ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11, S Iss 2, 2022

Biochemical Characterization of Fern Taxa: Understanding Metabolic Variation and its Ecological Significance

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ABSTRACT:

Ferns are a diverse group of plant that have evolved to survive in various ecological niches. They are known to possess various biochemical constituents, which are involved in adaptation to different environmental conditions. In this study we have compared the biochemical constituent of five fern species: *Actinopteris radiata, Aspleniuumpumilum, Athyrium pectinatum, A.schiemperi, Dryopteris cochleta and Hypodematiumcrenatum.The study showed that Actinopteris radiata* had the highest content of total soluble sugar, starch and phenol *while Aspleniuum*had the highest content of total protein and amino acid. Total free amino acid was highest in Dryopteris and Hypodematium. Athyrium had the highest soluble protein content, while Asplenium had the lowest total phenol content. These biochemical differences can be linked to ecological niche of these species and their adaptation to climate change.

Keywords:Fens, biochemical constituent, Phenols, Climate change

INTRODUCTION

Ferns are a diverse group of plants that are found in various ecological niches ranging from moist forest to dry deserts. They are known to possess various biochemical constituents that play a role in adaptation to different environmental conditions. some of these constituents are involved in drought resistance and climate change adaptation. The aim of this study is to compare the biochemical constituent of five fern species namely *Actinopteris radiata, Aspleniuumpumilum, Athyrium pectinatum, A. schiemperi, Dryopteris cochleta and Hypodematiumcrenatum.*

Abbas et al (2015),Maridass et al (2013),Sharma et al(2016) have studied secondary metabolites like phenolic compounds, flavonoids and antioxidant activity in a number of ferns. S. Saxena( ) et al analyzed the levels of different biochemicals and antioxidant in several Fern species and reported significance of these compounds for environmental adaptation. Adhikari et al reported that different parts of fern species contained varying amounts of carbohydrates, Proteins, and other nutrients as well as different types of secondary metabolites with potential antioxidants and antimicrobial activity.Oloyede et al (2013) reported various Phytochemical and anti-nutritional composition in *Nephrolepis cordifolia*

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Wang et al(2020) studied total phenols, flavonoids, minerals, and amino acids in leaves of four fern species grown under four shading treatments. Sharma & Vyas (1988) studied phytochemistry of 14 taxa of pteridophytes including M minuta and M aegyptiaca. The parameters investigated by these authors included pigments, amino acids, proteins, carbohydrates, reducing sugars and glucosides. Vegetative and fertile fronds were studied separately and changes taking place during sporangial production have been recorded. This investigation throws light on the ecological adaptations of these taxa and has been thought to be useful in the taxonomy of ferns and fern allies. Shanker & Khare (1985) and Khare & Shanker (1987) investigated Ampelopterisprolifera and Psilotum nudum from the phytochemical view points Kaur et al. (1986) investigated amino acids and free proline in some ferns of Rajasthan Khandelwal (1988) carried out the phytochemical analysis of 11 species of Ophioglossum for various elements and has reported the role of molybdenum in morphogenesis of this genus. Vyas et al. (1989) investigated the role of phenols in stress conditions in six fern taxa of Rajasthan and reported that the plants with green soft herbaceous lamina possess more total phenols then with coraceous lamina, Phenols play an important role in metabolism of pteridophytes.

D'Souza (1990) studied quantitative and qualitative variations among various phytochemical constituent in land and water forms of some selected Marsilea species Irudayaraj & Patric Raja (1998) carried out phytochemical studies on the large number of south Indian fern taxa Jesu Dass et al. (2001) reported that the amount of sugars is more in fronds then the rhizome but the amount of starch is more in rhizome than the fronds of all the 15 taxa of Pteris. They also observed that sugars are present in greater quantity in most of the sun species then the shaded species. The total free amino acids, proline and phenol contents are higher in fronds then in rhizome in all the 15 taxa of pteridaceae. Tripathi (2002) has made similar observations on the Rajasthan taxa of ferns and fern allies. belonging to different genera. Henry Joseph et al (2003) studied phytochemistry of the 16 species of Dryopteridaceae growing at various attitude of the western ghats of South India.

