Nutritional Composition of Seed Kernel and Oil of Wild Edible Plant Species from Western Himalaya, India

R.K. Maikhuri a, Dalbeer S. Parshwan b, Pushpa Kewlani b, Vikram S. Negi b, Sandeep Rawat c, and L.S. Rawat d

a Department of Environmental Science, HNB Garhwal University, Srinagar Garhwal, India; b G.B. Pant National Institute of Himalayan Environment (GBP-NIHE), Almora, India; c Sikkim Regional Centre of GBP-NIHE, Gangtok, India; d Garhwal Regional Centre of GBP-NIHE, Srinagar Garhwal, India

ABSTRACT
Wild edibles and non-cultivated plants were significantly contributing to nutritional security and livelihood in rural areas of Himalayan region. The rich nutritional value and diversity of secondary metabolites in these plants escaped proper recognition; hence, warranted systematic and research investigation. The present study focuses on the assessment of nutritional composition of three underutilized wild edible fruits i.e. Prinsepiea utilis Royle, Prunus persica L. and Neolitsea pallens D.Don. growing wildly in Western Himalaya. The seed kernels of all the selected species were found to be rich sources of nutrients (e.g., lipids, carbohydrates and proteins), minerals (e.g., phosphorus, magnesium, calcium, iron and sodium) and energy value. Edible oil obtained from seed kernels of P. utilis and P. persica were found rich in essential fatty acid (linolenic acid), important unsaturated (omega-6 & omega-9) and saturated fatty acids. Among these, seed kernels of P. utilis possessed maximum quantity of carbohydrate (20.6%) and crude fiber (14.57%), whereas, fat content (70.40%) and energy value (720k cal/100 g) were found maximum for Neolitsea pallens. The results of this study indicated potential of selected species in combating nutritional insecurity.

KEYWORDS
Wild edible; nutritional value; nutritional security; edible oil; seed kernels; western himalaya

Introduction
Food and nutritional security are the key issues in developing countries due to insufficiency and poor access to food (Adebooye and Phillips, 2006; Andersen et al., 2003; Bhatt et al., 2017; Toledo and Burlingame, 2006). Globally, ethnobotanical surveys on underutilized, wild and non-cultivated plants indicate that more than 7000 species have been used for human food (Grivetti and Ogle, 2000). Likewise, 1069 species of wild fungi consumed worldwide are important sources of protein and income in rural areas (Boa, 2004). Conservation and sustainable use of biodiversity has traditionally been recognized as a key step to combat hunger and malnutrition in developing countries (Negi et al., 2011; Toledo and Burlingame, 2006). Elimination of hunger and ensuring food security necessitates the exploration of new and natural ways to meet food needs including consumption of underutilized wild and non-cultivated edibles particularly in rural areas (Maikhuri et al., 2017). Wild edibles are eaten in many forms depending on the nature of species, i.e., fruits eaten raw, many cooked as vegetables, and few processed in the form of juice, squash, pickle; however, these valuable bioresources have not yet been considered as alternative food products and sources of regular nutrition (Maikhuri et al., 2004, 1994a; Negi et al., 2011). However, some recent literature demonstrated that wild edibles possess remarkable therapeutic and nutritional potential (Bhatt et al., 2017; Dhyani et al., 2007; Rawat et al., 2018, 2011; Singh et al., 2016), thus can be promoted as nutraceutical for health improvement among rural populations.

CONTACT Dalbeer S. Parshwan dalbeerp3@gmail.com G.B. Pant National Institute of Himalayan Environment (GBP-NIHE), Almora India.

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Beneficial effects of the wild fruits on human health have been attributed to high fiber contents, vitamins, valuable secondary metabolites, and minerals along with antioxidant functions. The modern monotonous diet has resulted many health-related problems, while dietary diversity with wild edibles has attracted the attention of peoples and researchers for nutritional security and livelihood options. Wild edibles grown in stressful conditions at natural habitats forced accumulation of diverse secondary metabolites, which helped in improving physiological activities, besides nutritional requirement. Recent trends of food habit and preferences of consumer to diversified diets suggested consumption of wild edibles not only as diet but also as healthy and functional foods (Bhatt et al., 2017).

