Prinsepia utilis Royle: Diversified and indigenous traditional uses of uncultivated multipurpose shrub

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Abstract

Prinsepia utilis Royle is a wild-woody oil yielding species of member Rosaceae, known as bhekal. This perennial deciduous shrub is growing, varying in habitat along the farm boundaries, open barren places, sacred grooves, wasteland, and open sunny places on dry hillsides or near any spring and water-course of Indian Himalaya. It is densely branched grows profusely in vertical and lateral directions to form large 4–6-meter thickest. The stems are cylindrically shaped, with rigid stout spines and profuse branches forming the clusters. The barks are grey or brown in the lower portion of mature stems, while the upper halves are green. Bhekal has good soil binding capacity and can survive in unattended and unprotected barren lands. It is suitable for well-drained sandy, loamy, and clay soils having a slightly acidic, alkaline nature;that crumb structure is optimal. Its deciduous qualities, including a deep taproot system, make this plant suitable for cultivation on a large scale to combat soil erosion and land sleep on degraded barren land. Significantly, the plants have the unique capacity to enjoy light, happiness is wet, cold-cool climate, snow-frost resistant, drought-enduring, strong adaptive capacity to the environment. Plant whole parts are all precious, its root, stem, leaf, fruit, seed oil can be used as medicine or it, have thermal detoxification, anti-inflammatory, promoting blood circulation, pain-relieving, helping digestion, oral suppression cavity, and enteritis. Its tender stems, leaf, and fibrous root decoction used in toothache and throat inflammation have an obvious anti-inflammatory, analgesic effect. Besides all this, the plant is also commonly used as bio-fence, apple grafting, a substitute for soap, cosmetics, and performing different ritualistic and holistic practices. Its termite-resistant and diseases freelocal people use wood for making the handle, musical instruments, toys, house commodities, and other items.

Keywords: *Prinsepia utilis*, bhekal, Chakrata, Flowering, traditional knowledge.

Introduction

Rosaceae family is the 19thmost prominent family of the plant kingdom (APW, 2007). It comprises more than 100 genera and 2830−3100 species (Mabberley, 1987;Judd et al., 1999). Most common fruits, including *Fragaria* (strawberries), *Prunus* (almonds, cherries, apricots, plums, and peaches), *Malus spp.*(apples), *Rubusellipticus*(raspberries), and *Pyrus spp.*(pears), as well as plenty of sources of ornamentals, e.g., *Potentilla*(cinquefoils), *Sorbus* (mountain ashes), and *Rosa* (roses), are produced by this family. Rosaceae family has been divided into four subfamilies based on fruit type:Maloideae (fruit- pome),Spiraeoideae (fruit-capsule or follicle) Prunoideae (fruit- drupe),and Rosoideae (fruit- achene), (Potter *et al*., 2002; Potter *et al*., 2007). The international code of botanical nomenclature (ICBN) listed 116 genera within the Rosaceae family, including *genusPrinsepia*. The *genusPrinsepia* was established by Royle in 1839 as a monotypic group initially but now in addition to *Prinsepia utilis*, there are the other three related species, *Prinsepia scandens* Hayata, *Prinsepia uniflora* Batal, and *Prinsepia sinensis* (Oliv.) Oliv. ex Bean, in the genus *Prinsepia*. Reportedly, 4 species of this genus only *P. utilis* occur in India. Geographically the whole genus of*Prinsepia* is confined primarily to continental eastern Asia. Its area of distribution ranges here from western Pakistan and N. W. India to southern and central China, E. Mongolia, Russia, Manchuria and Korea (Barnov, 1965). In India, this multipurpose woody deciduous shrub species is found in several states, locally referred to as Bhekal, bekuli and bekoi in Uttarakhand and Himachal PradeshRowari in Jammu and Kashmir, Phekrey in Sikkim, sohmon in Khasi and Jaintia hills. These species are essential components that form intermediate communities between grassland or heath and the high forest community. It has varying habitats, grows naturally on slopes near the edges of the forest area, from the hill slopes to the vertical cliffs, from the mountain valleys to the barren land (Maikhuri *et al*, 1994), and as a coloniser species in the degraded areas of Garhwal Himalaya (Maithani *et al*., 1986)between the altitude range from 1200-2700m asl. It is densely branched grows profusely in vertical and lateral directions to form 4-6 meter large thickets. The stems are cylindrical, with rigid stout spines forming clusters. The barks are grey or brown in the lower portion of mature stems, while the upper halves are green. Bhekal has good soil binding capacity, suitable for well-drained sandy, loamy, and clay soils having a slightly acidic, neutral and basic (alkaline) nature of crumb structure. Its deciduous qualities, including a deep taproot system, make this woody-shrub suitable for cultivation on a huge scale, especially to combat soil erosion and land sleep on unattended and unprotected barren degraded land. It is an extremely snow and frost-hardy species and can survive in those areas where little else grows (Plate-1). The native of the Garhwal Himalayarecognized the importance of this shrub long ago and utilize this plant in many manners. As an estimate, the potential yield of bhekal fruit ranges from 1-2kg of fruit per plant/year. The plant's mature fruit serves as a valuable and integral source of

