Review Article

A Review on Some Antioxidant Plant Species Growing in North East India

Hemanta Kumar Sharma, Barnali Gogoi*, Lalit Mohan Nainwal
Department of Pharmaceutical Sciences, Dibrugarh University, Assam, India.
***Corresponding author's E-mail:** barnali.gogoi88@gmail.com

Accepted on: 10-02-2016; **Finalized on:** 29-02-2016.

ABSTRACT

The objective of the present review is to find out the antioxidant potential of some plants, traditionally used by the local people of Northeast India. An antioxidant is any substance that retards or prevents deterioration, damage or destruction caused by oxidation, responsible for cells against the effects of free radicals. Free radicals are generated through normal metabolism of drugs, environmental chemicals as well as endogenous chemicals. Cellular damage or oxidative injury arising from free radicals or reactive oxygen species is the fundamental mechanism underlying a number of human neurodegenerative disorders i.e diabetes, inflammation, viral infections, hypertension, aging, cancer, AIDS, autoimmune pathologies and digestive system disorders. This paper reviews the antioxidant potential of several important medicinal species of Northeast India. Synthetic antioxidants such as Butylated hydroxytoluene (BHT) and Butylated hydroxyl anisole (BHA) are currently used as antioxidant and many plant species have similar antioxidant potentials as these synthetic ones. Accumulated evidence suggests that reactive oxygen species can be scavenged through chemoprevention utilizing natural antioxidant compounds present in foods and medicinal plants. The literature reveals that these natural antioxidants represent a potentially side effect- free alternative to synthetic antioxidants agents.

Keywords: Antioxidant, Northeast, Pharmacological, Chemical constituents, Phenol, Flavonoids.

INTRODUCTION

The term antioxidants do not represent only one kind of compounds having similar structures but it represents a class of compounds, comprising of different chemical structures, obtained from different sources but having similar characteristic property, to get rapidly reduced or bind to free radicals or reactive oxygen species which could result the oxidation of substances[1]. Antioxidants provides a protective effect against ROS (Reactive oxygen species) such as hydrogen peroxide (H2O2), hypochlorous acid (HOCL) and free radicals, like hydroxyl radical (OH) and superoxide anion (O2 -)[2,3] , generated as byproducts of biological reactions such as the mitochondrial respiratory chain or from exogenous factors or environmental pollutants[4,5]. Antioxidants possess free radical chain reaction breaking properties, thus defend the living cells against oxidative damage[6]. Under stress, our bodies produce more free radicals or reactive oxygen species (ROS) (e.g., superoxide anion radicals, hydroxyl radicals and hydrogen peroxide) than enzymatic antioxidants (e.g., superoxide dismutase (SOD), glutathione peroxidase (GPx), and catalase) and non-enzymatic antioxidants (e.g., ascorbic acid, tocopherol, glutathione, carotenoids, and flavonoids). This imbalance leads to cell damage and health problems. A lack of antioxidants, which can quench the reactive free radicals, facilitates the development of degenerative diseases including cardiovascular diseases, cancer, neurodegenerative diseases, Alzheimer's and inflammatory diseases. One solution to this problem is to supplement the diet with antioxidant compounds that are contained in natural plant sources. Studies have shown that many phytonutrients of fruits and vegetables might protect the human body against damage by ROS. In recent years, there has been a considerable interest in finding natural antioxidants from plant materials. The antioxidant phytochemicals from plants, particularly flavonoids and other polyphenols have been reported to inhibit the propagation of free radical reactions, to protect the human body from disease[7,8] and to retard lipid oxidative rancidity[9]. In addition, the use of synthetic antioxidants has been questioned because of their toxicity[10]. Therefore, there have been numerous researches on these bio-resources to seek for potential natural and possibly economic and effective antioxidants to replace the synthetic ones for treating diseases[11-28]. Antioxidants, including phenolic and flavonoids compounds have wide ranging pharmacological effects, such as anti- inflammatory, anti-carcinogenic and anti-atherosclerotic effects[29-31]. Natural antioxidants shows a comprehensive range of biochemical activities, including inhibition of ROS generation, direct or indirect free radicals scavenging activity, and changing intracellular redox potential[32]. Among them flavonoids have attracted most of the scientists and researchers due to their powerful potent antioxidants and free radical scavenging activity. Flavonoids inhibits radical-induced lipid peroxidation, likely though their membrane-stabilizing potential[33,34]. The plant extracts possessing antioxidant activity are evaluated on the basis of their total phenols, total flavonoids , total flavonols, phenolic acids, tannins, catechins and lignans contents[35-39].

