



## A REVIEW ON NUTRITIONALLY RICH WILD VEGETABLE DIPLAZIUM ESCULENTUM

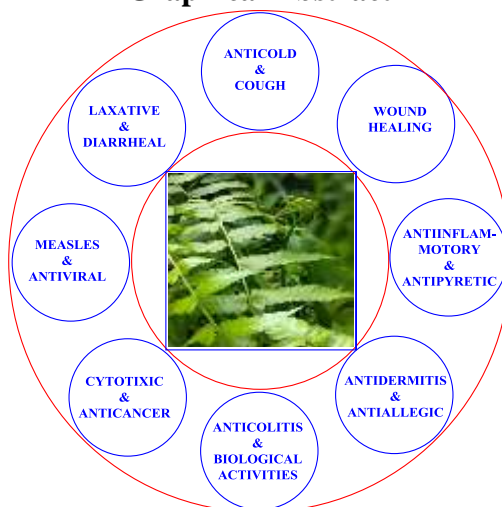
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### Graphical Abstract



### Traditional and medicinal uses of *Diplazium esculentum*

#### Abstract

Since the beginning of time, tribal cultures have used various wild species for food and medicine. Given the significance of such bioresources, attempts have been made to identify wild species based on their significance for the security of food, nutrition, and medicine. The green wild fern *Diplazium esculentum* was the subject of this study's analysis of knowledge and value in terms of food plants. These wild food plants are used as both medicines and a significant component of the indigenous diet. With a vegetarian diet high in proteins and carbs, it is also a significant source of vitamins and micronutrients. Such a meal is included in traditional knowledge. Curry is made with fresh leaves and bulbs; leaves that have been dried are used as a seasoning and medicinal. To improve nutrition security, this vegetable might be further promoted for increased commercialization. It is also strongly recommended that additional research be done on the creation of cultivation techniques for this wild vegetable.

**Keywords:** Traditional foods, *Diplazium esculentum*, Vegetable fern.

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### 1. Introduction

Herbs and the goods made from them were in high demand globally. Herbs are used extensively in modern medicine to prevent, cure, and control a wide range of illnesses and infections. These conventional or natural medicines were gathered from wild sources [1-4], although certain medicinal plants are now grown for commercial purposes. Some of these plants are also useful as food. It has long been known that traditional medicine can be used to maintain excellent health [5-7]. Alternative medicines and healthcare supplies have been made from traditional medicine. These plants produce provitamins, phytochemicals, and nutritional supplements that help people stay healthy and fight sickness. These provided evidence

that natural products are valuable sources and resources for the development of new drugs [8–10]. *Diplazium* species grow on humus-rich forest floors between 900-2500 m and are found in Nepal, Sri Lanka, Myanmar Japan, Malaya, China, and India particularly, Uttarakhand, Himachal Pradesh, Sikkim, Darjeeling, and Meghalaya also. *Diplazium* Family Contains 400 species, but probably 29 species and 2 varieties are reported in India [11-12]. Some common varieties are included *D. hymenodes*, *D. molokaiense*, *D. lonchophyllum*, *D. australe*; *D. dietrichianum*; *D. pycnocarpon*; *D. melanochlamys*; *D. sibiricum*, *D. dilatatum*; *D. lobulosum*; *D. Frondosum*; *D. Spectabile*; *D. squamigerum*; *D. subsinuatum* and *D. esculentum*.



**Figure 1.** Picture of vegetable fern *Diplazium esculentum* (Retz.) Sw.

*Diplazium esculentum* (Retz.) Sw. Syn- *Asplenium esculentum* (Athuriaceae or Dryopteridaceae) is a vegetable fern indigenous to Thailand and also found throughout Asia and Oceania (Table 1). In India it is generally found in low altitudes of the Kumaon Himalayas, Himachal Pradesh, Sikkim, and swamps of the Garhwal region, growing abundantly along water channels and wetlands. *D. esculentum* is sometimes grown as a house plant. The rhizome is thick, stout, ascending, clothed with brown colored, margin toothed, black, thick, and cartilaginous (Fig.1). This is considered of high economic value

amongst the natives of Tehri hills Uttarakhand, India. It is known as paco in the Philippines, and linguda in northern India, referring to the curled fronds. This plant can attain an average height of 0.5 to 2.5 meters and is eaten as ‘ulam’ or green edible leaves, usually consumed with hot sauce. Greek root is diplazein meaning double. Few species extended into temperate areas [13-20]. The rhizome of the *Diplazium* genus varies from creeping to erect and is scaly. Its fronds are deciduous or evergreen, are trophopodic, and are either monomorphic or weakly dimorphic. The stipe is green, deeply grooved from above, and is either scaly or glabrous.