nutrition and an additional source of income for villagers as they extract edible oil from the seed kernel. Seed kernels oil of *P. utilis* are pale yellow and locally consumed for culinary practices.Medicinally, the oil can cure rheumatic problems, skin disease, stomach ailments, headache, cough, cold, memory improvement, burn cut, and wound. Up to date, the chemical components of its seed oil (e.g., palmitic acid 15.2%; linoleic acid 43.6%; and oleic acid 32.6%;) possess particular benefits and have potential for human health and medicinal therapy (Zhan, 2010), which is undoubtedly comparable to Mediterranean olive oil (Wang, 2013). Besides this plant is traditionally used as bio-fence, apple grafting, substitute of soap, cosmetics and for performing different ritualistic and holistic practices. Local people use its diseases-free termite-resistant wood for making the tools handle, musical instruments, toys, house commodity and other items.

Material and Methods

Site Selection and Study Area

The study area (Chakrata Forest Division) comes under Yamuna circle lies between 30º31' to 31º3'N and 77º42' to 78º05'E of latitudes and longitudes, respectively constituting tehsil of Chakrata, Tiuni and Kalsi in Dehradun district. The study area is bounded by the Tons Forest Division and Yamuna Forest Division in the North and the east, respectively, in Southand west, the inter-state boundary with Himachal Pradeshformingby Yamuna and Tons River. The division lies in the lesser Himalayan ranges at the western end of the central Himalayas. The topography is mountainous and is broken by numerous streams and torrents, presenting a very rugged configuration. The elevation ranges from 405 m (asml) at the Yamuna and Asan rivers in Rampur mandi block to 3071 m (asml) at Kharamba peak. As per the Koppen climate classification, Chakrata has temperate climates with dry winter and warm summer (C*wb*). The average annual temperature is 14.8 °C, while January is the coldest and June warmest with an average temperature of 6.7 °C and 21.1 °C, respectively. The average annual precipitation is about 1734 mm, while July and November are the wettest and driest months, respectively. The winter season has much less rainfall than the summer

Selection of key informants and community understudy

Stratified and random sampling of villages in Chakrata region was carried out to identify key informants. A total of 109 (80 male and 29 female) key informants aged between 45 to up to 75 years were selected non-randomly by the system of chain referrals sampling/ snowball sampling (Goodman, 1961).

Ethnobotanical Data Collection and Analysis

The principle of Free, Prior and Informed Consent was followed during data collection. The informants were apprised of the objective and purpose of the study being carried out. It was ensured that the respondents participated in the interview voluntarily. A pilot study was previously undertaken where focussed group discussion with tribal and local people was conducted. Based on the group discussion, the local community's free listing of plant/product and mode of uses was carefully done (Plate-3). Pertinent literature for species identification and taxonomic classification related to *P. utilis* use was also surveyed for secondary data collection. However, primary data was collected employing questionnaires and personal interaction with the key informants. To better identify and prompt the respondents to talk, the projective test has also been done where pictures and photographs of the species were shown to the informants (Neto, 2006). The interviews were conducted in their local language, using a voice recorder. The transcription of the recording was done afterwards for analysis.

Results and Discussion

P. utilis is a much-branched deciduous spiny shrub of exceedingly vigorous habit growing up to 1.5-4 m. in height. The younger shoots slightly down at first, soon glabrous and profused to branched above the ground. Stems are cylindrical, soft when young, hard at maturity, up to 6cm in diameter, possess ascending stout spines produce in every leaf axil of 0.5cm to 5cm long sometimes bearing leaf, green in colour, sharp-pointed with a broad base. Primary branches are numerous up to eight which are further divided into numerous sub-branches. The new leaves appear in April, the leaves are simple dark green, elliptic to narrow-lanceolate, up to 5cm long, 1.8cm wide, margin entire and minutely toothed. Scented white cream colour flower grow singly but in the cluster from the base, hypogynous with radial symmetry, valvate aestivation, actinomorphic, cyclic and complete, 7-15mm in across. Under optimal conditions, root growth starts on 15-28 days of sowing, splitting testa takes place near to the micropyle, radical emerge and elongation takes place from the seed coat, at maturity, vigorous, tap and branched (Plate-2). The fruits are drupeoblong-cylindrical-shaped single-seeded berry with edible fleshy mesocarp, dark purple, single-seeded but sometimes double seeded.