Indian Himalayan Region (IHR) is one amongst the biodiversity hotspots supporting a great diversity of wild edible fruits (675 species), with high nutritional value and anticipatory role against various diseases (Samant et al., 1998). Earlier studies have indicated the potential of wild edibles from IHR as an option for alternate foods (Andola et al., 2008; Bhatt et al., 2017; Dhyani et al., 2010; Maikhuri et al., 2004; Negi et al., 2011), but still large volume has not been well explored. Interest in underutilized wild edibles has grown significantly with the increasing awareness in linking biodiversity conservation with nutritional security and poverty alleviation (Negi et al., 2011). In this regard, wild edibles could be important reservoirs of nutrition and health promoting agents to fulfil requirement of poor people particularly in developing world.

Among many wild edibles of Himalaya, *Prinsepia utilis* Royle (family Rosaceae), *Prunus persica* L. (family Rosaceae) and *Neolitsea pallens* D.Don. (Lauraceae) found in subtropical to temperate region of Indian Himalayan Region within 1000–2500 m asl, are important oil yielding high value medicinal herbs used in traditional healthcare system (Gaur, 1999). The seed and kernels of these species have been used as a source of edible oil and for medicinal purpose by the marginal communities of western Himalaya. Seed kernels of *P. utilis* are medicinally important, and its fatty oil is been consumed in cooking in Himalayan region and some parts of China (Xu et al., 2007). Similarly, *P. persica* oil meals contained higher amounts of total phenolic and stronger antioxidant activities than regular oils, enabling their application as ingredients for functional or enriched foods (Wu et al., 2011). Among these, fatty oil of *N. pallens* has not been explored yet for chemical composition and biological properties. Besides, majority of oil-bearing plants grow in tropical and subtropical regions, these species mostly preferred subtropical to temperate region of western Himalaya. Despite having rich nutritional and economic potential, these plants have not been much explored. Therefore, the present study is an attempt to analyze the nutritional potential of seed/kernel portion of selected species to be linked them with nutritional security and livelihood options in the region.

**Materials and Methods**

In the present study, we have analyzed the seed/kernel portion of the selected species since the fruits of *P. utilis* and *N. pallens* are not edible, while literature indicates that seed/kernel of *Prunus persica* is a rich source of nutrients. Further, the field-based study indicates that the seed/kernel of all the selected species are used for oil extraction for long time in the region.

**Plant Material Collection and Plant Morphology Description**

The fresh, matured ripen fruits (~1 kg each) of *P. utilis*, *P. persica* and *N. pallens* were collected from healthy plants (i.e., 25 plants of each) from wild populations betweenJoshimath (lat. 30° 33’ 37” N; long. 79° 33’ 34” E) and Tapovan (lat. 30° 29’ 34” N; long. 79° 37’ 53” E) region of Chamoli District in Uttarakhand, Western Himalaya. Immediately after collection, the fruits were kept in airtight zip locked polythene bags and brought to the laboratory. Pulp of the fruits was removed and dried at room temperature in desiccator. The seed coats of the dried seeds were separated and edible parts (seed kernel) were used for nutritional composition, mineral analysis and isolation of edible oil. Seeds were chopped into small pieces for nutritional and mineral analysis.
Prinsepia utilis Royle is globous spiny shrub (1–5 m height) with grayish green branched stem, oblong to ovate-lanceolate leaves (3–5 cm long), racemes axillary inflorescence with white to yellowish flowers, and purplish brown to blackish purple fruits. Prunus persica (L.) is widely popular small-sized tree (3–10 m) for sweet and juicy fruits, and beautiful blossoms. It has long-lanceolate serrulate leaves (6–15 cm long); 1–2 together flowers, pink to red (3–4 cm across) with luscious fruits (5–8 cm long). Neolitsea pallens is a small tree (5–15 m tall), with young branchlets, yellowish brown, leafstalks alternate or clustered (3–5 nos.) toward tip of branchlet leaves, borne in umbels in leaf-axil flowers (up to 1 cm), thick bracteate, spherical (8 mm in diameter), and hairless, apiculate at the tip of yellowish brown fruits. The average fresh weight of mature fruit of P. utilis was 5.33 g and dry weight was 2.01 g. Fresh seed weight was calculated as 0.167 g. Similarly, the average fresh weight of mature fruit was 48.25 g and 11.42 g, respectively, for P. persica and N. pallens, respectively. The weight of seed was observed as 12.12 g and 2.21 g, respectively, for P. persica and N. pallens, respectively. The quantitative analysis of the seed kernels was broadly done for proximate and ultimate analysis. The seed oil was extracted using the electric mill and filtered with the help of a muslin cloth.

