

Diversity, Distribution, Use Pattern and Evaluation of Wild Edible Plants of Uttarakhand, India

S.K. Joshi*, B. Ballabh, P.S. Negi and S.K. Dwivedi

#DRDO-Defence Institute of Bio-Energy Research, Haldwani, Uttarakhand-263139, India

**E-mail: skantjoshi@gmail.com*

ABSTRACT

Wild edible plants are crucial not only for their role as a source of food and nutrition but are also integral part of culture and traditions of the Himalayan societies. Because of availability of diverse altitudinal, topographical and microclimatic conditions, the state of Uttarakhand supports a huge diversity of wild edible plants. Most of the species of wild edible plants in Uttarakhand are primarily consumed as a food by the local communities residing in remote hilly regions. However, several other species are consumed for their medicinal and health promoting benefits. The availability of enormous diversity of wild edible plants in the region has attracted attention of researchers. Consequently, research has been carried out on different aspects of wild edible plants. These include studies on distribution and use pattern, development of propagation protocols and bioprospecting and biochemical evaluation. As a result of this, some of the species are being utilized at commercial scale, and thus are considered capable of providing alternate options of livelihood for marginal communities residing in far flung areas of the state. However, there are several other promising species of wild fruits in the region, which need attention for conducting research on various aspects so that their optimum nutritional and economic potentials could be harnessed in sustainable manner.

Keywords: Wild edible plants; Multipurpose plant species; Nutraceuticals; Antioxidants

1. INTRODUCTION

The Himalaya is the most complex and diversified ecosystem among the global mountain systems. It supports immense diversity in climate and habitat conditions due to great variation in topographical features¹. Occurrence of rich vegetational diversity in the Himalayan flora that too with the high levels of endemism indicates the ecological and potential economic significance of the region. As a result, Himalaya is endowed with immense biological diversity in general and floristic diversity in particular. According to the estimates, Himalaya is home to nearly 18,440 species of plants (including fungi), of which 25.3 per cent are endemic^{2,3}.

Uttarakhand, located between latitude 28°43' to 31°8' N and longitude 77°35' to 81°02' E and covering an area of 53,485 km², falls under the western Himalaya biogeographical province of the Indian Himalaya Region (IHR)⁴. In the northwest, Tons river separates the state of Uttarakhand from Himachal Pradesh, whereas Kali river forms its eastern boundary with Nepal⁵. Uttarakhand covers about 12 per cent area of the IHR, and nearly 40 per cent of its total area falls under different forest types⁴ indicating its rich vegetational wealth. The region is spread from foothills in the South to the northern snow-clad peaks of the Himadri, which delineates the Indo-Tibetan boundary⁵. Likewise the other Himalayan

states, Uttarakhand is well known for its rich biotic wealth and cultural and ethnic diversity. Uttarakhand is largely a mountainous state, where great altitudinal variability (300 m amsl to 7817 m amsl) is seen⁵. Such a wide variation in altitude has resulted in complex topographical, meteorological, floral and faunal diversity.

2. POTENTIALS OF WILD EDIBLE PLANTS

Global estimates indicate that even in the 21st century one third of the population is facing food insecurity. In response, international agencies including the World Health Organisation and Food and Agriculture Organisation have given impetus on the discovery of new food resources⁶. Among others, underutilised wild edible plants are considered as potential alternative for achieving nutritional security⁷. Wild edibles even play crucial role during the acute and chronic food shortages that occur during wars and other extreme survival situations like natural calamities. An example of such a role of wild edible was witnessed during Bosnia Herzegovina war (1992-199) when the war-torn population reportedly consumed wild plants for their survival⁶. Moreover, incorporation of biologically active food components or compounds from wild edible plants will have direct health benefits. This is much significant for the communities reside in marginal ecosystems including the mountains, where there is poor access to healthy food⁸.

In the Himalayan context, wild edible plants have been known to play significant role in meeting nutritional needs of

local communities. Economically potential under exploited and underutilised natural resources are crucial in maintaining subsistence lifestyles in traditional mountain communities⁹. A large number of plant species are already reported to be used as food by different communities in the Himalaya^{10,11}. In addition to this, a number of other plant species are reported to be used by the Himalayan people to meet their fuel, fodder, timber, therapeutic and other needs. Available data indicate that importance of evaluation of nutritional properties of lesser known wild edible plants has been well-recognised¹¹⁻¹³. Realising this, a number of studies have been carried out on wild edible plants across the world in general and Himalaya in particular. Consequently, issues pertaining to wild edible plant species have found prominent place in discussion and policy framework of rural development and biodiversity conservation¹¹. Considering these facts, availability of updated and compiled information on different aspects of wild edible plants is a prerequisite for formulating future strategies for development of this sector.

