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Nutritional and Health Benefits of Diplazium esculentum: A Review of the Himalayan Edible Fern

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Abstract

The genus *Diplazium* within the family Athyriaceae includes around 350 species of pteridophytes. Among these, *Diplazium esculentum* (Retz.) Sw., widely recognized as a wild vegetable, holds particular significance in the Himalayan and sub-Himalayan regions. Literature analysis reveals that *D. esculentum* has traditionally been utilized to prevent or treat a variety of ailments, including diabetes, smallpox, asthma, diarrhea, rheumatism, dysentery, headaches, fever, wounds, pain, measles, hypertension, constipation, oligospermia, bone fractures, and glandular swellings. Various extracts of *Diplazium esculentum* have been evaluated to uncover their phytochemical profiles and pharmacological activities. The species exhibits a range of bioactive properties, including antioxidant, antimicrobial, antidiabetic, immunomodulatory, central nervous system stimulant, and antianaphylactic effects across different plant parts. This review presents a systematic examination of the pharmacognosy, phytochemistry, and pharmacological applications of *D. esculentum* . However, comprehensive scientific assessment regarding its full therapeutic potential, toxicity, and safety in humans remains incomplete. Published literature on D. esculentum and its therapeutic benefits was gathered using search engines such as Wiley Online, PubMed, Springer Link, Scopus, ScienceDirect, Web of Science, Google Scholar, and ACS Publications, with search terms like *Diplazium esculentum*, bioactive compounds," "biological activities," and "health benefits" spanning the period from 1984 to March 2021. Further research is needed to elucidate the detailed mechanisms of D. esculentum 's bioactivity both in vitro and in vivo, along with increased studies focused on its conservation, cultivation, and sustainable use.

Key Words:*Diplazium*,Athyriaceae, Phytochemical studies, Pharmacological potential

1. Introduction

Pteridophytes, a group of vascular land plants that includes ferns and their allies, are thought to have evolved during the Silurian and Devonian periods and later became the dominant plant group in the Carboniferous period. Globally, there are approximately 12,000 species of pteridophytes (Dixit 2000). Ethnomedicine and phytopharmacology have highlighted the therapeutic potential of pteridophytes, demonstrating their effectiveness in treating various ailments, including respiratory, digestive, and skin issues, thanks to the bioactive compounds present in these plants. Their antioxidant, antimicrobial, and anti-inflammatory properties have also garnered significant interest among researchers. *Diplazium*, a large genus within the family Athyriaceae, comprises over 350 species worldwide (Schuettpelz *et al.* 2016). The genus *Diplazium* is widely distributed across various global

regions, thriving in habitats like moist forests, shaded slopes, and stream banks in tropical and subtropical countries. Traditionally, *D. esculentum* has been used for treating a range of ailments (as shown in Figure 1) such as Different communities in India and other countries use *D. esculentum* to treat various conditions, including diabetes, smallpox, asthma, diarrhea, rheumatism, dysentery, headaches, fevers, wounds, pain, measles, high blood pressure, constipation, oligospermia, bone fractures, glandular swellings, and skin disorders (Abe *et al.*, 2013, Zannah *et al.*, 2017).

2. Taxonomic Description

Most species of *Diplazium* are terrestrial, with stems that are usually upright and sometimes creeping, bearing scales at their tips. The leaves are predominantly monomorphic, occasionally dimorphic, with a lamina that can range from simple to 1–4-pinnate pinnatifid, either smooth or with fine hairs. The veins are free, and sori grow in pairs, positioned "back-to-back" along each vein and covered by an indusium. Early researchers coined the term "diplazioid" to describe sori arranged "back-to-back" on both the acroscopical and basiscopic sides of a vein—a characteristic of this genus. Sori are typically oblong to linear, straight or slightly curved, occurring singly or in pairs, with indusia that are linear, laterally joined, and persistent. The spores are brownish, ellipsoidal, and monoletic, with surfaces that vary from smooth, reticulate, or papillate to spiny between the folds, and the wings are usually broad. The base chromosome number is x = 40, 41.