**Nutritional Composition**

The moisture, ash, crude fiber, crude protein, fat and carbohydrate contents in seed kernels were analyzed according to standard methods (AOAC, 1997). The moisture content of the fruits was determined by drying of powder material (5 g) in an oven at 105°C for 6 h. The ash content was determined by combusting the powder material (10 g) in silica crucibles in a muffle furnace at 625°C for 3 h (AOAC, 1997). The crude protein content of samples was determined by Macro-Kjeldal apparatus (Pelican Equipments, India). The digested material was neutralized after the addition of alkali. The released ammonia was collected in 4% boric acid. The boric acid contained the ammonia released from the digested material was then titrated against 0.1 N HCL. The crude protein was calculated by using factor 6.25 the value of nitrogen content. Crude fat in plant samples was determined by extracting a known weight of powdered plant material (10 g) with petroleum ether using Soxhlet apparatus at 80°C (AOAC, 1997). The carbohydrate content in the plant samples was estimated by Anthrone method (Andola et al., 2010). Briefly, 100 µL of the sample was added to 2 mL of 0.1% Anthrone prepared in concentrated H2SO4. The solution was well mixed for 1 min at room temperature, and the reaction mixture was incubated at 80°C in a water bath for 30 min under dark condition. The samples were cooled at room temperature before the absorbance was recorded at 625 nm using a spectrophotometer (U-2100, Hitachi, Tokyo). A calibration curve was prepared with different concentrations of glucose for quantification. Calorific values were estimated (in kcal/100 g) from carbohydrate, protein and fat contents following Dhyani et al. (2007) as:

Calorific values = (4 × Percentage of protein) + (9× Percentage of fat) + (4× Percentage of carbohydrate).

**Mineral Analysis**

Mineral elements (calcium, potassium, phosphorus, sodium, zinc, manganese, magnesium, lead, cadmium and iron) in dried seed kernels were determined using Atomic Absorption Spectrophotometer (Shimatzu AA-6300, Germany). The chopped samples (2.0 g) were mixed with 5.0 mL of distilled water, 25 mL of concentrated nitric acid and digested under reflux over a water bath at 90°C for 4 h. The refluxed solution was cooled and 10 mL of concentrated perchloric acid added. Concentrated hydrochloric acid (2 mL) was added to the samples and a final volume of 100 mL was prepared with distilled water. The digested samples were passed through atomic absorption spectrophotometer using different lamps, and calibrated for different micronutrients (Allen, 1989).
Edible Oil Isolation and Physical Properties Analysis

The dried seed kernels were used for extraction of fair amount of oil. The seed kernel oil was extracted using the electric grinding mill (OM-250, Buy beauty-Mierue, India) and filtered with the help of a muslin cloth. The specific gravity and solidification value of edible oil were determined following standard analytical methods. The iodine value (mg of iodine/100 g of oil) of the edible oil was determined by the method of Kates (1972). The saponification value (g of KOH/100 g of oil) of the edible oil was determined by the method described by Pearson (1976). Determination of unsaponifiable matter and acid value (g KOH/100 g of oil) was carried out following Pearson (1976).