Phenology of *P. utilis*

Foliation in *P. utilis* occurs in April- May, which can be referred to as summer foliation. As the process of reproduction is a very high energy-consuming activity, leaves may supplement the plants' food requirements and helps to produce food reserves for winter seeding. A close view at the metrological data of Chakrata Forest Divison during last two year indicate a common local belief, bhekal perform well under good rainy season when the temperature is optimum. Almost 100% of the interviewer stated that bhekal good seeding is followed by the rainy year. The phenological study was undertaken from October 2017 to September 2018, summarized in Table- 1 on a weekly basis reveals that the emergence of inflorescence started in October with the peak during Nov and December, followed by relatively poor or occasional emergence of inflorescence in January and February. Flowering increase with decreasing temperature, flowering initiated in December and reached its peak in January and February. Flowering was also noticed to be initiated in March and April, but there was no seed-set in such flowers. Seed formation started in January and reached its peak in February and March. Moderate or very often immature seeds were also recorded in April and May. Maturation of seed started in March, with rare instances of seed dispersal. April shows good seed dispersal while peak seed dispersal time of

P.utilis is May and June. The plant shed all the fruits by July, even the unripe fruits were shed by the plant. Seed germination was recorded in June, peak germination was recorded in July and August, relatively poor germination was also recorded in September and October. New axillary buds producing vegetative shoots started to appear from April and was recorded in peak from May to October, leaf fall began in December (Table-1).

Table 1. Phenogram of Prinsepia utilis

Period	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Inflorescence												
Flowering												
Seed formation												
Seed Dispersal												
Seed Germination												
Leafing												

Legends

	peak (60-100% branches showed the phenological event)
	Moderate (20-60% branches showed the phenological event)
	Poor (<20 % branches showed the phenological event)

Reproductive biology of *P. utilis*

The most amalgamating feature of angiosperms is to produce flower in order to continuation and existence of their progeny. A flower is a basic tool for pollination and fertilization which ultimately leads to fruit formation and seed setting. Seed setting is proficient by the interaction of, (1) external forces triggered by pollination systems, and (2) the physical forces which act upon plant before the formation of a bud, up to seed maturation.

In *P. utilis,* profuse flowering appears on both the new and old shoots, but mostly on one-year-old shootsinthe winter season–November-January. Under the optimum condition, flowering can be observed from November up to the second week of February, the peak flowering period begins from mid-December to mid-January. Flowering could continue from December to march in varying intensities. Buds were sessileat the initiation while,at maturity, they developed pedicles which were 1.0 to 1.5cm long;the inflorescence was simple raceme or mixed type, appeared both on the terminal and axillary position of shoots. Flowers takes place on primary as well as lateral shoots.The floral bud development can be referred to as the first flowering stage, so the male and female parts can develop and produce pollen and receptive ovules. The pollens are produced by stamens within the flower, while the ovules develop inside a pistil. Floral induction is the first stage of flower development. This physiological process occurs when the apical meristem becomes strong enough to develop flowers. Floral induction is a microscopic process that takes place inside the cells; whereas the next phases are macroscopic,these phases can be viewed easily. The first phase involves chemical reactions inside the cells that cause meristematicvegetativecells transformation to meristematic-reproductive cells. Rai *et al.* (2006), in their research on Mangosteen's flower development, confirmed that the flower induction phase correlated with the changes of gibberellin and sugar contents. The current study focuses on macroscopic phases of flower development. Based on the studies, the whole process of fruit form (from initiation of bud to fruit maturation) is completed in 85-101 days. The whole process, from the development of floral bud to seed maturation, can be divided into ten stages, which are described below;

Stage		Developmental stages
Stage I	**:**	At this stage,floral buds were observed minutely to the naked eye. They were very tender, dark pink under open conditions, green colour buds were observed in the plants growing under the canopy. These buds were more or less circular. The buds' average size (length and width) was recorded as 1.4mm.
Stage II	**:**	Bud become circular, slightly more extensive than those in stage one. The buds increased slowly and were recorded as 3.8mm × 2.9mm length and width,respectively.
Stage III	**:**	The buds were circular from the dorsal surface and conical from the ventral surface at stage III. The unfolding of the calyx distinguished this stage. The size of the buds was 4.0mm × 3.0mm.
Stage IV	**:**	This stage can be distinguished by the epicalyx lobes, which start separating and corolla become visible at the top of the bud. The margin of the epicalyx has a bright tinge. The buds measured about 4.3mm × 3.7mm.
Stage V	**:**	Bud starts tobloomacquire a more roundish and complete shape. The size of the bud was measured to be 4.8 × 4.2mm
Stage VI	**:**	This stage was distinguished by early blooming; petals start unfolding. Anther and stigma were visible from the front of the bud. The size of the bud was measured to be 6.9 × 5.8mm.

Stage VII : In this stage, the corolla becomes fully open. The complete bloom stage depicts an anther sized flower exposing the various whorls and reproductive parts. Movements of nectariferous insects and honey bees around the flower become more frequent and noticeable. The size of the bud was measured to be 16.6mm × 7.8mm.

StageVIII : Stage eight can be characterised by perianths and another fall, making central stigma visible.

