



# Edible and Medicinal Pteridophytes of Nepal: A Review

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## Review

### Abstract

**Background:** Traditional use of pteridophytes as food and medicine is a common practice around the world. Many ethnic communities hold vast knowledge about the uses of pteridophytes and the documentation of such knowledge and biodiversity of edible and medicinal pteridophytes is important for health care, food security and conservation. Although being one of the biodiversity rich countries, the detailed use of edible and medicinal pteridophytes from Nepal is not well documented and they are one of the underutilized plant resources having vast potential. Thus, the aim of this review is to compile the knowledge about the use of edible and medicinal pteridophytes in Nepal.

**Methods:** Relevant information on traditional uses as medicinal and edible species were collected from published literatures such as research articles on ethnobotanical surveys, books, book chapters and conference proceedings.

**Results:** The literature survey revealed that a total of 26 species of pteridophytes were used as food and 43 species were used as traditional medicines. Among 55 useful species, 14 species were used as both food and traditional medicine. *Diplazium esculentum*, *Diplazium maximum*, *Dryopteris cochleata* and *Ophioglossum reticulatum* were common edible species and *Aleuritopteris albomarginata*, *Equisetum ramosissimum*, *Nephrolepis cordifolia* and *Tectaria coadunata* were common medicinal pteridophytes. Most of species are growing in natural habitat and the potential utilization species were sold in the market which has also supported livelihood. Some of these pteridophytes were also used in preparation of ethnic foods such as fermented foods and pickles.

**Conclusion:** Findings from the study suggested that only a few common species of pteridophytes are used as food and traditional medicines in Nepal. The knowledge about the traditional uses of pteridophytes and their biodiversity is also affected by socioeconomic changes in communities, lack of sharing of traditional knowledge through generations, improper collection practices and climate change. Very few pteridophytes from Nepal have been studied in detail for their phytoconstituents and biological activities and safety. Future research activities should focus on providing scientific evidence for traditional uses as well as development of proper conservation, cultivation, and product formulation methods in a sustainable manner.

**Keywords:** Conservation, ferns, fern allies, food security, human health

## Background

Pteridophytes are the transition group of plant between non-tracheophytes and spermatophytes. There are about 12,000 species of pteridophytes (ferns and lycophytes) found in the world (Christenhusz & Byng 2016). They are widely used as vegetables and traditional medicines, and for landscaping and horticulture in several part of the world (Benjamin & Manickam 2007, Ho *et al.* 2010, Liu *et al.* 2012, Minarchenko *et al.* 2017, Ranil & Bussmann 2021, Sarker & Hossain 2009). Edible pteridophytes are good sources of proteins, vitamins, crude fiber, and minerals (Chettri *et al.* 2018). They are rich in various phytochemicals such as steroids, terpenoids, phenolic acids and flavonoids among others. Various extracts and isolated compounds from ferns have also shown diverse biological activities (Bohm & Tryon 1967, Cao *et al.* 2017, Cerón-Carpio *et al.* 2019, Cui *et al.* 1993, Ho *et al.* 2010, Ueno *et al.* 1963, Watanabe *et al.* 2021).

Nepal is a small land lock country in south Asia with vast geographical variation and rich biodiversity. Recent publication reported the existence of 582 taxa (32 families, 99 genera, 550 species and 32 subspecies) of pteridophytes in Nepal (Kandel & Fraser-Jenkins 2020). In Nepal, ferns are distributed all over the country from east to west and low land Terai to high altitude Himalayas. Central Nepal of altitude about 2000 m harbors maximum species richness of the nation (Bhattarai *et al.* 2004). They are found in varied habitat like terrestrial, lithophytes, climbers, aquatic, epiphytes etc. and many ferns are also found in more than one habitat (Thakur & Rajbhandary 2018). Three volumes of book *Ferns and Fern Allies of Nepal* have provided detailed account on taxonomy, distribution, threaten status of pteridophytes of Nepal (Fraser-Jenkins *et al.* 2015, Fraser-Jenkins & Kandel 2019, Kandel & Fraser-Jenkins 2020). In these books, the distribution of pteridophytes in Nepal is divided into; low altitude (50–600 m), lower-mid altitude (600–1000 m), mid altitude (1000–1600 m), upper-mid altitude (1600–2200 m), higher altitude 2200–3000 m, high Himalayan (3000–5000 m) in elevation scale. Eastern Nepal being climatically richer zone for pteridophytes, greater numbers on distribution of pteridophytes are reported from central Nepal due confined collections to Central Nepal and Western Nepal has the lowest number of species recorded, due to dry climate (Kandel 2020). In general, the trend of species number decreases from the east to the west with an anomaly around Pokhara, Central Nepal (Fraser-Jenkins *et al.* 2015). Study made by Bhattarai *et al.* (2004) also suggests that high mountains of Himalayas are richer in fern species than the lower plains in Nepal. Three species of fern are endemic to Nepal viz. *Asplenium pseudofugax* Fraser-Jenk. & Kandel, *Bolbitis andreisii* Fraser-Jenk. & Kandel and *Polystichum annapurnicola* Fraser-Jenk. ex Thapa (Fraser-Jenkins *et al.* 2015, Fraser-Jenkins & Kandel 2019, Kandel & Fraser-Jenkins 2020).