A strong knowledge base in form of compiled information on different aspects of wild edibles is essential for identification of gap areas and prioritisation of future research priorities. Realising the importance of comprehensive and synthesised data on different aspects of wild edible plants, the present paper attempts to review the available scientific information on their diversity, distribution and utilisation pattern in Uttarakhand, Himalaya.

3. DIVERSITY AND USES OF WILD EDIBLE PLANTS IN UTTARAKHAND

Uttarakhand is one of the richest states in India in terms of natural resources in general and plant resources in particular. Due to the wide ranging variability in topographical and climatic features, distinct types of vegetation are found in the state along the altitudinal gradient. Some of the major vegetation types classified along the altitudinal gradient are tropical, sub-tropical, temperate, sub-alpine and alpine⁴. Under these vegetation belts, rich diversity of ecologically and economically valuable plant species is found. This is evident from the fact that of the different biogeographical provinces of Himalaya, western Himalaya (mostly comprised of Uttarakhand Himalaya) has richest diversity (344 species; nearly 50 per cent of total IHR) of wild edible plants¹⁴. Of these, several species have potential food values. Some of them are consumed directly as fruits and vegetables by the local communities¹⁴, whereas others can be consumed after processing and value addition.

Diversity and uses of some of the wild edible plants and fungi of Uttarakhand are described in Table 1. Some of the wild edible species are widely popular and consumed directly as food (fruits, vegetables, edible oil, etc.) by the native communities since long time. Wild edible plants are not only consumed for food by the local communities but are also source of their income generation. Species like, *Myrica esculenta* is collected from the wild and sold in local market¹⁴ at a rate of Rs. 200 per kg - 300 per kg in many parts of state (personal observation). Some species, such as, *Hippophae* spp., *Rhododendron arboretum* and *Prunus armeniaca* are being utilised at commercial scale for making value added

products, like squash and other beverages. Moreover, there are several species of wild edibles, which provide multiple benefits and have traditional usage in the region. Such species of wild edibles are termed as multipurpose plants. Among these multipurpose species, some species are used as fodder (*Diploknema butyracea*, *Prunus cerasoides*, *Grewia optiva* etc.); medicinal (*Berberis aristata*, *Zanthoxylum armatum*, etc.); Timber (*Castanopsis indica*, *Ougeinia oogeinensis*, etc.); Fuel wood (*Corylus jacquemontii*, *Pyrus pashia*) etc¹⁴. Such kinds of use pattern of wild edibles indicate their significance in day to day life of the local communities residing in remote marginal areas of Uttarakhand. As a result of this, research studies have been gaining momentum not only on the well-recognised popular species, but also on the ones which are either underutilised or less explored. Recognising the potentials of wild edibles for fulfilling different needs, research on their various aspects has been carried out. Most of the studies on wild edibles of Uttarakhand have been carried out on their diversity, distribution and use pattern, bioprospecting and biochemical evaluation, estimation of biological activities and development of propagation protocols. Natural distribution, pattern of use, economic potentials and reports on propagation protocols of selected tree and shrub species of wild fruits of Uttarakhand Himalaya are described in the following section.

3.1 *Benthamidia capitata* (Wall.) H. Hara (Syn. *Cornus capitata* Wall.)

Commonly known as 'Bhamor' in Uttarakhand, *B. capitata* (Fig. 1 A) is a small to medium sized tree found in forests and shrubberies between 1200 m and 3000 m altitude along the edges and gaps in oak-mixed forests. Ripened fruits (yellow-red) of the species are eaten by local people in hills of Uttarakhand though their utilisation at commercial scale is not reported till date. Stem bark of the tree is a source of brown-red dye. Studies on natural distribution and edible uses⁴ and seed germination¹⁵ of *B. capitata* are reported. However, reports on biochemical studies of fruits of *B. capitata* are lacking from the state. Evaluation of biochemical properties as well as biological activities of fruits of *B. capitata* would be of high significance for harnessing its economic potentials.

3.2 *Berberis aristata* DC

Commonly known as 'Kilmora' in Uttarakhand, *B. aristata* is well-known for its medicinal properties in traditional as well as modern systems of medicine¹⁶. *B. aristata* is utilised in Ayurveda as 'Daruharidra' and used for treatment of various ailments. Among others, berberine, an alkaloid, is the major bioactive molecule present in wood, bark and plant extract *B. aristata*¹⁶. Ripened fruits of the species are edible and are consumed by the local communities in the Himalaya. Moreover, it has also been reported as a source of nutraceuticals¹⁷. Research on different aspects including diversity and distribution¹⁸, biochemical evaluation¹⁷ and development of propagation methods¹⁹ of the species are well reported.

3.3 *Berberis asiatica* Roxb. ex DC.