Stage IX : At this stage, the pistil becomes dry, the receptacle becomes swollen and the formed the early stage of the fruit. At this stage, the average size of miniature fruit is 2.65 x 1.66mm

Stage X : Flower buds reach its last stage, characterized by the ripening of fruit. The average size of the fully mature fruit is 14.7 x 9.2mm

From bud initiation to fruit ripening, Stage VI was the longest among all developmental stages. This stage was distinguished by fall of corolla and stamens, dried stigma and swollen receptacle. This is the most crucial phase for forming fruit and seed production. All the fertilized stigma may not form fruits due to several reasons. This is not the problem in *P. utilis*, as most fertilised seeds form fruits. In *P. utilis*,the stigma is in the middle of stamens. This position is ideal for anther and stigma. it facilitates pollination and fertilization. The flowering plant attracts a host of nectariferous insects, and honey bees are the most common visitors. The plant bears fragrant flowers. The fragrance of flower indicates entomogamy but literature favouring entomogamy in *P.utilis* is not available. This research only observed the visitors of *P. utilis* (Image 3), while the real pollinator is the subject of further research. The last phase of flower development is the formation of fruit.Stage 9 (fruit development after fertilization) was observed after 53 days of bud initiation. The ripe fruits were observed after 85-101 days of bud initiation.

Fruiting in*P. utilis*

Fruiting in winter was observed in February-march in most of the plants. Phenological observations indicate that high intrapopulation variations suggest a high degree of homeostasis in the species. Even though plantsshow peak flowering during the winter months and the maximum mature fruits are available just before the onset of monsoon. Generally, in April -May, no green fruits were available. They produced mature fruits about 1 month before the rainy season, ensuring that the seeds were already in the ground. The plant can afford this behaviour may because of its ability to draw moisture from deeper soil layers. Over different years, there is wide variation in flowering and subsequent fruiting patterns between plants and within the same plant. January flowering is profuse, producing fruits of up to 1- 2kg per plant by the end of April-May. Fruit yield varies in plants depending on age, genetic potential and environmental factors. Each fruit contains a single seed,occasionally double.

Natural variability in*P. utilis*

Under natural populations, rich variability occurs in *P. utilis* inhabit, fruit size, seed size, pulp content, spiny habit, spreading of branches, compactness of canopy, time of flowering, and fruit-seed maturation. However, no systematic efforts have been made so far to collect and conserve plants representing this diversity or to promote the most desirable variants. There is a need to identify suitable types to select plants that are heavy yielding, large seed size as it yields edible medicinal oil, proper total soluble solids of fruit, tartness less acrid test, etc. In general, two distinct plant types of bhekal occur: a small tree form occur rarely, and common shrub forms. It appears that tree form is attained when remaining undisturbed and beyond human and other biotic entities. On the other hand, plants as their natural habit and exposure to biotic interference may produce more shoots. The plant can also be trained by allowing a single stem to grow and integrated as one of the components in different cropping models. However, scientific evaluation is needed to assess the relative compatibility and economic viability under different resource situations. In the present scenario, where there is no commercial cultivation of this species and mature violet fruit harvested by the rural people, it is evident that more fruits will be picked up from the non-spiny open type shrubs.

Propagation and management of *P. utilis*

Ripen fruit should be collected directly from the bush from April to June. It is observed that seeds collected early and later give poorer germination. According to altitude, the best time of seed collection is from the end of April to mid-June. When fruit is ripe, it turns into dark violet or almost black from bright green and startsdepulp, exposing the red pulp inside. The seed should be procured from the fruit as soon as they harvested. They are heaped in the shade for a day by gentle hand meshing remove red pulp under running water. At the time of washing, the light seed that float should be rejected from the storage point of view and further experimental process.The seed does not stand storage and must be sown as soon after collection as possible. It has been found that seed lost viability quite rapidly and germination decreased considerably from 78.0% initially to just 10.50% by the end of three months (Bhagat and Singh, 1989). If the seed has to be transported, it must ensure that it has tolerated moisture level, is free from pulp, and is better packed in airtight plastic containers. The seed viability is short hence sowing is done in July- August under shade nursery bed for protection against sun and harsh conditions.After three months of germination, seedlings are ready for transplanting. This is usually done during early April or June July at the onset of the monsoon season. The seed responds to treatments, and the high oil content of the seed indicates that the viability deteriorates rapidly with lowering moisture content but can be stored under low temperature. Propagation is not a problem as bhekal can be grown readily from seeds, but the plant is overexploited in some areas for fuel and fence.

Harvesting of *P. utilis*

Hand plucking the fruit is a common practice for harvesting. By handpicking, only mature fruits are harvested, and immature ones are avoided; hence there is no need for further grading of the fruits. Moreover, the plant is spiny, thus careful harvesting is required, sometimes, harvesting the fruits with twigs also done.

Maturity indicesof *P. utilis*

Plant flower early in its life, but no instances are recorded exact seed production period from its germination. Local people claim that fruit comes in after 4-5 years of age. Although good seeds are observed almost every year, goats, sheep, frugivore birds, monkey languor consume a fair quantity of fruit when they are ripe. So, at best, only a tiny proportion of the seed becomes available for natural regeneration. The fruit should be harvested when it matures and attainsthe final violet stage colour to extract oil from its stony seed. This stage can be judged by the fruit's size and by pressing the berries. It is also suggested that the fruits should be harvested 45-55 days after the fruit set when they attain 12-17mm length and 4-7mm width during April-June.

