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BIOACTIVE COMPOUNDS AND ITS IMPORTANCE IN PTERIDOPHYTES

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ABSTRACT

Pteridophytes are the seedless vascular cryptogams. They have been used as food and folk medicine traditionally. Unique classes of natural bioactive compounds are abundant in these lower plants. Majority of the Pteridophytes have the potential to cure many dreadful diseases, it is due to the presence of active natural bio compounds. Many of the earlier research works proved that, the one of the precious group of plants are pteridophytes. Now-a- days the usage of natural products has been considerably increased, so the plants like pteridophytes were screened for their medicinal activity. Novel drugs were discovered in these lower plants. Number of compounds were isolated from this group of plants and found to be effective on many diseases. The present review aims to give a brief summary on the available literature data on the natural bioactive compounds and its importance among Pteridophytes.

Key words: Bioactive compounds, drugs, diseases.

INTRODUCTION

Pteridophytes are the lower group of seedless vascular plants, they can cure many diseases. They are represented by about 305 genera comprising more than 10,000 species all over the world. About 191 genera and more than 1000 species are reported from India (Dixit, 1984). The pteridophytes are mostly distributed in the Himalayas. More than 300 species of ferns and fern allies are reported from the Western Ghats, South India (Manickam and Irudhayaraj 1992). The Pteridophytes are known to man for more than 2000 years for their medicinal values (Kirtikar et al., 1935; Nayar 1959; Nadkarni 1954; May 1978). The value of ferns is more keenly appreciated. Ferns are found to provide food, medicine, fiber, craft and building material, abrasives and of course decoration.

Folklore Medicinal pteridophytes

The ferns had an important role in folklore medicine. Pteridophytes have been successfully used in the different systems of medicines like Ayurvedic, Unani, Homeopathic and other systems of medicines. As folk medicine, the pteridophytes which constitute fern and ferns allies, have been known to man for more than 2000 years, and also been mentioned in ancient literature (Kirtikar and Basu, 1935; Chopra et al., 1958; Kumar and Roy, 1972; Watt, 1972; Sharma and Vyas, 1985; Kaushik (1998) emphasized on the ethno-botanical importance of ferns of Rajasthan, India.

Ferns have lived with human beings for a long time. They influenced millions of human lives as traditional medicinal cures or treatments for many diseases. Young leaves of the ferns *Diplazium esculentum* (Retz.) Sw., *Helminthostachys zeylanica* (L.) Hook, *Nephrolepis cordifolia* (L.) Presl and *Stenochlaena palustris* (Burm.) Bedd. are cooked as vegetables by the tribals in Indian mountains. In the case of water fern *Marsilea drummondii* the starchy paste of the sporocarps is made in to cakes called "Nardoo" and is eaten by the natives of Australia. Only few Pteridophytic plants are used as medicine eg. *Nephrolepis auriculata* (Linn.) Trimen., tuber paste is used to lower down the brain fever and headache by applying locally. *Selanginella bryopteris* Linn. Bak is considered as highly useful in unconciousness, the decoxinon aerial leafy sporophyte is used to regain vigor. Similarly *Heminthostachys Zeylanica* (Linn) Hook.is used to revert the impotency. The paste of *Adtinatum incisum* Forssk. and *A. venustum* is useful in the healing of wounds (Samant *et al.*, 1998; Kholia and Punetha, 2005).

Quite a number of ferns and ferns allies are of great medicinal value, among them mention may be made of *Equisetum arvense* Linn. This is used in nasal polyps and kidney infections, ashes useful in acidity. *E. debile* Roxb, is diuretic and given in

gonorrhoea. *Lycopodium clavatum* Linn., in the form of decoction used in rheumatism and diseases of lungs and kidneys. The paste of the leaves of *Ophioglossum reticulatum* Linn., is used in headache. *Botrychium virginianum* Sw. is used in dysentery. *Helminthostachys zeylanica* (Linn.) Hook. is used for vitality and brain tonic. *Lygodium flexuosum* (Linn.) Sw., is an expectorent and used in ulcers, cutwounds and sprains. The fronds of the gleicheniaceous fern *Dicranopteris linearis* (Burm.) underwood are used for asthma and in woman's sterility. *Osmunda regalis* Linn. are used as stypic and tonic. The *Angiopteris evecta* rhizomes (Forst.) Hoffm., are used for scabies (Vasudev, 1999).