There are various published articles based on the survey of medicinal and food uses of pteridophytes in the different parts of the world. For example, in China, 52 species of edible pteridophytes have been reported from ethnobotanical review (Liu *et al.* 2012). Similarly, 39 medicinal pteridophytes are reported from Ukraine (Minarchenko *et al.* 2017), 283 pteridophytes have been reported to have ethnomedicinal use in India (Sureshkumar *et al.* 2018), 61 medicinal pteridophytes are reported from Western Ghats of India (Benjamin & Manickam 2007), 51 species medicinal pteridophytes are reported from North-Eastern India (Benniamin 2011), 37 pteridophytes with traditional uses (food, medicine, ornament) are reported from Sri Lanka (Ranil & Bussmann 2021), 16 pteridophytes are reported to have traditional uses in Bangladesh (Sarker & Hossain 2009), and 36 species of medicinal pteridophytes are reported from Nigeria (Nwosu 2002).

In Nepal, many ethnic communities living in rural areas depend upon the natural resources for food and medicine in their daily life. Earlier there have been few studies undertaken to document the uses of pteridophytes in Nepal (Gurung 1979, Manandhar 1996, Tuladhar 2002). However, in recent times, no study focusing on ethnomedicinal use of pteridophytes has been reported. Although there has been significant amount of work on collection and taxonomy of pteridophytes from Nepal, not much attention has been given to their traditional use of food and medicine. Thus, the main aim of this review is to compile the knowledge about the use of edible and medicinal pteridophytes in Nepal based on published literatures such as research articles on ethnobotanical surveys, books, book chapters and conference proceedings.

## Traditional uses Pteridophytes as food and medicines

Various publications such as ethnobotanical field reports, book and conference proceedings have reported the food and medicinal uses of ferns in Nepal. The literature survey revealed that a total of 26 species of pteridophytes were used as food and 43 species were used as traditional medicines belonging to 20 families. Among them 14 species were used as both food and traditional medicine. The detailed list of these species is given in Table 1.

Table 1. List of reported edible and/or medicinal pteridophytes from Nepal

Family Scientific name [Synonym]	Local Name <sup>a</sup>	Uses <sup>b</sup>	Traditional uses
<b>Athyriaceae</b>			
<i>Athyrium atkinsoni</i> Bedd.	<b>niuro</b>	E	The young leaf of the plant is used as vegetable (Kandel 2020, Kandel & Fraser-Jenkins 2020).
<i>Athyrium strigillosum</i> (T. Moore ex Lowe) Moore ex Salomon	<b>niguro</b>	E	The young frond of the plant is consumed as vegetable by local people of Godawari, Lalitpur District (Fraser-Jenkins & Kandel 2019).
<i>Deparia boryana</i> (Willd.) M. Kato [ <i>Dryoanthyrium boryanum</i> (Willd.) Ching]	<b>kalo neuro, kali niguro, liuro, niuro, dhengan</b> (Tamang)	E/M	Tender shoots are used as food (Joshi & Joshi 2008, Rijal 2011, Rokaya <i>et al.</i> 2010). Root paste is applied externally to cure burns, injury, and wounds (Rokaya <i>et al.</i> 2010). Tender shoots are given in dysentery and rhizome is used in abdominal spasm (Rijal 2011). Leaf is used as medicine (Singh 2015).
<i>Diplazium esculantum</i> (Retz.) Sw. ex Schrader	<b>pani neuro, niguro, masino neuro, kuturke</b>	E/M	Tender shoot or fronds are consumed as vegetables (Joshi <i>et al.</i> 2007, Manandhar 2002, Ojha & Niroula 2021, Uprety <i>et al.</i> 2012). Rhizomes are used in the treatment of scabies and boils (Manandhar 2002), used as medicine (Bhagat & Shrestha 2010), the paste of leaf and stem is applied externally in treatment of cuts and wounds (Bhattarai & Khadka 2016).
<i>Diplazium kawakamii</i> Hayata	<b>niuro</b>	E	Tender shoots are used as vegetable (Kandel 2020, Fraser-Jenkins & Kandel 2019).
<i>Diplazium maximum</i> (D. Don) C. Chr.	<b>neuro</b>	E/M	Tender shoots are used as vegetable (Joshi <i>et al.</i> 2007, Rana <i>et al.</i> 2015). Young shoots are taken during stomach problem (Rana <i>et al.</i> 2015).
<i>Diplazium spectabile</i> (Wall. ex Mett.) Ching	<b>neuro</b>	E	Tender shoots are used as vegetable (Joshi <i>et al.</i> 2007).
<i>Diplazium stoliczkae</i> Bedd.	<b>kalo niuro, neuro, kalinyuro, bhandhengan</b> (Tamang)	E/M	Tender shoots are used as vegetable (Joshi <i>et al.</i> 2007, Rokaya <i>et al.</i> 2010, Shrestha & Dhillion 2006). The Juice of the tender leaf is given in treatment of diarrhea and dysentery (Malla & Chhetri 2009). The paste of roots is applied externally for the treatment of burns, injury, and wounds (Rokaya <i>et al.</i> 2010).
<b>Blechnaceae</b>			
<i>Stenochlaena palustris</i> (Burm. f.) Bedd		E	Young shoots are used as vegetables (Kandel 2020, Kandel & Fraser-Jenkins 2020).
<b>Cyatheaceae</b>			
<i>Cyathea spinulosa</i> Wall. ex Hook.	<b>chattre, rukh uniyu, thulo uniyu</b>	E/M	Young shoots of the plant are cooked as vegetable (Bhattarai & Khadka 2016, Kandel 2020). Young leaf of the plant is taken orally during excessive bleeding in menstruation (Bhattarai & Khadka 2016); the decoction of soft pith prepared in ghee is taken orally during fracture and body ache (Adhikari <i>et al.</i> 2019).
<b>Davalliaceae</b>			
<i>Davallia pulchra</i> D. Don. [ <i>Araiostegia pulchra</i> (D. Don.) Copel., <i>Katoella</i>	<b>mariesii</b>	M	Rhizome juice is taken orally to get relieve from body pain and to cool down the body temperature (Malla 2018).