Plants selected for this study are commonly found in the North East region of India and have been used as folk

remedies by local practitioners for a variety of ailments. North-east India is a hub of many medicinal plants. Some of these plants are used not just for the treatment of specific diseases, but also for maintaining general health. There are several reports of such traditional medicinal uses of plants phytochemical screening and estimation of total phenol and flavonoid contents. These types of plants have attracted much attention of researchers for their potential antioxidant activities[40-47].

This paper reviews the antioxidant potential of extracts from the stems, roots, bark, leaves, fruits and seeds of several important medicinal species of northeast India. The literature reveals that these natural antioxidants represent a potentially side effect-free alternative to synthetic antioxidants in the food processing industry and for use in preventive medicine.

MATERIALS AND METHODS

To collect the data which support this review we performed an extensive literature survey of chemical abstract from 1917-2008. An systematic review using Sciencedirect, Scopus, Pubmed, Google and MEDLINE database is performed.

All English-language articles published between 1990 and 2015 were searched using the terms 'Medicinal plants, 'Antioxidant', 'Plant extract', 'Phenolic', 'Flavanoid'. Details regarding the antioxidant activity of different plant extracts are captured in this database. Evidence for the support of an extract was assessed from multiple studies.

Table 1: Medicinal species of Northeast India with reported antioxidant potential

S. No	Plant	Family	Parts	Antioxidant value [Me extract][48]
1	*Alocasia fornicata* (Roxb.) Schott.	Araceae	Rhizomes Aerial part	41.06 21.63
2	*Alpinia malaccensis Rosc.*	Zingiberaceae	Aerial part	5.69
3	*Alpinia officinarum Hance*	Zingiberaceae	Rhizomes Aerial part	94.02 74.97
4	*Aquillaria malaccensis* Lamk.	Thymelaeaceae	Stem Aerial part	43.30 92.03
5	*Callicarpa macrophylla* Vahl	Verbenaceae	Stem Leaves	53.65 47.20
6	*Clerodendrum indicum* (Linn.) Kuntze.	Verbenaceae	Aerial part Root	47.07 1.0
7	*Dalbergia volubilis* Roxb	Fabaceae	Stem Twig	86.44 88.93
8	*Dipterocarpus turbinatus*	Dipterocarpaceae	Stem Leaves Fruit	75.86 10.76 97.26
9	*Garuga pinnata* Roxb	Burseraceae.	Stem Leaves	87.56 65.01
10	*Hydnocarpus kurzii* (King)Warb	Flacourtiaceae	Stem Twig Fruit	45.96 53.27 47.95
11	*Melastoma malabathricum* Linn	Melastomataceae	Aerial part	36.58
12	*Murraya koenigii* (Linn.) Spreng	Rutaceae	Aerial part	41.75
13	*Phlogacanthus thyrsiflorus* Nees	Acanthaceae	Stem Twig	37.70 14.43
14	*Psidium guajava* Linn	Myrtaceae	Aerial part	67.34
15	*Saraca asoca* (Roxb.) DeWilde	Caesalpiniaceae	Stem Leaf	95.52 79.50
16	*Schima wallichii* (DC.)	Theaceae	Stem Leaf	96.46 96.72
17	*Syzygium cerasoideum* (Roxb.)	Myrtaceae	Stem Leaf	93.60 94.65
18	*Litsea glutinosa* (Lour.)	Lauraceae	Stem Twig	90.57 41.53
19	*Artocarpus chama* Buch-Ham.	Moraceae	Stem Leaf	47.70 76.94

Me extract-Methanol extract

Table 2: Medicinal plant species of Northeast India with reported Flavonoid and Phenolic content

