



## Nutrients Analysis of *Diplazium esculentum*: Underutilized Wild Wetland Pteridophytes Ensure Food and Nutritional Security

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### Abstract

Food and nutrition (hidden hunger) for rapidly growing global populations (expected to increase 10 billion by 2050) are major concern of public health issue in most of the global developing countries. One way to tackle these problems is through the intervention of local traditional less-explored high-value food crops as dietary supplements for ensuring food and nutritional security. The *Diplazium esculentum* (Retz.) Sw (also called as 'Vegetable fern' or 'Liguna'; fam. Athyriaceae) is an underutilized wild wetland pteridophytes occurring commonly throughout world, from sea level to 2,300m. The young frond and rhizomes of *D. esculentum* are generally used as green vegetables during the monsoon season, which are reported to possess notable nutritional and medicinal properties. This research article highlights the detailed nutritive phytochemical (primary and secondary metabolites, essential mineral content, dietary fibres, calorific value etc) profiling of young fronds of *D. esculentum*. Our results suggest that *D. esculentum* fronds contains rich amounts of protein (52.3%), carbohydrate (28.2%), antioxidants (Vitamin C etc) and exceptionally high contents of important minerals (Ca, Fe, Na), dietary fibre (17.44%) with good calorific energy value (324 Kcal/100 gm). The overall results suggest that, the young fronds of *D. esculentum* contains rich source of phyto-nutrients that may be commercially utilized for the development of healthcare value added products as a sustainable solution to the health and nutritional security.

**Keywords:** *Diplazium esculentum*; Edible Ferns; Food and Nutritional Security; Phytonutrient Analysis; Therapeutic Phyto-Constituents; Traditional Vegetables; Wetland Pteridophytes

### Abbreviations

AOAC: Association of Official Analytical Chemists; MUFA: Mono Unsaturated Fatty Acid; NABL: National Accreditation Board for Testing and Calibration Laboratories; PUFA: Poly Unsaturated Fatty Acid; WHO: World Health Organization

Food and nutritional security are presently two foremost problems being faced worldwide. Mineral and protein deficiencies in human populations are one of the greatest health concerns for several developing countries that causing approximately 462 million adults is underweight and around 45% of deaths among children under 5 years of age are linked to malnutrition (WHO, 2017). To meet this challenge, use of local less-explored, nutritionally rich

traditional vegetable crops as dietary supplement for improving mineral and protein deficiencies is advocated [1,2]. In India, from ancient past we have the rich tradition of using local traditional plants with medicinal properties as food as well as in therapeutic diseases [3]. Due to wide range of geographic expansion India is rich in biodiversity thereby providing a rich source of plants with different therapeutic activities waiting to be explored. Especially the wet lands are areas with immense biodiversity, which are yet not properly evaluated for therapeutic plant resources. Several Pteridophytes growing in these wet lands attained very fewer attention of scientific community in spite of having high nutritional and medicinal values [4]. In this effort, the *Diplazium esculentum* (Retz.) Sw. (English name is 'Vegetable fern' and locally called as 'Li-

guna'; fam. Athyriaceae) is an important wild edible pteridophyte occurring commonly throughout world, which grows in gregarious colonies in open marshy areas, stream banks and canals from sea level to 2,300m [5]. Young frond and rhizomes of *D. esculentum* are generally used as green vegetables by tribal population, which is reported to possess notable nutritional and medicinal properties [6,7]. Moreover, consuming as vegetable, *D. esculentum* has been reported to have profound use as traditional medicine in diseases like fever, dermatitis, measles, dysentery, glandular swellings, indigestion, anthelmintic, analgesic, diabetic, diarrhoea and various skin infections [5,8-10]. Apart from nutritional and medicinal values, liguna is highly adaptive to wet and marshy land and can efficiently withstand various biotic and/or abiotic stresses. These properties thus on the whole make it as excellent model as local traditional high value vegetable crop for addressing health and nutritional security (hidden hunger) issues of growing world population. The detailed nutrient analysis of young fronds of *D. esculentum* has not been carried out so far. The present research work is an attempt to evaluate detailed nutritive phytochemical (primary and secondary metabolites, essential mineral content, dietary fibres, calorific value etc) analysis of young frond of liguna.

The naturally grown fronds of liguna were collected from its natural habitat as Urgam valley (2200m asl), Distt. Chamoli, Uttarakhand during rainy season in 2019 year (Figure 1a-1c). The mature fronds were thoroughly cleaned with deionized water and chopped into small pieces of size (1 - 2 cm<sup>2</sup>) followed by sun drying for 1 week for reducing moisture content (Figure 1d). Completely dried fronds sample was powdered in grinder before nutritive phytochemical analyses.