<i>pulchra</i> (D. Don.) Fraser-Jenk., Kandel & Pariyar]			
<b>Dennstaedtiaceae</b>			
<i>Dennstaedtia appendiculata</i> (Wall. ex Hook.) J. Sm.	<b>lute sottar, masino unyu, shyaula tamda</b> (Tamang)	M	The juice of the fronds is applied to cuts (Shrestha & Joshi 1993).
<b>Dryopteridaceae</b>			
<i>Dryopteris cochleata</i> (D. Don) C. Chr.	<b>niguro, danthe neuro, rani neuro, lotah niuro, unyau, dhengan</b> (Tamang)	E/M	Tender shoots are used as vegetable (Joshi <i>et al.</i> 2007, Joshi <i>et al.</i> 2015). Leaf juice is used to treat muscular and rheumatic pain (Joshi & Joshi 2008). Young shoots are used as medicine (Aryal <i>et al.</i> 2009).
<i>Dryopteris splendens</i> (Hook. ex Bedd.) Kuntze	<b>danthe neuro</b>	E	The plant is used as vegetable in Dhahran, Eastern Nepal (Shrestha & Rai 2012).
<i>Polystichum squarrosum</i> (D. Don) Fée	<b>phusre neuro, thulo neuro</b>	E	The tender shoots are consumed as vegetable (Joshi <i>et al.</i> 2007, Joshi & Joshi 2008, Shrestha & Dhillon 2006).
<b>Equisetaceae</b>			
<i>Equisetum arvense</i> L.	<b>kurkure, middho</b> (Tamang)	M	The paste of roots is applied on wounds caused by thrones (Shrestha 1988). The whole plant with rhizome is used as medicine (Budha-Magar <i>et al.</i> 2020).
<i>Equisetum ramosissimum</i> Desf.	<b>akhle jhaar, harjor talchama</b> (Newari), <b>thongachhe</b> (Tamang)	M	The paste made from pounded dried plant is applied in bone fracture (Joshi <i>et al.</i> 2011). Tamang tribes of Makwanpur District apply ash of the whole plant for the treatment of scabies and burns (Joshi, 2014).
<b>Gleicheniaceae</b>			
<i>Diplopterygium giganteum</i> (Wall. ex Hook. & Bauer) Nakai [ <i>Gleichenia gigantea</i> Wall. ex Hook.]	<b>hade unyu</b>	M	The paste of the leaf is applied externally in the treatment of cuts and wounds (Bhattarai & Khadka 2016, Joshi <i>et al.</i> 2011).
<b>Lindsaeaceae</b>			
<i>Odontosoria chinensis</i> (L.) J. Sm. subsp. <i>chinensis</i> [ <i>Sphenomeris chinensis</i> (L.) Maxon]	<b>amaaro</b> (Majhi), <b>rato unyu, saano unyu</b>	M	The powder of leaf is inhaled to cure sinusitis (Shrestha & Joshi 1993). The paste of leaves is rubbed in the body swelling and feet sprain (Malla <i>et al.</i> 2015).
<b>Lycopodiaceae</b>			
<i>Lycopodiella cernua</i> (L.) Pic. Serm	<b>sano nagbeli</b>	M	Whole plant is used as medicine (Malla 2018).
<i>Lycopodium japonicum</i> Thunb.	<b>nagbeli, banmala</b>	M	The paste of the spore is used in cuts, wounds, boils, and cracked heels (Joshi 2014).
<b>Lygodiaceae</b>			
<i>Lygodium flexuosum</i> (L.) Sw.	<b>lahare unyu, janai lahara</b>	E/M	Tender shoots of the plant are used as vegetable (Bhattarai 2020). Plant ash is used to treat herpes (Dangol 2008). Whole plant is used in treatment of sprain, fracture, cuts and wound (Bhattarai 2020).