Secondary metabolites and Phytochemical compounds worked out in Pteridophytes so far.

Plants normally produce various secondary metabolites not only to adapt to their environment but also to defend themselves against biotic or abiotic stress, and natural enemies. Phytochemicals are chemicals found in plants that protect plants against bacteria, viruses, and fungi. To provide protection against adverse effects of their environment, plants have the tendency to produce many kinds of secondary metabolites in severe conditions (Bennett and Wallsgrove 2006). These metabolites are polyphenols, flavonoids, terpenoids, steroids, quinones, alkaloids, polysaccharides and so on (Swain 1977). These functional metabolites have properties which prevent and cure various diseases as well as aging in mammals including humans. Phytochemicals may decrease the risk of developing certain cancers as well as diabetes, hypertension, and heart disease. They may act as antioxidants or nutrient protectors, or prevent carcinogens from forming. Such important phyto compounds are rich in pteridophytes. Since ferns and fern allies have survived from Paleozoic times, they have adapted with many more various changes of environment than the other primitive vascular plants (Wallace et al. 1991). Therefore, ferns are expected to have many useful secondary metabolites than other plants.

Several studies proved that pteridophytes have more active compounds, yet ferns have not been widely investigated by phytochemical analyses. Very less amount of works were carried out to prove the active compounds of pteridophytes. Here is a short survey of some of the research works on secondary metabolites and bioactive compounds given.

Table 1 Survey of pteridophytes studied by various authors for its bioactive compounds and curative properties for various ailments

S.No	Author and Year	Name of the plant	Secondary metabolites	Compound	Uses or Disease cured	Microbes	Clinical details
1.	Thews et al 2006	*Davallia solida*		Benzophenones P-glycoproteins	efflux transporters in the body, detoxification		
2.	Toji Thomas 2011	*Angiopteris evecta*			Hinder the growth and multiplication of multidrug resistant bacterial strains	*Staphylococcus aureus, Pseudomonas aeruginosa*	
3.	Vasudeva 1999	*Angiopteris evecta* (Rhizome)			Scabies		
4.	Kaushisk and Dhiman 1995	*Angiopteris evecta* (Rhizome)			Styptic and antihelminthic		
5.	Santhosh Kumar and Nagarajan 2012	*Adiantum capillus-veneris*			Expectorant, Treatment of wounds and eczema, Cures jaundice, Dysmenorrhoea, Spermatorrohea, skin disease.	*S.aureus, Streptococcus pygines, E.coli, Klebsiella pneumonia, Candida albicans.*	
6.	Vasudeva 1999	Adiantum species			Skin diseases, Treatment of various infectious diseases	Antibacterial activity	
7.	Parihar et al 2010 Chandrappa et al 2011 Herin et al 2012	*Adiantum-capillus-veneris*			Various diseases.	Antibacterial activity	
8.	Banerjie and Sen 1980				Antibiotic activity of pteridophytes were studied		
9.	Bhabbie 1972	*Adiantum radiate*			Skin diseases.	Microbial activity.	
10.	Konoshima et al 1996	*Polypodium nipponnica P. formosanum P.vulgare, P. faurriei P. virginianum Dryiopteris crassirizoma Adiantum monochlamys Oleandra wallichi*			cancer	Anticancerous study.	