**Table 1.** Scientific classification of *Diplazium esculentum* Synonyms: *Athyrium esculentum*

Kingdom	Plantae	Season	March- December
Division	Pteridophyta	Edible parts	Young fronds
Class	Pteridopsida	Mode of Consumption	Vegetables, Curry, and sauces
Order	Blechnales	Description:	Arching fronds, usually only five or six in number, on a

			dark trunk a few inches in length.
Family	Athyriaceae	Soil Type	Use good rich potting soil (soil that retains water yet drains well).
Genus	Diplazium	Watering	Keep the soil on the wet side. Use warm water.
Species	Diplazium. esculentum	Fertilizer	Feed monthly spring through fall with a water-soluble fertilizer. An alternative is a granular slow-release fertilizer if applied annually in the early spring.

The young fronds are stir-fried as a "vegetable" or used in salads. They may have mild amounts of fern toxins but no major toxic effects are recorded. Fresh leaves and bulbs are used along with potato for the preparation of curry; dried leaf is used as medicine and condiment. Fresh immature fronds are wiped with a cloth to remove red petiolar hairs and boiled. Boiled fronds are cut and fried in cooking oil with spices. Fern shoots for consumption are obtained

from *D. esculentum* is not known to have these anti-nutritional qualities, so it can be eaten freely [21-23].

#### Phytochemicals:

Extractive and qualitative chemical analysis of leaves of *D. esculentum*:

Successively leave extracts with petroleum ether, chloroform, acetone, methanol, and water respectively, their extractive values were noted (Table 2).

**Table 2.** Extractive values of the leaves of *Diplazium esculentum* in different solvents

Solvent	Extractive value in %	Extraction time in hr
Petroleum ether	1.48	12-15
Chroloform	2.4	12-15
Acetone	1.72	08-10
Methanol	8.62	10-12
Water	11.12	11-13

Preliminary phytochemical analysis on the whole plant of *D. Esculentum* showed the presence of steroids, triterpenoids, saponins, phenolic

components, flavonoids, carbohydrates, and proteins but alkaloids are absent (Table 3) [24].

**Table 3.** Qualitative chemical analysis of leaf extracts of *Diplazium esculentum*

Phytochemical Screening	Pet. Ether	Chloroform	Acetone	Methanol	Water
Alkaloids	-	-	-	-	-
Carbohydrate	-	-	+	+	+
Steroids	-	-	-	+	+
Phenolics and Tannins	+	+	+	+	+
Amino acids and Proteins	-	-	-	+	+
Fixed oils	-	-	-	-	-

*D. esculentum* contained isolated a glycoside, eriodietyl 5-O-methyl ether 7-O- $\beta$ -D-xylosylgalactoside. It isolated a new triterpene acid named esculentic acid I, flavanone glycoside, eriodictyol-5-O-methyl ether-7-O- $\beta$ -D-xylosylglactoside. *D. esculentum* contains various phenolic acids such as protocatechuic acid and syringic acid. Plants gave tetratriacontanol, tetratriacontanoic acid and  $\beta$ -sitosterol- $\beta$ -Dglycoside, maslenic acid, and a new triterpene acid

named as esculentic acid, protocatechuic acid and syringic acid, The structure of esculentic acid a new triterpene acid has been established as 2 $\alpha$ ,3 $\alpha$ , 23-trihydroxyurs-12-en-28-oic acid by chemical and spectral method. Mean values (mg/100g) of calcium, iron, manganese ion, copper, and sulfur were 146.92, 7.92, 303-12, 2.39, and 400.45 respectively (Table 4). The oxalate and condensed tannin composition averaged 8.69 and 0.37% respectively [24-28].