Gas Chromatographic Analysis of Oil

Fatty acid composition was determined by conversion of seed kernel oil to fatty acid methyl esters followed by gas chromatography. Analysis of fatty oil was carried out on Gas Chromatograph (GC) Model-14B, Shimadzu, Japan loaded with software Class GC-10 (version-2.00). The GC was equipped with Flame Ionization Detector (FID) and stainless-steel column (dimension 10 X 1/8), packed with 5% DEGS-PS (0.32 mm internal diameter, 5 m length and 0.25 mm film thickness). The column was conditioned at 180°C about 2 h for attaining thermal stability before use. The operating condition was programmed at oven temperature 150°C (hold time 5 min) with increasing rate 8°C/min to 190°C (without initial hold time), 2°C/min to 200°C (hold time 10 min), injection temperature 250°C and detector temperature 250°C. Nitrogen was used as a carrier gas with flow rate of 20 mL/min. All the experiments were conducted in three replicates and the reported values were the averages of the individual runs and the inaccuracy percentages were less than 2% of the average value. Identification of the individual compounds of edible oil was based on comparison of their linear retention indices (RIs). Whenever possible, the identity of some compounds was confirmed by co-injection with pure standard compounds (under the same GC-FID conditions). For quantification purposes, relative area percentages obtained by FID were used without the use of correction factors.

Statistical Analysis

All determinations of nutritional attributes and mineral elements were conducted in five replicates along with separate extraction. Values for each sample were calculated as means ± standard deviation (SD) and were subjected to analysis of variance (ANOVA). Significant differences in mean values of analyzed parameters among different species were tested by Least Significant Difference (LSD) using Microsoft Excel 2007.

Results

Nutritional Composition and Mineral Elements

Seed kernels of target species showed the presence of all the dietary components in different concentrations (Table 1). In different analyzed parameters, a significant variation was recorded (p < .05) among target species (Table 1). The moisture content of seed kernels was found highest in P. utilis (7.36%), followed by P. persica (6.10%) and N. pallens (4.10%). Fat content was the major component in all the species and found as 70.40% in N. pallens, 48.00% in P. persica and 34.24% in P. utilis. Carbohydrate also made up a good amount in P. utilis (20.65%), P. persica (12.82%) and N. pallens (9.60%), and crude fiber was found higher in the seed kernel of P. utilis (14.57%) than others. Total protein content was highest in the seed kernels of P. persica (27.40%) followed by P. utilis (20.99%) and N. pallens (12.40%). However, total ash content was found highest in P. persica (2.30%) followed by (2.19%) and N. pallens (1.70%). Thus, based on all these parameters, maximum calorific value was observed in seed kernel of N. pallens (720 k cal/100 g), followed by P. persica (590 k cal/100 g) and P. utilis (475 k cal/100 g).
Table 1. Nutritional attributes in seeds kernel of selected wild edible oil yielding plants.

| Nutritional parameters | Prinsepia utilis | Prunus persica | Neolitsea pallens | LSD (p < .05) | f-value |
|------------------------|-----------------|----------------|-------------------|--------------|---------|
| Moisture (%)           | 7.36 ± 0.11     | 6.10 ± 0.00    | 4.10 ± 0.03       | 0.14         | 1724.50 |
| Total ash (%)          | 2.19 ± 0.05b    | 2.30 ± 0.05c   | 1.70 ± 0.04a      | 0.09         | 171.79  |
| Crude protein (%)      | 20.99 ± 0.11b   | 27.40 ± 0.4a   | 12.40 ± 0.24c     | 0.59         | 1767.97 |
| Fat (%)                | 34.24 ± 0.41b   | 48.00 ± 0.39b  | 70.40 ± 0.59c     | 0.94         | 4663.75 |
| Carbohydrates (%)      | 20.65 ± 0.86c   | 12.82 ± 0.39b  | 9.60 ± 0.66c      | 1.32         | 206.32  |
| Crude fiber (%)        | 14.57 ± 0.14c   | 3.38 ± 0.38b   | 1.80 ± 0.08a      | 0.47         | 2462.08 |
| Calorific value (k cal/100 g) | 475 ± 14.93a  | 590 ± 13.65b   | 720 ± 5.57c       | 24.17        | 289.53  |

Value are mean ± SD of three determinants, values with different letters in a row are significantly at (p < 0.05).