<i>Lygodium japonicum</i> (Thunb.) Sw.	<b>janai laharo,</b> <b>lute jhar, pinse</b> (Tamang), <b>Ukuse jhar</b> (Magar), <b>parewavuri</b> (Tamang, Bankaria)	E/M	Young leaves are used as vegetable (Joshi & Siwakoti 2012). Whole plant is used as medicine (Joshi <i>et al.</i> 2007, Luitel <i>et al.</i> 2014). Juice of the plant is applied in wound, boils and scabies, and the paste of the plant is applied to treat joints pain (Malla <i>et al.</i> 2015, Manandhar 1995a).
<b>Marsileaceae</b>			
<i>Marsilea quadrifolia</i> L.	<b>charpate behuli</b>	E	Tender shoots are used as vegetable (Joshi & Joshi 2009).
<b>Nephrolepidaceae</b>			
<i>Nephrolepis cordifolia</i> (L.) C. Presl [ <i>Nephrolepis auriculata</i> (L.) A. Rich]	<b>pani amala,</b> <b>bhui amala, ras</b> <b>amala, ambeli</b> (Tamang), <b>pani</b> <b>saro</b> (Majhi)	E/M	Tuberous roots are eaten (Luitel <i>et al.</i> 2014, Rijal 2011, Uprety <i>et al.</i> 2011). Tuberous root juice is used to treat fever, indigestion, cough, cold and headache (Aryal <i>et al.</i> 2009, Dhama 2008). The paste of leaf is used in itching; tuberous roots are eaten to cure hypertension and inflammation (Malla <i>et al.</i> 2015). Root paste is used to treat jaundice, boils, bone fracture and skin problems (Pradhan <i>et al.</i> 2020).
<b>Oleandraceae</b>			
<i>Oleandra wallichii</i> (Hook.) C. Presl	<b>jibre unyu</b>	M	The paste of rhizome is applied to forehead to relieve headache and in cases of bone dislocation & fracture (Malla 2018).
<b>Ophioglossaceae</b>			
<i>Botrychium lanuginosum</i> Wall. ex Hook. & Grev.)	<b>jaluko,</b> <b>bayakhra</b>	E/M	Shoots are also cooked as vegetable (Joshi <i>et al.</i> 2007, Singh 2015). The root paste is applied in treatment of boils on the tongue and applied on the forehead to relieve headache (Manandhar 1995b). Shoots are used in body ache (Singh 2015).
<i>Botrychium lunaria</i> (L.) Sw.	<b>harre jha</b>	M	Paste of the plant is applied in treatment of boils and cooked plants are prescribed to convalescent patients as a tonic (Bhattarai 1992).
<i>Botrychium multifidum</i> Trevis	<b>ruprecht,</b> <b>bayakhara</b>	M	The paste of root is applied on forehead to relieve headache; also used in treatment of blemishes on tongue (Manandhar 1986).
<i>Helminthostachys zeylanica</i> (L.) Hook.	<b>majur goda</b> (Chepang)	E	Tender shoots are used as vegetable (Rijal 2011).
<i>Ophioglossum petiolatum</i> Hook.	<b>jibre sag</b>	E/M	Fronds are used vegetable (Kandel 2020). The leaf is used to control bleeding from nose (Singh 2015).
<i>Ophioglossum reticulatum</i> L.	<b>ek patiya</b> (Tharu), <b>jibre dhap</b> (Tamang)	E	Leaves are used as vegetable (Bhagat & Shrestha 2010, Dangol 2008, Joshi <i>et al.</i> 2007, Uprety <i>et al.</i> 2012).
<b>Osmundaceae</b>			
<i>Osmunda claytoniana</i> L.		E	Leaves are used as vegetable in Dhunche, Rasuwa District (Joshi <i>et al.</i> 2007).
<b>Polypodiaceae</b>			
<i>Drynaria propinqua</i> (Wall. ex Mett.)	<b>uneu, hadjoda,</b> <b>kammari</b> (Majhi and Magar)	M	Rhizome paste is used in treatment of backache and dislocated bone (Malla <i>et al.</i> 2015, Tamang <i>et al.</i> 2017). It is also used to cure sprains and applied on forehead to get relieve from headache (Malla <i>et al.</i> 2015).

<i>Drynaria quercifolia</i> (L.) J. Sm.	<b>thatuma</b> (Rai)	M	The rhizome and frond paste are used in treatment of cuts, wounds and infections by Rai tribes of Pathari Municipality, Eastern Nepal (From author observation).
<i>Lepisorus bicolor</i> (Takedal) Ching	<b>dhule uniu</b>	M	A teaspoonful of leaf juice is taken orally twice a day (for 3-4 days) in the treatment of rheumatic pains (Bhattarai 1989).
<i>Lepisorus mehrae</i> Fraser-Jenk.	<b>bispech</b>	M	The plant is used in gastrointestinal disorders (Uprety <i>et al.</i> 2010). The powder of rhizome is used to treat back pain, stomach problems and fever (Pradhan <i>et al.</i> 2020).
<i>Lepisorus thunbergianus</i> (Kaulf.) Ching	<b>unyu</b>	M	Gurung tribes Parbat district uses juice of the plant, orally in the treatment of urinary tract infections, bacterial dysentery, chronic bronchitis, and rheumatism (Malla 2018).
<i>Loxogramme involuta</i> (D. Don) C. Presl	<b>parpare</b>	M	Gurung tribes Parbat district uses rhizome juice externally to treat cuts and wounds (Malla 2018).
<i>Polypodiodes amoena</i> (Wall. ex Mett) Ching	<b>bhiespaj</b>	M	Rhizome is used as medicine and sold in the streets of Kathmandu (Author's observation).
<b>Pteridaceae</b>			
<i>Adiantum capillus-veneris</i> L.	<b>pakhale unyu</b>	M	Leaf paste is used in headaches and chest pain; decoction of plant is taken in the treatment of whooping cough, throat, and bronchitis problems (Joshi & Joshi 2008). The whole plant is used as medicine (Bhagat & Shrestha 2010). Leaf paste is applied externally in cuts to prevent bleeding (Singh & Hamal 2013). Root juice is taken in migraine, snake bite and scorpion bite (Kunwar <i>et al.</i> 2008). A paste of plant is applied to the forehead to relieve headache and to chest to relieve chest pain. Juice of frond is mixed with honey and used for the treatment of cough (Manandhar 2002).
<i>Adiantum caudatum</i> L.	<b>uneu, ratijar, daluko, dan sinki, seto sinki, twasilwa</b> (Tamang)	M	About four tablespoons of decoction prepared from plant is given twice a day in case of gastric troubles (Manandhar 1993). Juice of the rhizome is used for the treatment of fever and indigestion (Manandhar 2002). Green leaves are used in skin infection, decoction of dried leaves is used for the treatment of cough and fever. Leaf juice is used for the treatment of diabetes (Joshi & Joshi 2008).
<i>Adiantum incisum</i> Forssk.		M	Frond juice is used to cure scabies (Joshi & Joshi 2008). The fronds are used as medicine (Bhagat & Shrestha 2010).
<i>Adiantum philippense</i> L. [ <i>Adiantum lunulatum</i> Burm. f.]		M	The whole plants are used as medicine (Bhagat & Shrestha 2010).
<i>Adiantum venustum</i> D. Don	<b>daluko</b>	M	Paste of rhizome is used in cuts and wounds (Manandhar 2002).
<i>Aleuritopteris albomarginata</i> (C.B. Clarke) Ching [ <i>Cheilanthes albomarginata</i> C.B. Clarke, <i>Cheilanthes dalhousiae</i> Hook]	<b>damini sinka, dankernu, dumni sinka, rani sinka, kalising</b> (Sherpa), <b>duwane sinka</b> (Tharu)	M	The juice of the leaves is used for the treatment of stomachache (Uprety <i>et al.</i> 2011). Two to three table spoons of frond juice is taken in treatment of gastritis (Thapa 2012). Rai tribes of Bhojpur District eat raw frond of the plant during snake bite (Rai & Singh 2015). The powder of rhizome is used to treat gastritis and stomach problems (Rana <i>et al.</i> 2015, Pradhan <i>et al.</i> 2020). The paste of the leaves is

