
| *Oxyria digyna* (L.) Hill. | 0.21 | - | - | - | - | - | - | - | - | - | - |
| *Phytolacca acinosa* Roxb. | 0.14 | - | - | - | - | - | - | - | - | 0.02 | - |
| *Pinus roxburghii* Sarg. | - | - | - | - | - | 0.16 | - | - | - | - | - |
| *Pinus wallichiana* A.B.Jacks. | - | - | - | - | - | 0.15 | - | - | - | - | - |
| *Portulaca oleracea* L. | 0.34 | - | - | - | - | - | - | - | - | - | - |
| *Prinsepia utilis* Royle. | - | - | - | - | - | - | - | - | - | 0.00 | 0.12 |
| *Prunus armeniaca* L. | - | - | - | - | 0.26 | - | - | - | - | - | 0.13 |
| *Prunus cornuta* (Wall. ex Royle) Steud. | - | - | - | - | 0.10 | - | - | - | - | - | - |
| *Prunus persica* (L.) Batsch. | - | - | - | - | 0.38 | - | - | - | - | - | - |
| *Punica granatum* L. | - | - | - | - | - | 0.09 | 0.21 | - | - | - | - |
| *Pyrus pashia Buch.*-Ham. ex D.Don | - | - | - | - | 0.27 | - | - | - | - | - | - |
| *Quercus floribunda* Lindl. ex A.Camus. | - | - | - | 0.15 | - | - | - | - | - | - | - |
| *Rhizopogon* sp. | - | - | - | - | 0.20 | - | - | - | - | - | - |
| *Rhododendron arboreum* Sm. | - | - | - | - | - | - | 0.07 | - | - | - | 0.01 |
| *Rosa brunonii* Lindl. | - | - | - | 0.05 | 0.20 | - | - | - | - | - | - |
| *Rosa macrophylla* Lindl. | - | - | 0.19 | - | - | - | - | - | - | 0.00 | - |
| *Rubus ellipticus* Sm. | - | - | - | - | 0.34 | - | - | - | - | 0.02 | - |
| *Rubus niveus* Thunb. | - | - | - | - | 0.32 | - | - | - | - | 0.06 | - |
| *Rumex hastatus* D. Don. | 0.03 | - | - | - | - | - | 0.21 | - | - | - | - |
| *Rumex nepalensis* Spreng. | 0.24 | - | - | - | - | - | - | - | - | - | - |
| *Sageretia thea* (Osbeck) M.C. Johnst. | - | - | - | - | 0.23 | - | - | - | - | - | - |
| *Sinopodophyllum hexandrum* (Royle) Ying | 0.03 | - | - | - | 0.26 | - | - | - | - | - | - |
| *Solanum villosum* Mill. | - | - | - | - | 0.19 | - | - | - | - | 0.00 | - |
| *Sparassis crispa* (Wulfen) Fr. | - | 0.36 | - | - | - | - | - | - | - | - | - |
| *Sparassis radicata* Weir. | - | 0.37 | - | - | - | - | - | - | - | - | - |
| *Stellaria media* (L.) Vill. | 0.33 | - | - | - | - | - | - | - | - | - | - |
| *Taraxacum officinale* (L.) Weber ex Wigg. | 0.33 | - | - | - | - | - | - | - | - | 0.12 | - |
| *Taxus baccata* L. | - | - | - | - | - | - | - | 0.06 | - | - | - |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| *Thymus mongolicus* (Ronniger) Ronniger. | - | - | - | - | - | - | - | 0.02 | 0.17 | - | - |
| *Urtica dioecia* Hill. | 0.22 | - | - | - | - | - | - | - | - | 0.01 | - |
| *Viburnum grandiflorum* Wall. ex DC. | - | - | - | - | 0.37 | - | - | - | - | - | - |
| *Vicia sativa* L. | - | - | - | - | - | 0.21 | - | - | - | - | - |
| *Viola canescens* Wall. | - | - | - | - | - | - | - | 0.33 | - | 0.07 | - |
| *Viola odorata* L. | - | - | - | - | - | - | - | 0.33 | - | 0.07 | - |
| *Zanthoxylum armatum* DC. | - | - | - | - | 0.14 | - | - | - | - | - | - |
| *Ziziphus oxyphylla* Edgew. | - | - | - | - | 0.26 | - | - | - | - | - | - |

**Seeds consumed raw**

Seeds of five species are consumed raw. The most preferred species were *Vicia sativa* L. (CI = 0.21), *Impatiens glandulifera* Royle (0.18), *Pinus roxburghii* Sarg. (0.16), and *Pinus wallichiana* A.B. Jacks (0.15).