S. No	Plant	Family	Phenolic content	Flavonoid content
1	*Polygonum microcephalum* (Leaf)	Polygonaceae	19.0 [Et -H_2O ext][49]	39.6[Et -H_2O ext] [49]
2	*Moringa oleifera* Lamk. (Leaf)	Moringaceae	13.4 [Et -H_2O ext][49]	37.0 [Et -H_2O ext] [49]
3	*Croton tiglium* Linn. (Leaf)	Euphorbiaceae	7.48 [Et -H_2O ext][49]	26.6 [Et -H_2O ext] [49]
4	*Gomphrena globosa*(Leaf)	Amaranthaceae	3.6[Et -H_2O ext][49]	17.2[Et -H_2O ext] [49]
5	*Zanthoxylum armatum*(Fruit)	Rutaceae	59.34±0.13 [Me ext][50]	-
	Artocarpus gomeziana(Fruit)	Moraceae	96.19±1.18[Me ext][50]	
6	*Osbeckia chinensis*(Fruit)	Melastomataceae	12.74 ± 0.35[Me ext][50]	-
	Gymnopetalum cochinensis Lour. (Fruit)	Cucurbitaceae	13.84±0.31[Me ext][50]	-
7	*Baccaurea sapida*(Fruit)	Euphorbiaceae	21.14±0.23 [Me ext][50]	-
8	*Smilax perfoliata* Lour(Leaf)	Smilacaceae	13.8± 0.09 [M.E ext][51] 3.5±0.05 [E.E ext][51]	15.6± 0.24 [M.E][51] 2.5±0.12 [E.E ext][51]
9	*Gynocardia odorata* (Seeds)	Flacourtiaceae	3.31±0.10[Aq Me ext][52] 4.43±0.36[Acetone ext][52]	-
10	*Gentiana pedicellata* (Leaf)	Moraceae	9.33 ± 0.15[Aq Me ext][52] 2.61±0.13[Acetone ext][52]	-
11	*Ficus pomifera* (Leaf)	Moraceae	9.33 ± 0.15[Aq Me ext][52] 2.61 ±0.13[Acetone ext][52]	-
12	*Ficus geniculata* (Leaf)	Moraceae	9.33± 0.15 [Aq Me ext][52] 2.61± 0.13[Acetone ext][52]	-
13	*Ficus clavata* (Leaf)	Moraceae	14.47±0.32[Aq Me ext][52] 5.23 ±0.53[Acetone ext][52]	-
14	*Fagopyrum cymosum* (Leaf)	Polygonaceae	9.22 ± 0.08[Aq Me ext][52] 6.85 ± 0.13 [EA ext][52]	-
15	*Bauhinia purpurea*	Leguminosae	27.67±0.16 [M.E ext][52] 3.47 ±0.48[Acetone ext][52]	-
16	*Dillenia pentagyna* (Flower)	Dilleniaceae	9.33±0.15[Aq Me ext][52] 2.61±0.13[Acetone ext][52]	-

Et -H_2O –Ethanol water extract, E.E-Ethyl acetate extract, Aq Me-Aqueous methanol extract

Table 3: Chemical constituents of plant species

S. No	Plant	Chemical constituents
1	*Alocasia fornicata*	Leaves contain triglochinin, tubers contain sterols-campesterol, cholesterol, beta-sitosterol, trypsin/chymotrypsin inhibitors[53]
2	*Alpinia malaccensis*	Essential oil from rhizome consists of methyl cinnamate[53]
3	*Alpinia officinarum*	Rhizomes contain gingerols and diaryheptanoids.[53]
4	*Aquillaria malaccensis*	Essential oil contains argofurans, gmelofuran agarol, coumarin olignanquillochin, spirosesquiterpene alcohols.[53]
5	*Callicarpa macrophylla* Vahl	Leaves and seeds contain calliterpenone, betasitosterol.[53]
6	*Clerodendrum indicum*	*β*-sitosterol, *γ*-sitosterol octacosanol.[53]
7	*Dalbergia volubilis*	Stem and leaves contain dalbergio, tectorigenin, friedelin, flavonoid glycosides[53]
8	*Dipterocarpus turbinatus*	Humulene, beta-caryophyllene, tannins.[53]
9	*Garuga pinnata*	Leaves and stem bark contain sterols, sitosterol, stigmasterol, campesterol. Gum-resin contains alpha-amyrin, butyrospermol and dammarandiol[53]
10	*Hydnocarpus kurzii*	Oil consists glycerides of cyclopentenyl fatty acids like hydnocarpic acid (48%), chaulmoogric acid (27%), gorlic acid (23%), oleic acid (12%) and palmitic acid (6%). Tannins are present in bark[53]
11	*Melastoma malabathricum*	Leaves contains beta-sitosterol and a triterpene, melastomic acid[53]