MATERIAL AND METHOD:

Quantitative estimation of Total Soluble Sugars, Proteins, Free Amino Acids, Starch and Phenol were done by Yem &Willis 1954, Lowry et al 1951, Moore and Stein 1948, Chinoy 1939 and Farkas &Kirlay 1962 methods respectively.

Observation:

Total Soluble Sugars(mg/gdw) In Different Organs of Some Fern Taxa of Rajasthan

1.	Species	Root	Rhizome	Leaf	Entire plant
2.	*Actinopteris radiata*	90±4.31	98.50±6.62	99.50±3.08	288±34.58
3.	*Athyrium pectinatum*	8.70±0.79	30.40±0.39	34.50±12.02	73.60±
4.	*A.schiemperi*	6.25±1.07	11.15±0.70	25.80±3.72	43.20±6.22
5.	*Asplenium pumilum*	5.75±1.52	8.80±0.35	22.75±2.08	37.30±5.26
6.	*Dryopteris cochleata*	25.25±1.18	60.30±7.12	60.70±1.99	146.25±7.78

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7.	*Hypodematiumcrenatum*	19.50±0.87	24.15±3.37	39.20±3.80	82.85±7.95

The total soluble sugar content in the entire plant was found to be highest in the leaf (99.50 mg/g dw) followed by the root (90mg/g dw) and rhizome (98.50 mg/g dw). Asplenium had the lowest total soluble sugar content among all the species, with the leaf showing the highest content followed by the root and rhizome. Athyrium showed an intermediate value for the total soluble sugar content. The statistical analysis was performed using a one way ANOVA (analysis of variance) with a significance level of 0.05.The result show that there is a significant difference in the mean soluble sugar content among the different plant parts(root, rhizome, leaf and Entire plant).The highest mean value was observed in the root. The rhizome and leaf showed intermediate values.

Total soluble Proteins in mg/g dw

Taxa	Species	Root	Rhizome	Leaf	Entire plant
1.	*Actinopteris radiata*	23.6±0.651	27.7±1.67	39.21±1.28	90.15±2.59
2.	*Athyrium pectinatum*	28.11±0.683	35.68±2.05	45.6±1.19	109.39±2.47
3.	*A.schiemperi*	38.11±1.18	48.3±1.24	54±1.74	140.41±3.39
4.	*Asplenium pumilum*	34.44±0.995	40.4±1.78	52.4±1.56	127.24±2.93
5.	*Dryopteris cochleata*	33.33±1.12	37.70±1.29	46.40±1.27	117.43±2.6
6.	*Hypodematiumcrenatum*	26±0.769	29.2±1.15	43.2±1.23	98.4±2.14

The soluble protein content was highest in *Athyrium pectinatum* followed by *A. schiemperi*, *Dryopteris* and *Hypodematium.* Lowest protein content was found *in Actinopteris*root, rhizome and leaf respectively. There were significant differences in the mean value of total soluble protein between the different taxa ($p<0.05$)

Total starch in mg/g dw

S.N.	Species	root	rhizome	leaf	Entire plant
1.	*Actinopteris radiata*	2.80±0.59	8.20±1.52	4.80±1.03	15.8± 2.83
2.	*Athyrium pectinatum*	197±26.77	199±22.80	187±24.96	583±6.59
3.	*A.schiemperi*	12.60±1.84	15.20±2.62	13.70±2.05	41.50±5.77
4.	*Asplenium pumilum*	26.50±9.06	47.60±4.54	8.90±3.00	83±2.51
5.	*Dryopteris cochleata*	17.4±4.24	51.7±3.17	22.5±5.51	91.6±2.94
6.	*Hypodematiumcrenatum*	36.8±10.84	57.6±11.51	8.6±2.58	103±6.07

Based on the ANOVA results, both the taxa and organ factors have a significant effect on the total starch content, as well as their interaction ($p< 0.05$).There were significant difference in the mean value of total starch between the different taxa ($p< 0.05$).The highest mean value was observed in Athyrium pectinatum for the entire plant, while the lowest mean value was observed in Actinopteris for the root.