The phyto-nutrients (primary and secondary metabolites) were determined as per the standard biochemical methods described by the Association of Official Analytical Chemists (AOAC) [11-13]. Mineral analysis was carried out after digestion of 2g of the grounded sample with 10 mL of a mixture of nitric acid, sulphuric and perchloric acid (4:1:1, v/v) until a clear solution was obtained. The digest was allowed to cool and then transferred into a 100 mL volumetric flask and made up to mark with de-ionized water. The mineral elements like sodium, calcium and iron were analysed using atomic absorption spectrophotometer (Perkin Elmer) equipped with air-acetylenes flame. The total dietary fibre and calorific values of samples was estimated according to the study conducted by Pandey, *et al* [14]. All phytochemical analysis was performed in replicates and data (average) obtained were also

verified for genuineness by third part evaluation by reputed NABL accredited lab (EKO PRO Engineers Pvt. Ltd, Ghaziabad).



**Figure 1:** *Diplazium esculentum* (a) mature fern growing in natural habitat of URGAM valley, Distt. Chamoli, Uttarakhand; (b) mature wild fern under sprouting; (c) harvested fronds for marketing as local traditional vegetable; and (d) harvested chopped fronds samples for phyto-nutrient analysis.

The young fronds of liguna contains significant higher amount of total protein (52.3%) and carbohydrate (28.2%) as primary metabolites, however, the total sugar and fat content was found low with values of 0.86 and 0.25%, respectively. The fatty acid profiles including MUFA, PUFA, trans fat, saturated fat and cholesterol content was found negligible in fronds of liguna (Table 1). Liguna fronds also contains good amount of secondary metabolites viz. total phenol, tannin and flavonoids content that improves its nutritional value as vegetable as suggested by Tongco., *et al* [15]. The presence of phenolic and flavonoids contents of liguna fronds may be correlated to their antimicrobial activity [7]. Among antioxidants, Vitamin C contents was found maximum (46 mg/100g), which is in accordance with Zannah., *et al* [16]. However, Vitamin A and D content was found negligible (Table 1). Among essential minerals, the liguna fronds contain exceptionally higher amount of calcium (Ca), iron (Fe) and sodium (Na) contents with values of 12.25, 10.71 and 1.18 mg/100g, respectively. The young fronds of liguna also contains good amount of total dietary fibre content (17.44%), which is good for health as suggested by Veena and Christopher [3]. The total calorific energy of fronds was found (324.13 Kcal/100 gm) that suggest its importance as high value vegetable (Table 1).

S. No.	Nutrient parameters	Mature fronds of <i>D. esculentum</i>
1.	Total protein (%)	52.31
2.	Carbohydrate (%)	28.15
3.	Total sugar (%)	0.86
4.	Total fat (%)	0.25
5.	Fatty acid Profile: MUFA (%)	BLQ*
6.	Fatty acid Profile: PUFA (%)	BLQ*
7.	Fatty acid Profile: Saturated fat (%)	BLQ*
8.	Fatty acid Profile: Transfat (%)	BLQ*
9.	Cholesterol (mg/100g)	BLQ*
10.	Total phenol (mg GAE /100 g FW)	0.56
11.	Tannin (mg TAE/g FW)	0.12
12.	Flavonoids (mg QE/100 g FW)	0.16
13.	Vitamin C (mg/100g)	46.0
14.	Vitamin A (mg/100g)	BLQ*
15.	Vitamin D (mg/100g)	BLQ*
16.	Sodium (mg/100g)	1.18
17.	Calcium (mg/100g)	12.25
18.	Iron (mg/100g)	10.71
19.	Total Dietary Fibre (%)	17.44
20.	Energy (Kcal/100g)	324.13

**Table 1:** Phyto-nutrients analysis of fronds of *Diplazium esculentum*.

\*BLQ: Below Limit of Quantification.

## Conclusion

It is concluded from this study that the fronds of *D. esculentum* contains rich source of phyto-nutrients (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 conservation of this wild edible fern and its effective propagation techniques is essentially required for its sustainable use in ensuring health security of rural and tribal communities. Though this wild edible ferns are not available year round, but its dried fronds can be processed and stored for later consumption in form of some products like pickle, soup etc. These liguna based processed products may act as good

supplement in diet and can also be encouraged to provide seasonal employment to rural and tribal communities. The outcome of nutraceutical analysis of fronds of this underutilized fern is expected to create interest for consumption of local traditional vegetables for nutritional and health security.

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## Conflict of Interest

The authors declare that they have no conflict of interest.

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