



Ethnobotanical notes on some potential wild edible fruits used by the *Bhotia* community of Niti Valley, Uttarakhand, India

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The present study deals with the diversity, distribution and ethnobotany of wild edible fruits consumed by the *Bhotia* tribe of Niti valley, Chamoli, Uttarakhand, India. Most of these valuable resources fulfil the nutritional, health and economic requirements of *Bhotia* community up to a large extent. Though the wild edible fruits have great socio-economic significance in sustenance of many tribal/rural communities but due to the increasing trends of modernized agriculture, climate change and various natural and anthropogenic hazards, a large number of genetic resources of wild edible fruits are under severe threat, hence warrants immediate attention for their conservation, domestication and utilization through improvement/selection. Keeping this in view, ethnobotanical knowledge and diversity distribution patterns of 27 potential wild edible fruits consumed by *Bhotia* tribe in Niti Valley have been recorded with their botanical names, family, local names, uses and indigenous processing methods.

Keywords: *Bhotia* tribe, Ethnobotany, Niti Valley, Potential wild edible fruits, Uttarakhand

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On account of the towering mountains, undulating topography, diverse soil types and varied climatic conditions, the Indian Himalayas are famous for their rich reservoir of floristic wealth hence are considered as one of the richest ecosystems on the earth¹. Local communities of Indian Himalayas fulfil their basic needs through use of many naturally occurring plant species including wild edible fruits. These resources have been long harvested from natural habitats with little effort of their domestication². Wild edible fruits are important sources of minerals, vitamins, etc. and are also having traits to adapt according to different biotic and abiotic stresses. Uttarakhand state, situated in the central part of Indian Himalayas is known to have rich economic floristic diversity³. Of which, Niti valley in Chamoli district of Uttarakhand possesses high species richness including endemic species⁴. The valley also known as Upper Dhauri valley, is named

after the river Dhauri Ganga that forms one of the major catchments of river Alaknanda.

It has been reported that 52% of total floral diversity in the valley is represented by ten families of higher plants namely Asteraceae, Poaceae, Lamiaceae, Fabaceae, Brassicaceae, Rosaceae, Polygonaceae, Apiaceae, Ranunculaceae and Orchidaceae⁴. The floristic diversity is mainly dominated by taxa like *Pinus wallichiana*, *Cedrus deodara*, *Picea smithiana*, *Betula utilis*, *Abies pindrow*, *Juniperus* spp., *Hippophae* sp., *Salix* spp. *Myricaria* sp., *Caragana* sp., *Potentilla* spp., *Lonicera* spp., *Trachydium roylei* etc. During the present effort, majority of the wild edible fruits collected from Niti valley are represented by genera like *Cotoneaster*, *Fragaria*, *Malus*, *Prunus*, *Rosa*, *Sorbaria* and *Sorbus* of family Rosaceae^{5,6}. Among the 36 species of *Prunus* reported from India, 18 are wild edibles⁷. Of these, occurrence of seven species (*Prunus armeniaca*, *P. persica*, *P. cerasoides*, *P. cornuta*, *P. venosa*, *P. nepalensis*, *P. cornuta* and

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P. Jacquemontii have been reported from this part of Himalaya^{5,8}. Likewise, seven species of *Pyrus* (*Pyrus pyrifolia*, *P. pashia*, *P. serotina*, *P. Jacquemontiana*, *P. polycarpa* and *P. khasiana*) are distributed in the temperate and sub-temperate regions in wild and semi-wild forms⁹. Among these, *Pyrus pyrifolia* and *P. pashia* are reported to be distributed in Niti valley⁵ and *Malus baccata*, a close relative of Asian domesticated apple grows in the wild form in Indian Himalayas^{10,11} possess various desirable horticultural traits¹².

Most of the remote valleys/far flanged areas are not well connected through roads, hence large scale cultivation of commercial varieties of fruits is not possible here. Due to least anthropogenic activities, rich diversity of wild edible fruits can be witnessed in the Niti valley which substitutes the requirement of commercial fruits. Moreover, the potential value of these wild edible fruits is still unknown to the urban community. Hence, documentation of their ethnobotanical uses including nutraceutical importance and therapeutic values of these resources has become essential for their exploitation and management as well as to fulfil the present and future needs.

Materials and Methods

Study area

Niti valley in Chamoli district (Uttarakhand) (Fig. 1), a part of Indian Trans-Himalaya is situated