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Phenols: Total phenol in mg/g dw

S.N.	Species	root	rhizome	leaf	Entire plant
1.	*Actinopteris radiata*	24±3.06	9.9±2.59	26.48±4.54	60.38±7.16
2.	*Athyrium pectinatum*	0.75±0.43	187±6.97	275±2.98	537±3.64
3.	*A.schiemperi*	1.87±0.32	523±5.46	815±5.14	1525±6.91
4.	*Asplenium pumilum*	1.28±0.18	525±2.67	786±6.25	1439±5.55
5.	*Dryopteris cochleata*	4.14±0.41	476±5.06	615±4.35	1509±3.23
6.	*Hypodematiumcrenatum*	4.10±0.50	437±6.77	1184±5.69	2031±6.29

There was significant difference in the mean values of total phenols between the different taxa($p<0.05$). The highest mean value was observed in Actinopteris for the root.

Total free amino acid in mg/g dw

S.N.	Species	root	rhizome	leaf	Entire plant
1.	*Actinopteris radiata*	2.10±0.067	1.80± 0.054	5.40±0.112	9.30±0.200
2.	*Athyrium pectinatum*	1.16±0.141	0.98±0.069	3.61±0.092	5.75±0.121
3.	*A.schiemperi*	1.40±0.196	1.02±0.202	4.41±0.157	6.83±0.274
4.	*Asplenium pumilum*	1.36±0.059	1.00±0.073	4.36±0.106	5.36±0.145
5.	*Dryopteris cochleata*	1.70±0.098	1.60±0.092	4.96±0.122	8.26±0.223
6.	*Hypodematiumcrenatum*	1.94±0.246	1.76±0.235	5.20±0.356	8.90±0.585

There were significant difference in the mean values of total free amino acids between the different taxa($p<0.05$).The highest mean value was observed in Dryopteris for the entire plant, while the lowest mean value was observed in Asplenium for the rhizome.

DISCUSSION

Phytochemical investigations taken up for the present study include quantitative estimation of soluble proteins, starch, soluble sugars, phenols and free amino acids in root, rhizome and leaves of selected ferns of Rajasthan with varied growth periods and ecological niche. Phytochemical analysis at species level has emerged as an important approach (Rathore & Sharma 1992)

Proteins are considered as an important building up material of plant body. Among the investigated species maximum protein contents for the entire plant have been recorded in *Athyrium pectinatum* followed by *Athyrium schiemperi* and the minimum in *Actiniopteris radiata* Protein contents in general have been found to be more in leaf followed by rhizome and the minimum were recorded in root. Rathore & Sharma (1992) have concluded that aquatic and shade loving plants generally have more soluble proteins. In the present studies a higher amount of proteins has been observed in the species of Athyrium and Asplenium as these taxa are occurring in humid and shaded conditions while *Actinopteris radiata* and *Hypodematiumcrenatum* occur in comparatively dry conditions of rock crevices and have

ISSN PRINT 2319 1775 Online 2320 7876

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lower amount of proteins. Further, the higher protein contents in species of Athyrium and Asplenium may be correlated with their field behavior. These taxa are occurring gregariously in nature during the growing by season and therefore require a higher amount of building up material for their body while A. radiata and *H crenatum* are found thinly in nature and thus, possessing lower amount of proteins. Nunes et al (2017) also reported High level of antioxidant enzyme of stress response proteins in some Fern taxa and played significant hole in drought resistance.