11.	Devmurari et al 2010	*Adiantum venusetum* Don			Reduce elevated level of lipid peroxidation and also anticancer activity		
12.	Woo et al 2005	*Selaginella*	Bioflavonoids		Cytotoxicity		
13.	Star and Marby 1971 Sukumaran and Kuttan 1991	*Pityrogramma calomelanos*	Flavonoids		Cytotoxicity		
14.	Li et al 1998 Li et al 1999	*Pteris semipinnata* *Pteris multifada*			Cytotoxicity		
15.	Hunyadi et al 2013		Natural flavonoids	Protoflavones with non-aromatic B-ring and a hydroxyl group at C-1	Anticancer activity		Synthetic semi synthetic protoflavone analogs as anticancer drugs
16.	Han and Xu 1998	*Pteris multifada*	Terpenoids	Pterokaurane	Anticancer activity		
17.	Checchi et al 2003			Microtubule stabilizing agents (Taxol) Microtubule depolymerizing agents (Vincristine, vinblastine and colchicine)	Show stronger anticancer activity through inhibiting the cell cycle progression and including programmed cell death.		
18.	Wilson et al 1998			Several differently active constituents	Cytotoxic effects on blades cancer cells as well as inhibition of the cell growth through cell cycle arrest.		
19.	Gibellini et al 2011 Lugli et al 200	Bracken fern	Flavonoids	Quercetin	Antiproliferative and proapoptotic effects and cell cycle regulator		
20.	Gupta and panda 2002		Flavonoids	Quercetin	Targetting tubilins which lead to depolymerization of the cellular microtubules		
21.	Somjintana et al 2005	*Angiopteris evecta*	Alkaloids	Angiopterioside	Inhibition of HIV-1 Reverse Transcriptase cytotoxicity against lung cancer cell line		

22.	Twentyman et al 1989	*Angiopteris evecta*	Alkaloids	Angiopterioside	Antitumour activity for lung cancer other includes fibroblastsand inhibition of HIV-1 RT and lung		6- tumour cell lines, HS 27(fibroblast), Kato-3(gastric), RT
23.	Anupam Das et al 2011	*Abacopteris penanjiana Huperizia selago Equisetum arvense Drypteris crassirhizome*		Flavon-4-ol glycosides, Abacopterins, Huperzine A, Isoquercetin, Di- E-Caffeeoyl Mesotartaric acid,flavaspidic acid PB, flavaspidic acid AB, flavan-3- ol Kaempferol A – Type, Proanthocyanidin Afzelechin	Antioxidant activity Ant inflammatory Anti duretic Anti-arthritic activity Antimicrobial activity		
24.	Daonian et al 2010	*Arachinoide sexilis*		Antioxidant and hepato protective activity			
25.	Yung Husan et al 2008 Chen et al 2008	*Davallia solida* (Rhizome)	Phenolic compounds	To treat osteoporosis arthralgia and arthritis			
26.	Shweta Sood et al 2003	*Onchium contiguum*	Phenolic compounds	Antioxidant activity			
27.	Jair et al 2005	*Equisetum arvense*		Antioxidant, antiproliferative activity. Reverses the cognitive impairment invitro antioxidant activity.			
28.	Wang et al 2006	*Pteris multifida*		Antioxidant reducing power			
29.	Mimica et al 2008	*Equisetum arvense*	Phenolic compounds Flavonoids	Antioxidant reducing power Isoquercetin di-E- caffeoyl mesotartaric acid	Anti oxidant activity		

30.	Choudhary et al 2008	*Salvinia molesta*	Phenolic compounds and other constituents glycosides	6,2- o- (3,4 di hydroxyl benzoyl) a-d-glucopyranosyl ester (1) and 4-o-a-d-gluccopyranoside- 3-hydroxymethyl benzoate (2)	Antioxidant radical scavenging activity		
31.	Zhong xiang et al 2007	*Abacopteris penangiana*	Flavonoids , glycosides	Flavan-4-ol glycosides, abacopteris E-I (5-9	Antioxidant activity		
32.	Helena et al 2005	*Equisetum telmateia*	Phenolic compounds	Flavan-3-ol Kaempferol and phenolic acid derivatives.	Anti inflammatory, diuretic properties Antioxidant activity		
33.	Bai.D. 1993	*Lycopodium Linn syn Huperzia*			Tribals used as memory enhancing effect		
34.	Zhang et al 2002	*Huperzia* *Abacopteris penangiana*	 Flavonoid	Huperzine A Flavan-4-ol glycosides, abacopterins	In vitro antioxidant activity Antioxidant activity		
35.	Staerk et al 2004.	*Huperzia selago*	Alkaloids	Huperzine A	Anti oxidant activity		
36.	Lee et al 2003	*Dryopteris crassirhizome*		Flaspidic acid PB Flaspidic acid AB	Anti oxidant activity		
37.	Hutadilok 2006	*Angiopteris evecta*			Induce erythrocyte hemolysis and lipid peroxidation		
38.	Shin and Lee 2010	*Polystichum lepidocaulon , P.polyblepharum, Davallia mariesii Cyrtomium fortune Dicranopteris pedata Athurium niponicum Dryopteris niponensis*	Polyphenols		Antioxidant activity		