**Spices and condiments**

Spices and condiments are the plant parts which are added to the food for enhancing its flavour. Seven species were used as source of spices and condiments. These most used species include *Angelica glauca* Edgew. (CI = 0.37), *Elwendia persica* (Boiss.) Pimenov & Kljuykov (0.28), *Mentha longifolia* L. (0.18), and *Thymus mongolicus* (Ron.) Ronniger (0.17).

**Beverages**

Six species are used for making hot and cold beverages. A hot drink is prepared by brewing fresh or dried flowers of *Viola canescens* Wall. (CI = 0.33) and *Viola odorata* L. (0.33) in milk. Leaves of *Cannabis sativa* L. (0.29) are used for making sedative milk drink (locally known as *shardhai*) on the occasion of Hindu festival *Shivratri*. Roots of *Bistorta amplexicaulis* (D.Don) Greene (0.15) and bark of *Taxus baccata* L. (0.06) are used for making tea.

**Chutney (sauce)**

Eight species were used for making chutney. Leaves of *Mentha spicata* L. (CI = 0.32) were the most used species for making chutney, closely followed by *Mentha arvensis* C. Presl. (0.30) and *Mentha longifolia* L. (0.29). Seeds of *Punica granatum* L. (0.21) and leaves of *Rumex hastatus* D. Don. (0.21) were the other species used for making chutney. Flowers of *Rhododendron arboreum* Sm. (0.07), and leaves of *Allium stracheyi* Baker. (03) were also used in this category.

**Preserved WEPs (Pickle and *murabba*)**

Pickle is a food item preserved in salt, oil or vinegar by anaerobic fermentation which adds flavour to it and also facilitates its long-term storage. Two WEPs viz. circinately coiled tender leaves of *Diplazium frondosum* C. Chr. (CI = 0.03) and rhizomes of *Arisaema propinquum* Schott. (0.09) were used for making pickle whereas *Rosa macrophylla* Lindl. (0.19) was used for making *murabba*.

**Nutraceuticals**

*Gaddi* and *Sippi* tribes consume WEPs primarily for meeting their nutritional requirements; however 28 reported WEP species also have medicinal values. The most commonly used nutraceutical WEPs were *Malva neglecta* Wallr. (CI = 0.12), *Taraxacum officinale* F.H. Wigg. (0.12), *Cichorium intybus* L. (0.10), and *Juglans regia* L. (0.10).

**Miscellaneous use**

This category of WEPs includes all those plant uses which could not be grouped in any of the above-mentioned categories. This category involves use of 8 species of WEPs in different ways. For example, flowers of *Rhododendron arboreum* Sm., and peeled tender twigs of *Berberis lyceum* Royle, *Berberis aristata* DC., and *Rosa brunonii* Lindl. were eaten raw, paste of boiled rhizomes of *Arisaema propinquum* Schott. mixed with wheat dough was used for making leavened fried bread (locally known as *babru*) and leaves of *Cannabis sativa* L. are used for making sedative snacks (*pakora*) on the occasion of *Shivratri*. Edible oil is obtained from seeds of two WEPs viz. *Prunus armeniaca* L., and *Prinsipia utilis* Royle.

Fourteen species have dual edible usage. These species with their edible part and usages are *Allium stracheyi* Baker. (leaves: condiment, chutney), *Arisaema propinquum* (rhizomes: pickle, leavened the fried bread), *Boletus edulis* Bull. (fruiting bodies: vegetable, roasted), *Diplazium esculentum* and *Diplazium frondosum* (leaves: vegetable, pickle), *Mentha arvensis, Mentha longifolia* and *Mentha spicata* (leaves: condiment, chutney), *Oxalis corniculata* L. (aerial parts: eaten raw, chutney), *Prunus armeniaca* (fruits: eaten raw, seeds: oil), *Punica granatum* L. (seeds: eaten raw, chutney), *Rhododendron arboreum* (flowers: eaten raw, chutney) *Sinopodophyllum hexandrum* (fruits: eaten raw, vegetable), and *Thymus serphyllum* (aerial parts: condiment, tea).

Only one edible part is derived from most of the reported plant species. However, two edible parts are derived from *Anethum sowa*, *Prunus armeniaca* (fruits and seeds each) and *Rosa brunonii* (fruits and tender twigs), while three edible parts are derived from *Berberis lyceum* and *Berberis aristata* (leaves, fruits, and tender twigs).

**Important WEPs**

The most important WEPs, on the basis of CI values, were *Geopora arenicola* (Lev.) Kers. (CI = 0.66), *Geopora sumneriana* (Cooke) M. Torre. (0.60), *Diplazium esculentum* (Retz.) Sw. (0.56), *Diplazium frondosum* C. Chr. (0.54), *Mentha arvensis* C. Presl. (0.52), *Mentha longifolia* L. (0.51), *Mentha spicata* L. (0.50), and *Juglans regia* L. (0.49).