The fruits of *B. asiatica* (Fig. 1 B) are edible and are considered as a potent source of natural antioxidants²⁰. *B.*

Table 1. Wild edible species of Uttarakhand Himalaya.

Plant species	Parts used	Method of use	Plant species	Parts used	Method of use
<i>Acacia modesta</i> Wall.	Gum	Fried with ghee and eaten	<i>A. polyodioides</i>	Fronds	Vegetable
<i>Achyranthes aspera</i> L.	Whole plant	Edible, young leaves are cooked and used as vegetable/saag			Seeds are warmed on <i>Tawa</i> and eaten with honey during winter, fried seeds mixed with jaggery to form <i>Laddu</i> (sweets).
<i>Aegle marmelos</i> (L.) Corr.	Fruits	Ripe fruits eaten and used in preparation of sweet drink	<i>Amaranthus blitum</i> L.	Seeds, leaves	<i>Chapati</i> frequent as of grinded seeds during winter rains were very common in past. Boiled and fried leaves and tenders are used as green vegetables
<i>Aesculus indica</i> Colebr.	Kernel	Edible			
<i>Agaricus campestris</i> L.	Fruiting body	Fruiting bodies are used fresh for making vegetables by boiling in water, decanting hot water and then fried in edible oil.	<i>Astibleri vularis</i> Buch.-Ham. ex Don	Leaves	Edible
<i>Agave americana</i> L.	Tender stems	Used as vegetable	<i>Atriplex hortensis</i> L.	Leaves, seeds	Vegetable
<i>Ainsliaea aptera</i> DC	Flowers	Flowers consumed for their nectar.	<i>A. sativa</i> L.	Seeds	Edible
<i>Albizia lebbek</i> (L.) Benth.	Resin	Resin from stem bark edible	<i>Bambusa arundinacea</i> Willd.	Young shoots	Curry, pickles
<i>Allium atropurpureum</i> Waldst. & Kit	Leaves	Used as vegetable	<i>B. vahlii</i> Wight & Arn.	Fruits, flower buds	Edible fruit. Flower buds either pickled or cooked as vegetable
<i>Allium carolinianum</i> DC.	Leaves, flower tips	Fresh or dried leaves added as condiment to vegetable	<i>B. variegata</i> L.	Flower buds	Flower buds eaten as vegetable, petals used in a curd preparation
<i>A. griffithianum</i> Boiss.	Seeds, grains	Spices and condiment	<i>Barleria cristata</i> L.	Whole plant	The whole plant is edible.
<i>A. humile</i> Kunth.	Leaves, flower tips	Fresh or dried leaves added as condiment to vegetable	<i>Bauhinia variegata</i> L.	Flower buds	Flower buds eaten as vegetable, petals used in a curd preparation
<i>A. jacquemontii</i> Kunth	Leaves	Vegetable	<i>Benincasa hispida</i> Thunb.	Fruits	Used as vegetable
<i>A. rubellum</i> M. Bieb.	Bulbs	Bulbs used for making chutney and as spices and condiment	<i>Benthamidia capitata</i> (Wall. ex Roxb.) Hara	Fruits	Edible fruits
<i>A. roylei</i> Stern.	Bulb, leaves	Bulbs and leaves used as vegetables or spices.	<i>Berberis asiatica</i> Roxb.	Whole plant	Edible fruits, tender shoots used as vegetable
<i>A. stracheyi</i> Baker	Leaves, flower tips	Vegetable and condiment	<i>Bergenia ligulata</i> (Wall.) Engl.	Rhizomes	Edible
<i>A. tuberosum</i> Sprengel Rottl. ex	Leaves, flower tips	Vegetable and condiment	<i>Berberis aristata</i> DC	Whole plant	Edible
<i>A. wallichii</i> Kunth.	Leaves	Fried young leaves are used as vegetables.	<i>Bidens pilosa</i> L.	Whole plant	Edible
<i>Alpinia galanga</i> (L.) Willd.	Rhizomes	Spices and condiment	<i>Cajanus cajan</i> L.	Seeds	Edible as pulse
<i>Alternanthera sessilis</i> L.	Shoots, leaves	Young shoots and leaves are cooked as pot herb.	<i>Callicarpa macrophylla</i> Vahal	Fruits	Fruits are edible
		Young tendrils are burnt over fire and eaten raw; Tendril is also boiled into soup which is considered as very good tonic during recovery after long illness	<i>Castanea sativa</i> P. Mill.	Fruits, seeds	Edible fruits
<i>Asparagus adscendens</i> Buch-Ham. ex Roxb.	Tendrils		<i>Catunaregam spinosa</i> (Thunb.) Tirveng.	Fruits	Ripe fruits are eaten after roasting or cooked, leaves are cooked as vegetable
			<i>Ceiba pentandra</i> L.	Fruits	Tenders fruits cooked as vegetable
			<i>Celtis australis</i> L.	Fruits	Ripe fruits are eaten
			<i>Chaerophyllum villosum</i> Wall. ex DC.	Roots, seeds	Edible as vegetable