between 30°17' to 30°41'N latitude and 70°41' to 80°05'E longitude harbours wealth of many wild edible plants¹³. The altitude of the valley ranged between 2200-3500 m above mean sea level and the annual precipitation has been recorded between 750-2000 mm, while the temperature varies from below 0°C (December-January) to 35°C (June-July). This area is situated in the rain-shadow zone of Nanda Devi Biosphere Reserve (NDBR) and dryness increases towards upper reaches of the valley, which remain snow bound for more than six months in a year. Summer is very short and generally lasts from June to August. The region receives low amount of precipitation and remains dry and dusty above 3,200 m asl. The vegetational cover spreads to over 22.2% of its total area, while 4.5% of this is covered by grasslands or alpine pastures (locally known as *Bugyals*), which are source of many rare, endangered and high value medicinal and aromatic plants¹⁴. Tolchha and Marcha sub-communities of the *Bhotia* tribe, a transhumant community of semi-mongoloid people of Tibetan origin¹⁵ are inhabiting in 19 villages namely Helan, Lata, Raigaddi, Reni, Sukhi, Bhalgaon, Suraithota, Tolma, Phagti, Tamak, Jhuma, Kosa, Malari, Bampa, Kailashpur, Ghamshali, Niti, Dronagiri and Parsari (Fig. 1). The inhabitants are culturally rich and live in a situation where resources are scattered and accessible only in spatial pockets. They migrate from lower altitudes or permanent villages (below 1500 masl) to higher altitudes or

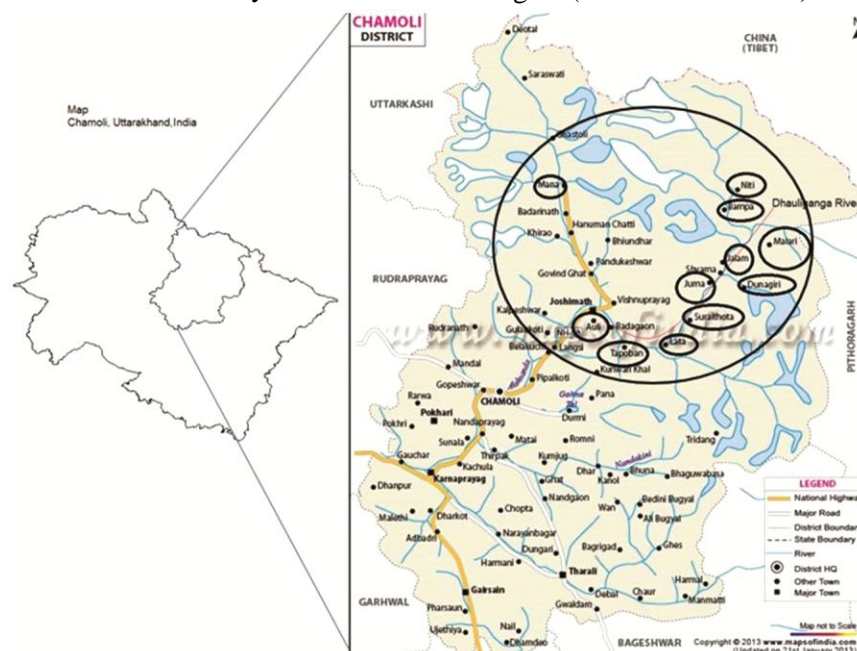


Fig. 1 — Geographical location of study area.

summer villages (2000-3500 masl) and stay there for six months mainly for sheep rearing and performing short duration traditional agriculture. During stay, men or both men and women migrate with their livestock to shorter distances but towards higher reaches with all the necessary items as they do not have permanent dwellings in the summer villages. Due to the cold climate in the high hills, they wear clothes mainly comprise woolen material, quite often homemade. Rice, wheat, millets, pulses, amaranth, buckwheat and a wide variety of local wild and semi-domesticated plants are the main food of the inhabitants of the region.

Survey, germplasm collection and maintenance

Following the standard procedure¹⁶, two surveys were undertaken during September 2018 and September 2019 to record the information on diversity, distribution and local/ethnobotanical uses of wild edible fruits. During surveys, about 50 key informants (primarily old experienced village folk i.e., 60-75 year's age group) were selected for interview but only 65% informants responded well. Both structured and unstructured questionnaires were used to record ethnobotanical information with prime consent on some essential parameters like local/vernacular name, time of availability, flowering and fruiting time, taste, local uses and processing methods. Germplasm was collected in the form of fruit at the time of maturity. Passport information was recorded as per passport data book developed by Indian Council of Agricultural Research-National Bureau of Plant Genetic Resources (ICAR-NBPGR), while geographical coordinates of the collection sites

were recorded using global positioning system (GPS) (Fig. 2). Additional information on the habitat dynamics, threat status, factor of climate change, change in food habits of *Bhotia* tribe and their source of income were also recorded. Live specimens were collected for herbarium preparation and photographs were taken to verify identity of the collected material/plants. Fruit samples were sent for conservation and herbarium specimens were deposited in the National Herbarium of Cultivated Plants at ICAR-NBPGR, New Delhi. Botanical identity of material was validated/authenticated with the help of experienced taxonomists and by consulting various floras^{16,17,5}. Recorded information was validated using published literature to find out the new uses¹⁸⁻²¹.