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Additionally, several Diplazium species are known to reproduce apogamously (Rothfels et al. 2012, Sundue et al. 2014).

Kingdom : Plantae
Division : Pteridophyta
Class : Polypodiopsida
Order : Polypodiales
Family : Athyriaceae
Genus : *Diplazium*

3 Ethnobotanical Importance

Numerous species within the genus *Diplazium* are documented in literature for their use among various tribal and ethnic groups worldwide. These communities have utilized different species of this genus as remedies for conditions such as infertility, parasitic infections, cancer, diabetes, inflammation, rheumatism, and liver

protection. For both food and medicinal purposes, various plant parts, including the rhizome and fronds, are used in diverse ways.Various Diplazium species are consumed as vegetables worldwide, valued for their distinctive flavor, which contributes to many culinary traditions. In Jeram Kedah village, locals use the young fronds and petioles of *Diplazium esculentum* (Retz.) Sw. and D*iplazium* speciosum Bl. as vegetables. (Ong et al. 2012).). Local residents in Baler, Aurora, Philippines, use *D. esculentum* (Retz.) Sw. and D. molokaiense Robinson as food (Barrogo et al. 2021). Among the indigenous peoples of the Malay Peninsula, D. *esculentum* is consumed both as a vegetable and as a tonic following childbirth. (Tharmabalan 2023). The Adi tribe natives of the Dehang Debang Biosphere Reserve in Arunachal Pradesh, India, consume the boiled young fronds of *D. esculentum* as a vegetable with boiled rice for its laxative effects (Kagyung et al., 2010).

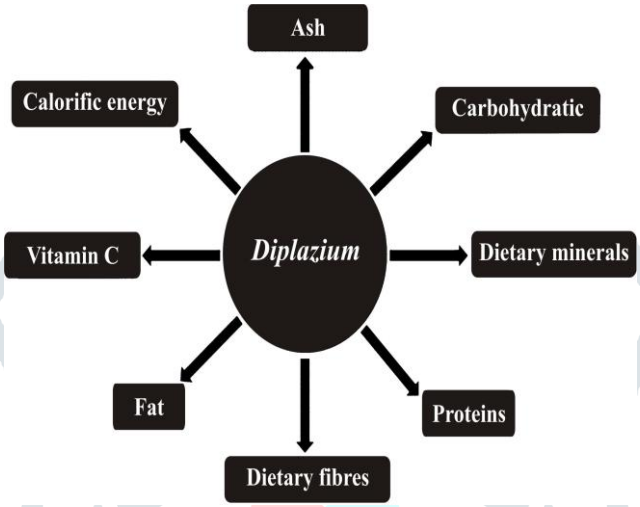

Figure: Nutritional factors present in *Diplazium* species.

4 Therapeutic Properties of D. esculentum

4. 1. *Phytochemical Composition of D. esculentum*

D. esculentum is recognized for its diverse array of phytochemicals, which include alkaloids, anthraquinones, anthranol glycosides, cardiac glycosides, cyanidins, flavonoids, glucosides, leucoanthocyanins, phenolic compounds, phytosterols, saponins, steroids, tannins, and terpenoids. (Das *et al.*, 2013, Tongco *et al.*, 2014). The bioactive compounds found in this fern include esculentic acid, 5-O-Methyleriodictyol 7-O-(4-O-D-xylosyl)-β-D-galactoside, pterosin B, ptaquiloside, lutein, phosphoric acid, phytol, 2,6,10-trimethyl,14-ethylene-14-pentadecene, hexadecanoic acid methyl ester, pentadecanoic acid, Stigmasta-5,22-dien-3-ol acetate, (3beta), beta-ocimene, 1,2-benzenedicarboxylic acid, BIS(2-Methylpropyl)ester, 1-heneicosanol, 5,8,11,14-eicosatetraenoic acid methyl ester (all Z), ergost-5-en-3-ol (3beta), and stigmast-5-en-3-ol (3beta).(Tandon *et al.*, 1980)