Plant species	Parts used	Method of use	Plant species	Parts used	Method of use
<i>Chenopodium album</i> L.	Whole plant	Young shoots are used as vegetable	<i>Holboelia latifolia</i> var. <i>angustifolia</i> (Wall.) Hook. f. & Thoms.	Fruits	Edible
<i>Cinnamoum tamala</i> Nees & Eberm.	Leaves, bark	Edible as spices	<i>Indigofera pulchella</i> Roxb.	Flower, inflorescence	Edible as vegetable
<i>Cleome viscosa</i> L.	Fruits	Used as spice	<i>Lactuca dissecta</i> D. Don.	Tendrils, leaves	The young tendrils and leaves are used for vegetable purpose.
<i>Corylus jacquemontii</i> Decne	Fruits	Fruits are edible	<i>Linum usitatissimum</i> L.	Seed oil	Used as edible oil
<i>Cotoneaster microphylla</i> Wall. ExLindl.	Rhizome, leaves	Edible	<i>Litsea elongate</i> Nees	Seed oil	Used as edible oil
<i>Dendrocolamus hamiltonii</i> Nees Ex Arn.	Shoots	Boiled young shoots and used for making pickles.	<i>Madhuca indica</i> J.F. Gmel.	Fruits	Fruits are edible
<i>D. strictus</i> Nees	Shoots, leaves	Edible	<i>Maytenus rufa</i> (Wall. ex Roxb.) Raju & Babu	Fruits	Edible
<i>Dendrophthoe falcate</i> (L.f.) Etting	Fruits	Ripe fruits edible	<i>Melia azedarach</i> L.	Fruits	Edible
<i>Dioscorea deltoidea</i> Wall ex Kunth.	Tuber	Edible, vegetable	<i>Melothria heterophylla</i> (Lour.) Cong.	Fruits	Edible
<i>D. glabra</i> Roxb.	Tubers	Edible as vegetable	<i>Moringa oleifera</i> Lam.	Fruits, leaves	Ripened fruits are edible and leaves are used to flavor the dishes (curries) and pickled
<i>D. rotunda</i> Poir.	Tuber	Edible vegetable	<i>Morus serrata</i> Roxb.	Fruits	Ripe fruits edible
<i>Diplazium acrostichoides</i> Bir.	Fronds	The young fronds are cooked and relished as vegetable	<i>Ophioglossum reticulatum</i> L.	Frond	Edible
<i>D. esculentum</i> (Retz.) Sw.	Frond, stems, leaves	Stem and leaves of very young plant is cooked and then fried/ used for the preparation of pickle	<i>Oxalis corniculata</i> L.	Whole plant	Edible, leaves taken as salad or cooked as vegetable
<i>Diploknema butyracea</i> (Roxb.) H.J.Lam	Fruits and seeds	Fruits edible Edible oil from seeds	<i>Paeonia emodi</i> Wallich ex Royle	Leaves, twigs	Green leaves and twigs are boiled, mitigated and cleaned before frying and eaten as vegetable
<i>Elaeagnus conferta</i> Roxb.	Fruits	Edible	<i>Parthinocissus himalayana</i> Planch.	Fruits	Edible
<i>Fagopyrum cymosum</i> Trev.	Leaves, shoots	Used as vegetable	<i>Perilla frutescens</i> L.	Seed oil	Used as edible oil Yellowish mature fruits, which also are rich in vitamin C are eaten and as value added used for preparing jams, jellies products and pickles.
<i>Ficus palmata</i>	Bedu	Ripe fruits are edible	<i>Phyllanthus emblica</i> L.	Fruits	Edible
<i>Ficus auriculata</i>	Bedu	Ripe fruits are edible	<i>Pinus gerardiana</i> Wall. ex D. Don	Seeds	Edible
<i>Ficus sarmentosa</i>	Khinua	Ripe fruits are edible	<i>Pinus roxburghii</i> Sarg.	Seeds	Edible
<i>F. cunia</i> Buch.-Ham. ExRoxb.	Fruits	Fruits are edible	<i>Pistacia integerrima</i> Bin.	Fruit, Kernel	Edible
<i>F. glomerata</i> Roxb.	Fruits	Fruits are edible	<i>Prinsepia utilis</i> Royle	Fruit, seed oil	Ripe fruits eaten. Seed oil is used for edible purposes
<i>Flemingia vestita</i> Benth. ex Baker	Root, fruits, tuber	Edible	<i>Prunus armeniaca</i> L.	Fruits and cotyledon	Ripe fruit and cotyledons eaten.
<i>Fragaria indica</i> Andr.	Fruits	Ripe fruits edible	<i>Polygonum nepalensis</i> Meissn.	Seeds, fruits	Seeds yield oil, used as edible purposes. Fruits are edible
<i>F. nubicola</i> Lindl. ex Lacaita	Fruits	Ripe fruits edible			
<i>Garuga pinnata</i> Roxb.	Fruits	Fruits edible			
<i>Grewia optiva</i> J.R. Drumm.Ex Burret	Fruits	Ripe fruits edible			
<i>Hedera nepelensis</i> Koch.	Fruits, leaves	Edible			
<i>Heracleum candicans</i> Wall. ex DC.	Whole plant	Edible			
<i>Hippophae rhamnoides</i> Linn.	Fruits	Edible			
<i>H. salicifolia</i> (Don) Serv.	Fruits	Edible			
<i>H. tibetana</i> Schlecht.	Fruits	Fruits are edible			