12	*Murraya koenigii*	All parts of plant gives carbazole alkaloids.[53]
13	*Phlogacanthus thyrsiflorus* Nees	Leaves contains diterpene lactone, phlogantholide A and its glucoside[53]
14	*Psidium guajava*	Quercetin, beta-sitosterol, pentacyclictriterpenoid, guajanoic acid, uvaol, oleanolic acid and ursolic acid.[53]
15	*Saraca asoca*	Flowers contain gallic acid; apigenin-7-O-beta- D-glucoside, cyanidin-3, pelargonidin-3, 5-diglucoside, quercetin. Barh contains *n*-octacosanol, leucocyanidin, catechin(+)-catechol, (–)-epicatechin, leucopelargonidin, procyanidin derivatives.[53]
16	*Schima wallichii*	Stem bark contains octacosanol, phytol, alpha-spinasterol and a saponin, schiwallin.[53]
17	*Syzygium cerasoideum*	Bark contains bergenin, myricyl alcohol, friedelan-3- alpha-ol, friedelin and betulinic acid, kaempferol, quercetin, betulinic acid and crategolic (maslinic) acid.[53]
18	*Litsea glutinosa*	Leaves and seeds contain pyrrolizidine alkaloids, caffeic, chlorogenic, rosmarinic acid as well as luteolin-7 beta-glucuronide, lithospermic acid and shikonin, acetyl-shikonin[53]
19	*Artocarpus chama*	Two new stilbenes with two isoprenoid groups, *E* and *Z*-4-[2-(7-methoxy-2, 2-dimethyl-6-(3-methylbut-2-enyl)-2*H*-1-benzopyran-5-yl) vinyl] benzene-1, 2-diol[53]
20	*Moringa oleifera*	Leaves contain nitrile glycosides, niazirin, niazirinin, mustard oil glycosides, spirochin and pterygospermin[53]
21	*Croton tiglium*	Seeds contain diterpene esters of the tigliane type (phorbol esters)[53]
22	*Zanthoxylum armatum*	Essential oil contains mono and sesquiterpenes, nerol acetate, beta- famesene, germacrene D, trans-nerolidol, 2-furanmetahnol, 3-Nonanol,6,7-dipoxy-3,7-dimethyle acetate. Seeds consists of Zanthoxylum flavone xyloside, Methoxysalicylic acid, Hydroxyanthraquinone, Diphenyl alatumoic dimethyl ester.[53]
23	*Osbeckia chinensis*	2-Furoic acid, succinic acid, ursolic acid, quercetin and daucosterol[53]
24	*Smilax perfoliata*	1,6-O-diferuloyl-(3-O-p-coumaroyl)-b-D-fructofuranosyl-2-O-acetyl-a-D-, gluco pyranoside rutin, narcissin, cassiamin A, cassiamin B and 1, 2, 3-trimethoxy-5-hydroxyphenol-1-O-b-D-glucopyranoside[53]
25	*Gynocardia odorata*	Oil from seeds contains a triterpenoid ketolactone, odolactone[53].
26	*Gentiana pedicellata*	Three new 6-aryl-2-pyrones pedicellin, pedicellanin, pedicellatin, triterpene, secoiridoid[53], carotenoids.
27	*Fagopyrum cymosum*	Benzoic acid, beta-sitosterol, 5, 5'-di-alpha-furaldehyde dimethyl ether, p-hydroxybenzoic acid, rutin, quercetin, daucosterol, succinic acid[53].
28	*Dillenia pentagyna*	Stems are found to contain naringenin-41-O-b-D-xylopyranoside, flavonoid glycosides, naringenin 7-galactosyl glucoside and dihydroquercetin 5-galactoside along with rhamnetin-3-glucoside, diterpene namely dipoloic acid, betulin, betulinic acid and β-sitosterol[53].
29	*Bauhinia purpurea*	Flowers contain astragalin, isoquercitrin and quercetin, also anthocyanins. Seeds contain chalcone glycosides[53].