Table 2. Macro and micro mineral elements in seeds kernel of target species.

| Mineral elements | Prinsepia utilis | Prunus persica | Neolitsea pallens | LSD (p < .05) | f-value |
|------------------|-----------------|----------------|-------------------|--------------|---------|
| Iron (mg/100 g)  | 6.64 ± 0.26b    | 4.13 ± 0.12a   | 4.49 ± 0.17a      | 0.38         | 121.27  |
| Sodium (mg/100 g)| 14.80 ± 0.51b   | 3.31 ± 0.16a   | 3.50 ± 0.07a      | 0.62         | 1283.08 |
| Magnesium (mg/100 g) | 148.00 ± 4.58b | 201.00 ± 3.51c | 125.00 ± 2.52a    | 7.25         | 343.16  |
| Manganese (mg/100 g) | 1.51 ± 0.09b   | 0.87 ± 0.05a   | 1.74 ± 0.04c      | 0.13         | 152.29  |
| Phosphorus (mg/100 g) | 283.00 ± 5.51a | 337.00 ± 4.51c | 316.00 ± 7.64b    | 12.02        | 50.72   |
| Calcium (mg/100 g) | 31.20 ± 0.83a   | 50.00 ± 1.03c  | 40.60 ± 0.95b     | 1.89         | 296.25  |
| Zinc (mg/kg)      | 2.53 ± 0.06a    | 46.10 ± 1.65c  | 34.70 ± 0.37b     | 1.94         | 162.27  |
| Lead (mg/kg)      | 0.51 ± 0.06c    | 0.11 ± 0.01a   | 0.38 ± 0.08b      | 0.11         | 37.31   |
| Cadmium (mg/kg)   | 0.04 ± 0.01a    | 0.06 ± 0.01c   | 0.05 ± 0.01b      | 0.01         | 9.00    |

Value are mean ± SD of three determinants, values with different letters in a row are significantly at (p < 0.05).

The seed kernel of all the species was found rich in macro and micro nutrient composition, i.e., phosphorus, magnesium, calcium, sodium, iron, manganese, zinc, lead, cadmium and content of these elements varied significantly (p < .05) among the species (Table 2). The phosphorus and magnesium contents were found in significant proportion in all the species. In P. persica, higher content of magnesium (201.00 mg/100 g, phosphorus (337.00 mg/100 g), calcium (50.00 mg/100 g), zinc (46.10 mg/kg) and cadmium (0.06 mg/kg) content was recorded. Also, seed kernels of P. utilis were found rich of sodium (14.80 mg/100 g), iron (6.64 mg/100 g) and lead (0.51 mg/kg).

Physicochemical Properties of Seed Kernel Oil

Physicochemical properties were also determined in the extracted oil of the target species (Table 3). Specific gravity of oils was found between 0.91 (P. utilis) and 0.99 (P. persica). The iodine value was found maximum in P. persica 96.40%, followed by P. utilis (93.80%) and N. pallens (44.10%). Similarly, saponification number acid was ranged between 182.20 (P. utilis) and 237.60 (N. pallens). Unsaponifiable matter was observed higher in N. pallens (3.00%) and lower in P. utilis (0.47%). Acid value was observed as 1.0 in P. utilis and N. pallens, and 1.40 in P. persica. GC analysis revealed that the dominant fatty acids of these oils were unsaturated in N. pallens, while saturated in P. utilis and

Table 3. Physicochemical attributes in oil extracted from seed kernels of target species.