Plant species	Parts used	Method of use	Plant species	Parts used	Method of use
<i>Polystichum aculeatum</i> (L.) Roth.	Fronds, leaves	Used as vegetable	<i>Sechium edule</i> Jacquin	Fruits, leaves	Used as vegetable
<i>Prunus cerasoides</i> D. Don	Fruits	Ripen fruits are edible	<i>Silene conoides</i> L.	Shoots, leaves	Shoots and leaves are cooked as vegetable
<i>P. napaulensis</i> Ser.	Fruits	Fruits are edible	<i>Solanum nigrum</i> L.	Fruits	Ripen fruits are eaten
<i>Pueraria tuberosa</i> DC.	Tubers	Used as vegetable and tuberous roots having a taste like liquorices are boiled and consumed	<i>Sorbus cuspidata</i> (Spach) Hedlund	Fruits	Fruits edible Fresh fruiting bodies are used for making delicious vegetables. These are boiled, water decanted, squeezed and fried in oil. Species is likened by the people of area very much and collect it more quantity. Fructification is also dried and stored for winter uses, when other vegetable are not available
<i>Pyracantha crenulata</i> (D. Don) M. Roem.	Fruits	Ripe fruits eaten	<i>Sparassis crispa</i> Fr.	Fruiting body	
<i>Pyrus pashia</i> Buch.-Ham. ex D. Don	Fruits	Edible	<i>Spondias pinnata</i> (L.f.) Kurz	Fruits	Edible
<i>Randia tetrasperma</i> (Roxb.) Benth. & Hk.	Fruits	Edible	<i>Taraxacum officinale</i> Wigg.	Leaves and roots	Fresh or dried leaves are cooked as vegetable roots eaten raw
<i>Rhamnus triquetra</i> (Wallich) Lawson	Fruits	Ripe fruits edible	<i>Taxillus vestitus</i> (Wall.) Danser	Fruits	Edible
<i>Rheum australe</i> D. Don.	Leaves	Leaves used as vegetable	<i>Taxus wallichiana</i> Zucc.	Stem bark and leaves	Bark and leaves for making for beverage (tea)
<i>R. emodi</i> Wall. ex Meissn.	Leaves	The leaves are used as vegetable	<i>Terminalia chebula</i> Retz.	Fruits	Dried fruit eaten and medicinal
<i>R. moorcroftianum</i> Royle	Leaves, tendrils	Young leaves and tendrils are boiled especially by <i>Gaddi</i> and shepherd in alpine region. It imparts sour taste	<i>Typhonium diversifolium</i> Wall. ex Schott.	Tubers	Used as vegetable
<i>Rhododendron arboreum</i> Sm.	Flowers, buds	Flowers eaten raw or made into sauce, jellies, jams or refreshing drinks. Flowers buds are used as vegetable	<i>Urtica ardens</i> Link	Leaves, shoots	Leaves, shoots Tender shoots, inflorescence Vegetable, remedy for sciatica
<i>Rhus parviflora</i> Roxb.	Fruits	Edible	<i>U. parviflora</i> Roxb.		
<i>Rosa macrophylla</i> Lindl.	Fruits	Ripe fruits are eaten	<i>Viburnum cotinifolium</i> D. Don	Fruits	Ripen fruits are edible
<i>R. moschata</i> L.	Fruits	Edible	<i>V. mullah</i> Buch.-Ham. ex D. Don	Fruits	Ripen fruits are edible
<i>R. sericea</i> Lind.	Fruits	Fruits are edible	<i>Vitis lanata</i> Roxb.	Fruits	Fruits are edible
<i>Rubus barbatus</i> Edgew.	Fruits	Edible	<i>Zanthoxylum armatum</i>	Dried fruits/ seeds as condiment	Dried fruits/seeds as condiment and for oral hygiene
<i>R. biflorus</i> Buch.-Ham. ex Sm.	Fruits	Edible	<i>Ziziphus jujube</i> (L.) Gaertn.	Fruits	Ripe fruits edible
<i>R. ellipticus</i> Sm.	Fruits	Edible	<i>Z. vulgaris</i> Lamk.	Fruits	Eaten raw
<i>R. foliosus</i> D. Don	Fruits	Edible			
<i>R. fruticosus</i> L.	Fruits	Edible			
<i>R. macilentus</i> Cambess	Fruits	Edible			
<i>R. nepalensis</i> (Hook.f.) Kuntze	Fruits	Edible			
<i>R. niveus</i> Thunb.	Fruits	Edible			
<i>R. paniculatus</i> Smith	Fruits	Edible			
<i>Rumex hastatus</i> Don	Aerial parts, Leaves	Aerial parts refreshing and eaten raw. Leaves edible			
<i>Schleichera oleosa</i> (Lour.) Oken	Fruits	Unripe fruits are pickled and ripe fruits eaten			