			applied in cuts and wounds (Budha-Magar <i>et al.</i> 2020).
<i>Aleuritopteris anceps</i> (Blanf.) Panigrahi [ <i>Cheilanthes anceps</i> Blanf.]	<b>ranisinka</b>	M	Juice of the plant mixed with that of <i>Drymaria diandra</i> is used for peptic ulcer (Manandhar 2002). The shoots are used in abdominal spasm and wound (Rijal 2011). The leaf and stem of plant is boiled and consumed 3 times a day to cure case of stomach problems (Ambu <i>et al.</i> 2020).
<i>Aleuritopteris bicolor</i> (Roxb.) Fraser-Jenk. [ <i>Cheilanthes bicolor</i> Forssk.]	<b>dankernu, rani sinka</b>	M	The powder of whole plant is taken orally in sinusitis and applied in fever and cuts (Luitel <i>et al.</i> 2014, Tamang <i>et al.</i> 2017). The juice of the plant is taken during diarrhea, dysentery, and gastritis (Adhikari <i>et al.</i> 2019).
<i>Aleuritopteris rufa</i> (D. Don) Ching [ <i>Cheilanthes rufa</i> D. Don.]	<b>kane sinka, dub khando</b>	M	The juice of rhizome and frond is used in treatment of abdominal disorders, cuts, and wounds (Dhami 2008)
<i>Ceratopteris thalictroides</i> (L) Brongn	<b>dhaniya jhar, pani dhaniya</b>	E/M	Tender shoots are used as vegetables (Dangol 2008, Joshi & Joshi 2009). The leaves and roots are used as a poultice against skin complaints (Bhatt <i>et al.</i> 2021).
<i>Oeosporangium tenuifolium</i> (Burm.f.) Fraser-Jenk. & Pariyar [ <i>Cheilanthes teunifolia</i> (Burm. f.) Sw.]	<b>kaali sinkaa</b>	M	The paste of frond is applied on abscesses in the form of poultice to remove pus (Singh & Hamal 2013). The rhizome and roots of the plant is used as general tonic, anthelmintic for asthma (Bhatt <i>et al.</i> 2021).
<i>Pteris aspericaulis</i> Wall. ex J. Agardh	<b>mauro</b>	M	The paste of rhizome is applied in treatment of cuts, boils, and muscular swellings; the peeled rhizome fried in clarified butter is eaten for effective treatment backache (Manandhar 1990). Juice of rhizome is used in diarrhea and dysentery (Manandhar 2002).
<i>Pteris biaurita</i> L.	<b>dantheniuro, haaade unyu, kuthurke</b> (Raji)	E/M	Young leaves are consumed as vegetable by Raji tribes in western Nepal (Thapa <i>et al.</i> 2014). Newar, Chhetri, Tamang and Bankaria communities of Makawanpur District occasionally uses as wild vegetable (Joshi & Siwakoti 2012). The paste of frond is applied in treatment of cuts and wounds (Manandhar 2002). The Magar tribes of Palpa District uses leaves of the plant in cuts and wounds (Ale <i>et al.</i> 2009).
<b>Tectariaceae</b>			
<i>Tectaria coadunata</i> (Wall. ex Hook. & Grev.) C. Chr. [ <i>Tectaria macrodonta</i> (Fée) C. Chr.]	<b>niuro, kalo neuro, kalo kuthurke, toplign degni</b> (Tamang)	E/M	The young leaves are used as vegetables (Aryal <i>et al.</i> 2009, Dangol 2008, Joshi <i>et al.</i> 2007, Joshi <i>et al.</i> 2015, Luni <i>et al.</i> 2011) Root juice is used to treat diarrhea and dysentery (Adhikari <i>et al.</i> 2019). About 6 tablespoon of rhizome juice twice a day for 4 days is given in case of gastric trouble (Manandhar 1995a).
<b>Thelypteridaceae</b>			
<i>Thelypteris nudata</i> (Roxb.) C.V. Morton [ <i>Thelypteris multilineata</i> (Wall. ex Hook.) Morton]	<b>koche</b>	E	Young shoots are used as vegetables (Joshi <i>et al.</i> 2007).

<sup>a</sup>All these local names are in Nepali language unless explained in parentheses.

<sup>b</sup> E= edible, used as food, M-Medicinal

Photographs of some of these species are included in Figures 1-4. Pteridaceae is the largest family of pteridophytes with traditional uses (13 species) followed by Athyriaceae (8 species). According to *Ferns and Fern Allies of Nepal*

Vol. 1-3, Dryopteridaceae (110 species) is the largest family of pteridophytes in Nepal followed by Pteridaceae (92 species) in Nepal. Pteridaceae is also reported as the largest family of traditionally used species in India (Sureshkumar *et al.* 2018).