**Knowledge of WEPs with respect to age and education level of informants**

The correlation analysis between the knowledge of WEPs was found significant with age (r = 0.73; *P<0.001*) and education level (r = 0.42; *P<0.001*) of the informants (Fig. 7); and shows that the knowledge of WEPs significantly increased with age and decreased with education level.

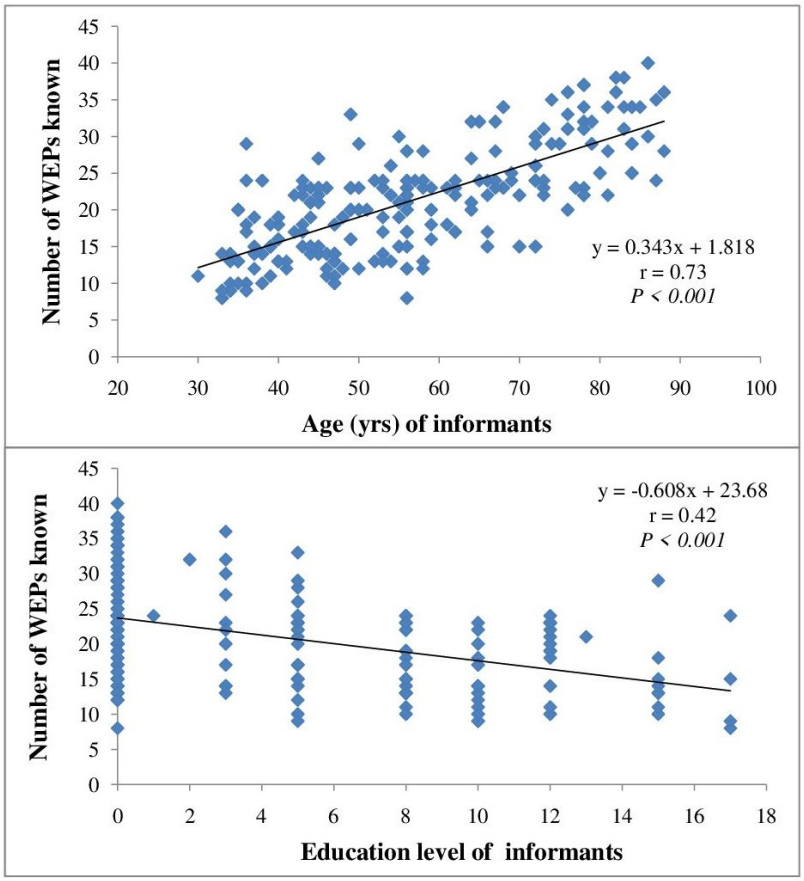


Figure 7. Correlation analysis between knowledge of WEPs and (i) age and (ii) education level of informants.

**Factor informant consensus ($F_{ic}$)**

All the uses were further clustered into eight categories for the calculation of $F_{ic}$ (Table 4), an index that calculates the extent of consensus for a particular usage-category of WEPs. A total of 4900 citations were recorded for 8 usage categories. The maximum citations (1922) were recorded for cooked vegetables, closely followed by WEPs consumed raw (1690). The highest number (35 species) of WEPs was consumed raw. The values of $F_{ic}$ ranged between 0.99 (cooked vegetables) and 0.91 (nutraceuticals).

Table 4. Informant consensus factor ($F_{ic}$) for various use categories

| Categories (usages) | $n_{ur}$ | $n_{tax}$ | $F_{ic}$ |
|---|---|---|---|
| Cooked as vegetables (leaves, fruits, fungal fruiting bodies) | 1922 | 29 | 0.99 |
| Raw (fruits, leaves, seeds, twigs) | 1690 | 35 | 0.98 |
| *Chutney* | 299 | 8 | 0.98 |
| Beverages (drinks, decoctions, tea) | 237 | 6 | 0.98 |
| Flavouring agents (spices, condiments) | 283 | 7 | 0.98 |
| Preserved foods (pickle, *murabba*) | 65 | 3 | 0.97 |
| Miscellaneous (all usages not covered in other categories) | 128 | 7 | 0.95 |
| Nutraceutical | 276 | 27 | 0.91 |

## Discussion

### Diversity and characteristics of WEPs

In the present study, 77 WEPs were recorded. Most of the workers have reported 26-70 WEPs from JKUT (Rashid *et al.* 2008; Kumar and Hamal 2009; Dad and Khan 2011; Dangwal *et al.* 2014; Mir 2014; Showkat and Akhtar 2018; Singh and Bedi 2018; Mir *et al.* 2020a; Sarwar and Nigam 2020; Kidane and Kejela 2021; Mahmood and Farooq 2021; Singh *et al.* 2021; Bhagat *et al.* 2022) whereas Bhatia *et al.* (2018), Khan and Hussain (2014), Srivastava (1988), and Thakur and Dutt (2020) have documented 90, 97, 109, and 130 WEPs, respectively. The only other study conducted exclusively on *Gaddi* tribe by Thakur *et al.* (2020) has reported only 49 WEPs from Chamba and Kangra districts of Himachal Pradesh, India. Therefore, the results of current study, in terms of number of species used, are higher than most of the other similar studies already conducted in JKUT and nearby regions.