39.	Raimana et al 2010	Microsorum genus			Purgative, antibacterial gastric and renal infection treatment diuretic pain killer anti inflammatory	Synthetic semi synthetic protoflavone analogs as anticancer drugs	6- tumour cell lines, HS 27(fibroblast), Kato-3(gastric), BT 474(Breast), Chago (lung), SW 620(Colon) and HEP G2 (Heptoma)
40.	Sani *et al.*, 2007	*Lophira lanceolata*	flavonoids, anthraquinones, carbohydrate, glycoside, phenols, saponin steroid, tannin, free reducing sugar.	quercetin as the genin			
41.	Clericuzio 2012	*Ophioglossum vulgatum* L.	glycosylated and acylated flavonols	quercetin-3-*O*-[(6-caffeoyl)-*β*-glucopyranosyl (1 → 3) *α*-rhamnopyranoside]-7-*O*-*α*-rhamnopyranoside (2), and kaempferol-3-*O*-[(6-caffeoyl)-*β*-glucopyranosyl (1 → 3) *α*-rhamnopyranoside]-7-*O*-*α*-rhamnopyranoside (3), together with the known quercetin-3-*O*-methyl ether (1),			
42.	Zhang et al 2002, Hirasawa et al 2006	*Lycopodium*	Lycopodium alkaloids,	Alpha-onocerin and lycoperine A,	Acetylcholine esterase inhibition activity		
43.	Rancon et al 2001	*Davallia solida*	glycosides, and lactone glycosides	Benzophenones, ent-pimarene			
44.	Irudayaraj 2011	*A. affine* and *A. decrescens A. zenkeranum*	alkaloids, triterpenes, and flavonoids				
45.	Malay Bharti And Ram Pravesh., 2012	*Lygodium flexuosum* (L) Sw. and *Ampelopteris prolifera*	phenolics, triterpenoids and flavonoids		antibacterial activity expectorant, Treatment of wounds and eczema. Cures jaundice. Roots of the plant have also been employed against	*M. luteus* and *S. aureus*	

					dysmenorrhea and cure spermetorrohea. skin disease		
46.	Hima et al 2011	*Hemionitis arifolia*	flavonoid, steroids and glycosides		burns, menstrual disorders, anti-flatulence and antifertility. antibacterial activity against infectious disease causing bacterial pathogens	*Enterobacter aerogens, Klebsiella pnemoniae, Salmonella paratyphi A, Ralstonia eutropha, Salmonella typhi, Salmonella paratyphi B, Staphylococcus aureus, Bacillus cereus, Bacillus subtilis, Bacillus sphericus, Bacillus sterothermophilus* and *Micrococcus luteus*	
47.	Konoshima et al. (1996)	*Polypodium nipponica, P. formosanum, P. vulgare, P. fauriei, P. virginianum, Dryopteris crassirizoma, Adiantum monochlamys,* and *Oleandra wallichii*	Triterpenoids hydrocarbons		Antitumor activity.		
48.	Abdul, et al 2011	*Selaginella ciliaris* (Retz.), *Marsilea minuta* (L.) and *Thelypteris prolifera*			Antitumor activity	*Agrobacterium tumefaciens*	
49.	Hseu, T. H. (1981)	*Angiopteris evecta*	Alkaloid	Angiopteroside	diuretic, antipyretic, tonic, analgesic and antidiarrheal. Against HIV-1 Reverse Transcriptase and several cancer cell-lines		
50.	Cambie and Ferguson, 2003	*Asplenium bulbiferum*	flavonoids:	Kaempferol glucosides	Antioxidant activity.		

51.	Singh and Singh 2010	*Huperzia serrata*	Alkaloid	Huperzine A	fever, cold, swellings, menstruation, rheumatism, schizophrenia and myasthenia gravis.Treatment of Alzheimer's disease		

CONCLUSION

This review provides a base for the enhancement towards the compound identification and functional activities of the particular compound in pteridophytes. This survey also proves that the pteridophytes have much more medicinal properties and biological activities. In future Pteridophytes will lead to a great potential for research and as a source of good material for the discovery of novel drugs.