**Table 4.** Chemical Composition and Nutritional Value of *D. esculentum* (Sikkim Edible wild plant)

Moisture %	% On a dry matter basis				mg/100g		
	Ash	Fat	Protein	carbohydrate	Na	K	Ca
93.1 (92.3-93.9)	18.8 (17.4-18.8)	29.0 (18.5-19.6)	37.7 (36.7-38.7)	14.5 (14.0-15.2)	8.1 (7.4-8.4)	927.4 (871.5-968.0)	200.5 (200.0-201.0)

### Ethnobiology and Pharmacology

India is an area with great biological diversity where the tribal peoples greatly depend on wild food resources. This wild plant is an essential source of nutrients and vitamins, as well as much seasonal dietary variety. Since time immemorial useful plants have been handled by human societies for medicinal and food purposes. Today, most human plant food is based on a rather limited number of crops, it is clear that in many parts of the world, the use of wild plants is not negligible [29-32]. Changing social values, and depopulation of rural areas have led to erosion of traditional knowledge. Many publications have emphasized the diversity and value of traditional vegetables. The nutritional value of traditional leafy vegetables is higher than several known common vegetables. Consumption of traditional diets known to these societies is said to have many beneficial effects such as prevention of some age-related degenerative diseases—arteriosclerosis, stroke, etc [33-36] Despite these advantages, most traditional plant foods are generally uncultivated, and underutilized. Wild foods are considered by the local inhabitants in the region as a necessity rather than as a supplement and are eaten frequently. While several studies were conducted to document the diversity of resources and their ethnobotanical uses [37-40], very few studies prioritized the species of local importance and quantified their availability. The purpose of the present study was to document plant species consumed as traditional and leafy vegetables. *D. esculentum* is mainly used as a wild vegetable and rarely used as a medicinal herb. Dried fronds are reported to be the preferred animal bedding material during winter. It is common for households to collect this leafy vegetable during their visits to various places such as grazing lands, forests, crop fields, and watercourses for grazing the animals, collecting fuel or fodder, tending the crop fields or collecting water, etc. This leafy vegetable does not any special processing for cooking or consumption, though removal of stings from nettle and hairs from fronds of vegetable fern could be specific requirements. This leafy vegetable is prepared like spinach and eaten as a form of stew or cooked in edible oil with salt and spices [41-45].

### Medicinal Properties and Edible Uses:

#### Ethnomedicinal uses

The Apatani tribe of Arunachal Pradesh, India uses the frond of *Diplazium esculentum* plant as medicine for constipation. It has been shown that the local

inhabitants of Similipal Biosphere Reserve, Orissa, India used to take honey with decoction of boiled water extract of *D. esculentum* on an empty stomach twice a day for 15 days to cure spermatorrhea. The natives of Adi tribe of Dehang-Debang Biosphere Reserve of Arunachal Pradesh, India use the boiled young fronds of *D. esculentum* as vegetables with boiled rice for laxative purposes. In the Kolli hills of Eastern Ghats, Tamil Nadu, India, the natives use handfuls of *D. esculentum* leaves to make juice taken orally twice a day to get relief from colds and coughs. Moreover, the local people of this region use the frond parts of this plant as laxatives and are often used to treat colitis and constipation. The local people of Manokwari, West Papua Province use this plant for wound healing and as an ailment of headache. In a Sudanese community in Indonesia, *D. esculentum* is used for the treatment of fever, dermatitis, and measles.

#### Uses of *D. esculentum* as food

*Diplazium esculentum* is one of the most common varieties and the most commonly consumed fern throughout Asia and Oceania. In India, young fronds of *D. esculentum* are popularly known as lingra in Northern India, rukja and lochanch in North Eastern India, and dhecki sak in West Bengal, India. The newly emerging coiled fronds are consumed after cooking as a seasonal vegetable during the monsoon season which continues for almost five months. The front of this fern is generally cooked in oil or butter; using them in a vegetable curry is less preferred. In northeastern India, especially in Sikkim, and in the central and north-western Himalayan states of India, the local folk relish both vegetables and pickles from *D. esculentum*. Natives consider these recipes effective both to counteract constipation and as an appetizer, especially as a pickle. A study conducted in the villages of the Parvati Valley, Himachal, India revealed that out of the 50 consumed wild edibles, *D. esculentum* is used as a vegetable/pickle by an average of 66% of the inhabitants. In Malaysia, this plant is eaten as 'ulam' or green edible leaves, usually consumed with hot sauce. This practice of eating 'ulam' with sauce is also known as 'krawoo' [46-49]. The leaves of *Diplazium esculentum* (Retz.) Sw. are used as vegetables and the dried rhizome is used as an insecticide. The crude ethanol extract showed marginal anticancer activity. A decoction is used for the cure of hemoptysis and cough. It is also sometimes recommended as a tonic. Pharmacological investigations on the crude ethanolic extract of *D.*