| Attributes            | Prinsepia utilis | Prunus persica | Neolitsea pallens | LSD (p < .05) | f-value |
|-----------------------|-----------------|----------------|-------------------|--------------|---------|
| Specific gravity      | 0.91 ± 0.04a    | 0.99 ± 0.01c   | 0.93 ± 0.02b      | 0.05         | 5.23    |
| Moisture (%)          | 0.27 ± 0.04a    | 0.70 ± 0.04b   | 1.30 ± 0.04c      | 0.07         | 568.58  |
| Iodine value          | 93.80 ± 2.55b   | 96.40 ± 1.51b  | 44.10 ± 1.37a     | 3.76         | 778.17  |
| Saponification value  | 182.20 ± 3.57a  | 193.70 ± 0.70b | 237.60 ± 5.05c    | 7.17         | 189.99  |
| Unsaponifiable matter (%) | 0.47 ± 0.03a  | 1.90 ± 0.05b   | 3.00 ± 0.27c      | 0.32         | 206.62  |
| Acid value            | 1.00 ± 0.02 a   | 1.40 ± 0.10 b  | 1.00 ± 0.01a      | 0.12         | 75.34   |

Value are mean ± SD of three determinants, values with different letters in a row are significantly at (p < 0.05).
Table 4. Fatty acid constituents (%) in oil extracted from seed kernels of target species.

| Fatty acid | Name                  | Prinsepiautilis | Prunus persica | Neolitseapallens |
|------------|-----------------------|-----------------|----------------|------------------|
| C10:0      | Capric acid           | nd              | nd             | 35.60            |
| C12:0      | Lauric acid           | nd              | 0.70           | 51.10            |
| C14:0      | Myristic acid         | nd              | nd             | 2.72             |
| C16:0      | Palmitic acid         | 18.90           | 5.85           | 1.04             |
| C16:1(ω-7) | Palmitoleic acid      | 0.43            | nd             | nd               |
| C18:0      | Stearic acid          | 4.70            | 1.45           | 0.18             |
| C18:1(ω-9) | Oleic acid            | 36.25           | 58.00          | 3.85             |
| C18:2(ω-6) | Linoleic acid         | 32.10           | 30.80          | 2.75             |
| C18:3(ω-3) | Linolenic acid        | 2.00            | 0.95           | nd               |
| C20:0      | Arachidic acid        | 0.38            | nd             | nd               |
| C22:1(ω-9) | Erucic acid           | 3.85            | 1.60           | nd               |
| C22:0      | Behenic acid          | nd              | 0.09           | nd               |
| MUFA       |                       | 40.53           | 59.60          | 3.85             |
| FUFA       |                       | 34.10           | 31.84          | 2.75             |
| SFA        |                       | 23.98           | 8.00           | 90.64            |
| Total      |                       | 98.61           | 99.44          | 97.24            |

MUFA – Monounsaturated fatty acids; PUFA – Polyunsaturated fatty acids; SFA – Saturated fatty acids; nd – not detected.

P. persica. The detailed composition of the oils is presented in Table 4. In oil of P. utilis, major constituent was oleic acid (36.25%), linoleic acid (32.10%) and palmitic acid (18.90%). Similarly, in P. persica, major constituents were oleic acid (58.00%) and linoleic acid (30.80%). However, in N. Pallens, major constituents of oil were lauric acid (51.10%) and capric acid (35.60%). The amount of unsaturated and saturated fatty acid was similar in P. utilis and P. persica. Also, mono and poly saturated fatty acid was in similar ration in P. utilis and P. persica; however, in N. Pallens, oil was dominated by saturated fatty acids (~90%).