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REFERENCES

1. Abdul, Md ., Qayum Sarker, Palash C Mondol, Md Jahangir Alam, M Sarwar Parvez, M Firoz Alam ., 2011. Comparative study on antitumor activity of three pteridophytes ethanol extracts. International Journal of Agricultural Technology .1686-9141. 7(6):1661-1671
2. Anupam Das Talukdar, Ramananda Ghosh Tarafdar, Manabendra Dutta Choudhury, Deepa Nath, Shuvasish Choudhury.2011. A Review on Pteridophyte Antioxidants and their Potential Role in Discovery of New Drugs. Assam University Journal of Science & Technology: Biological and Environmental Sciences Vol. 7 Number I .151-155.
3. Bai, D. (1993). Traditional Chinese medicines and new drug development. *Pure & Applied Chemistry.* 65:1103-1112.
4. Banerjee, R. D. and Sen, P. 1980. Antibiotic activity of pteridophytes. Economic Botany. 34(3): 284-298.
5. Bennett, R. N. and Wallsgrove, R. M. 2006. Secondary metabolites in plant defense mechanisms.New Phytol. 127:617–633.
6. Bhabbie SH, Tewari P and George CX: Chemical analysis of *Actiniopteris radiata* (Sw.) Link. Current Sci. 1972; 41:88.
7. Cambie, R.C., Ferguson, L.R. (2003). Potential functional foods in the traditional Maori diet. *Mutation Research*. 523-524:109-17.

8. Chandrappa CP Shilpashree CB Karthik MR Govindappa M and Sadananda TS. 2011. Antibacterial and Antioxidant Activities of *Adiantum pedatum* L. Journal of Phytology, 3(1): 26-32.
9. Checchi PM, Nettles JH, Zhou J, et al (2003). Microtubule-interacting drugs for cancer treatment. *Trends Pharmacol Sci*, 24, 361-5.
10. Chen, Y. H., Chang, F. R., Lin, Y. J., Wang, L., Chen, J. F., Wu, Y. C., and Wu, M. J. 2008. Identification of phenolic antioxidants from Sword Brake fern (*Pteris ensiformis* Burm.). Food Chem. 105:48–56.
11. Chopra, R. N., Chopra, I. C., Handa, K. L. and Kapur, L. D. 1958.Studies on Indigenous Drugs of India.; U.N. Dhur and Sons Pvt. Ltd., Calcutta. pp.647.
12. Choudhary, M. I., Naheed N., Abbaskhan A., Musharraf S. G., Siddiqui H., Atta-Ur-R. (2008). Phenolic and other constituents of fresh water fern *Salvinia molesta*. *Phytochemistry*. 9(4):1018-23.
13. Daonian, Z., Jinlan, R., Yaling, C., Zhaomei, X., Wei, F. and Anhua, W. (2010). Antioxidant and hepatoprotective activity of ethanol extract of *Arachniodes exilis* (Hance)Ching. *Journal of Ethnopharmacology.* Article in Press.
14. Devmurari, V. P Pandey, S. Goyani, M. B. Jivani, N. P. Marotrao, S. Sivakumar, P.2010 Anticancer Activity of Plant: Adiantum venustum Don International Journal of PharmTech Research, Vol. 2 Issue 1, p. 488.
15. Dixit, R.D. and Bhatt, G.K. (1975). Ferns-a muchneglected group of medicinal plants. II. *Journal of Research in Indian Medicine.* 10:68–76.
16. Gibellini L, Pinti M, Nasi M, et al (2011). Quercetin and cancer cheoprevention. *Evid Based Complement Alternat Med*, 2011, 591356
17. Gupta K, Panda D (2002). Perturbation of microtubule polymerization by quercetin through tubulin binding: a novel mechanism of its antiproliferative activity. *Biochemistry*, 41, 13029.
18. Han.D., and R. Xu. 1988. *Abstracts in Chinese Medicine*, 2, 466-83.
19. Helena, C., Ana González-Paramás, Maria, T. A.,Celestino Santos-Buelga and Maria, T. B. (2005).Characterisation of Polyphenols by HPLC-PADESI/ MS and Antioxidant Activity in *Equisetum telmateia.Phytochem. Anal*. 16:380–387.
20. Herin Sheeba Gracelin,D., A. John De Britto and P. Benjamin Jeya Rathna Kumar., 2012. Antibacterial Screening of A Few Medicinal Ferns Against Antibiotic Resistant Phyto Pathogen., *IJPSR*, Vol. 3(3): 868-873 ISSN: 0975-8232.
21. Hima Bindu N, Devi, P Suvarnalatha Rukmini, K Charya, M A Singara. 2011. Phytochemical screening and antibacterial activity of *Hemionitis*

arifolia (Burm.) Moore. Tirumala Publisher: NISCAIR-CSIR, India.