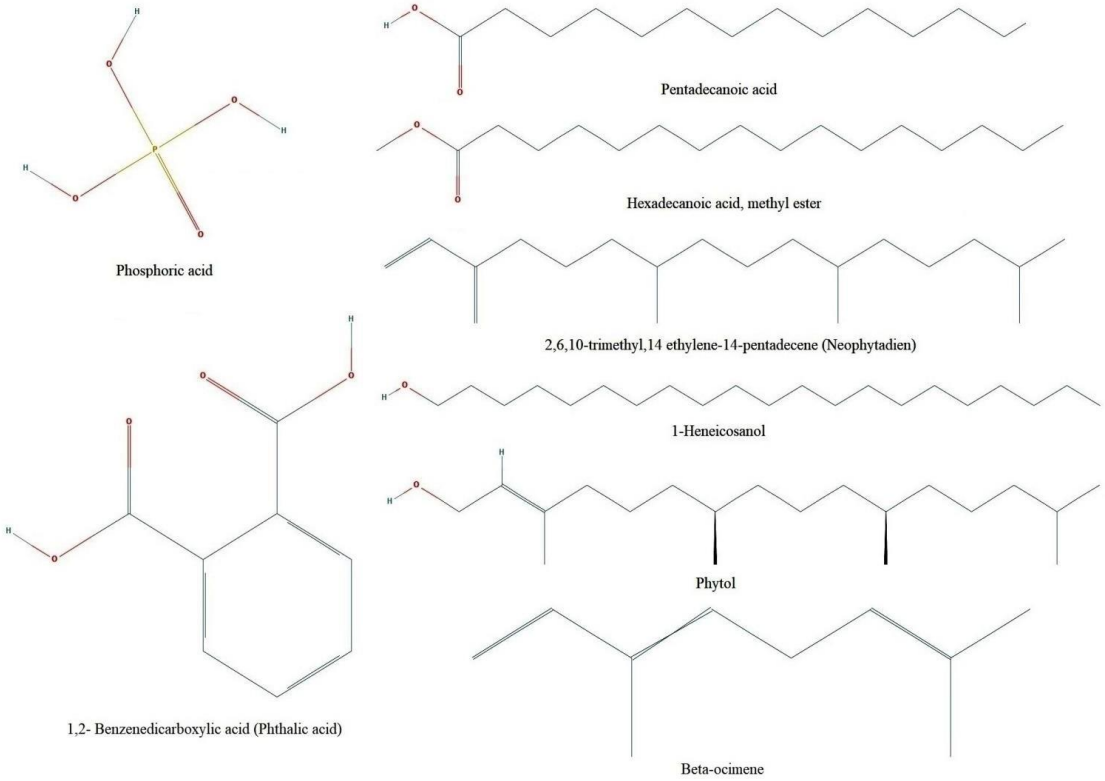

Figure - 2: Bioactive principles in *D. esculentum*

4.2 Antioxidant Properties and Free Radical Scavenging Activities of D. esculentum

Oxidative stress in the liver was evaluated by measuring the antioxidant enzymes catalase and reduced glutathione in Wistar rats. The results showed that administering a hydroalcoholic extract of *D. esculentum* significantly lowered lipid peroxidation levels. Additionally, the levels of the antioxidant enzymes, specifically catalase and reduced glutathione, were significantly reduced in a dose-dependent manner, highlighting the strong antioxidant potential of D. esculentum (Junejo *et al.*, 2018). The methanolic extract of *D. esculentum* demonstrates scavenging activities against various reactive oxygen species (ROS) and reactive nitrogen species (RNS), including hydroxyl radicals, superoxide, hydrogen peroxide, singlet oxygen, hypochlorous acid, nitric oxide, and peroxynitrite. Additionally, the extract functions as an iron chelator and exhibits reducing power, as well as the ability to inhibit lipid peroxidation. Furthermore, *D. esculentum* is noted to contain significant levels of flavonoids and phenolic compounds. Both of these classes of compounds exhibit strong antioxidant potential and have notable effects on human nutrition and health (Roy *et al.*, 2013a).