Discussion

The growing attention to the sustainability of diets and nutritional systems highlights the greater role of biodiversity. Over 50% of the world’s daily energy requirement is fulfilled from three major crops, e.g., wheat, maize and rice (Jaenicke and Hoschle-Zeledon, 2006), and 12 species contribute 80% of total dietary intake (Bharucha and Pretty, 2010). Thus, wild foods can contribute significantly in the dietary diversity (Sundriyal and Sundriyal, 2003; Meda et al., 2008; Collier and Soedjito, 2008). Most of the wild edibles are known for their nutritional value and health benefits against various diseases (Andola et al., 2008; Dhyani et al., 2007; Maikhuri et al., 2017; Meda et al., 2008; Negi et al., 2011; Rawat et al., 2011). In the current study, seed kernels of these fruits found rich source of essential nutrient (fat, carbohydrate, protein, fiber and energy), minerals and fatty acids. In previous studies on Himalayan wild edible fruits, comparable content of fat (64.5%), carbohydrates (11.0%), and protein (15.6%) have been reported in seeds of Junlans regia (Sundriyal and Sundriyal, 2001). Also, nutrients and mineral content in seed kernels of these fruits were higher or comparable than most of the studied wild edible fruits of Sikkim Himalaya (Sundriyal and Sundriyal, 2001). Also, oil content has been reported between 6.12 to 67% in 32 species of oil seed-bearing wild edibles of Indian Himalaya and Dipoknena butyracea and Juglans regia were the species with >65% edible oil content (Jain et al., 1990). Similarly, in a previous report, Bacheti et al. (2012) found fatty oil as 44.3% in seed kernels dominated with oleic acid (73.58%) and linoleic acid (19.26%).

The chemical investigation of selected underutilized species in the present study clearly indicates that they are good source of essential fatty acids (e.g., linoleic and linolenic acids). The chemical components of P. utilis kernel oil (e.g., oleic acid 36.25%; linoleic acid 32.10%; palmitic acid 18.90%) and Prunus persica kernel oil (e.g., oleic acid 58.00%; linoleic acid 30.80%; palmitic acid 5.85%) suggested to have health and physiological benefits, which can be comparable with Mediterranean olive oil (Xu et al., 2007). α-Lipoic acid is an important fatty acid with potent antioxidant properties due to the presence of two sulfur molecules that can easily be oxidized or reduced. It acts as a cofactor...
for several important multi-enzyme complexes and catalyzes critical energy metabolism reactions inside the mitochondria. α-Lipoic acid is reduced to α-dihydrolipoic acid through the activity of enzymes present in the cells, which may prevent oxidative damage by interacting with potentially damaging ROS and RNS (Trigiani et al., 2006).

Generally, fatty acids with 18 carbon atoms and one to three double bonds were the most abundant components in seed oils examined in the present study. Oleic acid (C18:1), an omega-9 fatty acid, was recorded as a major monounsaturated fatty acid on P. utilis and P. persica. Humans generally possess all the enzymes required for the synthesis of oleic acid, thus is not essential for human body. Under severe conditions of essential fatty acids deprivation, mammals elongate and desaturate oleic acid to produce mead acid (C20:3) (Voet and Voet, 2004). Oleic acid is found in olive oil and is known for its effectiveness in reducing oxidation of cholesterol levels (Puiggros et al., 2002); decrease the blood pressure and cardiovascular diseases. Linoleic acid belongs to one of the two families of essential fatty acids, and human body cannot synthesize due to the lack of desaturase enzymes required for its production. A deficient intake of Essential Fatty Acids (EFA) can be responsible for many problems, such as dermatitis, immuno-suppression and cardiac dysfunctions (Burr et al., 1930). In addition to linoleic and α-linolenic acids, some of the essential metabolites belonging to omega-6 and omega-3 series were identified in this study. The omega-3 and –6 fatty acids are the biosynthetic precursors of eicosanoids, meaning that their intake concentrations will strongly influence eicosanoids production, and therefore, the organism’s metabolic functions (Borsonelo and Galduroz, 2008). Humans can synthesize other omega-3 fatty acids from linolenic acid, including eicosapentaenoic acid and docosahexaenoic acid. These omega-3 fatty acids can modulate the expression of a number of genes, including those involved in fatty acid metabolism and inflammation. They may regulate gene expression through their effects on the activity of particular transcription factors such as NF-κB and members of the peroxisome proliferator-activated receptor (PPAR) family (Trigiani et al., 2006). In addition, many works showed that these omega-3 fatty acids can decrease the total amount of fat in blood (cholesterol), thus reducing the risk of cardiovascular diseases (Connor, 2000).