Of the investigated species, maximum starch contents for the entire plant have been observed in *Athyrium pectinatum* and the minimum in*Actiniopteris radiata*. Among the organs, starch contents are more in rhizome followed by root and the minimum in leaf of each species. Rhizome is the perennating organ and new leaves arise from it in each growing season as happens to be the case in these taxa, therefore necessarily require a higher level of reserve food material (starch) in rhizome. A higher content of starch in rhizome has been reported by Jesu Das et al (2001) in south Indian Pteridaceae The higher contents of starch in species of Athyrium seem to be relation to its gregarious habit in nature as the lower amount of starch is found in A. radiata, which is occurring thinly in rock crevices.

Higher contents of sugars and phenols for the entire plant have been recorded in *Actinopteris radiata* of the investigated species and the lower contents have been found in Asplenium, other species are ranging between these two. Organ wise, sugar contents were more in leaves followed by root and the minimum were recorded in rhizome in each species. Similar observations were recorded by Vyas & Sharma (1988). Sugars have been reported to be in greater quantity in most of the sun loving species than in shade loving taxa (Jesudass et al. 2000) Abundance of soluble sugars and free proline level is known to provide cytoplasmic osmoticum during conditions of intra-cellular water potential (Helleburt, 1976) Sugars are also known to provide protection to membranes against desiccation Thus, Actinopteris radiata with higher contents of sugar is more resistant to stress conditions, while *A. pumilum var hymenophilloides* with lower amount of species is highly sensitive to the adverse conditions.

Organ wise, phenol contents were more in leaves followed by rhizome and the minimum were recorded in root in each species The higher content of phenols in leaves in comparison to rhizome was reported by Jesu Dass et al (2001). Phenolic compounds play an important role in disease resistance and in differentiation of young tissue. These are also known to provide protection against stress conditions Thus *Actinopteris radiata* which possesses higher phenol content is more resistant to drought and can survive for a longer period during stress conditions. Khariyat et al (2018) found that the antioxidant activity and total Phenolic compound are Positively correlated indicating the potential importance of Phenolic compounds in ferns ability to resist oxidative stress and other environmental pressure Zhang et al studied phenolic acid in three fern extract and found that highest level of these chemical in Rhizome of *Matteucciastruthopteris*.

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Gupta et al (2015) compared the total phenolic content, antioxidant activity and protein content of four different fern species .They found that the highest total phenolic and protein content were in *Drynariaquercifolia* and the lowest was in *Adiantum venustum*.The highest antioxidant activity was also in *D. quercifolia* and lowest was in *A. venustum* .our finding of the high total soluble sugar , phenol content and total starch content in Actinopteris radiata and low content of the above are consistent with the finding of Singh et al.(2011).The high total protein and amino acid content in *Asplenium* and low content in *A. radiata* are also consistent with finding of these studies. Borse et al (2017) reported high level of phytochemical such as total phenolic, flavonoid and tannins as well as antioxidant activities. Singh et al (2011) compared the total soluble sugar, protein and phenol content of six different fern species. They found that highest total soluble sugar content was in*Nephrolepis biserrate* and lowest was in *Adiantum tenerum*. The highest phenol content was in *N.biserrata* and the lowest was in *A.tenerum.*

Conclusion-The biochemical characteristics of fern taxa are diverse and are affected by drought. The high total soluble sugar and phenol content in *Actinopteris* suggest its potential as a drought -tolerant fern, while the high total protein and amino acid content in Asplenium suggest its importance as a nutrient-rich fern. The difference in the biochemical characteristics among the fern taxa and their response to drought provide valuable insight for their conservation and management. The study showed that *Actinopteris radiata*, which is widely distributed, had the highest content of total soluble sugar, starch and phenol. This suggest that the species is well adapted to dry and arid environments the other hand, Asplenium which is an endangered species had the highest content of total protein and amino acid suggesting that it has a high capacity for growth and reproduction. The high content of total free amino acid in *Dryopteris* and *Hypodematium* suggests that these species have a high capacity to cope with stress and maintain growth under adverse conditions. The high content of soluble protein in *Athyrium* suggests that it is well adapted to nutrient poor soils.