4.3 Larvicidal Properties of D. esculentum Against Mosquitoes

The strong larvicidal activity of the methanol extract of *D. esculentum* was initially noted against Culex larvae. The larvicidal activity was assessed using third or fourth instar Culex larvae. An LC50 value of 149.279 ppm suggests that the methanolic extract of D. esculentum is an effective larvicidal agent. (Halimatussakdiah *et al.*, 2018). The crude ethanolic extract of the aerial parts of D. esculentum was tested against third instar larvae of Anopheles gambiae and Culex quinquefasciatus , revealing a significant larvicidal effect. Higher mortality rates were observed in both mosquito species as the concentration of the extract increased. The extract demonstrated greater potency against A. gambiae larvae. This variation in susceptibility may be due to the differing physiological characteristics of the two mosquito species. (Umohata *et al.*, 2020).

4.4Central Nervous System Stimulant Activities

The impact of D. esculentum on cognitive function has been evaluated.(You *et al.,* 2020). A total of 132 individuals participated in this cross-sectional study, where anthropometric measurements, dietary history, meal frequency, cognitive performance, and sociodemographic data were assessed. The results indicated that D. esculentum offered a protective effect of 62.9% against cognitive decline. The methanolic isolate of D. esculentum was evaluated for its ability to inhibit NADH oxidase and exhibit anticholinesterase activity (Roy *et al.,* 2015). Recent studies have shown that inhibiting anticholinesterase activity is an effective strategy for treating neurodegenerative diseases.

5. Conclusion

D. esculentum has persisted since the Paleozoic era and has adapted to a much broader range of environmental changes. As a result, it is expected to possess more beneficial chemical constituents compared to other plants. This review concludes that the fronds of D. esculentum are an excellent source of micronutrients, including carbohydrates, proteins, lipids, flavonoids, alkaloids, minerals, and saponins. Mature fronds may also contain other bioactive compounds with significant commercial potential for use in healthcare products. There is a longstanding tradition of using regional plants with medicinal properties in both cuisine and for treating various ailments. Although this wild edible fern is not available year-round, dried fronds of *D. esculentum* can be processed and preserved for future use in foods such as pickles, soups, and other dishes. Further research on the conservation of this wild edible fern and the implementation of suitable agricultural practices, including effective propagation techniques, is necessary to ensure its long-term availability for the health security of rural and tribal communities. The results of the nutraceutical analysis of the fronds are expected to generate interest in local traditional vegetables for their dietary and health benefits. The findings indicated that the methanolic isolate of D. esculentum inhibited NADH oxidase and acetylcholinesterase with IC50 values of 265.81 and 272.97 µg/ml, respectively, in a dose-dependent manner (Kaushik *et al.,* 2012).