Results and Discussion

Ethnobotanical information was gathered on 27 potential wild edible fruits consumed by inhabitants of Niti valley. An account of range of distribution, vernacular name, habit, time of availability, economic part, biological status and habitat, uses and processing methods of these wild edible fruits has been presented in Table 1 and (Fig. 3, 4 and 5). Wild foods are considered as necessity by the local inhabitants in the region rather than as a supplement and are eaten frequently²². Majority of the wild edible fruits are eaten as raw or ripened while a few are consumed as pickles, chutneys, juice, pulps after processing and are also stored for future/off-season use. Besides this, during their six months stay some short duration crops namely potato (*Solanum*

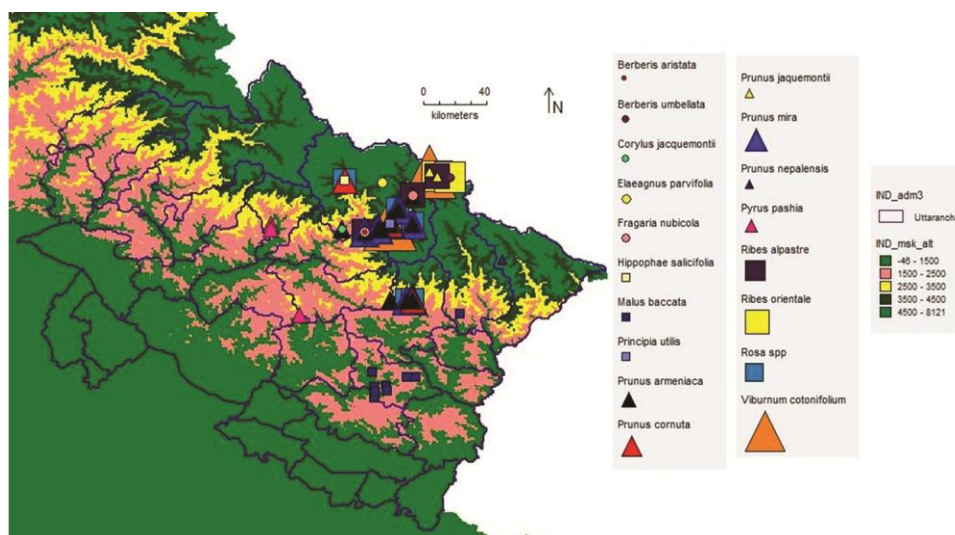


Fig. 2 — GIS map representing collection site of wild edible fruits.

Table 1 — List of wild edible fruit species distributed in High Altitude area of Niti valley, Chamoli, Uttarakhand

S No.	Scientific name	Vernacular name	Time of fruiting	Distribution altitude (m)	Frequency	Habit	Habitat (s)*	Economic part	Ethnobotanical uses
1	<i>Berberis pseudumbellata</i> R. Parker Family: Berberidaceae	Kilmore	Jun.-Sep.	1200-3000	Frequent	Shrub	b,c,e	Fruit	Fruits and roots are used as flavouring material for "Agyar" (local beverage). The twigs of the plant are used in psychomedicine.
2	<i>Corylus jacquemontii</i> Decne. Family: Corylaceae	Kapasi	Sep.-Oct.	2500-3000	Rare	Shrub	E	Kernels	Kerneloil is used in rheumatic arthritis and itching. Kernelsare edible.
3	<i>Cotoneaster microphyllus</i> Wall. ex Lindl. Family: Rosaceae	Ruins	Aug.-Sept.	2500-3500	Occasional	Shrub	b,c,e	Fruits	Dried and crushed fruits are smoked with tobacco.
4	<i>Elaeagnus parvifolia</i> Wall. ex Royle Family: Elaeagnaceae	Giwain	Jun.-Sep.	1200-3000	Occasional	Shrub	b,c,e	Fruits	Ripe fruits are eaten raw, also made into pickles and chutney.
5	<i>Fragaria nubicola</i> (Lindl. ex Hook. f.) Lacaita Family: Rosaceae	JangaliKaphal	Jun.-Jul.	1600-3500	Frequent	Herb	a,d	Fruits	Ripe fruitsare eaten raw, sweet and sour in taste.
6	<i>Hippophae salicifolia</i> D. Don Family: Elaeagnaceae	Amesh	Oct.-Dec.	Above 2500	Frequent	Shrub	b,c,e	Fruits	The salt mixed ripe fruits are eaten raw, also made into pickles and chutney.
7	<i>Hippophae rhamnoides</i> Family: Elaeagnaceae	Chuk, Tarwa	Oct.-Dec.	Above 3000	Frequent	Shrub	b,c,e	Fruits	The salt mixed ripe fruits are eaten raw, also made into pickles and chutney.
8	<i>Malus baccata</i> (L.) Borkh. Family: Rosaceae	Jangali seb	Aug.-Sep.	1500-2500	Rare	Tree	d	Fruits	Ripe fruits are eaten raw, also preserved for later use. Fruits are made into chutney end pickles.
9	<i>Prinsepia utilis</i> Royle Family: Rosaceae	Bhekal	Apr.-Oct.	1500-2500	Rare	Shrub	b,c,e	Seed	Seed oil is used for body massage especially for pregnant women.
10	<i>Prunus mira</i> Koehne Family: Rosaceae	Kirol	Jul.-Sept.	2700-3500	Occasional	Tree	b,c,e	Fruit, kernel	Its kernel oil is bitter in taste but is considered good in terms of quality and quantity. Its fruits are used in preparation of local liquor, kernel oil is used in body massage and paste is applied externally on wounds of livestock.
11	<i>Prunus armeniaca</i> L. Family: Rosaceae	Chuli or cholo	Apr.-Jun.	Up to 3000	Frequent	Tree	b,c,d,e	Fruit, kernel	Its kernels contain 45-50% oil, are eaten as raw and also used for extraction of edible oil ⁵⁰ . The oil is exchanged with mustard oil and also sold in local market @ of Rs 500/- per litre (Fig. 4 g).
12	<i>Prunus cerasoides</i> Buch.-Ham.Puddam ex D. Don. Family: Rosaceae		Feb.-Mar.	700-2400	Frequent	Tree	b,d,e	Fruits/ timbers	Fruit pulp is eaten occasionally. Branches and twigs are used in local rituals. Young branches are used in bone fractures of livestock.
13	<i>Prunus cornuta</i> (Wall. ex Royle) Steud. Family: Rosaceae	Jangalijamun	Sep.-Oct.	Above 2800	Rare	Tree	c,d,e	Fruit	Its fruits are eaten as raw to quench the thirst and pulp is used in the preparation of chutney. Its wood is a good timber for furniture, handles of agricultural implements, and as a fuel wood; leaves offer good fodder for cattle and supposed to increase the quantity of milk; gum is used as an adhesive; and kernels are source of edible oil 'taste like almond oil', also used for body massage.
14	<i>Prunus jacquemontii</i> Hook. f. Family: Rosaceae	Khursang	Apr.-Jul.	Above 2800	Rare	Shrub	b,c,e	Fruit	Ripe fruits are considered to be sweeter than all other <i>Prunus</i> spp. and hence heavily exploited by the inhabitants of valley because of its sweet and pulpy fruits.