Post-harvest technologyof *P. utilis*

The unripe fruit of bhekal is generally not harvested as there is no potential use for edible and other purposes due to their acrid test, but mature fruit is directly utilized to extract oily seed and some time for eating for folk medicinal practices. Based on fruit size, their relative grades of processed bhekal are available in the field; big, medium, and small. The basis of size grading and fruit colour is the relative maturity of the fruit.

Medicinal uses of *P. utilis*

Medicinal plants are indispensable for traditional health care systems (Kandari, 2005). The contribution of medicinal plants to the health of the rural people in the Himalayan region is significant because most of the people living here still rely on the traditional healthcare systems (Maikhuri *et al*. 1998). Besides economic, environmental and cultural values, bhekal is also tapped for its medicinal quantities. In Chinese and Indian folk medicine, all parts of this plant have long been used to treat numerous diseases, such as rheumatism, skin diseases, and fractures (Guan, 2014; Zhang, 2015). The phytochemical studies showed that this plant contained hydroxynitrile glucosides, triterpenoids, and diterpene glucosides (Guan, 2014; Zhang, 2015; Guan, 2013). Thephenolic profiles and antioxidant properties of *Prinsepia utilis* Royle fruits delineate the inhibition toward digestive enzymes. A total of 20 phenolics was identified and quantified from *P. utilis* fruits exhibited radical solid scavenging activities and good inhibition on cellular reactive oxygen species (ROS)(Zhang *et al*, 2018).

Leaves of the *P. utilis* Royle have marked protective effects against osteoporosis and improved bone quality, attenuated bone resorption, enhanced the rate of bone formation and restored bone density(Gupta et al, 2015).This may provide evidence for the pharmacological basis for its traditional therapeutic uses. The phytochemical investigation of the aerial parts of *P. utilis* Royle resulted in the isolation and identification of twelve pentacyclic triterpenoids, most of these compounds showed significant cytotoxic activities against four human cancer cell lines (A549, HCT116, MDA-MB-231, and CCRF-CEM)(Guan et al., 2013). Besides this modern medicinal science, the Indigenous people have traditionally considered the plant and their products in traditional medicines. The information related to the composition of medicine prepared using Bhekal for curing different ailments was obtained from traditional healers and key respondents. Different people were found to offer different use of this species and different treatments for the same ailment. The data from different villages were compared, and the conclusion was derived. The finally-derived information about the medicinal values, mode of preparations and uses in particular ailments is described below:

Rheumatic joint pain: Rheumatoid Arthritis (RA), causes extreme pain and inflammation in joints, and the condition aggravates during winter. The most common symptoms of RA include swelling of joints, joint pain, stiffness and loss of joint function.Villagers claim that the oil extracted from the seed kernel of *P.utilis* has anti-rubefacient properties. Applying the lukewarm oil twice a day and massage on joints provides relief from rheumatic joint pain and other joint-related pain in elderly people. The seed oil is sedative and takes some time with lukewarm milk and various roasted flour to halt abdominal pain in pregnancy.

Skin diseases: Acne is one of the most common skin problems young people have. Bhekal oil is useful in curing skin diseases like pimples, achene, and eczema. Regular application of oil on the affected area of the face, limbs, and skin folds help in curing skin infections caused by the fungus and acne and pimples in young males and females. Pounded seeds (2g) paste with Haldi applied on all kinds of skin disease till recovery.

Stomach ailments:*P. utilis*lukewarm oil has also been used in curing common stomach ailments like stomach aches and constipation. Its laxative properties are found effective in stomach ailments. The decoction of seed powder is also used in a stomach ache and is used as anthelmintic medicine for children. Infusion of plant root bark gives relief in bloody dysentery and diarrhoea. The leaves are laxative;spoonful decoction is used in scabies and throat pain.

Headache, cough and cold: A spoonful of oil is commonly used in common ailments like headache, cough, and cold. Locals believe that the oil is good for improving memory power;that's why it is recommended for children.

Burn, cut and wound: The seed powder is valued for its healing properties. The sprinkling of seed powder gives relieves burn, cut and wound. The use of root paste on the boil, blisters, burn, cut, etc. was found helpful in curing it. The leaves-pastes also possess significant antibacterial and antifungal properties, curing wounds and cuts. The bark paste and seed cake are used to heal the wound, scabies, throat problems and burning sensation of the body. The bark of root paste is applied to sores.

The herbal medicines are primarily administered in oil, juice, paste or powder,decoction, prepared in a crude method from different plant parts such as bark,flowers, leaves, fruits, root,seeds and whole plant.