(Source: Angchok⁴⁷, *et al.*, Anonymous⁴⁸, Ballabh and Chaurasia⁴⁹, Bhatt⁵⁰, *et al.*, Chandra⁵¹, *et al.*, Dangwal⁵², *et al.*, Dwivedi and Ahmed²⁹, Kala⁴, Khan and Hussain⁵³, Mehta¹⁸, *et al.*, Mir⁵⁴, Pande and Pangtey⁵⁵, Pant and Samant⁵⁶, Rana⁵⁷, *et al.*, Tewari⁵⁸, *et al.*, Upreti⁵⁹, *et al.*)

asiatica is found in shrubberies, grassy and rocky slopes between 1200 and 2500 m altitude. This species is considered as a substitute for *B. aristata*¹⁶. Studies on biochemical and bioactivity evaluation are described by Bhatt²¹, *et al.* and Andola²², *et al.* Cultivation and plantation of the species in community land or pastures in and around natural habitats of the species is desirable for ensuring continuous supply of raw materials for the industry.

3.4 *Corylus jacquemontii* Decne.

C. jacquemontii ('Bhotia Badam' or 'Kabasi') is a medium sized tree, widely distributed from Afghanistan to West Nepal in the Himalaya between 1800 and 3000 m amsl. Nuts from mature fruits are consumed directly by the local communities in Garhwal region. Distribution and use pattern²³ and propagation techniques²⁴ for the species have been reported. Mass plantation of quality planting material of the species around villages and in the forests will help in providing the desired quantity of this nutritious wild fruit nut.

3.5 *Diploknema butyracea* (Roxb.) H.J. Lam

A tree up to 20 m tall and commonly called 'Cheura' in Uttarakhand, *D. butyracea* is widely distributed in Himalaya from Uttarakhand to Arunachal Pradesh up to 1500 m elevation. It is one of the most valuable and popular multipurpose tree having several useful properties. Its fruits are eaten raw and seed oil is used for cooking purpose, whereas the leaves and wood are used as fodder and fuel respectively¹⁴. Propagation techniques¹³ and biochemical studies²⁵ for *D. butyracea* have been reported. Although the species is traditionally grown in and around villages for its immense values, systematic plantation of its high yielding genotypes on community forests or lands will result in adequate production of edible (fruits and seeds) and fodder (leaves) components thereby supplementing the nutritional and livelihood security to the people residing in far flung and backward areas of the state.

3.6 *Ficus palmata* Forssk.

F. palmata (Fig. 1 (C)) is a common wild fig, popularly known as 'Bedu' in Uttarakhand, occurs up to 2300 m altitude from Afghanistan to Nepal on rocky slopes, drier regions and near cultivated areas. Fruits are edible and are also used for medicinal purpose by the local communities¹⁴. Distribution and use pattern^{4,14,18} and biochemical evaluation²¹ are well documented for the species. Leaves of *F. palmata* are used as fodder and for ethnoveterinary purposes as well²⁶.

3.7 *Ficus auriculata* Lour.

Commonly called 'Timla' or 'Timil' in Uttarakhand, *F. auriculata* (Fig. 1 (D)) is found up to 1600 m elevations around cultivated areas and forest edges from Pakistan to Bhutan. Its fruits are edible and leaves are lopped for cattle fodder during winter season throughout the state. *F. auriculata* is also used for treatment of livestock diseases²⁶. Distribution and use pattern¹⁴, biochemical studies²⁷ and propagation techniques²⁸ for the species have been reported.

3.8 *Hippophae rhamnoides* L.