CONCLUSION

Medicinal plants have great antioxidant potential due to the presence of phytochemical constituents. All plants discussed in this review exhibit pharmacological activities which are correlated to the present of antioxidant compounds in these plants. This review discussed medicinally significant plant species of North east India and showed that many have high antioxidant activity when compared to synthetic antioxidants. In addition, many of these species have a high phenolic content and a large amount of flavanoids and flavonols. The authors have tried to present the role of native herbs and the active principles present in many plants that can be explored as therapeutic agents in chronic diseased conditions. The work gives sufficient information for the clinicians as well as the researchers to exploit the naturally available antioxidants as therapeutic drugs for cure of untreated diseases like Alzheimer, cancer, parkinsons, diabetes etc. However further *in vivo* studies of these species are required, and a systematic investigation of these antioxidant rich species is needed before they can be used in the food processing industry and as preventive medicines.

REFERENCES

1. Shyma TB, Deviprasad AG, Raghavendra MP, "Assessment of antioxidant activity, total Phenolic content of some medicinal plants used by tribes in Wayanad, Kerela". *Journal of Chemical and Pharmaceutical Research*, vol. 4, no. 10, 2012, 4501-4505.
2. Krinsky N.I. "Mechanism of action biological antioxidants", *Proceedings of the Society for Experimental Biology.* vol. 200, no. 2, 1992, 248–254.
3. Ghimire BK, Seong ES, Kim EH, Ghimeray AK, Yu CY, Ghimire BK, Chung IM. "A comparative evaluation of the antioxidant activity of some medicinal plants popularly

used in Nepal.", J. *Med. Plants Res*, vol. 5, no. 10, 2011, 1884-1891.