Livelihood dynamics around *P. utilis*

The survey revealed that the Indigenous Traditional Knowledge (ITK) about *P. utils* is largely manifested with edible, medicinal, rituals, and other purposes to schedule various activities in the local community. The extraction of oil from the seed kernels used

to be a common household practice which widely used for food consumption. The collection of seeds and the process of oil was considered to be labourersand physically challenging work. The many other parts of these plants and their products had numerous socio-cultural and economical uses. Its utilization as an ethnomedicinal plant and usages for fuel, as a hedge for crop protection, grafting of apple, seed kernel used as a substitute of soap and fodder for cattle are some other important applications. This ITKs is based on the knowledge acquired and developed over the years by observing the different ritualistic-custom practices. Owing to the immense changes to the lifestyle in most rural areas and access to easy and alternate sources in the market, there has been a considerable reduction in the indigenous knowledge and traditional uses of this plant. What was once an integral part of the socio-cultural life of native people,for this reason, has become highly neglected nowadays and used for religious purposes and rituals only. The valuable knowledge and information collected about the indigenous and traditional usages and practices have been categories under the typology of Edible, medicinal, ritual and other viz., fuelwood, bio fence, soil stabilizer, fodder, grafting, commodity (agricultural equipment and toys) in the following paragraph:

Fruit and oil

The plant produces, single-seededediblefruit. Mature fruit has a dark purple to almost black epicarp, with starkly contrasting pink, or red colour mesocarp. The flesh is juicy and has a flavour that combines sweets and tart with a slightly astringent after taste. This fruit is eaten raw and especially loved by children. An edible oil extracted from the seeds of *P. utilis* used to be one of the common household items in Chakrata regions until a few decades ago. This oil was also popular among the locals of the higher Himalayan valley of Garhwal regions where it was locally extracted through traditional methods and diesel or electric operated oil mills (Makhuri*et al*, 1994). Oil is chiefly used for cooking apart from its medicinal uses. It was found that the crude method of oil extraction using wooden pestle-mortar and the rectangular saucer of deodar wood was widely practised among the villagers of the Chakrata region

Fodder

Woody or herbaceous shrubs are well recognized as a source of supplementary feed/browse, mulch and green manure to develop sustainable and low-input production systems (Sumberg, 1984).Traditionally farmers rais certain trees and shrubs in their crop production systems to maintain soil fertility, top feeds, fuelwood etc. (Moorman and Greenland, 1980; Getahun et al., 1982). Shrubs and tree fodders are an excellent option for protein supplementation and can be easily planted on bunds, riversides, waysides and homesteads (Chema et al., 2011; Saadullah, 1990). Domestic animals are of great importance in remote villages of Chakrata, where people generally lead an agricultural or pastoral life and reared sheep and goats in great numbers, both for meat and wool. The goats and sheep are essentially dependent on pasture and receive a substantial portion of their feed in grains and other concentrates. Bhekal leaves are palatable fodder for goats and sheep (Nautiyal *et al*., 2018). These two species can be reared well with bhekal fodder. Pastures with perennial fodder plants like bhekal provide good fodder even during seasons of heavy snowfall.

Fuel

Fuelwood is the prime energy source for roughly 2.5 billion people worldwide and impoverished households that lack energy alternatives (IEA 2017). Fuelwood collection encompasses 55% of global forest harvesting (Ballis et al. 2015).The fuelwood contribution and total energy consumed varies from place to place and is determined by the level of development and availability.Bhatt and Sachan, 2004 reported that, on average, India's 87% cooking energy demand is met from non-commercial fuels, and the demand for firewood has been growing faster.The fuelwood is the one primary source of energy,chiefly used for cooking and heating purposes for poorerpeople living in villages of the Chakrata region. Our observation revealed that every bhekal bush lopping provides many twigs, which could be utilized as firewood by many poor people. A lopped bush has been observed optimum for producing quantity fuelwood, but it could differ from plant to plant and season of lopping (Plate-4). However, the stem and branches of Bhekal are used for fuelwood; it gives the poor quality of the fuel as it burns quickly and does not sustain heat for a longer time. Quantitive analysis of fuelwood properties like carbon,calorific value,volatile matter, ash-biomass ratio, density silica,moisture, and fuelwood index of bhekal is still unrevealed.

Bio-Fence

Bio fencing with bhekal is a common practice in Chakrata region because its thorny and profuse branching system and capability to grow in the water-deficient area can protect crops and habitat from stray animals. Fencing locally called *Jhaal*. It is grown in line along the agricultural boundary without any spacing. The dense branches of mature plants from strong clumps and together they act as a natural fence. Hence, it's a natural method of fencing that does not require any cost. This is also a cost-effective, locally-adapted method of keeping grazing and wild browsing animals away from agricultural land. In the older days, when farmers had minimal options for protecting the boundaries of agriculture fields, bio-fencing with Bhekal bushes was a popular method. Due to the large landholding size, fencing the whole area with alternate methods used to become a costly affair.

Shelterbelt and hedge

in India and South China,one of its preferred use as a hedge plant (Barnov, 1965). As it snows,is frost resistant, and could withstand neglect, the species can benefit Garhwal Himalaya as a live hedge, providing edible fruit, seed oil, fodder and fuelwood.