Seabuckthorn (*H. rhamnoides*), a thorny nitrogen-fixing deciduous shrub of cold arid region, is a valuable plant, which has recently gained worldwide attention, mainly for its medicinal and nutritional potentials²⁹⁻³². It is currently domesticated in several parts of the world including India due to its nutritional and medicinal properties. Biochemical evaluation^{30,33} and propagation^{34,35} of the species have been carried out. In India, DRDO developed technologies for production of different products of Seabuckthorn have been well-received by different stakeholders including industries, NGOs and local entrepreneurs³⁵.

3.9 *Hippophae salicifolia* D. Don.

Another species of the genus *Hippophae*, sharing most of the characters as that of *H. rhamnoides*, *H. salicifolia* (Fig. 1 (E)) grows as a small tree (up to 5 m tall) in the cold arid regions/subalpine forests of Ladakh, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh. Fruits of the species are a rich source of vitamins (A, B, C, K and E) with immense antioxidant properties^{36,37}. In addition to its edible and immense nutritional properties, *H. salicifolia* is capable of fixing atmospheric nitrogen and has potentials to control soil erosion and reclamation of degraded lands³⁷.

3.10 *Myrica esculenta* Buch.-Ham. ex D. Don

M. esculenta (Fig. 1 (F)), commonly called 'Kaphal' in Uttarakhand, is one of the most popular wild edible fruits, which is distributed from Kashmir to Bhutan in the Himalaya. In Uttarakhand, it grows in Oak-mixed and Chir-pine forests at an altitudinal range of 1000 m amsl to 2300 m amsl. Ripened fruits (red to deep red) are edible and are collected and sold in market during May-June by the local people throughout the state. Wild trees grown in the forests, however, are the only source of fruit collection at present. Studies on biochemical attributes of fruits have been published³⁸. The species is rich source of natural antioxidants, which can play vital role in managing the oxidative stress and preventing from certain degenerative diseases³⁸. Identification and prioritisation of elite genotypes of *M. esculenta* and subsequent plantation of their quality planting material in the forests or around the villages will not only ensure uniform and high quality fruit production but will also strengthen livelihood opportunities for the local people. Moreover, there is a tremendous potential for making value added products such as health beverages from the fruits of *M. esculenta*.

3.11 *Prunus armeniaca* L.

A deciduous, large and spreading tree with dark-brown to black bark, around 8 m - 10 m tall, is common in cultivated areas across the Himalaya. It is a hardy species, having 50-60 year economic age. Ripe fruits are eaten and sold fresh or dried by local communities. Seeds contain 45-50% oil, which is used for medicinal, cosmetic and confectionery purposes³⁹.

3.12 *Pyracantha crenulata* (Roxb. ex D. Don) M. Roem.

A spiny evergreen shrub, commonly called 'Ghingharu', is found in shrubberies and forest edges and near cultivated

areas in Uttarakhand at an altitudinal range of 1000 m amsl to 2400 m amsl⁴⁰. Mature fruits (Fig. 1 (G)) are eaten by the local communities. Fruit juice of the species possess potential nutraceutical properties²¹. After extensive R&D on various aspects including standardisation of propagation techniques of the species⁴¹, a product named 'Hridayamrit' has been developed by DIBER. The product will be available in the market after the transfer of technology to the appropriate industry.

3.13 *Pyrus pashia* Buch.-Ham. ex D. Don

Commonly called 'Mehal', *P. pashia* is a small or medium sized tree. It is found in forest edges, shrubberies and cultivated areas at altitudinal range from 750 to 2700 m in the Himalaya. Half rotten fruits of the species are eaten by the local communities. Leaves of *P. pashia* are used as fodder, whereas its wood is utilised as fuel and for making small agricultural implements¹⁴. The species is used as a rootstock for propagating most of the cultivars of pear. Despite its abundant natural availability in forests and agricultural areas, *P. pashia* is a commercially unexplored species in Uttarakhand. However, its fruits can be used for making different value-added food products.

3.14 *Rhododendron arboreum* Sm.

Popularly called 'Buransh' in Uttarakhand, *R. arboretum* (Fig. 1 (H)) is the most widely distributed tree-rhododendron in the Himalaya, found over a wide range of altitudes (1500 m to 3600 m)⁴⁰. Flower petals of *R. arboreum* are reported to have hepato-protective, anti-inflammatory and anti-nociceptive, antidiabetic and adaptogenic properties⁴². Juice extracted from the petals is used for making a refreshing beverage by some cottage industries/ NGOs in the state. Local people collect its flowers during March-April and sold to the local dealers for making a refreshing beverage, and thus get short term employment.

3.15 *Rubus ellipticus* Sm.