Nine (8 species cooked as vegetable and one species eaten raw) wild edible mushrooms are consumed by *Gaddi* and *Sippi* tribes. These results are well within the range of 5 to 41 fungal species reported from Bhaderwah, JKUT, India (Kumar and Sharma 2011), Yunnan, China (Liu *et al.* 2018), Armenia (Nanagulyan *et al.* 2020), Aegadian Islands (La Rosa *et al.* 2021), and Jammu, JKUT, India (Sharma *et al.* 2022).The number of wild fungus consumed by *Gaddi* and *Sippi* tribes is much higher than that of other tribes, who either do not consume wild edible fungi at all (Rana *et al.* 2012; Dangwal *et al.* 2014; Singh and Bedi 2019) or have reported only one (Rashid *et al.* 2008; Radha *et al.* 2018) or two species (Mir *et al.* 2020a).

The dominance of Rosaceae is also in accordance with previous studies carried out in the Himalayan region (Sundriyal and Sundriyal 2001; Dangwal *et al.* 2014; Singh and Bedi 2019; Singh *et al.* 2016; Prasad and Sharma 2018; Mir *et al.* 2020a; Thakur *et al.* 2020; Abdullah and Andrabi 2021; Singh *et al.* 2021). The dominance of Rosaceae may be ascribed to temperate climatic conditions of the study site (Hussain 2019), and the good representation and higher consumption of the Rosaceous fruits that also ensures their better dispersal in the region.

Herbs were the most utilized habit with 37 species followed by trees (19 species). Similar to these results, the *Gaddis* of Himachal Pradesh (Thakur *et al.* 2020) also use herbs (29 species) as main WEPs followed by trees (10 species). These results are also in agreement with the findings for other tribes viz. *Gujjar* and *Bakarwal* tribes of Rajouri, JKUT (Rashid *et al.* 2008; Dangwal *et al.* 2014), *Sheena* tribe of Kashmir, JKUT (Singh and Bedi 2018), *Garo* tribe of Meghalaya, India (Singh *et al.* 2012), *Galo* tribe of Arunachal Pradesh, India (Doni and Gajure 2020), and studies conducted in other parts the World (Liu *et al.* 2018; Nanagulyan *et al.* 2020; Al-Fatimi 2021; La Rosa *et al.* 2021). In contrast to these findings, Midlands Province of Zimbabwe (Maroyi 2011), Teso-Karamoja region of Uganda use trees (Ojelel *et al.* 2019), and *Koya* and *Guttikoya* tribes of Telangana (Rao *et al.* 2021), whereas in south Ethiopia (Balemie and Kebebew 2006) shrub are used as main WEPs.

### Diversity of WEPs and their usage

A rich diversity of WEPs is consumed by *Gaddi* and *Sippi* tribe of the study area. *Diplazium esculentum*, *Diplazium frondosum*, *Amaranthus spinosus, Amaranthus viridis, Chenopodium album*, and *Malva sylvestris* were the most preferred vegetables of Doda district. Consumption of these vegetables has also been reported in other parts of the Himalayas (Rashid *et al.* 2008; Bhatia *et al.* 2018; Radha *et al.* 2018; Devi 2020; Thakur *et al.* 2020). Fronds of *Diplazium esculentum* have good nutritive value (3413.2 Kcal $Kg^{-1}$) and crude protein content (143.8 g $Kg^{-1}$) (Seal 2012). The protein (9.00g/100g) and carbohydrate (21.29 g) contents of fresh leaves of *Amaranthus spinosus* is also very good (Effoe *et al.* 2020). The high content of carbohydrates (7.0 g/100g), proteins (29.2 g/100g), fibre (36.5 g/100g), calcium (1.8 g/100g), potassium (4.9 g/100g), and magnesium (1.4 g/100g) in shoots of *Chenopodium album* can be utilized as potential healthier diets against malnutrition (Gqaza *et al.* 2013). *Malva sylvestris* is rich source of vitamins and good for getting relief from stomach ailments (Mousavi *et al.* 2021).