Erosion control

The dense root system of *P. utilis* acts as a 'living soil nail' and binds and holds the soil. It can check the soil erosion on slopes and enhance the soil properties. It can be used to stabilise soil on the slopes when grown along the contours. Control of soil erosion and the stabilisation of the slopes will help enhance the physicochemical and biological properties of soil. Though natural

catastrophes, overexploitation and utilization have threatened genetic resources for an extended period, the fast pace of human interventions in the natural ecosystem poses a growing threat. The need is thus to understand the practice of the conservation of environmental resources with the involvement of traditional indigenous practices, thereby promoting a conservation ethic and retaining traditional cultural values. Plan can be used in landscape gardening, afforestation and reforestation in fragile and disturbedHimalayan barren land. Plantation helps to prevent soil erosion, particularly in controlling runoff in temperate areas as well as it helps to soil increase in organic carbon by fixing mineral nutrients and available N, P and K. It is found to be best species in colonisation and soil stabilization in Garhwal Himalaya, and its morphometry plays an essential role in soil stabilization in the exposed and barren land. Leaves from plants emit oxygen and absorb carbon dioxide and pollutants from the atmosphere both for quality of human life reasons, biosphere support (Sahoo *et al.* 2021).

Household commodity

Bhekal mature wood is light brown or almond colour, hard or moderately complex and light-weighted. Fully mature plant yields 5-7 kg of dry wood. Aside from fruit, fodder and oil bhekal wood also serves varied uses. Bhekal wood has been used to line well, make the handle of butter extractor, small agricultural equipment, hut poles, tool handles, grafting on apple and making toy guns, etc. It provides termite-resistant wood suitable for making small beams, huts, and fences (Mohammed*et al.* 2020).

Religious Significance

The traditional devotion practices show the symbiotic relationshipbetween human beings and nature. The human culture, customs, ethos, religious rites, folk tales, folk songs, food, legends, and myths are deeply associated and influenced by the plants (Badoni and Badoni, 2001).Indigenous communities worldwide lived in harmony with nature and conserved its valuable biodiversity. Chakrata (Jaunsar-Bawar), inhabited by primitive people, embodies one of the most significant ethnobotanical. This study reveals that elderly folks possess comprehensive knowledge of the traditional use of this plant.The people use this plant in various ways, including worshipping gods and goddesses for the protection and betterment of their lives.The villagers of Chakrata celebrate many festivals and rituals throughout the yearsin whichbhekal plant forms a crucial part of such events. This plant has been associated with several social customs and religious rituals from time immemorial. Due to its cultural and religious significance, this plant is generally cultivated near temples and cherishessacred the Mahasu Devta (a representative of Shiva) and his three brothers. Mahasu Devta is considered the God of justice and his temple as a court. The devotees of Mahasu Devta plead for justice by offering the leaves and branches of this plant in the temple.

Local people firmly believe that God has bestowed some specific power and divine qualities to this plant, hence they have been using leaves for enchantments, and twigs are for sacred fire during hawan-pooja. The local Priests who help people perform most of the religious ceremonies and the festivals claimed that Bekal is one of the most sacred plants in this region. The leaves and younger stems of *P. utilis*are an integral part of several Jaunsari rituals conducted during festivals and ceremonies.The younger branches are used to perform naming ceremonies of a child on the 7^{th} or 21^{st} days of his or her birthday. Due to its magico-religious power,it is believed that a thorny branch of bhekal tied to the door and window of houses is capable to keep the evil spirits away and to ward off the negative energies from the house. To keep the spirit of dead people away from its former home, the thorny branches of this plant are kept on *Chowk* while carrying the dead body for cremation.

Conclusion

The research focused on Bhekal-related indigenous traditional knowledge in the Chakrata Himalaya. Uttarakhand and other Himalayan areas value bhekal. In addition to providing food and medicine, it provides building materials, fuelwood and fodder, and ceremonies. It improves soil fertility and soil binding capability. To enhance rural lives and barren land productivity, extensive research and support initiatives are necessary. However, due to lack of awareness among younger generations and rising socio-economic changes, traditional knowledge about this plant's use is fast vanishing. The plant's genetic diversity is being protected through creating a germplasm bank for seeds from diverse parts of India, developing techniques for vegetative propagation to clone chosen germplasm, and promoting bhekal as a food crop. Encourage commercial cultivation of P. utilis oilseeds to maximise this plant's economic value. The area's socioeconomic status may improve if businesses collect, process, and extract oil from oilseeds. Research on Bhekal cultivation and conservation is lacking. Large plants will reduce soil erosion on degraded and wastelands around settlements. With these plants, the rising local population would have more access to arable land and food. Due to the fact that most of the relevant responders were aged 60-75, if their expertise is not documented quickly, it would be irreparably lost. Thus, this work should help maintain heritable knowledge about P. utilis in village environments.