(Contd.)

Table 1 — List of wild edible fruit species distributed in High Altitude area of Niti valley, Chamoli, Uttarakhand (*Contd.*)

S no.	Scientific name	Vernacular name	Time of fruiting	Distribution altitude (m)	Frequency	Habit	Habitat (s)*	Economic part	Ethnobotanical uses
15	<i>Prunus nepalensis</i> Hook. f. Family: Rosaceae	Bhang-bhalu	Sep.-Oct.	1800-2500	Rare	Tree	b,c,e	Fruit	Ripe fruits are eaten raw; leaves and young branches are considered as poisonous to livestock; wood is used as fuel and in making tool handles. As per the published literature, in NW Himalaya this species is found to be present in wild form but in eastern Himalaya it is locally known as “Shiong” and is available in domesticated or semi-domesticated form. Its fruits have been reported to be excellent source of vitamins A and C ³⁸ . Fruits are edible.
16	<i>Prunus venosa</i> Koehne Family: Rosaceae	Gad Aru	Jul.-Sep.	1500-3000	Rare	Tree	-	Fruit	Fruits are edible.
17	<i>Pyracantha crenulata</i> (Roxb. ex D. Don) M. Roem. Family: Rosaceae	Ghingaru	Jun.-Oct.	1500-2500	Abundant	Shrub	b,c,e	Fruits	Fruits and fruit juice possess nutraceutical properties ⁴¹ ; also an ayurvedic product ‘Hridayamrit’ (for the treatment of heart disease) has been developed by DIBER ⁴² .
18	<i>Pyrus pashia</i> Buch.-Ham. ex D. Don Family: Rosaceae	Mehal	Aug.-Oct.	1200-2000	Occasional	Tree	b,d,e	Fruits	Fruits are consumed as raw, dried fruits are crushed and mixed with a local product Sattu, which is prepared by roasted cereals & pulses and considered as complete food).
19	<i>Ribes alpestre</i> Wall. ex Decne. Family: Grossulariaceae	Lipchi,	Jul.-Aug.	3000-3300	Occasional	Shrub	b,c,e	Fruits	Ripe fruits are eaten, sweet or sour in taste, also made into sauce and chutney. Fruits are considered good for urination.
20	<i>Ribes orientale</i> Desf. Family: Grossulariaceae	Darbag	Jul.-Aug.	3000-3300	Occasional	Shrub	b,c,e	Fruits	Ripe fruits are eaten, sweet or sour in taste, also made into sauce and chutney. Fruits are considered good for urination.
21	<i>Rosa macrophylla</i> Lindl. Family: Rosaceae	Kawa Sidum	Sep.-Oct.	2500-3000	Rare	Shrub	b,c,e	Fruits	Ripe fruits are consumed as raw and made into pickles and chutney. Its fruits are excellent source of vitamin C ⁴³ . In Niti valley, the root decoction is given in suppressed urination.
22	<i>Rosa sericea</i> Wall. ex Lindl. Family: Rosaceae	Sidum	Sep.-Oct.	2500-3000	Frequent	Shrub	b,c,e	Fruits	Ripe fruits are consumed as raw and made into pickles and chutney. Its fruits are excellent source of vitamin C ⁴³ . In Niti valley, the root decoction is given in suppressed urination.
23	<i>Rosa webbiana</i> Wall. ex Royle Family: Rosaceae	Sidum	Sep.-Oct.	2500-3000	Rare	Shrub	b,c,e	Fruits	Ripe fruits are consumed as raw and made into pickles and chutney. Its fruits are excellent source of vitamin C ⁴³ . In Niti valley, the root decoction is given in suppressed urination.
24	<i>Rubus biflorus</i> Buch.-Ham. ex Sm. Family: Rosaceae	Hinsara	Jun.-Jul.	1200-3000	Rare	Shrub	b,c,e	Fruits	Ripe fruits or roots are mixed with yew material of local beverage to increase the flavour and taste.
25	<i>Rubus ellipticus</i> Sm. Family: Rosaceae	Hisalu	May-Jun.	1200-2500	Abundant	Shrub	b,c,e	Fruits	Ripe fruits are eaten raw. Its fruits have been reported to be a good source of health promoting biomolecules and antioxidants ⁴⁴ .
26	<i>Rubus macilentus</i> Jacquem. ex Cambess. Family: Rosaceae	Hinsula	Jun.- Sep.	1200-3000	Abundant	Shrub	b,c,e	Fruits	Ripe fruits or roots are mixed with yew material of local beverage to increase the flavour and taste.
27	<i>Viburnum cotinifolium</i> D. Don Family: Caprifoliaceae	Ghenu	May-Oct.	1800-2800	Occasional	Shrub	b,c,e	Fruits	Ripe fruits are eaten raw.