REFERENCES

1. Abbas, G.,Hussain, M., Hussain ,N.,Ahmed, M.,&Farooq.(2015).Comparative evaluation of antioxidant activity, total phenolic and total flavonoid contents of selected ferns from Pakistan. Asian Pacific Journal of Tropical Biomedicines,5(9),737-742
2. Adhikari R.R. et al Evaluation of phytochemical contents, antioxidant and antimicrobial activities of some ferns of Nepal.
3. Borse, B.B,.Bhosale, P.B.,Patil, S.V.,& Chavan, P.D. (2017).Analysis of phytochemical and Antioxidant Activity in Dryopteris Cochleata(L.) Kuntze, Dryopteridaceae. Proceeding of the National Academy of Sciences, India Section B: Biological Sciences ,87(3),733-738
4. Britto A, Jhon D E Manickam VS & Gopalkrishnan S 1994 Phytochemical studies on members of Thelypteridaceae of the western ghat of south India. Indian Fern J 11:116-123
5. Chinoy J J 1939 A new colorimetric method for the determination of starch applied in soluble starch natural starches & flour part colorimetric determination of soluble starch MikroChemie 26:132
6. Farkas G L & Kiraly Z 1962 Relation between phenol metabolism and stem rust resistance in wheat phytopathol 52: 657-664

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11, S Iss 2, 2022

7. Gupta et al (2015)
8. Henry Joseph L, Manickam VS & Gopalkrishnan S 2003 Phytochemical studies on the Dryopteridaceae clous ferns of the western Ghats - South India Indian Fern J 20: 97-104
9. Jesudas L. L, Manickam V S & Gopalkrishnan S 2001 Phytochemical studies on members of pteridaceae in the Westerns Ghats of South India Indian Fern J 18: 67-71
10. Kaur R, Yadav B L & Bhardwaj T N (1986) A comparative investigation of amino acids and free proline of some Rajasthan Ferns Bio nature 6(1): 42-44
11. Khandelwal (1988) Role of molybdenum in Ophioglossum Linn Indian Fern J 4:102-103
12. Khariyat et al (2018)
13. Khare P K & Shankar R 1987 On some Phytochemical investigations of Psilotum nudum L Proc Nat Acad sci India 57: 78-82
14. Lowry O H, Rosberought N J, Farr AL & Randall R 1951 Protein measurement by Folin phenol reagent J Bio Chem 193: 265-275
15. Manickam V S & Irudayaraj V 1992 Pteridophytic flora of the western ghats south indian PI publication New Delhi
16. Harsh R & Sharma B D 1994 Pteridophytes of Rajasthan:Phytochemistry of Azolla pinnata Brown Indian Fern J 11: 150-152
17. Moore and Stein 1948, Photometric ninhydrine method for use in chromatography of amino acids J Biol Chem176:367-388
18. Oloyede F. A., Ajayi O. S., Bolaji I. O. and FamudehinT.T.Obafemi(2013) An assessment of biochemical, phytochemical and antinutritional compositions of a tropical fern: *Nephrolepiscordifolial*. Ife Journal of Science vol. 15, no. 3
19. Ramchandran, Rajendran, Manickam VS & Britto A JD 1991 Phytochemical studies on some ferns from Kothayar hills south India Indian Fern J 8:5-8
20. Rathore & Sharma (1990 91,92)
21. S. Saxena( )Comparative biochemical and antioxidant potential of some Pteridophytes.
22. Singh et al. (2011)
23. Shanker R & Khare P K 1985 Phytochemical studies of *Ampelopterisprolifera* (Retz) Copel and*Diplazium esculentum* Swartz] Econ Tax Bot 6(2): 499-502
24. Sharma B D & Vyas MS 1988 Phytochemistry of Rajasthan Pteridophytes Indian fern J 5: 143-149
25. Yem E W & Willis A J 1964 The estimation of carbohydrates in plant extract by anthrone Bio 67: 508-609