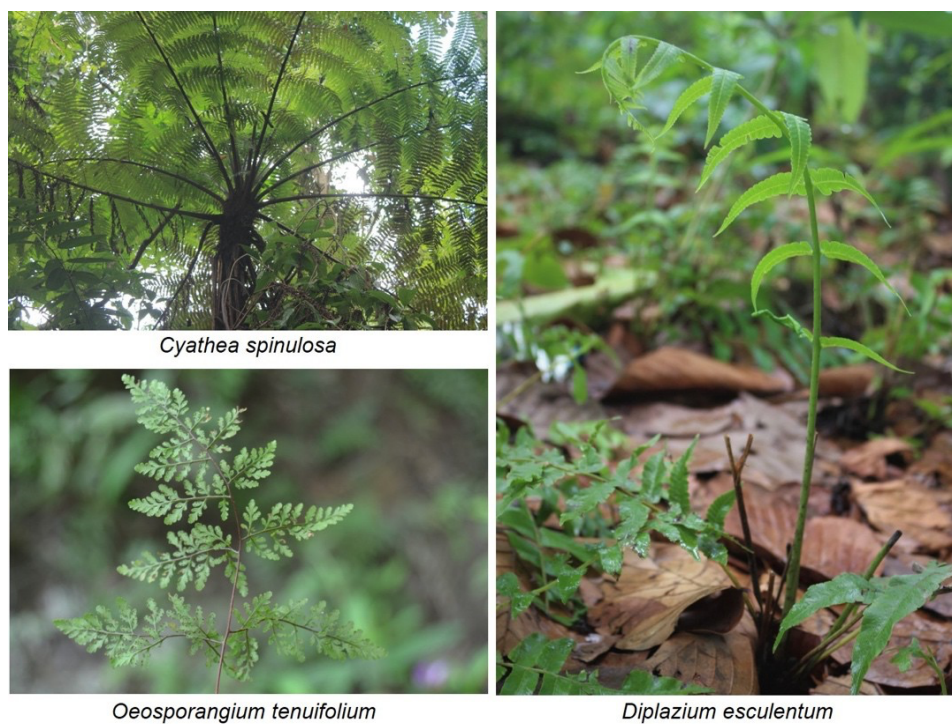


*Aleurites bicolor*

*Drynaria propinqua*

*Stenochlaena palustris*

Figure 1. Photographs of *Aleurites bicolor*, *Drynaria propinqua* and *Stenochlaena palustris*



*Cyathea spinulosa*

*Oeosporangium tenuifolium*

*Diplazium esculentum*

Figure 2. Photographs of *Cyathea spinulosa*, *Oeosporangium tenuifolium* and *Diplazium esculentum*



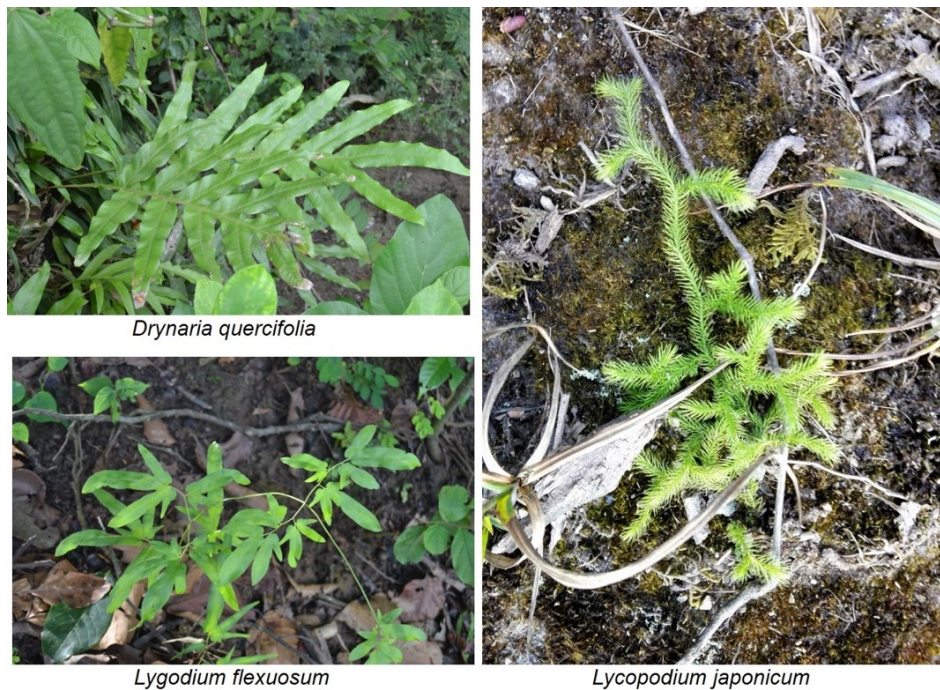


Figure 3. Photographs of *Drynaria quercifolia*, *Lygodium flexuosum* and *Lycopodium japonicum*

This study revealed that there is a treasure of knowledge about the food and medicinal use of pteridophytes in Nepal. *Diplazium esculentum*, *Diplazium maximum*, *Dryopteris cochleata* and *Ophioglossum reticulatum* are common edible species and *Aleuritopteris albomarginata*, *Equisetum ramosissimum*, *Nephrolepis cordifolia* and *Tectaria coadunata* are common medicinal species of pteridophytes. Although various studies have reported their use as traditional medicines, only a few studies have reported the dose, preparation method and duration of administration. In many published articles, these aspects of medicinal uses such as details of formulation process, dosage, duration, etc. are not reported. None of these studies report the possible toxicities or any precautions that should be taken when using them as vegetable or medicine. Ethnobotanical studies should report all these details about the edible and medicinal plants. Similarly, these reports only mention the traditional use for the treatment of some diseases or symptoms, but there is no reliable data or scientific evidence on their effectiveness.