Mostly fresh plant parts were used as vegetables but certain vegetables like those derived from *Diplazium esculentum, Fagopyrum cymosum, Geopora arenicola, Geopora sumnerian*, *Morchella esculenta, Oxyria digyna, Phytolacca acinosa*, *Sparassis crispa*, *Sparassis radicata*, and *Taraxacum officinale* were used fresh as well as after sun drying. Bhatia *et al.* (2018) has also reported *Diplazium esculentum* (CI, 0.52) as the most important vegetable in Udhampur district whereas Singh *et al.* (2021) has reported *Fagopyrum acutatum* (Lehm.) Mansf. ex K. Hammer (CI, 0.74), and *Diplazium esculentum* (0.68) as the most used vegetables in Paddar valley of Kishtwar district. Drying of vegetables is also practiced in other temperate regions of Himalayas (Thakur *et al.* 2017; Bhatia *et al.* 2018; Singh *et al.* 2021) and consumed during winter season when there is a scarcity of fresh vegetables (Kang *et al.* 2013; Bhatia *et al.* 2018).

Fruits with high CI values include *Juglans regia*, *Prunus persica*, *Viburnum grandiflorum*, *Rubus ellipticus*, and *Morus alba*. In Udhampur (Bhatia *et al.* 2018), the most used fruits were *Phyllanthus emblica* (CI, 0.94), *Punica granatum* (CI, 0.68), and *Cordia dichotoma* (CI, 0.60), and in Paddar valley of Kishtwar (Singh *et al.*, 2021), *Berberis lyceum* Royle (CI, 1.34) *Vitis vinifera* L. (1.10), *Elaeagnus umbellata* Thunb. (0.68) were the top three fruits consumed. Wild fruits are consumed by the indigenous communities because of their organoleptic and nutritional properties as they are delicious, refreshing, have pleasing flavor, and are rich source of nutrients (Shirsat and Koche 2020). Seal *et al.* (2014) have reported that the content of micronutrients like Fe, Cu, Zn, Mn and Mg in certain wild fruits was higher than commercial fruits. Most of the fruits are eaten fresh by *Gaddi* and *Sippi* tribes however a few of them are also consumed after sun drying e.g. *Prunus armeniaca*, *Diospyros lotus*, and *Ziziphus oxyphylla*. Dried fruits are locally known as *shukdi*. *Shukdi* are stored in containers and consumed during harsh winter season.

In addition to drying, WEPs are also preserved in the form of pickle and *murabba*. According to Sayin and Alkan (2015) pickling process is relatively a good method for the preservation of phenolic acids and antioxidant capacities in vegetables. These preserved foods, which can be used during scarcity period, ensures food security and throughout the year availability. Pickle made from young leaves of *Diplazium esculentum* has also been reported from other parts of Himalayas (Sharma *et al.* 2009; Devi 2020). The fresh fronds of *Diplazium esculentum* are sold at a price of Rs. 40 to 80 per Kg, whereas the cost of pickle ranges from Rs. 300 to 400 per Kg. Therefore, the efforts should be made to popularize the tradition of pickling for elevating the socio-economic status of these tribes.

*Gaddi* and *Sippi* tribes are highly skilled in identifying and utilizing wild poisonous plants as food. They have developed different techniques for removing the bitterness, foul smell, and even the harmful toxic compounds from certain wild edibles so as to improve the flavor and make their consumption safe e.g. leaves of *Phytolaca acinosa* and *Urtica dioecia* are boiled in water and drained before cooking to remove bitterness. Rhizomes of *Arisaema propinquum* are highly poisonous due to presence of calcium oxalate crystals known as raphide (Ali and Yaqoob 2021). These rhizomes are boiled in water with tamarind (*imli*) for 7-8 hours to neutralize its toxic affect and the pickle is then prepared from the dried rhizomes.

A number of studies have proved that WEPs are more nutrient rich than their cultivated counterparts e.g. the quantity of protein and some minerals like Ca, Na and Se in the seeds of *Fagopyrum cymosum* has been found to be higher than in its cultivated species. Moreover, its amino acid content is also higher than those of major cereal crops like wheat, rice, corn etc. Thus the introduction of potential wild edible species in the agricultural system would play a pivotal role in ensuring food security and human wellbeing (Singh *et al.* 2020). Although popularity of wild edible plants is increasing day by day among urban population, but such plants lack scientific investigations *vis-a-vis* their toxicity and harmful effects which is a matter of safety concern (Saad *et al.* 2006). Sometimes consumption of WEPs may involve risk of life as some of them may contain toxic and harmful compounds (Guil *et al.* 1997) but *Gaddis* and *Sippis* are highly experienced in identifying and excluding such plants from their menu.

Some of the wild edible vegetables like fruiting bodies of *Morchella* spp., *Geopora* spp., and young fronds of *Diplazium esculentum* and *Diplazium frondosum* were also collected by *Gaddis* and *Sippis* from the forest for commercial purpose and sold in the local market. Dry fruiting bodies of *Morchella* spp., have a very high market price of about 25,000 rupees per kg and is a good source of income for poor people of the study area.