Fig. 3 — Photograph of collected wild edible fruits from study area: **a-** *Prunus armeniaca* L., **b-** *Prunus mira* Koehne, **c-** *Prunus cornuta* (Wall. ex Royle) Steud., **d-** *Prunus jacquemontii* Hook. f., **e-** *Elaeagnus parvifolia* Wall. ex Royle., **f-** *Pyracantha crenulata* (Roxb. ex D. Don) M. Roem., **g-** *Ribes orientale* Desf, **h-** *Viburnum cotinifolium* D. Don, **i-** *Ribes alpestre* Wall. ex Decne., **j-** *Ribes alpinum* L., **k-** *Hippophae salicifolia* D. Don., **l-** *Rubus ellipticus* Sm, **m-** *Rosa macrophylla* Lindl., **n-** *Rosa webbiana* Wall. ex Royle., **o-** *Rosa sericea* Wall. ex Lindl., **p-** *Pyrus pashia* Buch.-Ham. ex D. Don.

tuberosum), buckwheat (*Fagopyrum tataricum* and *F. esculentum*), two and six rowed barley (*Hordeum vulgare* and *H. himalayense*), amaranth (*Amaranthus paniculatus*), etc. are grown in their small farmlands and some potential wild/semi-wild plants like *Allium* spp. “Pharan”; *Carum carvi/ Bunium persicum* “Siya-jira”; *Angelica glauca* “Choru” “Gandrain”; *Phytolacca acinosa* “Jarag” and several other emergent medicinal plants in their kitchen gardens. Produce from wild/semi-wild herbs including *Cordyceps sinensis* “keedajadi” (Fig. 4f), collected from high altitudes fetches high price²³ are also sold in local markets as a source of income. Presently, apple cultivation has also been started by a few farmers in the valley.

From time immemorial, wild edible fruits have been considered as important dietary constituents for human beings^{24,25}. As per the outcome of ethnobotanical surveys of wild plants, over 7000 species have been used for human food at some stage in human history^{26,27}. Among the diverse wild edible

fruits collected from Niti valley, sweet and bitter kernel types in *Prunus armeniaca* (wild apricot) available in wild/ naturalized, semi-wild/ domesticated forms at an altitude of 2000 m to 3500 m asl⁸ (Above sea level); *Prunus mira* in wild from at an altitude of 2700 m to 3500 m asl in Himachal Pradesh, also collected from Niti valley but it is mentioned as *Prunus persica* in the Flora of Chamoli⁵ (Fig. 6); *Prunus cornuta* and *P. jacquemontii* (having ornamental value) are also available here in wild forms, while dense population of *P. jacquemontii* in and around “Malari” and “Kailsahpur” villages were noticed above 2700 m; *Prunus venosa* and *P. nepalensis*, reported to be available in North-western Himalaya⁸, but not found to occur in the valley. A total of 25 species under genus *Rosa* have been reported from India²⁸, of which about 10 species are distributed in NW Himalaya. *Rosa webbiana*, *R. sericea* and *R. macrophylla* are growing between 2500 m to 4000 m in the valley; *Pyrus pashia*, a wild relative of pear reported to be distributed in entire



Fig. 4 — Photographs representing indigenous utilization of wild fruits: **a-** A Bhotia women collecting stones of wild apricot, **b-** Sun drying of wild apricot and Kirol, **c-** Utensils used for distillation to prepare local liquor, **d-** Chutney prepared from Apricot fruits, **e-** Tribal women collecting wild fruits of *Prunus*, **f-** Keeda jari- *Cordyceps sinensis*., **g-** Bhotia man showing oil of wild apricot, **h-** Wooden mechanical oil extractor, **i-** Dungboo prepared from wood of *Dendrocalamus strictus* used for preparing local tea from *Taxus baccata* (Thuner ki chai)