Figure 4. Photographs of *Equisetum ramosissimum* and *Pteris biaurita*

There were some similarities and differences of use of edible and medicinal pteridophytes in Nepal and other countries. *Pteridium aquilinum* (L.) Kuhn is most common edible fern in China and Nigeria (Liu *et al.* 2012; Nwosu 2002). Several pteridophytes reported from Nepal such as *Asplenium unilateral* Lam., *Blechnum orientale* L., *Coniogramme intermedia* Hieron, *Coniogramme denticuloserrata* (Hieron.) R.D. Dixit & A. Das, *Matteuccia intermedia* C. Chr., *Osmunda japonica* Thunb., *Pteris wallichiana* J. Agardh, *Thelypteris prolifera* (Retz.) C.F. Reed,

*Woodwardia unigemmata* (Makino) Nakai are used as edible species in China. Similarly, *Cyathea gigantea* (Wall. ex Hook.) Holttum, *Hypodematium crenatum* (Forssk.) Kuhn, *Leucostegia truncata* (D. Don) Fraser-Jenk., *Microsorium punctatum* (L.) Copel., *Pityrogramma calomelanos* (L.) Link., *Psilotum nudum* (L.) P. Beauv., *Pteris cretica* L., *Pteris vittata* L., *Pyrosia lanceolata* (L.) Farw., *Lygodium microphyllum* (Cav.) R. Br., *Huperzia phlegmaria* (L.) Rothm., *Huperzia squarrosa* (G. Forst.) Trevis., *Thelypteris interrupta* (Willd.) K. Iwats, etc. are used as medicine in India and other parts of the world (Benjamin & Manickam 2007, Benniamin 2011, Liu *et al.* 2012, Minarchenko *et al.* 2017). Some of the species like *Athyrium atkinsoni*, *Athyrium strigillosum* are consumed as vegetable only in Nepal as per our knowledge.

Edible and medicinal pteridophytes in Nepal were found to be distributed in different geographical regions. In the same genus, species were found to be distributed from low altitude to high altitude. For example, *Athyrium atkinsoni* is high altitude vegetable fern; *A. strigillosum* is an upper mid altitude vegetable fern. *Diplazium esculentum* is common vegetable fern in lower to upper mid altitude; *D. kawakamii* and *D. spectabile* are mid to upper mid altitude vegetable ferns; *D. maximum* is upper mid to higher altitude vegetable fern and *D. stoliczkae* is higher Himalayan vegetable species. *Lygodium flexuosum* and *L. japonicum* are low to mid altitude edible and medicinal ferns. *Botrychium lanuginosum* is a mid to higher altitude vegetable and medicinal fern; *B. lunaria* high altitude to high Himalayan medicinal species and *Botrychium multifidum* is mid altitude to high Himalayan medicinal species. *Ophioglossum reticulatum* is low to mid altitude vegetable fern whereas *O. petiolatum* is an upper mid altitude vegetable and medicinal fern. *Equisetum arvensis* is low altitude medicinal fern whereas *E. ramosissimum* is a mid to high altitude fern. *Drynaria quercifolia* is low altitude medicinal fern whereas *D. propinqua* is mid to upper mid altitude medicinal fern. *Lepisorus bicolor* is a mid to high altitude medicinal fern whereas *L. mehrae* and *L. thunbergianus* are upper mid to higher altitude medicinal fern. *Adiantum capillus-veneris*, *A. incisum* and *A. philippense* are low to upper-mid altitude medicinal fern species; *A. caudatum* is low altitude medicinal fern species; *A. venustum* is upper-mid to high Himalayan medicinal fern species. *Aleuritopteris albomarginata* is upper- mid to higher altitude; *A. anceps*, *A. bicolor* and *A. rufa* are low to mid altitude medicinal species.

### Other uses as fermented/processed foods, cultural and ritual uses

Dried fermented food (**gundruk**) is prepared from *Ophioglossum reticulatum* in Dolakha district (Shrestha & Dhillion 2006). Tendrils of *Dryopteris cochleata* are used in making pickle (**achar**) (Acharya & Acharya 2010).

Apart from the traditional use as food and medicinal value some pteridophytes *Polystichum lentum* (D. Don) Moore is used in animal bedding, *Equisetum diffusum* is used as fodder (Toba 1975). The fronds of *Gleichenia gigantea* is used as fuel and mulching (Joshi & Joshi 2008). *Lygodium japonicum* (**nagbeli**) is used for religious purpose by Magar and Majhi especially in "Sauane sakranti" and in decoration of gates during weeding and other celebration, in decoration of Rato Machindra nath chariot of Patan (Kandel, 2020, Malla 2018). Stipe of *Aleuritopteris bicolor* is used to plug ear-piercing holes (Gyawali *et al.* 2021). *Selaginella involvens* (Sw.) Spring is used in Hindu ceremony "Satta nara" and in decoration of gate (Toba 1975) and women use spore powder as substitute to vermilion powder (sindoor) (Manadhar, 1996).