22. Hirasawa, Y., Kobayashi, J. and Morita, H. 2006. Lycoperine A, a novel C72N3 type pentacyclic alkaloid from Lycopodium hamiltonii, inhibiting acetyl cholinesterase. Organic Letters 8: 3123-126.
23. Hseu, T. H. (1981) "Structure of Angiopteroside (4-O-b-D-Glucopyranosyl-L-thero-2-hexane-5-olide) Mono-hydrate, a Fern Glycoside from Angiopteris lygodiifolia" Ros. Acta. Cryst. B37, 2095 -2098.
24. Hunyadi, A., A.Martins, B. Danko, F. R. Chang, Y. C. Wu., 2013. Protoflavones: A class of unusual flavonoids as promising novel anticancer agents. Phytochem Rev Investigational Report No: 29, Institute of Natural Resources, University Natal, and Pietermaritzburg.
25. HutadilokTowatanan.N, P.Chaiyamutti, K.Panthong, W.Mahabusarakam and V.R ukachaisirikul., 2006 Antioxidative and Free Radical Scavenging Activities of Some Plants Used in Thai Folk Medicine. Vol. 44, No. 3.Pages 221-228.
26. Irudayaraj.V and M. Johnson, *2011*,Regular article pharmacognostical studies on three *Asplenium* species. *Journal of Phytology 2011, 3(10): 01-09.* Available Online: www.journal-phytology.com
27. Jair Guilherme dos S. Jr., Fabrício H. M. do Monte,Miriam Marcela Blanco, Vanusa Maria do N. Bispo L., Flávio D. M., and Luzia Kalyne de Almeida L. (2005).Cognitive enhancement in aged rats after chronic administration of *Equisetum arvense* L. with demonstrated antioxidant properties *in vitro.Pharmacology Biochemistry and Behavior*. 81(3):593- 600.
28. Kaushik P., Dhiman A., "Common Medicinal Pteridophytes", Indian Fern Journal 1995; 12(1): 139-145.
29. Kaushik, P. (1998). Ethnobotanical Importance of Ferns of Rajsthan: Indigenous Medicinal Plants. Today and Tommorrow Printers and Publication, New Delhi. pp. 61-66.
30. Kholia, B.S. and Punetha, N.N. 2005. Useful Pteriophytes of kumaon central Himalaya, India.*Indian Fern Journal* 22: 1-6.
31. Kirtikar, K. R. and Basu, B. D. 1935. Studies on medicinal palnts of India and its adjacent countries including Sri Lanka, Nepal, Bhutan,Pakistan, Bangladesh etc. Indian medicinal plants. IV: 2525-2527.
32. Konoshima, T., Takasaki, M., Tokuda, H., Masuda, K., Arai, Y., Shiojima, K., and Ageta, H. 1996. Anti-tumor-promoting activities of triterpenoids from ferns. Biol. Pharm. Bull. 19:962–965.
33. Kumar and Roy, S.K. (1972). Some medicinal ferns from Neterhat hills (Bihar), *Journal of Scientific Research.* 23:139–142.