NW Himalayas between an altitude of 700 m to 2700 m asl, available in and around habitation in semi domesticated form¹¹; *Rubus ellipticus*-a potential fruit facing heavy exploitation pressure was found growing in wild and semi-wild forms. One of the most important potential wild edible fruits *Hippophae rhamnoides*, a thorny shrub reported to be distributed in high altitudinal zones of Jammu & Kashmir, Himachal Pradesh, Uttarakhand in NW Himalaya and North Sikkim in Eastern Himalaya²⁹ along with *Hippophae salicifolia*, a thorn less shrub/small tree; a potential wild edible nut *Corylus jacquemontii* found to be distributed from 2500 m to 3500 m in Uttarakhand is also available in the valley. *Malus baccata*, a potential wild relative of domesticated apple, rare in occurrence and reported to be distributed



Fig. 5 — Wild edible fruits collected from Niti valley.



Fig. 6 — Photograph representing Stones of *P. mira* collected from Niti valley, Uttarakhand (mentioned as *Prunus persica* in Flora) and Kinnaur (Himachal Pradesh).

in temperate regions of NW Himalaya^{5,11} was not seen in Niti valley.

Nutritional value of wild edible fruits

Bio-chemical analysis of wild edible plants may help in selection of valuable wild species for their improvement and domestication^{30,31}. Majority of the wild edible fruits does play an opportunistic or overlapping role as medicinal plants, hence through adding extra value, these resources could be attractive and important to the users. Although sporadically nutritional aspect of wild edible plants have been documented being an essential part of diet of tribal people but even then examination of their nutritional composition is required, because data on actual analysis of these resources are scanty or less documented³²⁻³⁴. Rana *et al.*¹¹ have reported nutritional composition of some wild edibles of NW Himalaya, such as wild apricot (*Prunus armeniaca*) is a rich source of vitamin C (9.95 mg/100 g) and

minerals like phosphorus (0.08%), potassium (0.99%) and calcium (0.97%). The fruit of 100 g of edible portion of *P. mira* has 2.03% acidity, 10.9% TSS and 4.83% total sugar. The Asiatic Pear (*Pyrus pyrifolia*) is a rich source of vitamin A (14 IU/100 mg), riboflavin (0.03 mg/100 mg), nicotinic acid (0.20 mg/100 mg) and minerals (0.30 g/100 g). *Corylus jacquemontii* is known to be excellent source of mono-unsaturated fat (61 g/100 g), poly-unsaturated fat (46 g/100 g), protein (15 g/100 g), Vitamin B (113 µg/100 g), calcium (114 mg/100 g), iron (4.7 mg/100 g), phosphorus (290 mg/100 g) and potassium (680 mg/100 g). *Eleagnus* spp. has been reported as rich source of vitamin A (54 µg/100 g), vitamin C (5 µg/100 g), vitamin B complex (15.72 mg/100 g), vitamin E (2.20 mg/100 g) and potassium (130 mg/100 g). *Pyreantha crenulata* contains total phenolic content (7.43 mg/g), β carotene (5 µg/g) and lycopene (16.86 µg/g) which makes it a potential fruit to reduce the ill effect of free radicals in our body, maintains blood pressure and reduce cholesterol³⁵. *Berberis pseudoumbellata* has been reported to contain vitamins such as riboflavin (0.84 mg/g), thiamine (17.5 mg/100 g) and minerals such as potassium (432.6 mg/100 g) and calcium (158.4 mg/100 g)³⁶. *Berberis* species are also known to possess large amounts of alkaloids like berberine, palmatine, jetrorrrhizine and coloumbanine³⁷. *Rubus ellepticus* contains crude protein, carbohydrates, crude fiber, minerals (calcium, magnesium, potassium and phosphorus) and vitamins³⁸. Sea-buckthorn (*Hippophae* spp.) are well known source of vitamin C (1400 mg/100 g), vitamin E (255 mg/100 g), vitamin A (11 mg/100 g), vitamin B1 (0.04 mg/100 g), vitamin B2 (0.56 mg/100 g) and minerals like iron (116 mg/100 g), phosphorus (50 mg/100 g) and calcium (150 mg/100 g)³⁹. *Prunus nepalensis* was reported to be a rich source of vitamin C (609 mg/100 g), calcium (1220 mg/100 g), phosphorus (70 mg/100 g) and iron (10.70 mg/100 g)⁴⁰. In terms of nutritional composition, wild edible fruits mentioned above are known to be much higher in quantity than commercially available fruits which reflect their potential as a dietary supplement.