**WEPs as nutraceuticals**

There may be an overlapping between dietary and medicinal plants, and such plant species are referred to as food medicine or nutraceutical species. Some studies have already proved the nutraceutical values of plant species reported in the present study, for example, leafy vegetables of *Malva parviflora, Urtica dioecia*, and *Phytolacca acinosa* are consumed by *Gaddi* and *Sippi* tribes as a remedy for constipation. *Malva parviflora* leaves and stems possess nutraceutical values as it could be used as anticarcinogenic, antimutagenic, and antiaging agent because of its strong antioxidant activity (Farhan *et al.* 2012). The leafy vegetables of *Fagopyrum cymosum*, *Oxyria digyna*, and *Portulaca oleracea* are used as liver tonic, cooling agent, as a remedy for mouth blisters and bitterness of mouth and also for improving digestion. *Oxyria digyna* leaves are sour in taste, rich in vitamin C and are used against scurvy and gum inflammation (Ibadullayeva *et al.* 2021). The seeds of *Fagopyrum cymosum* contain bio-progestrone which helps in dilation of blood vessels and decreasing cholesterol level thereby alleviating cardio-vascular diseases (Gang *et al.* 2004). *Mentha* spp. are used by the informants against loose motions and other gastric ailments. The findings of different research studies have revealed that *Mentha longifolia* is a potential functional food as it possessed antidiabetic, antioxidant, antiparasitic, antimutagenic, anti-insect, anti-diarrhea, neuroprotective, and spasmolytic properties due to presence of a number of bioactive compounds in it (Farzaei *et*

*al.* 2017). Fresh leaves of *Oxalis corniculata* and *Rabdosia rugosa* are crushed together and taken orally by the tribes under investigation in case of gastric troubles, bloats, stomachache, and flatulence.

A hot drink prepared by boiling flowers of *Violas* in water or milk is used for curing throat pain. The aerial parts of *Viola odarata* including flowers have been widely used for curing respiratory tract infections (Gautam and Kumar 2012). Thus the nutraceutical plant species help *Gaddi* and *Sippi* tribes not only to satiate their hunger but also to maintain good health. Hot beverage prepared from the bark of *Taxus baccata* is consumed as tea. Anti-cancerous activity of *Taxus baccata* is mentioned in *Ayurveda* and Tibetan medicinal system (Saqib *et al.* 2006) and also in Pauri district of Uttarakhand, India (Khajuria *et al.* 2021).

*Taraxacum officinale* and *Cichorium intybus* are recommended as light food and tonic for convalescing mothers during postpartum period. Use of *Taraxacum officinale* as postpartum food has also been reported in Udhampur (Bhatia *et al.* 2014) and Srinagar (Kumar *et al.* 2015) regions of JKUT. *Taraxacum officinale* is rich in inulin which acts as a prebiotic and thus stimulates the growth of intestinal flora (Hobbs 1998). The experimental studies have validated the use of *Cichorium intybus* as functional food against diabetes, inflammations, hepatotoxicity, microbial activity, and as prebiotic. The medicinal properties of *Cichorium intybus* are attributed to the presence of bioactives like inulin, phenolics, sesquiterpene lactones and oligofructose in this plant (Perovic *et al.* 2021). Seed oil of *Prunus armeniaca* mixed with jaggery is given with chapatti to the women after delivery as postpartum tonic for speedy recovery.

*Pyrus pashia fruits have been consumed by many Himalayan communities for treatment of respiratory, gastrointestinal and blood related problems* (Jambaz *et al.* 2015). Rhizomes of *Arisaema propinquum* possess antihelminthic properties and can be used for treatment of helminthic diseases (Mir *et al.* 2020b). Podophyllotoxin is an important bioactive compound present in *Sinopodophyllum hexandrum* which exhibits anticancer properties (Gupta and Manhas 2021). The fruits of *Rubus niveus* have gastroprotective properties due to presence of high level of polyphenols and are used against gastric ulcers (Nesello *et al.* 2017).

Wild edible mushrooms e.g. *Boletus edulis*, *Geopora arenicola*, *Morchella deliciosa*,and *Sparassis crispa* exhibit high antioxidant activities and free radical scavenging properties because of the presence of phenolic compounds in them (Elmastas *et al.* 2007; Ferreira *et al.* 2007; Keles *et al.* 2011; Lalotra *et al.* 2018). Edible mushrooms are recommended for patients suffering from high blood cholesterol as they have low fat content (Gunc Ergonul *et al.* 2013).The findings of meta-analysis by Ngoc *et al.* (2018) have suggested that *Sparassis crispa* has anti-fungal, anti-inflammatory, anti-cancer, anti-diabetic and oxidative values and could be used as a potential candidate for the development of medicines in future.