34. Lee, S.M., Na, M.K., An, R.B., Min, B.S. and Lee,H.K.(2003). Antioxidant activity of two phloroglucinol derivatives from *Dryopteris crassirhizoma. Biol.Pharm. Bull*. 26(9):1354-1356.
35. Li J, Liang N, Mo L, Zhang X, He C. 1998. [Comparison of the cytotoxicity of five constituents from *Pteris semipinnata L.* in vitro and the analysis of their structure43 activity relationships]. Yao Xue Xue Bao. 33(9):641-4. Chinese.
36. Li JH, He CW, Liang NC, Mo LE, Zhang X. 1999. Effects of antitumor compounds isolated from *Pteris semipinnata* L on DNA topoisomerases and cell cycle of HL- 60 cells. Zhongguo Yao Li Xue Bao.20(6):541-5
37. Lugli E, Ferraresi R, Roat E, et al (2009). Quercetin inhibits lymphocyte activation and proliferation without inducing apoptosis in peripheral mononuclear cells. *Leuk Res*, **33**, 140-50.
38. Malay Bharti And Ram Pravesh., 2012. Antibacterial Activity Of Lygodium Flexuosum (L.) Sw.And Ampelopteris Prolifera (Retz.)Copel Of Ranchi., District Of Jharkhand. An International Quarterly Journal of Environmental Sciences. The Ecoscan: Special issue, Vol. 1: 397 - 401: 2012. ISSN: 0974 – 0376
39. Manickam, V.S. and Irudayaraj, V. 1992. *Pteridophytic flora of the Western Ghats, South India*.BI Publications Pvt. Ltd., New Delhi, p. 653.
40. Marco Clericuzio, Stefano Tinello, Bruno Burlando, Elia Ranzato, Simona Martinotti, Laura Cornara and Arianna La Rocca 2012. Flavonoid Oligoglycosides from *Ophioglossum vulgatum* L. Having Wound Healing Properties. *Planta Med* ; 78(15): 1639-1644.
41. May, L.W. 1978. The economic uses and associated folklore of ferns and fern allies. *Bot Rev*. 44 (4): 191-528.
42. Mimica-Dukic, N., Natasa, S., Jelena, C., Emilija, J., Dejan, O. and Biljana, B. (2008). Phenolic Compounds in Field Horsetail (*Equisetum arvense* L.) as Natural Antioxidants. *Molecules.* 13:1455-1464.
43. Nadkarni, B.K. 1954. *Indian Materia Medica with Ayurvedic, Unantibii, Siddha, Allopathic,Homeopathic, Naturopathic and home remedies*, Popular book depot, Bombay.
44. Nayar, B.K. 1959. Medicinal ferns of India. *Bull. Nat Bot Gard. Lucknow* 29: 1-36.
45. Parihar P Leena P and Bohra A. 2010. In vitro antibacterial activity of fronds (leaves) of some important Pteridophytes.
46. Raimana Ho, Taivini Teai, Jean-Pierre Bianchini René Lafont,and Phila Raharivelomanana., 2010.Ferns: From Traditional Uses to Pharmaceutical Development, Chemical Identification of Active Principles. Working with Ferns, pp 321-346.

47. Rancon S, Chaboud A, Darbour N, Comte G, Bayet C, Simon PN, Raynaud J, Di Pietro A, Cabalion P, Barron D. 2001. Natural and synthetic benzophenones: interaction with the cytosolic binding domain of P-glycoprotein. Phytochemistry. 57(4):553-7.
48. Sani Ali Audu, Ilyas Mohammed1and Haruna Abdul Kaita., 2007. Phytochemical screening of the leaves of *Lophira lanceolata* (Ochanaceae).*Life Science Journal, Vol 4, No 4.*
49. Samant, S.S. Dhar, U. and Palni L.M.S. 1998. medicinal plants of Indian Himalaya, Diversity,Distribution and potential value. Gyannodya Prakasha nainital, India.
50. Santhosh Kumar S and Nagarajan N., 2012. Screening of preliminary phytochemical constituents and antimicrobial activity of Adiantum capillus–veneris. Journal of Research in Antimicrobials (1(1): 056-061. An International Online Open Access Publication group, Ficus Publishers.
51. Sharma, B.D. and Vyas, M.S. (1985). Ethnobotanical studies on the fern and fern allies of Rajasthan. *Bulletin of Botanical Survey of India.* 27:90–91.
52. Shin, S. L. and Lee, C. H. 2010. Antioxidant effects of the methanol extracts obtained from aerial part and rhizomes of ferns native to Korea. Korean J. Pant Res. 23:38–46.
53. Shweta, S., Dawra, R. K., Sharma, O. P. and Kurade, N. P. (2003). Exposure to the fern *Onychium contiguum* causes increase in lipid peroxidation and alters antioxidant status in urinary bladder. *Biochemical and Biophysical Research Communication.* 302(3):476-479.
54. Singh. H. B and Manish Kumar Singh., 2010. Huperzia Serrata: A Promising Medicinal Pteridophyte from Northeast. India NeBIO (2010) Vol. 1(1); 27-34.
55. Somjintana Taveepanich , Nanthita Kamthong ,Narumon Sawasdipuksa and Sophon Roengsumran., 2005. Inhibitory Activities of Angiopteroside for HIV-1 Reverse Transcriptase and ,Lung Cancer Cell-line . J. Sci. Res. Chula. Univ., Vol. 30, No. 2.
56. Staerk, D., Larsen J., Larsen LA., Olafsdottir ES., Witt M., Jaroszewski JW. (2004). Selagoline, a new alkaloid from *Huperzia selago*. *Natural Products Research*.18(3):197-203.
57. Star, A.E., Mabry, T.J. 1971. Flavonoid Frond Exudates from 2 Jamaican Ferns-*Pityrogramma tartarea* and *Pityrogramma calmoelanos*. Phytochemistry (Oxford) 10 (11) : 2817-2818
58. Sukumaran K, Kuttan R. 1991. Screening of 11 ferns for cytotoxic and antitumor potential with special reference to *Pityrogramma calomelanos.* Journal of Ethnopharmacology. 34(1):93-6.