esculentum found marginal anticancer activity. It determined the antioxidant activity of vegetable shoots and the cytotoxic effect of ethanol extract against different cancer cell lines and the extracts did not appear to have potential as anticancer agents for colon and liver cancers. Feeding of *D. esculentum* by calves at 5 kg fern/calf/day, for about 30 days after fern feeding. The calves showed a significant decrease in hemoglobin, blood, glucose, plasma, ascorbic acid, serum, thiamine, and calcium and a marked increase in blood pyruvic acid and serum acid phosphates. The level of phosphate and creatine were not much affected. Antimicrobial and cytotoxic activities carried out on the ethanol extract of *D. esculentum* (Retz.) Sw. against 6 pathogenic microorganisms, showed antimicrobial activity with minimum inhibitory concentration and minimum lethal concentration values in the range 100-800 and 400-800 5 g/ml. respectively. Leave extracts of *D. esculentum* exhibited antioxidant activity and central nervous system stimulant effect in mice. Aqueous extract showed maximum antioxidant power than other organic extracts. It is concluded from this study that the fronds of *D. esculentum* contain a rich source of phytonutrients (primary and secondary metabolites, antioxidants, and essential minerals), which ensure food and nutritional security in the dietary practices of humans. The mature fronds may contain other bioactive pharmaceuticals as well that will be best suited for commercial exploitation for healthcare value-added products. However, further research on suitable agronomic strategies including the conservation of this wild edible fern and its effective propagation techniques is essentially required for its sustainable use in ensuring the health security of rural and tribal communities. Though these wild edible ferns are not available year-round, their dried fronds can be processed and stored for later consumption in the form of some products like pickles, soup, etc. These laguna-based processed products may act as good supplements in diet and can also be encouraged to provide seasonal employment to rural and tribal communities. The outcome of the nutraceutical analysis of the fronds of this underutilized fern is expected to create interest in the consumption of local traditional vegetables for nutritional and health security [50-55].

## **2. Discussion**

India is a biodiversity hotspot, with a diverse range of habitats from temperate forests to coastal marshes and from tropical rain forests to alpine vegetation. Wild resources have advantages that cannot be disregarded. Thus, all of the information about the nutritious contents is drawn from the written word. The majority of edible wild plants provide significant levels of vital nutrients, especially for diets that are typically strong in proteins and starches. Even though

the majority of herbs are used medicinally, they also serve as leafy vegetables, which gives them additional value while also making them very appealing and significant to their users. Essential green vegetables are provided by wild edible herbs. This highlights the importance of herbs in peoples' diets. We acknowledge that gathering, preserving, and documenting this knowledge is essential for facilitating the exploration of new food sources worldwide as well as for preserving regional cultural traditions. It is especially impressive how often plants are used both as food and as medicine. The research on non-crop food plants may be helpful in the creation of such goods in the context of rising interest in foods or nutraceuticals [55–58]. The *D. esculentum* leaf extracts, which have the largest concentrations of flavonoid and phenolic components, had the highest antioxidant activity. Antioxidants are helpful for several degenerative illnesses and conditions, including cancer, heart disease, declining immune function, and aging. Free radicals are the primary cause of food deterioration through lipid oxidation, which ultimately impairs the organoleptic qualities and edibility of foods, in addition to harming live cells. Free radicals are frequently produced as byproducts of biological processes or as a result of foreign elements. It benefits much because it is a vegetable in many regions of the world. To fully understand the function of *D. esculentum* extracts and learn more particular biochemical, pharmacological, and molecular characteristics of the targeted compounds therein that may have the biggest effects on society, more research is needed [59–62].

## **3. Conclusion**

According to research, *D. esculentum* wild fern is a "good and healthy food." Traditional knowledge is an implicit or tacit sort of knowledge that individuals possess and use but rarely verbalize. Additionally, it is localized because it can only acquire a specific position through experience and practice within a specific social setting. Understanding the value of wild edible herbs to locally unrecognized economies and, consequently, the networks of tactics utilized mostly by households in distant locations for their livelihoods, which are largely devoid of formal markets, is largely dependent on the monetization of these herbs. The survey demonstrates that the majority of families use a wide variety of uncultivated species as green vegetables. These methods have been successful in addressing vitamin and micronutrient deficits. Numerous regions of the world have reported on the adoption of new status symbols, dietary attitudes, and appetites. It is unknown which dietary components are to blame for this link due to the complexity of food composition, although antioxidants seem to be a crucial factor in the protective effect of plant foods.

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