4. Halliwell B, Gutteridge JMC. Free radical in biology and medicine. Chapter 3. 3rd ed, London: Oxford University Press, 1998.
5. Smith CM, Marks AD & Lieberman MA. Oxygen toxicity and free radical injury. In: Marks Basic Medical Biochemistry: A clinical approach, 2nd edition. Lippincott: Williams & Wilkins press, 2005, 439-447.
6. Ningombam S, Nahakpam L, Laitnjam W S, Singh C B. "Antioxidant activities of the rhizomes of different Zingiberaceae plants of north-east India", *Asian journal of biological and life sciences*, vol-2, no 1, 2013.
7. Kinsella J. E., Frankel E., German B., Kanner J., "Possible mechanisms for the protective role of antioxidants in wine and plant foods.", *Food Technology*. vol.47, 1993, 85–89.
8. Terao J., Piskula M.K., "Flavonoids as inhibitors of lipid peroxidation in membranes.", *Flavonoids in health and disease*., Marcel Dekker, New York., 1997.
9. Duthie G.G., "Lipid peroxidation.", *European Journal of Clinical Nutrition*, vol.47, no 11, 1993, 759–764.
10. Valentao P., Fernandes E., Carvalho F., Andrade P.B., Seabra R.M., Bastos M. "Antioxidative properties of cardoon (*Cynara cardunculus* L.) infusion against superoxide radical, hydroxyl radical and hypochlorous acid., *Journal of Agricultural and Food Chemistry*, vol 50, 2002, 4989–4993.
11. Aruoma O.L, Free radicals, oxidative stress and antioxidants in human health and disease. "*Journal of American oil Chemist".* vol. 75, 1998, 199–212.
12. Lefer D. J and Granger D.N. "Oxidative stress and cardiac disease. *American Journal of Medicine"*, vol 109, 2000, 315–323.
13. Smith M.A, Rottkamp C.A, Nunomura A, Raina A.K and Perry G. "Oxidative stress in Alzheimer's disease". *Biochem Biophys Acta*, vol 1502, 2000, 139–144.
14. Bhatia S, Shukla R, Madhu S.V, Gambhir J.K and Prabhu K.M. "Antioxidant status, lipid peroxidation and NO end products in patients of type 2 diabetes mellitus with nephropathy". *Clin Biochem*, vol. 36, 2003, 557–562.
15. Peuchant E,Brun J, Rigalleau V, Dubourg L, Thomas M and Daniel J. Oxidative and antioxidative status in pregnant women with either gestational or type 1 Diabetes". *Clin Biochem.*, vol. 37, 2004, 293-298.
16. Steer P., Milligard J., Sarabi D.M., Wessby B. and Kahan T. "Cardiac and vascular structure and function are related to lipid peroxidation and metabolism". *Lipids*, vol. 37, 2002, 231–236.
17. Uchida K. "Role of reactive aldehyde in cardiovascular diseases". *Free Radical Biol Med.*, vol. 28, 2000, 1685–1696.
18. Shahidi F., Janitha P.K. and Wanasundara P.D. "Phenolic antioxidants". *Critical reviews in food science and nutrition.*vol 32, 1992, 67–103.
19. Gerber, M., Boutron-Ruault M.C., Hercberg S., Riboli E., Scalbert A. and Siess M.H. "Food and Cancer: state of the art about the protective effect of fruits and vegetables", *Bull Cancer*, vol.89, 2002, 293–312.
20. Di Matteo V. and Esposito E. "Biochemical and therapeutic effects of antioxidants in the treatment of Alzheimer's disease, Parkinson's disease, and amyotrophic lateral sclerosis". *Curr Drug Targets CNS Neurol Disord*., vol 2, 2003, 95–107.
21. Sreejayan N. and Rao M. "Free radical scavenging activity of *Curcuminoids"*. Drug Res. 46, 1996, 169–171.
22. Uddin SN, Eunus Ali ME, Yesmin MN. "Antioxidant and antibacterial activities of *Senna tora* Roxb. *Am. J. Plant Physiol*".3, 2008, 96-100.
23. Wagner H., Fransworth, N.R., Economic and Medicinal Plant Research. Academic Press Limited, London, 1994, 82, 83, 92, 93.
24. Grice H.P. "Enhanced tumour development by butylated hydroxyanisole (BHA) from the prospective of effect on fore stomach and oesophageal squamous epithelium". *Food Chemical Toxicology*. vol. 26, 1988, 717–723.
25. Nahak G, Sahu RK. "*In vitro* antioxidative acitivity of *Azadirachta Indica* and *Melia azedarach* Leaves by DPPH scavenging assay". *Journal of American Science*., vol. 6, no.-6, 2010, 123-128.
26. Sies, H. "Strategies of antioxidant defense". *European J Biochemistry*, vol. 215, 1993, 213–219.
27. Devasagayam TPA, Tilak JC, Boloor KK. "Review: Free radicals and antioxidants in human health". *Current Status and Future Prospects*. JAPI, vol. 52, 2004, 794-804.
28. Rahimi R, Nifkar S, Larijani B, Abdollahi M. "A review on the role of antioxidants in the management of diabetes and its complications". *Biomed Pharmacotherapy,* vol.59, 2005, 365-373.
29. Chung K.T., Wong T.Y., Huang Y.W. and Lin Y. "Tannins and human health: A review". *Critical Review Food Science Nutrition*. 38, 1998, 421–464.
30. C. Rice-Evans, L. Packer (Eds.), Flavonoids in Health and Disease, second ed. Marcel Dekker Inc., New York/Basel, 2003.
31. G. Rusak, H.O. Gutzeit, J. Ludwig-Muller, *Nutr. Res*. Vol. 25, 2005, 141–153.
32. Abdollahi M, Larijani B, Rahimi R, Salari P. "Role of oxidative stress in osteoporosis", Therapy, vol 2, 2005, 787-796.
33. J. Kinjo, M. Hitoshi and R. Tsuchihashi, "Hepatoprotective constituents in plants: protective effects of natural occurring flavonoids and miscellaneous phenolic compounds as determined in a HepG2 cell cytotoxicity assay", *Journal of Natural Medicines*, vol. 60, 2006, 36-41.
34. L. C. Wilms, J. C. K leinjans, E. J. Moonen and J. J. Briedé, "Discriminative protection against hydroxyl and superoxide anion radicals by quercetin in human leucocytes *in-vitro* ", *Toxicology*, vol. 22, 2007, 301-307.
35. Cai Y., Luo Q., Sun M. and Corke H., "Antioxidant activity and phenolic compounds of 112 traditional Chinese medicinal plants associated with anticancer", *Life Sci*., 74, 2004, 2157–2184.