References

1. Abe, R., & Ohtani, K. (2013). An ethnobotanical study of medicinal plants and traditional therapies on Batan Island, the Philippines. *Journal of ethnopharmacology*, *145*(2), 554-565.
2. Borah, D., Tangjang, S., Das, A. P., Upadhya, A., & Mipun, P. (2020). Assessment of non-timber forest products (NTFPs) in Behali Reserve Forest, Assam, Northeast India. *Ethnobotany Research and Applications*, *19*(43), 1-15.
3. Das, B., Paul, T., Apte, K. G., Chauhan, R., & Saxena, R. C. (2013). Evaluation of antioxidant potential & quantification of polyphenols of Diplazium esculentum Retz. with emphasis on its HPTLC chromatography. *journal of pharmacy research*, *6*(1), 93-100.
4. Dixit, R. D. (2000). Conspectus of Pteridophytic diversity in India. *Indian Fern J*, *17*(1-2), 77-91.
5. Gayathri, t. S., abhilash, k. S., alen, a. P., & leeja, l. (2016) phytochemical and pharmacological potential of the genus diplazium sw.(athyriaceae): a comprehensive review
6. Halimatussakdiah, H., Amna, U., & Wahyuningsih, P. (2018). Preliminary phytochemical analysis and larvicidal activity of edible fern (Diplazium esculentum (retz.) sw.) extract against culex. *Jurnal Natural*, *18*(3), 141-147.
7. Junejo, J. A., Gogoi, G., Islam, J., Rudrapal, M., Mondal, P., Hazarika, H., & Zaman, K. (2018). Exploration of antioxidant, antidiabetic and hepatoprotective activity of Diplazium esculentum-A wild edible plant from North Eastern India. *Future Journal of Pharmaceutical Sciences*, *4*(1), 93-101.
8. Kagyung, R., Gajurel, P. R., Rethy, P., & Singh, B. (2010). Ethnomedicinal plants used for gastro-intestinal diseases by Adi tribes of Dehang-Debang Biosphere Reserve in Arunachal Pradesh.
9. Ong, H. C., Lina, E., & Milow, P. (2012). Traditional knowledge and usage of edible plants among the Semai community of Kampung Batu 16, Tapah, Perak, Malaysia. *Scientific Research and Essays*, *7*(4), 441-445.
10. Rothfels, C. J., Sundue, M. A., Kuo, L. Y., Larsson, A., Kato, M., Schuettpelz, E., & Pryer, K. M. (2012). A revised family–level classification for eupolypod II ferns (Polypodiidae: Polypodiales). *Taxon*, *61*(3), 515-533.
11. Roy, S., Dutta, S., & Chaudhuri, T. K. (2015). In vitro assessment of anticholinesterase and NADH oxidase inhibitory activities of an edible fern, Diplazium esculentum. *Journal of Basic and Clinical*

Physiology and Pharmacology, *26*(4), 395-401..
12. Roy, S., Hazra, B., Mandal, N., & Chaudhuri, T. K. (2013). Assessment of the antioxidant and free radical scavenging activities of methanolic extract of Diplazium esculentum. *International Journal of Food Properties*, *16*(6), 1351-1370.
13. SCHUETTPELZ, E., SCHNEIDER, H., SMITH, A.R., HOVENKAMP. P., PRADO, J., ROUHAN, G., SALINO, A., SUNDUE, M., ALMEIDA, T.E., PARRIS, B., SESSA, E.B., FIELD, A.R., DE GASPER, A.L., ROTHFELS, C.J., WINDHAM, M.D., LEHNERT, M., DAUPHIN, B., EBIHARA, A., LEHTONEN, S. & ZHOU, X.M.A. 2016. Community-derived classification for extant lycophytes and ferns. Journal of Systematics and Evolution 54(6): 563–603
14. SUNDUE, M.A. & ROTHFELS, C.J. 2014. Stasis and convergence characterize morphological evolution in eupolypod II ferns. Annals of Botany 113(1): 35-54.
15. Tandon, R., Jain, G. K., Pal, R., & Khanna, N. M. (1980). Esculentic Acid, a New Triterpene Acid from Diplazium esculentum (Retz) sq. ex. *Schrad. Indian J. Chern. B*, *19*, 819.
16. Tharmabalan, R. T. (2023). Nutritional profiles of four promising wild edible plants commonly consumed by the semai in Malaysia. *Current Developments in Nutrition*, *7*(4), 100054.
17. Tongco JVV, Villaber RAP, Aguda RM, Razal RA. (2014). Nutritional and phytochemical screening, and total phenolic and flavonoid content of *Diplazium esculentum* (Retz.) Sw. from Philippines. J Chem Pharm Res, 6, 238–42.
18. Umohata, I. A., Ubulom, P. M. E., Udofa, E. J., Bala, D. N., & James, I. V. (2020). Potential of the Ethanol Extract of Aerial Parts of Diplazium esculentum (Retz) SW. AS Larvicide against Anopheles gambiae Giles and Culex quinquefasciatus Say. *International Journal of tropical disease & health*, *41*(3), 40-47.