**WEPs *vis-à-vis* other tribes of JKUT and the Himalayas**

A good number of research studies have already been carried out on WEPs used by two major tribes viz. *Gujjars* and *Bakarwals* of Jammu and Kashmir but the present study is the pioneering work on the ethnic forest foods consumed by *Gaddi* and *Sippi* tribes of this region. Some of the most commonly used WEP species with high CI values as inventorised in the present study e.g., wild vegetables like *Amaranthus viridis*, *Taraxacum officinale, Cichorium intybus, Fagopyrum cymosum, Malva sylvestris, Malva neglecta, Portulaca oleracea, Diplazium frondosum, Chenopodium album*, and *Stellaria media* and wild edible fruits like *Berberis lyceum, Diospyros lotus, Fragaria vesca, Morus alba, Rubus niveus* and *Viburnum grandiflorum* have also been reported to be consumed by *Gujjar* and *Bakerwal* tribes (Rashid *et al.* 2008; Dad and Khan 2011; Dangwal *et al.* 2014; Mir 2014; Mir *et al.* 2020b; Abdullah and Andrabi 2021; Mahmood and Farooq 2021) and some other communities (Singh *et al.* 2016; Showkat and Akhtar 2018; Singh and Bedi 2018; Singh *et al.* 2021) in the JKUT, NW Himalayas. Most of these wild plant species have also been used as a potential source of dietary supplement by many pastoral communities of Himachal, Garhwal, and Sikkim Himalayas (Sundriyal and Sundriyal 2001; Prasad and Sharma 2018; Radha *et al.* 2018; Thakur *et al.* 2020). Although people with different cultural backgrounds have different dietary patterns, food preferences, and food processing techniques (Alonso 2015), the consumption of a wide variety of similar WEPs by diverse communities in different region of Indian Himalayas indicates similarity in their gastronomic culture, dietary pattern, and vegetation cover in and around their inhabitations.

**Knowledge of WEPs with respect to gender, age and education level of informants**

Gender of informants is a critical variable that influences the distribution of local knowledge. The survey refutes the first hypothesis that women are more knowledgeable about WEPs than men because, among the Gaddi and Sippi tribes of the Doda district, male informants had much higher knowledge of WEPs. These findings are in

corroboration with the studies conducted in Poland (Kotowski *et al.* 2019), China (Kang *et al.* 2013), and Africa (Yorou and De Kesel 2002; Kristensen and Balslev 2003) reporting higher knowledge of WEPs for men than women. Most of the previous studies have however shown that women have more traditional knowledge of WEPs because they are usually unemployed in rural areas and dedicate themselves to household and subsistence activities (Bhatia *et al.* 2018; Singh *et al.* 2021; Bhagat *et al.* 2022), whereas in few other studies no significant difference regarding the knowledge of WEPs was found between the male and female informants (Joshi *et al.* 2015; Khakurel *et al.* 2021). The higher knowledge of WEPs possessed by males in the present study may be ascribed to their nomadic behavior. Men from these tribes cover temperate regions in the summer season and tropical regions in winter season. They travel long distances, move deep into the forests, pass through variety of habitats, and face lot of difficulties that increases their knowledge of WEPs.

The high dependence of *Gaddi* and *Sippi* tribes of district Doda on WEPs is attributed to various factors like their pastoral lifestyle, remoteness of their inhabitations, location of their settlements in close proximity of forests, lack of market access, and poverty. In relation to second hypothesis, a significant decline (r = 0.73, *P <0.001*) was observed in the knowledge of WEPs with age. The consumption of less number of WEPs by the young populace of these tribes may be due to improvement in socio-economic conditions, road connectivity to rural areas, urbanization, advanced agricultural practices, and social stigma associated with consumption of WEPs. Regarding the third hypothesis, as predicted, the education level of the informants was negatively related with the knowledge of WEPs (r = 0.42, *P <0.001*). These results are in accordance with Bhatia *et al.* (2018) and Singh *et al.* (2021). This decrease in knowledge of WEPs correlated with increasing educational status may be due to associated away movement from the villages that erodes the traditional knowhow of WEPs (Bhatia *et al.* 2018). A few wild vegetables e.g., *Urtica dioecia, Phytolacca acinosa, Rumex nepalensis* and *Rumex hastatus*, and edible oil derived from seeds of *Prunus armeniaca* and *Prinsipia utilis* which were in vogue and formed a part of food for these communities since long have now almost disappeared completely from their menu. Not only the traditional knowledge of tribes on local plant usage has been eroding at faster pace but depletion of some of the WEPs due to over exploitation and habitat loss has also been observed. Since this traditional knowledge is transmitted orally, there is a need for conservation of oral traditional plant-based knowledge before it is lost forever. Sustainable harvesting methods and cultivation of WEPs by local communities should also be encouraged for conservation of endangered species and sustainable utilization of wild edible plants should be encouraged.