Conclusion

Wild edible species provide more than food, as these are the most precious gifts by nature. The spontaneous change in culture and lifestyle with the advent of modernization, commercialization of agriculture, easy accessibility to market leads to loss

of traditional knowledge associated with these resources across the globe. The decline of traditional ways of life and decreased wild food use are interlinked. It is a well-known fact that the knowledge related to identification, gathering, processing and use of wild edible fruits is confined to elder/old experienced people, whereas the younger generation is least interested in its protection so the probability of loss of such invaluable information is extremely high. Hence, timely documentation of such knowledge has become the moral responsibility of scientific community/researchers, policy makers. In addition, development of strategy for propagation, popularization and domestication of potential wild edible fruits is equally important. Though little efforts have been made to identify the potentialities of wild edible plants as future economic resource/new crop^{8,12} however, sincere research efforts such as (i) conducting standardized, accessible and comparable studies on the nutritional and toxicological properties of potential wild edible species on a broad scale; (ii) and the identification of priority areas for conservation of wild food species and recording of food-relevant knowledge are essential to exploit their economic potentiality to diversify the food basket and to uplift the socio-economic condition of tribal and marginal farming communities. The ethnobotanical knowledge and rights of the *Bhotia* community regarding uses of plants need to be secured. Also, the appropriate mechanisms for effective benefits sharing of potential value of this knowledge needs to be developed.

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Conflict of Interest

The authors declare that they have no conflict of interest in the study undertaken.

Authors' Contributions

BS- Conceptualization, field trips, data generation, data analysis, writing the manuscript, images; KMR-Field trips, data generation; KCB-Botanical identification, editing/correcting manuscript; RC-Conservation, editing/correcting manuscript; SKD-Data generation; and SPA-Data analysis, editing/correcting manuscript.

References

- Negi S P, Forest cover in Indian Himalayan states-An overview, *Indian J For*, 32 (1) (2009) 1-5.
- Arora R K & Pandey A, *Wild edible plants of India*. New Delhi, Delhi, India: National Bureau of Plant Genetic Resources, (1996).
- Ratha K K, Joshi G C, Rungsung W & Hazra J, Use pattern of high altitude medicinal plants by *Bhotia* tribes of Niti Valley of Uttarakhand, *WJPPS*, 4 (6) (2015) 1042-1061.
- Kumar A, Adhikari B S, Mitra M & Rawat G S, Flora of Niti Valley: a cold arid region of Nanda Devi Biosphere Reserve, Western Himalaya, India, *Check List*, 12 (1) (2016) 1824.
- Naithani B D, Flora of Chamoli, Vol 1-2, Botanical Survey of India, Howrah, 1984.
- Pusalkar P K & Singh D K, Flora of Gangotri National Park, Western Himalaya, India, Kolkata: Botanical Survey of India, (2012) p. 708.
- Ghora C & Panigrahi G, Fascicles of flora of India, Rosaceae: Genus *Prunus*, (Vol. 18), Calcutta, India: Botanical Survey of India, (1984).
- Pandey A, Nayar E R, Venkateswaran K & Bhandari D C, Genetic resources of *Prunus* (Rosaceae) in India, *Genet Resour Crop Evol*, 55 (2008) 91-104.
- Rana J C, Dutta M & Rathi R S, Plant genetic resources of the Indian Himalayan region—an overview, *Indian J Genet*, 72 (2012) 115-129.
- Harries S A, Robinson J R & Juniper B E, Genetic clues to the origin of the apple, *Trend Genet*, 18 (8) (2002) 426-430.
- Rana J C, Pradheep K & Verma V D, Naturally occurring wild relatives of temperate fruits in western Himalayan region of India: an analysis, *Biodivers Conserv*, 16 (2007) 3963-3991.
- Sharma S K, Kishore D K & Pramanick K K, Utilization of indigenous crab apples for the management of foliar and soil borne diseases, In: *Proceedings of the national symposium on production, utilization and export of underutilized fruits with commercial potentialities*, Kalyani, Nadia, West Bengal, India, (2006, November) p. 22-24.
- Kala C P, Commercial exploitation and conservation status of high value medicinal plants across the borderline of India and Nepal in Pithoragarh, *Indian For*, 129 (1) (2003) 80-84.
- Jaiyati R, Rajdeo K, Ashish C, Archana S & Ruchi B, A survey to explore the herbal wealth and its utility as edibles, ethno-medicine and ethno-veterinary practices in Nanda Devi Biosphere Reserve (NDBR), Uttarakhand as a step to bio prospection, *Pharm Anal Acta*, 7 (11) (2016) p. 1-7.
- Phondani P C, Maikhuri R K, Rawat L S, Farooquee N A, Kala C P, *et al.*, Ethnobotanical uses of plants among the *Bhotia* tribal communities of Niti Valley in Central Himalaya, India, *Ethnobot Res Appl*, 8 (2010) 233-244.
- Arora R K, Plant genetic resources explorations and collection, planning and logistics, In: *Plant Exploration and Collection*, edited by K L Mehra, R K Arora and S R Wadhi, National Bureau of Plant Genetic Resources Science Monograph 3. NBPGR, New Delhi (1981), p. 46-54.
- Hooker J D, 1872-1897, Flora of British India, Vols.1-7, Oxford (rep. 1982), Bishen Singh Mahendra Pal Singh, Dehradun.
- Osmaston A E, 1927, A Forest Flora for Kumaon. Allahabad. (rep. 1978, Dehradun).
- Kirtikar K R & Basu B D, 1935, Indian Medicinal Plants, IInd revised, edited by E Blatter, J F Caius & K S Masker), Lalit Mohan Basu, Allahabad.
- The wealth of India – Raw Materials* (Vol. 8), (1969). New Delhi, India: Publication and Information Directorate, CSIR.
- Singh U, Wadhvani A M & Johari B M, Dictionary of Economic Plants in India, C.S.I.R., New Delhi, 1983.
- Agarwal V S, Economic Plants of India, Bishen Singh Mahendra Pal Singh, Dehra Dun, 1986.
- Maikhuri R K, Nautiyal S, Rao K S & Semwal R L, Indigenous knowledge of medicinal plants and wild edibles among three tribal sub communities of the central Himalayas, India, *IKDM*, 8 (2000) 7-13.
- Seth R, Haider S Z & Manindra M, Pharmacology, phytochemistry and traditional uses of *Cordyceps sinensis* (Berk.) Sacc: A recent update for future prospectsa, (2014).
- Gaur R D, Wild edible fruits of Garhwal Hills, JOHSARD, 1 (1977) 66-70.
- Samant S S & Dhar U, Diversity, endemism and economic potential of wild edible plants of Indian Himalaya, *Int J Sust Dev World*, 4 (1997) 179-191.
- Grivetti L E & Ogle B M, Value of traditional foods in meeting macro- and micronutrient needs: the wild plant connection, *Nutr Res Rev*, 13 (2000) 31-46.
- Millennium Ecosystem Assessment, Current state and trends, Washington, DC, (2005).
- Prakash M S, Utilization of wild rose species in India, In: *International Rose Hip Conference*, 690, 2004, p. 91-96.
- Mahapatra A K, Satarupa M, Basak U C & Panda P C, Nutrient analysis of some selected wild edible fruits of deciduous forests of India: An explorative study towards non-conventional bio-nutrition, *Adv J Food Sci Technol*, 4 (2012) 15-21.
- Maikhuri R K, Rao K S & Saxena K G, Bioprospecting of wild edibles for rural development in central Himalaya, *Mt Res Dev*, 24 (2004) 110-113.
- Rana J C & Verma V D, Genetic resources of temperate minor fruits. New Delhi: NBPGR, (2011).
- Sundriyal M & Sundriyal R C, Wild edible plants of the Sikkim Himalaya: Nutritive values of selected species, *Econ Bot*, 55 (2001) 377-390.
- Vincetti B, Eyzaguirre P & Johns T, The nutritional role of forest plant foods for rural communities. In: *Health and Forests: a global overview of issues practice and policy*, ed. Coler, C.J.P. London, UK, (2008) p. 63-96
- Pal R S, Kumar R A, Agrawal P K & Bhatt J C, Antioxidant capacity and related phytochemicals analysis of methanolic