### Market value of pteridophytes in Nepal

Literature survey reveals that at least 11 species of pteridophytes are sold in market as vegetable. *Diplazium esculentum*, *Helminthostachys zeylanica* and *Ophioglossum reticulatum* are sold in local markets of Western Nepal (Rajbhandari *et al.* 2015). *Diplazium esculentum*, *Diplazium maximum*, *Diplazium spectabile*, *Diplazium stoliczkae*, *Dryopteris cochleata*, *Dryoanthyrium boryanum*, *Polystichum squarrosus* and *Tectaria coadunata* are sold in market in Central Nepal (Joshi *et al.* 2007, Joshi & Siwakoti 2012, Shrestha 1988) and three species such as *Dryopteris cochleata*, *Dryopteris splendens* and *Tectaria coadunata* are sold in market in Eastern Nepal (Shrestha & Rai 2012). They are important wild plants for income generation in rural area and for food security. Indigenous communities like Chepang also are involved in trade of ferns like *Dryopteris cochleata* for income (Luni *et al.* 2011). Spore of *Lycopodium japonicum* is traded from Nepal to China (Chapagain *et al.* 2021). Till now no practices of cultivating useful pteridophytes have been reported, neither the potential of wild species for supporting local economy is estimated. These pteridophytes are harvested from wild without any consideration of their sustainable use thus overharvesting is creating challenges for conservation. The edible ferns can also help to overcome nutritional deficiency especially in hilly areas (Chettri *et al.* 2018).

## Threatened edible and medicinal pteridophytes in Nepal

Many ferns of traditional use such as like *Adiantum caudatum*, *Botrychium lunaria*, *Cyathea spinulosa*, *Helminthostachys zeylanica*, *Ophioglossum petiolatum* and *Stenochlaena palustris* are threatened and rare in Nepal (Fraser-Jenkins *et al.* 2015, Fraser-Jenkins & Kandel 2019). While considering ferns for medicinal value and food security, conservation about them is also important.

## Chemical constituents and biological activities of pteridophytes from Nepal

Phenolic acids, flavonoids, steroids, and their derivatives are commonly reported from ferns of different families (Bohm & Tryon 1967, Cao *et al.* 2017, Cerón-Carpio *et al.* 2019, Cui *et al.* 1993, Ueno *et al.* 1963). Phytoecdysteroids are also reported from various species of ferns (Cao *et al.* 2017, Dinan 2001, Hu *et al.* 2014). *Huperzia* is potential medicinal lycophyte of the Himalayas. The alkaloids present in the plant such as huperzine A and huperzine B are used in the treatment of various neurological diseases such as Alzheimer's disease (Yumkham *et al.* 2016). *Huperzia squarrosa* is important medicinal and ritual pteridophytes in Manipur, India this species is also traded in that area (Yumkham & Singh 2013). Along with the 7 species of *Huperzia*, *Huperzia squarrosa* is also present in Nepal but no report of medicinal uses and trade of the species is recorded.

There have been only a very few studies related to chemical analysis and pharmacological activities of medicinal and edible ferns of Nepal. Thapa *et al.* (2013) analyzed the total phenolic content, total flavonoid content and antioxidative activity of extract of *Diplazium stoliczkae*. Shrestha *et al.* (2019) performed the phytochemical fingerprinting and bioactivity analysis of the twigs and rhizomes of *Tectaria coadunata*. Flavonoids such as procyanidins, eriodoetyl glycosides and luteolin glycosides were identified as major compounds. The extracts also showed antioxidant and cholinesterase and tyrosinase inhibitory activities.

Pteridophytes used in Nepal for edible and medicinal purposes should be studied in detail for their major chemical constituents and biological activities. Identification of major compounds can help in designing protocols for the identification and quality control of the marketed species. Both the extracts and isolated compounds should be studied to evaluate their biological activities and to elucidate the mechanisms of actions. Pharmacological studies based on traditional uses can support to provide scientific evidence for their traditional uses as medicines.

## Safety and toxicity concerns of pteridophytes

Mostly, young leaves (fronds) of ferns are consumed as vegetables and rhizomes and leaves are used as traditional medicines. Many fern species, such as Bracken fern (*Pteridium aquilinum*) are reported to be toxic and carcinogenic due to presence of a carcinogenic compound, ptaquiloside (Potter & Baird 2000, Rasmussen *et al.* 2013, Virgilio *et al.* 2015). Ptaquiloside has also been reported from the milk of cows, sheep and goats grazing on *Pteridium aquilinum* (Virgilio *et al.* 2015). Great care should be taken for proper identification of wild fern species when collecting for food and medicinal purposes. Similarly, the processing of these species for their use as food and medicines should be properly documented. Any toxicities observed should be properly documented and such information related to possible toxicities should be properly communicated to local people.

## Conclusions

In this review, the available ethnobotanical information about the traditional knowledge of medicinal and edible uses of pteridophytes in Nepal is compiled. Many species which are used for medicinal purposes were also used for food values. However, there has not been any ethnopteridological study in Nepal that deals specifically about the traditional uses of ferns and fern allies. The knowledge of useful pteridophytes and their biodiversity are neglected in Nepal and available knowledge is also affected by socioeconomic changes in communities, sharing of knowledge through generations, etc. On the other hand, only a very few scientific studies have been carried out on the chemical constituents and pharmacological activities of pteridophytes collected in Nepal. There are no studies reported from Nepal regarding the safety and toxicity of commonly consumed pteridophytes which needs urgent attention. The nutritional values of edible species should be studied and for the medicinally used species, there should be extensive studies to identify the active chemical constituents and their pharmacological activities. Only a few species are sold in the markets which are mostly collected from wild. The unsustainable collection practices lead to the decrease in natural population, thus there should be initiatives for conservation and cultivation in collaboration with communities. Such practices can help in income generation and economic empowerment of local communities. The multidisciplinary collaboration is necessary for performing scientific studies related to useful pteridophytes of Nepal regarding their biodiversity conservation, sustainable utilization, and product developments.

## Declarations

**List of abbreviations:** Not applicable.

**Ethics approval and consent to participate:** Not applicable.

**Consent for publication:** This paper does not include any individual person's data and further permission for publication is not required.

**Availability of data and materials:** The data was not deposited in public repositories.

**Conflict of interests:** The authors declare that they have no competing interests.

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