**Consensus for the usage of WEPs**

The values of Factor consensus factor ($F_{ic}$) ranged between 0.91 and 0.99. Several studies conducted in JKUT (Singh *et al.* 2016; Bhatia *et al.* 2018; Singh *et al.* 2021; Bhagat *et al.* 2022) and other neighbouring regions (Jhamta *et al.* 2019; Thakur *et al.* 2020) have also reported high values for $F_{ic}$. High values of $F_{ic}$ are in accordance with the fourth hypothesis of a strong consensus over the use of WEPs. The high values of WEPs are in accordance with Bhatia *et al.* (2018) and Singh et al. (2021) due to their propensity to frequently disseminate information about WEPs (Bhatia *et al.* 2018).

The highest number of citations and maximum values of Factor consensus factor ($F_{ic}$) were recorded for WEPs cooked as vegetables (Citations = 1922; $F_{ic}$ = 0.99) or consumed raw (Citations = 1690; $F_{ic}$ = 0.98). Together these categories accounted for 73.7% of the total citations. These finding are in accordance with other studies in the Himalayas (Singh *et al.* 2016; Bhatia *et al.* 2018; Jhamta *et al.* 2019; Thakur *et al.* 2020; Singh *et al.* 2021) and other parts of the world (Ghanimi *et al.* 2022; Guo *et al.* 2022).

**Novelty and future prospects**

Although most of the plants reported in the present study have found mention in the earlier studies conducted in JKUT (Srivastava 1988; Dhar and Dhar 2000; Rashid *et al.* 2008; Khan *et al.* 2009; Kumar and Hamal 2009; Dad and Khan 2011; Dangwal *et al.* 2014; Khan and Hussain 2014; Mir 2014; Bhatia *et al.* 2018; Pandita and Dutt 2018; Showkat and Akhtar 2018; Singh and Bedi 2018; Thakur *et al.* 2019; Mir *et al.* 2020a; Sarwar and Nigam 2020; Thakur and Dutt 2020; Farooq 2021; Jan *et al.* 2021a,b; Khajuria 2021; Kidane and Kejela 2021; Mahmood and Farooq 2021; Mir *et al.* 2021; Singh *et al.* 2021; Bagal *et al.* 2022; Bhagat *et al.* 2022; Gangoo 2022; Jan *et al.* 2022a,b; Mir *et al.* 2022a,b,c; Peerzada *et al.* 2022; Sharma *et al.* 2022), and other neighbouring Himalayan regions (Kapoor *et al.* 2008; Sharma *et al.*, 2009; Rani *et al.* 2013; Radha *et al.* 2018; Jhamta *et al.* 2019; Devi 2020; Thakur *et al.* 2020; Sen 2021), but to best of our knowledge *Morchella crassipes, Pinus wallichiana, Quercus floribunda, Sageretia thea* (Osbeck) M.C. Johnst and *Viola canescens* are new reports from the union territory. The literature survey of WEPs further confirmed that species like *Anethum sowa*, *Arisaema propinquum*, *Diplazium frondosum*, *Dipsacus inermis*, *Elaeagnus umbellate*, *Elwendia persica*, *Geopora sumneriana*, *Impatiens glandulifera*, *Morchella crassipes*,

*Morchella conica*, *Prinsepia utilis*, *Sageretia thea*, *Solanum villosum*, *Thymus mongolicus*, and *Ziziphus oxyphylla* lack comprehensive nutritional, pharmacological and toxicological studies, which can be undertaken in future.

**Conclusion**

*Gaddi* and *Sippi* tribes of the study area consume a good number of WEPs. The documentation of this valuable traditional knowledge is important as both the information and diversity of WEPs are eroding with modernization, change in eating habits, and improving social and educational status. These tribes use WEPs in diverse ways viz. as vegetable, fruit, chutney, beverage, and pickle. They also dry vegetables and fruits for consumption during harsh conditions. *Gaddi* and *Sippi* have acquired and successfully preserved the knowledge about the poisonous plants, and their detoxification for edible purpose. All these practices need to be studied, documented, and conserved for the future generations. Moreover, food fairs, sensitization lectures, interaction of students with the locals, and value addition of products should be used to popularize WEPs among new generation. In the future, the detailed nutritional, pharmacological, and toxicological studies may be conducted to popularize WEPs. Besides, assessment studies may be conducted to enlist the WEPs with good market value after processing, and new food processing startups may be initiated for the upliftment of socio-economic status of these tribes.

## Declarations

**Ethics approval and consent to participate:** All participants provided oral prior informed consent.
**Consent for publication:** Participants shown in images agreed to have their images shown.
**Competing interests:** The authors declare that they have no competing interests.
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**Availability of data and materials:** All data generated or analyzed during the conduct and writing up of the manuscript is incorporated in the research article.
**Authors' contributions:** BPS, YD, VS and RKM planned the study. BPS carried out field surveys, data collection, and photography. RKM and BPS did the data analysis and wrote the manuscript. BPS, YD, VS and RKM reviewed the final manuscript. All the authors have read the final manuscript, and hereby approve it.

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