- extract of two wild edible fruits from north western Indian Himalaya, *Int J Pharm Bio Sci*, 4 (2) (2013) 113-123.
- 36 Andola H C, Rawal R S & Bhatt I D, Comparative studies on the nutritive and anti-nutritive properties of fruits in selected *Berberis* species of West Himalaya, India, *Food Res Int*, 44 (7) (2011) 2352-2356.
- 37 Dehar N, Walia R & Ratol S, Potentiation of thiopentone sodium induced hypnosis by *Berberis aristata* in rodents, *Asian J Pharm Clin Res*, 5 (1) (2012) 131-133.
- 38 Saklani S, Chandra S, Badoni P P & Dogra S, Antimicrobial activity, nutritional profile and phytochemical screening of wild edible fruit of *Rubus ellipticus*, *Int J Med Aromatic Plants*, 2 (2012) 269-274.
- 39 Dwivedi S K & Ahmed Z, Seabuckthorn (*Hippophae* sp.)-a potential underutilized fruit plant for cold arid India, In: *XXVII International Horticultural Congress-IHC2006: International Symposium on Asian Plants with Unique Horticultural*, 769 (2006) p. 297-302.
- 40 Agrahar-Murugkar D & Subbulakshmi G, Nutritive values of wild edible fruits, berries, nuts, roots and spices consumed by the *Khasi* tribes of India, *Ecol Food Nutr*, 44 (3) (2005) 207-223.
- 41 Kureel R S, Singh C B, Gupta A K & Pandey A, Wild apricot. National Oilseeds and Vegetable Oils Development Board, Delhi, 2007.
- 42 Bhatt I D, Rawat S, Badhani A & Rawal R S, Nutraceutical potential of selected wild edible fruits of the Indian Himalayan region, *Food Chem*, 215 (2017) 84-91.
- 43 Rathore D S, A note on ascorbic acid content of rose hips, *Progress Hortic*, 16 (1984) 159.
- 44 Badhani A, Rawat S, Bhatt I D & Rawal R S, Variation in chemical constituents and antioxidant activity in yellow Himalayan (*Rubus ellipticus* Smith) and Hill Raspberry (*Rubus niveus* Thunb.), *J Food Biochem*, 39 (6) (2015) 663-72.