Plate 1: Image showing the various habitat of *Prinsepia utilis* (1) degraded land, (2) Snow clad land

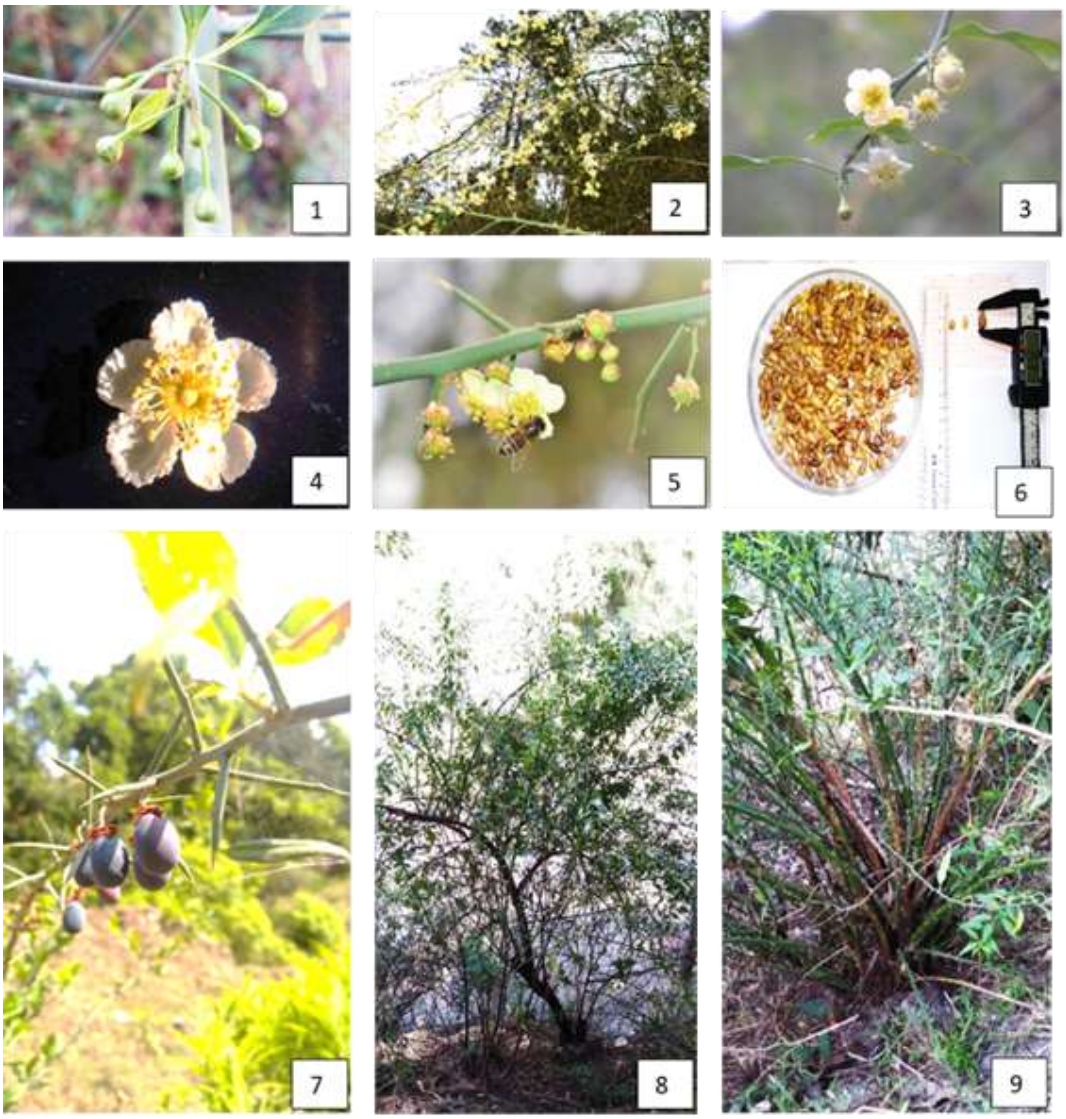

Plate-2: Image showing (1) floral stalk, (2) flower blooming, (3) Inflorencene, (4) flower, (5) nectariferous insects, (7) variability in seed size, (7) fruiting and (8-9) variability in plant type(8- small tree, 9 shrub form)

Plate 3: Surveying regarding indigenous traditional uses of *P. utilis*, (1) Mortar, (2-3 wooden oil extractor), (4-6, survey)

Plate 4: Indigenous traditional uses of *P. utilis*, (1) live fence, (2) Toy gun, (3,5) fuelwood, (4) wood used in ritualistic practice, (6) fodder, (7) Frugivore languour, (8) plant cultivated in the temple.

Phase 1.	**Microscopic phase, not observed**		
Phase 2.	**Floralformation**		
Stage 1: Bud initiation 3-4 days		Stage 6: Early blooming 1 day	
		Phase 4. Anthesis	
Stage 2: Floral bud fully emerge 8-9 days		Stage 7: Perfectly blooming 3-4 days	
		Phase 5. Pollination and fertilization	

Stage 3: Unfolding calyx 5-7 days		Stage 8: Perianths and anthers fall 4-5 days	
		Phase VI. Fruit formation, fruit ripening and seed formation	
Stage 4: Visible corolla 4-5days		Stage 9: Pistil become dry, swollen receptacle, early fruit structure 7-9 days	
Phase 3. Pre-anthesis			
Stage 5: Bud starts to bloom 3-4days		Stage 10: Ripe fruit 49-53 days	

Plate 5. ***stages of flowering and fruiting in P. utilis***

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