Commonly called as 'Hisalu', *R. ellipticus* (Fig. 1 I) is a large shrub found in shrubberies and cultivated areas at an altitude of 600 m - 2300 m across the Himalaya⁴⁰. Yellow coloured ripened fruits are a rich source of health promoting biomolecules and natural antioxidants⁴³. There are no reports available on the commercial exploitation of the species, though the ripened fruits are eaten by the local communities. Studies on distribution, utilisation¹⁸, biochemical evaluation⁴³ and standardisation of propagation methods⁴⁴ for *R. ellipticus* are reported. Although the species is not being utilised at commercial scale, there is a tremendous scope for development of value-added health promoting (nutraceuticals) or food products from its fruits.

3.16 *Rubus niveus* Wall. ex G. Don

R. niveus grows at higher elevations (2000 m - 3000 m) than *R. ellipticus* (Fig. 1 J) in forest edges and shrubberies. Ripened fruits are deep red and eaten by local people. Studies on distribution and use pattern⁴⁵, biochemical characterisation⁴³, and propagation methods⁴⁶ for the species are published. Likewise, *R. ellipticus*, *R. niveus* is also not being utilised at

commercial scale.

4. CONCLUSION

A rich diversity of wild edible plants is found in Uttarakhand Himalaya. As such, a strong traditional knowledge base on utilisation of wild edibles is available, particularly among the rural communities in the state. Rural hill communities are already consuming wild edibles as food and for other multipurpose uses. A number of research studies have been conducted on different aspects of several popular and well-known wild edible plants. However, proper evaluation of biochemical, nutritive and health promoting properties of unexplored/underutilised taxa would be of paramount importance for harnessing their optimum potentials.

In spite of the fact that propagation methods for several popular wild edibles are developed, complete agrotechnological practices and field evaluation of plant materials are lacking for most of the species. Therefore, development of efficient agrotechnological packages should also be a priority for research. This would also be required for ensuring the availability of quality planting material of the wild edible plants for their domestication in near future. Subsequently, plantation of such species in the forests/community lands available in the villages would be helpful in checking unsustainable harvesting of wild edibles from their natural populations, and thus will lead to their conservation in wild in the longer term.

Though value addition and product development have been carried out from some of the wild edible fruits and the same has resulted in providing alternate source of livelihood



Figure 1. Some of the common wild edible fruits of Uttarakhand Himalaya: **A-** *Benthamidia capitata*; **B-** *Berberis asiatica*; **C-** *Ficus palmata*; **D-** *F. auriculata*; **E-** *Hippophae salicifolia*; **F-** *Myrica esculenta*; **G-** *Pyracantha crenulata*; **H-** *Rhododendron arboreum*; **I-** *Rubus ellipticus*; **J-** *R. niveus*.

to the rural people, still value addition related issues for a large number of promising species are not addressed till date. Therefore, value addition and development of new products from the prioritised wild edible plants should be carried out. Thus, a holistic approach of R&D, which may encompass assessment of diversity and distribution of wild edible plants in their natural habitats, collection and validation of traditional knowledge through bioprospecting and phytochemical profiling, and subsequently, development and evaluation of economically viable products, would be of paramount importance for harnessing optimum economic and health promoting potentials of the wild edible plants of Uttarakhand, Himalaya.

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pp. 157 – 196.

CONTRIBUTORS

Dr S.K. Joshi has obtained his PhD (Botany). Currently working as Scientist 'D' at DRDO-Defence Institute of Bio-Energy Research, Field Station, Pithoragarh. He is currently engaged in research on survey, evaluation, propagation, conservation and utilisation of wild edible and other high value plant species of West Himalaya. Previously, he has contributed in establishing jatropa plantation on marginal land in semi-arid zone under the DRDO-Army Bio-diesel Programme. In the current study, he has carried out literature survey, compiled the data, synthesised the information and wrote the manuscript.

Dr Basant Ballabh received his PhD (Botany) from Kumaun University, Nainital, in 2003. Currently working as a Technical Officer 'B' at DRDO-Defence Institute of Bio-Energy Research and engaged in R&D on wild edible & medicinal plants of Himalayan regions of Uttarakhand. He is also involved in carrying out physico-chemical evaluation, cultivation & conservation of valuable wild resources of Himalaya. In the current study, he has contributed towards literature survey, data collection and analysis and manuscript preparation.

Dr P.S. Negi is Scientist 'E' and Officer-in-charge at DRDO-Defence Institute of Bio-Energy Research, Field Station, Pithoragarh. He has been engaged in research on medicinal and edible mushrooms of Himalaya. In particular, he has been engaged in developing food products from medicinal mushrooms of the Himalaya. He has also developed herbal health beverage from wild fruits of Himalaya. Has contributed towards manuscript preparation.

Dr S.K. Dwivedi is Scientist 'F' and Officiating Director, DRDO-Defence Institute of Bio-Energy Research, Haldwani. He is engaged in R&D on underutilised plant resources of Himalayas for their characterisation, conservation and propagation etc. Has conceived the idea and guided in manuscript preparation.