36. Djeridane A, Yousfi M, Nadjemi B, Boutassouna D, Stocker P. and Vidal N. Antioxidant activity of some Algerian medicinal plants extracts containing phenolic compounds. *Food Chem.* 97(4), 2006, 654–660.

37. Pietta P G. "Flavonoids as antioxidants*", Journal Natural Product*. vol 63, 2000, 1035-104.

38. Brighente IMC, Dias M, Verdi LG, Pizzolatti MG. "Antioxidant activity and total phenolic content of some Brazilian species". Pharmaceutical Biology, vol. 45, 2007, 156-161.

39. Dapkevicius A, Venskutonis R, Beek TA, Linssen PH. "Antioxidant activity of extracts obtained by different isolation procedures from some aromatic herbs grown in Lithuania". *J Sci Food Agric, vol*. 77, 1998, 140-146.

40. Rupanjali Sharma, HK Sharma. "Ethnomedicines of Sonapur, Kamrup District", Assam, *Indian J Trad Knowledge*, vol. 9, no 1, 163-165.

41. BK. Acharyya, HK. Sharma "Folklore medicinal plants of Mahmora area, Sivasagar district, Assam", *Indian J Traditional Knowledge* , vol.3, no 2, 2004, 365-372.

42. H.K Sharma, Lalrampare. Chhangte. & Dolui, A. "Traditional medicinal plants in Mizoram, India", *Fitoterapia,* vol.72, no 2, 2001, 146-161.

43. Jamir TT, HK Sharma, Dolui A. "Folklore medicinal plants of Nagaland, India", *Fitoterapia*, vol. 70, no 4, 1999, 395-401.

44. H.K. Sharma, Lalrampare. Chhangte & Dolui, A. (1999), 'Phytochemical Screening of somemedicinal plant samples from Mizoram, India', *Res. J. Chem. Environ.* 3(2), 77-79.

45. Paranjoli Boruah and H.K Sharma, "Phytochemical Screening, Evaluation of Membrane Stabilizing and Antibacterial Activity of the Leaves of *Cephalandra Indica* Naudin Collected from Dibrugarh District", Assam, India, *RJPBCS,* vol 5, no 2, 2014, 349-354.

46. H.K. Sharma, Sushma Mishra & A. Kumar, 'Evaluation of *in vitro* Antioxidant Activity of the Methanolic Extract of the Leaves of Mikania micrantha Kunth', *Asian J. Chem.* Vol 23, no 10, 2011, 4525-4527.

47. H.K. Sharma, A. Kumar. "Evaluation of Total Phenol, Flavonoid and *in vitro* Antioxidant Activity of Methanolic Extract of Leaves of Melastoma malabathricum, Linn.", *Asian J. Chem.* Vol 23, no 1, 2011, 434-438.

48. Kshirsagar, Rajendra Upadhyay, Shakti. Free radical scavanging activity of medicinal plant of Tripura, North East India, *Natural Product Radiance*, Vol. 8(2), 2009, 117-122.

49. Saikia L.R. and Upadhyaya S. "Antioxidant activity, phenol and flavonoid content of some less known medicinal plants of Assam". *International Journal of Pharma and Bio Sciences*, vol 2, no 2, 2011, 383-388.

50. Tapan Seal, Kaushik Chaudhuri and Basundhara Pillai. Antioxidant Activity of Some Selected Wild Edible Fruits of North-Eastern Region in India and Effect of Solvent Extraction System. Global Journal of Environmental Research, 6(3), 2012, 84-90.

51. H.K. Sharma and Munmi Kalita. "Phytochemical Screening, Estimation of Total Phenol and Flavonoid Content of the Leaves of *Smilax perfoliata* Lour. collected from Dibrugarh, Assam", *RJPBCS*, vol 5, no 4, 2014, 1156-1160.

52. Seal T. Antioxidant activity of some wild edible plants of Meghalaya state of India. "A comparison using two solvent extraction systems". *International Journal of Nutrition and Metabolism*, vol4, no 3, 2012, 51-56.

53. Khare CP. Indian Medicinal Plants: An Illustrated Dictionary, USA. Springer Science+ Business Media; 2007.

Source of Support: Nil, **Conflict of Interest:** None.