59. Swain, T. 1977. Secondary compounds as protective agents. Ann. Rev. Plant Physiol. 28:479–501.
60. Thews O, Gassner B, Kelleher DK, Schwerdt G, Gekle M. 2006. Impact of Extracellular Acidity on the Activity of P-glycoprotein and the Cytotoxicity of Chemotherapeutic Drugs. Neoplasia. 8(2):143-52.
61. Toji Thomas, 2011.Antibacterial Evaluation of Angiopteris Evecta (G. Forst.) Hoffm. Towards Bacteria Involved In Cutis Diseases. International Journal of Universal Pharmacy and Life Sciences 1(3): International Standard Serial Number (ISSN): 2249-6793.
62. Twentyman, P. R., Fox, N. E. and Rees, J. K., (1989) "Chemosensitivity testing of fresh leukaemia cells using the MTT colorimetric assay" Br. J. Haematol. 71, 19-24.
63. Vasudeva SM. 1999. Economic importance of Pteridophytes. Indian Fern Journal 16:130-152.
64. Wallace, R. A., Sander, G. P., and Ferl, R. J. 1991. Biology: the science of life. New York: Harper Collins, pp. 547–555.
65. Wang, T.C., Ti, M.C., Lo, S.C. and Yang, C.C. 2006. Free radical-scavenging activity of aqueous extract of *Pteris multifida* Poiret. *Fitoterapia.* 78(3):248-249.
66. Watt, G. (1972). *A Dictionary of the Economic Products of India* vols. 1–6, Cosmo Publications, Delhi, India.
67. Wilson D, Donaldson LJ, Sepai O (1998). should we be frightened of bracken? A review of the evidence. *J Epidemiol Community Health*, **52**, 812-7.
68. Woo ER, Lee JY, Cho IJ, Kim SG, Kang KW. 2005. Amentoflavone inhibits the induction of nitric oxide synthase by inhibiting NF-kappaB activation in macrophages. Pharmacology Research. 51(6):539-4
69. Wu, C. Y. 1990. A compendium of new China herbal medicine, vol. 3, Shanghai: Shanghai Science and Technology Press, p. 616.
70. Yung-Husan, C., Fang-Rong, C., Yih-Jer, L., Pei-Wen H., Ming-Jiuan, W. and Yang-Chang, W. (2008). Identification of antioxidants from rhizome of *Davallia solida*. *Food Chemistry.* 107(2):684-691.
71. Zhang Z, ElSohly HN, Jacob MR, Pasco DS, Walker LA, Clark AM. 2002. Natural products inhibiting Candida albicans secreted aspartic proteases from *Lycopodium cernuum.* Journal of Natural Products. Jul; 65(7):979-85.
72. Zhongxiang, Z., Jing, J., Jinlan, R., Chenchen, Z., Chaozhan, L., Wei, F. and Yaling, C. (2007). Antioxidant Flavonoid Glycosides from Aerial Parts of the Fern *Abacopteris penangiana, J. Nat. Prod.* 70 (10):1683– 1686.