Lauric acid was found as a major fatty acid in N. pallens (51.10%), which is also a primary fatty acid of coconut oil (45–53%). Lauric acid is rapidly metabolized because it is easily absorbed and is easily transported. Detailed studies have shown that the majority of ingested lauric acid is transported directly to the liver, where it is directly converted to energy and other metabolites rather than being stored as fat. The edible oil of the studied species may be important for the nutritionists and medical researchers due to its potential health benefits associated with the presence of important biochemicals and can be considered as potent nutraceutical due to presence of important bioactive compounds. In the Himalayan region, there are many such underutilized and unexploited plant species facing poor research and conservation efforts, while these could be rich source of nutrition and medicine (Maikhuri et al., 2004; Negi et al., 2011; Sundriyal and Sundriyal, 2003); hence can be utilized to fulfil the nutritional requirement of the people of the region.

Wild edibles and medicinal plants in the Himalayan region form an important constituent of traditional diets and also play a vital role in traditional healthcare system (Negi et al., 2018, 2011, 2020; Sundriyal and Sundriyal, 2003). Present study suggested that the seed kernels of all three species can be potential source to combat the hidden hunger of nutrient deficiencies in mountain region of western Himalaya. The nutritional value of P. utilis, P. persica and N. pallens provides an opportunity to harness the potential of these species for food value and medicinal utility. A number of wild edibles such as Hippophae salicifolia (Dhyani et al., 2010), Rhododendron arboreum, Aegle marmelos, Embelica officinalis (Maikhuri et al., 2004, 1994a; Negi et al., 2011, 2013), Myrica esculenta (Rawat et al., 2011), Spondias axillaris (Sundriyal and Sundriyal, 2003) and many more have begun to draw attention as one of the income-generating option to the rural economy, and also contributing significantly to nutritional and food security in the region (Maikhuri et al., 2017, 2004, 1994a). Considering this, it is important to rejuvenate the people’s interest in harnessing the full potential of such wild edibles. This study also indicates that all the selected species have potential for alternate food value and rural enterprise.
In the Western Himalaya, edible oil of *P. utilis*, *P. persica* and *N. pallens* has been used traditionally to cure joint pains, scabies, rheumatism and also for body massage. The oil cake of these species is used as nutritive feed to cattle’s for improving milk yield in the past (Maikhuri, 1995; Maikhuri et al., 1994b), but still not used commercially due to lack of scientific information. The oil and seed kernel of *P. persica* is also used as medicine in African countries since the plant reported to exhibit strong antifungal activity (Caccioni et al., 2002). Despite low or modest contributions to energy, wild foods accounted for a large portion of micronutrients consumed at a number of sites (Badhani et al., 2015; Bhatt et al., 2017). In Gabon (west coast of Central Africa), Blaney et al. (2009) reported 36% of total vitamin A and 20% of iron in the diet came from natural resources (wild foods); in Powell et al. (2015), reported 31% of retinol activity equivalent (vitamin A) and 19% of iron in the diet from wild foods; and, in a traditional Sweden agricultural community in the Philippines, wild foods contributed 42% of calcium, 32% of riboflavin, 17% of vitamin A and 13% of iron (Schlegel and Guthrie, 1973; Powell et al., 2015).

**Conclusion**

All the selected wild edible species in present study have been found rich in nutritional value and could be promoted for nutritional and nutraceutical development due to the presence of important bio-chemicals and essential fatty acids. The seed kernel of *P. utilis* was found rich in carbohydrate and fiber, while *P. persica* is rich in proteins and mineral ash. *Neolitseapallens* seed kernel is rich in fat and calorific value. Among the mineral elements, the level of iron, sodium and lead was high in *P. utilis*, while magnesium, phosphorus, calcium, zinc and cadmium were high in *P. persica*. There is need for the development of rapid, reproducible and economic techniques for the analysis of nutraceuticals from edible oil from selected wild species. The study indicated that wild edibles contribute substantially to nutritional security, health benefits and also offers livelihood opportunities in the western Himalaya. Therefore, sustainable harvesting of these species and promotion of plantation in different rehabilitation programmes is recommended. Further, detailed investigation in different aspects is warranted since the systematic research in these species is meager inspite of having high potential for nutritional security and livelihood opportunity.

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